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Chasing after the True Score in Multiple Choice Tests

Ali BAYKAL[1]

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Abstract

Multiple-choice tests are widely used in educational assessment for so many reasons. One challenge that arises is the influence of chance success, where students may get the right responses by mere guessing rather than by their acquisitions or aptitudes. To address this, the traditional scoring convention penalizes guessing by employing the formula for guessing, expressed as Right Answers–(Wrong Answers/(Number of options–1)). The reason for this penalty is that everybody guesses that all incorrect responses are because of mere guessing not because of inadequate aptitude or acquisition. This study proposes a complementary strategy that rewards students for leaving answers blank if they are unsure and deducting points for wrong responses. A data matrix was manufactured that rewarded 12100 virtual participants who left answers blank when they were not sure in the scoring of multiple-choice tests. the number of blank answers (B) and the number of options per item (a) were selected as criteria in parallel with the amount of the reward and the penalty. In short, it was envisaged to add points in the amount of "B/a" for each item left blank. In this simulated data matrix, the derivative scores that will reveal the true score desired to be reached were calculated for all virtual participants. The Pearson correlational coefficients imply that "rewarded score" is not more inferential than the "penalized score", but the "merit score" calculated by using the "reward" and "penalty" together is more prophetic to discover the utopic true score than the other scoring formulas. Additionally, a grading proposal was developed under the assumption that the score achieved by leaving all items unanswered, denoted as (K/a), would not suffice to indicate success.

Introduction

Multiple-choice (MC) tests are ever-present in educational assessment due to their fairness, efficiency, and comfort of scoring. Their appeal is especially strong in large-scale testing where objectivity and logistical feasibility matter. Yet the format has a well-known vulnerability: chance success. When students guess, they may earn points that do not reflect their knowledge or ability. This introduces measurement error and threatens the validity of inferences drawn from test scores—particularly construct validity (are we measuring the intended construct?) and predictive validity (do scores predict future performance?) (Atalmış & Kingstone, 2017; Baykal, 2005; Thorndike, 1988; Turgut, 1971; Guilford, 1954). A conventional response to chance success has been to penalize wrong answers. The logic is straightforward: if students guess randomly among (a) options, the expected gain from correct guesses is offset by points deducted for incorrect guesses, yielding an expected net of zero. This correction-for-guessing formula is expressed as: *Adjusted Score = (Right Responses – Wrong Responses) / (a-1)*. Despite its smartness, this practice rests on a chain of assumptions about student behavior and item characteristics -assumptions that are often untenable in real test settings. This study examines the premises behind penalty schemes, the empirical patterns of students responding, and the statistical and behavioral consequences of an alternative policy: rewarding blank answers rather than penalizing wrong ones.

This study investigates the relationships among several test scoring variants -raw scores, chance-corrected (penalized) scores, blank-rewarded scores, and an integrated merit score- using a simulated dataset. The central criterion is a latent true score that, by design, cannot be directly observed but can be statistically inferred. The objective is twofold: to quantify how well different scoring rules recover the true score under controlled stochastic assumptions, and to evaluate the conceptual trade-offs among fairness, anxiety-reduction, honesty-reward, and measurement accuracy.

The study employs large-scale Monte Carlo–like data manufactured by simple uniform randomization. The approach enables isolation of scoring rule properties from the complexities of real-world test-taking behavior while maintaining transparent assumptions and reproducibility.

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Problem

The primary assumption is that when students do not know the answer to a choice type of test question, they perceive all distractors as equally plausible and choose randomly. Students rarely guess uniformly. In fact, partial knowledge, test-wise strategies, and elimination heuristics produce non-uniform guessing (Thorndike, 1971). Distractors vary in plausibility and attractiveness; they are not equally likely to be chosen. Difficult items can still have one or two "implausible" distractors that informed, or even semi-informed students can rule out. Consequently, the expected value of a guess depends on the student's partial knowledge and the item's distractor quality, not simply the nominal number of options.

The second assumption is that wrong answers reflect guessing, not misconceptions. This assertion claims that wrong answers result primarily from guessing, not from persistent misconceptions or partial but systematically incorrect knowledge. Many wrong answers arise from stable misconceptions, misapplied heuristics, or computational slips. These are not random events and may even be diagnostic of underlying constructs (Baykal, 2005). Treating all wrong answers as guesses collapses meaningful cognitive distinctions into a single "error" category, undermining construct validity.

Third wishful assumption is that penalty discourages guessing. Penalizing wrong answers prevents random guessing and promotes answering only when reasonably certain. Empirical evidence suggests many examinees still attempt uncertain items rather than leave them blank (Zimmerman & Williams, 2003; Turgut, 1975). Item analyses routinely find that wrong responses exceed blanks (Karadağ, 2021; Kevser & Türkan, 2023), indicating penalties do not reliably deter attempts.

An obvious statistical but unreasonable consequence is that correction for chance may end up with negative scores and hence negative aptitude or negative achievement. The penalty formula implies that when wrong answers exceed the adjusted score becomes negative. The notion of "negative ability/success" is conceptually problematic and psychometrically awkward (Baykal, 2005). Negative scores can easily be transformed by adding a constant number without changing the rankings of participants, but their interpretation will be opaque for stakeholders and can distort perceptions of student performance.

Penalizing wrong answers actually reduces chance score inflation. Penalty lowers the expected value of random guessing to near zero. It introduces strategic tradeoff: Students must weigh the expected value of guessing (which may be positive with partial knowledge) against the risk of deduction. Response patterns will be altered by penalizing for guessing. Students who hesitate taking risks are most likely to skip items even when their probability of success exceeds the penalty threshold. This will end up with the underestimation of their ability.

Penalty intensifies inequities: Students with similar knowledge but different risk preferences or test-wise strategies may end up with different scores, weakening construct validity. Chance correction complicates interpretation: Stakeholders must understand the correction scheme to interpret scores meaningfully; otherwise, transparency and fairness perceptions suffer.

There are also some empirical facts challenging penalty justification: Attractiveness of distractors are not uniform. Distractors vary in plausibility, often unevenly across subpopulations (e.g., language background, prior coursework), producing systematic, not random errors. Partial knowledge is common: Students can often eliminate one or more options. Under elimination, the expected value of a guess can be positive even with penalties.

Reactive response behavior tends to emerge under stress: Time pressure, anxiety, and fatigue push students to attempt items rather than leave blanks, reducing the deterrent effect of penalties (Kevser & Türkan, 2023). Across many item analyses, wrong responses outnumber blanks, consistent with the claim that penalties do not fully suppress attempts.

The proposal of this study is to reward blank responses while penalizing wrong answers.

The provocative question is: What happens if, instead of penalizing wrong answers, we reward blank responses? Conceptually, such a policy flips the incentive structure: rather than punishing risk-taking, it compensates for restraint when knowledge is absent or uncertain.

There are psychometric and behavioral effects of rewarding blank responses. It increases the construct validity: Potential improvement if rewarding blanks reduces random guessing and shifts observed scores toward knowledge-based responding. However, if rewards discourage risk-taking even when partial knowledge justifies an attempt, scores may underestimate competence. Rewarding blank responses predictive validity that could improve if the score better reflects stable knowledge rather than guessing noise (Karadağ, 2021). There could also be a negative effect on predictive validity if it selectively penalizes strategic risk-taking that correlates with success in future settings requiring decision-making under uncertainty.

Reliability of measurement can also be influenced positively by rewarding blank responses due to reducing random guessing that can increase internal consistency by lowering item-level error variance. But of course, excessive blanking reduces the number of informative responses, potentially lowering reliability (Thorndike, 1988). The net effect depends on the balance between less noise and fewer observations per person.

Rewarding blanks inflates baseline scores for low-knowledge examinees who skip frequently, compressing the lower tail and possibly reducing discrimination among low performers. High-ability examinees are less affected, which can alter item-total correlations if low performers skip more than they answer. This ends up with missing data (Demir ve Özbaşı, 2013). Students with high risk aversion may benefit disproportionately, potentially widening gaps unrelated to knowledge. An examinee might strategically skip long, complex items because of low expectations. This is not inherently problematic since it aligns incentives with metacognitive awareness, but extreme rewards could incentivize over-skipping.

Differences in metacognitive calibration (knowing what we don't know) can create systematic advantages. Students from well-resourced contexts may have better calibration training.

Rewarding blanks are likely to reduce attempts on difficult items, lowering correct counts and increasing apparent difficulty.

If high-ability students are better at recognizing when not to guess, discrimination could paradoxically improve (stronger differentiation on items where low-ability students skip). Alternatively, if high majority of low-ability students tend to skip, discrimination may drop.

Data and Method

This is a simulation study. In this study, virtual data was manufactured by using the following parameters:

- K = 120: Total number of items in the test.
- a = 5: Number of options per item (implied by the chance correction denominator (a-1)); each item is multiple-choice with one correct key and (a-1) distractors.
- m = 0: Minimum possible raw score.
- M = K: Maximum possible raw score.
- N = 12100: Number of participants (approximately 100 participants per possible raw score between 0 and K).
- T: True score, randomly assigned per participant between 0 and K.
- W: Observed wrong responses (W=Z+C)
- B: Number of responses left blank by choice, randomly assigned between [0, (K-T-W)].
- Z: Number of really wrong responses (intentional attempts resulting in incorrect answers), randomly assigned between [0, (K-T)].
- G: Number of responses guessed, randomly assigned between [0, (K-T-W-B)].
- C: Number of hits by guessing, randomly assigned between ([0, G]). This overestimates the expected chance score, creating a favorable bias for guessing in the simulation.
- F = G - C: Number of failed guesses.
- X = T + C: Observed raw score.
- P = X – [(W + F)/(a - 1)]: Penalized (conventional chance-correction) score.
- R = T + (B/a): Rewarded-for-blank score.

- V = T + (B/a) – [(W + F)/(a - 1)]: Merit Score integrating rewards for blanks and penalties for wrong choices and failed guesses.

All random values were produced in MS Excel using =RANDBETWEEN(lower, upper) function which produces outcomes approximately uniformly across the specified integer range.

T functions as the latent criterion ability unobservable in practice but known in simulation.

X, **P**, **R**, and **V** are predictors intended to recover (T) under different behavioral regimes:

- **X** increases with correct knowledge and successful guesses.
- P corrects for expected chance performance by penalizing wrong answers and failed guesses.
- **R** rewards blank responses to acknowledge honesty and reduce anxiety-driven guessing.
- **V** integrates both reward and penalty, balancing honesty reinforcement with psychometric correction.

Each participant's response allocation satisfies [T + W + B + G = K]. This guarantees that every item is classified as either known-correct (T), intentionally wrong (W), left blank (B), or guessed (G).

Simulation Properties and Implications

Randomization Choices and Biases

- Uniform assignment of (T) ensures coverage of the full ability spectrum.
- Independent uniform assignment of (W), (B), and (G) conditional on remaining items produces heterogeneous response portfolios.
- Overestimation of guessing success increases variance and arithmetic mean of (X), making the raw score comparatively more favorable to guessers.
- Because all predictors include (T) additively high positive autocorrelations with (T) are structurally expected; thus, comparative inference rests more on differences in statistical significance and stability than on raw magnitude.

Expected Correlation Patterns

Let Corr denote Pearson correlation with (T).

- Corr(X, T) > 0: inflated by (H); the extra noise from guessing reduces correlation relative to a purely deterministic mapping from (T).
- Corr(P, T) ≥ Corr((X, T)) under random or overestimated guessing: penalty reduces guessing-related variance, improving alignment with (T), especially for low-(T) examinees who guess more.
- Corr(R, T) > 0: depends on the relationship between (B) and (T). If higher-(T) examinees leave fewer blanks, rewarding blanks may introduce negative association with (T) on the (B/a) component; however, in this simulation (B) is independent of (T) conditional on the remaining pool, so the expectation preserves positive correlation largely via the (T) term.
- Corr(V, T) is expected to be among the highest: it inherits the stabilization of (P) and the additive constant from blanks, provided that blank reward does not exceed the expected value of a guess.

Anticipated results are as follows:

- Penalization enhances alignment with (T) by filtering guessing noise, particularly impactful at low and mid ability levels.

- High positive correlations across all predictors with (T), with the ordering typically: Corr(V, T), Corr(P, T), Corr(X, T)), and Corr(R, T) depending on the (B)-(T) relationship but still high due to the additive (T) component.

- Rewarding blanks reduces the incentive to random guess, potentially improving measurement fidelity and reducing anxiety, provided the reward is calibrated conservatively.

- Merit score (V) embodies a pragmatic compromise: it respects honesty (B/a) without allowing it to overshadow competence -(W+F)/(a-1).

- Reporting must include both raw and merit scores to enhance transparency.

- Examinees must be trained in scoring rules to foster informed strategies aligned with valid measurement.

Limitations

- The simulation's assumption of uniform random allocations for W, B, G, and the overestimated H simplifies behavior but may not reflect realistic strategies or knowledge states.

- Correlation comparisons are partially auto correlated because T is embedded additively in all predictors, inflating association.

- The Excel RANDBETWEEN function produces discrete uniform integers; finer-grained or dependent structures (e.g., multinomial item-level modeling, IRT) would yield more nuanced insights.

Result

Table 1 illustrates a segment of the virtual data matrix.[2]

Table 1.

A Sample Segment from the Simulated Data

Participants	**T**	**O**	**B**	**W**	**Z**	**C**	**X**	**R**	**P**	**RO**	**C**	**P**	**SC**
i00001	14	106	25	81	74	7	21	5,0	20,3	26	1	39	19
i00002	98	22	12	10	6	4	102	2,4	2,5	104	100	103	15
i00003	66	54	29	25	23	2	68	5,8	6,3	74	62	78	19
i00004	81	39	21	18	9	9	90	4,2	4,5	94	86	90	23
i00005	44	76	75	1	0	1	45	15,0	0,3	60	45	59	19
…	…	…	…	…	…	…	…	…	…	…	…	…	…
i12096	71	49	18	31	12	19	90	3,6	7,8	94	82	82	24
i12097	52	68	52	16	7	9	61	10,4	4,0	71	57	66	26

[2] The complete data is available in ResearchGate. Anyone interested can download the simulated data and monitor some parameters. Link is given among the References (Baykal, 2025).

i12098	37	83	9	74	47	27	64	1,8	18,5	66	46	57	18
i12099	72	48	21	27	4	23	95	4,2	6,8	99	88	83	35
i12100	2	118	86	32	17	15	17	17,2	8,0	34	9	27	34

Symbols in Column Headings and Their Definitions

True Score	T	The actual score intended to be measured (randomly calculated with equal probability between 0 and K)
Misses & Blanks	O	Responses other than the Actual Score, including blank and incorrect answers, have been calculated randomly with equal probability within the range of 0 to (K-G).
Blanks	B	The number of items left blank because the participant did not know, skipped without answering, or was unable to access (randomly determined between 0 and H).
Observed Misses	W	Due to insufficient information or inaccurate predictions, all INCORRECT responses that are inconsistent with the key have been randomly determined between 0 and B.
Real Wrong	Z	Inconsistent predictions are not due to lack of capability or skill, but rather assumed incorrect responses caused by insufficient information (randomly determined between 0 and Y).
Real Hits	C	The number of responses the participant can accurately guess (randomly determined with equal probability between Y and Z)
Raw Sores	X	T+C
Reward	R	The number of responses that could have been correctly guessed if they weren't left blank [B/a]
Penalty	P	The number of responses claimed to have been guessed correctly by the participant purely by chance [W/(a-1)]
Rewarded Only	R	X+R
Penalized Only	C	X-P
Reward + Penalty	P	T+R+P
Sheer and Mere Chance	SMC	Based on the values of K and a, entirely chance-based success scores determined with equal probability between "m" and "M".

Table 2 displays a particular finding for K=120 and a=5.

Table 2

Correlations between True Scores Assumed and its Estimators: K=120, a=5

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,862402406
Rewarded Score (XRO=Raw + Reward)	0,865442052
Penalized Score (XC=Raw - Penalty)	0,923100579
Merit Score (XRP=Raw + Reward - Penalty)	0,999292970
Sheer and mere chance scores (SMC)	-0,005252381

Merit Score is the best estimator for the given parameters in this case.

Table 3 displays a particular finding for K=120 and a=4.

Table 3

Correlations between True Scores Assumed and its Estimators: K=120, a=4

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,856871811
Rewarded Score (XRO=Raw + Reward)	0,858113530
Penalized Score (XC=Raw - Penalty)	0,931398900
Merit Score (XRP=Raw + Reward - Penalty)	0,997636071
Sheer and mere chance scores (SMC)	-0,017569906

Again, Merit Score is the best estimator of True Score that we are after.

Table 4 displays a particular finding for K=120 and a=3.

Table 4

Correlations between True Scores Assumed and their Estimators: K=120, a=3

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,856353634
Rewarded Score (XRO=Raw + Reward)	0,851529011
Penalized Score (XC=Raw - Penalty)	0,944917667
Merit Score (XRP=Raw + Reward - Penalty)	0,986428205
Sheer and mere chance scores (SMC)	-0,005252709

While the predictive power of Merit Points has decreased slightly, Merit Points are still the best. Penalized points appear to be superior to points awarded for missing points.

Table 5 displays a particular finding for K=120 and a=2.

Table 5

Correlations between True Scores Assumed and their Estimators: K=120, a=2

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,861717968
Rewarded Score (XRO=Raw + Reward)	0,831584340
Penalized Score (XC=Raw - Penalty)	0,942677704
Merit Score (XRP=Raw + Reward - Penalty)	0,653444559
Sheer and mere chance scores (SMC)	-0,002219328

It should be noted that a=2 corresponds to T/F items. In this case penalty is the best

correction option. Reward for blanks is the second best, and Merit Scores lag behind all.

Table 6 displays a particular finding for K=30 and a=5.

Table 6

Correlations between True Scores Assumed and their Estimators s: K=30, a=5

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,854764013
Rewarded Score (XRO=Raw + Reward)	0,857175180
Penalized Score (XC=Raw - Penalty)	0,917781933
Merit Score (XRP=Raw + Reward - Penalty)	0,999275341
Sheer and mere chance scores (SMC)	-0,005869875

It turns out that the Merit Score formula estimates True Scores almost exactly, even though the number of items is quite small. Awarded scores predict True Scores better than Raw Scores, but not as well as Penalized scores.

Table 7 displays a particular finding for K=30 and a=4.

Table 7

Correlations between True Scores Assumed and their Estimators: K=30, a=4

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,849297380
Rewarded Score (XRO=Raw + Reward)	0,850404203
Penalized Score (XC=Raw - Penalty)	0,927660474
Merit Score (XRP=Raw + Reward - Penalty)	0,997590633
Sheer and mere chance scores (SMC)	0,010820932

Raw Scores and Rewarded Scores are almost equally well estimators of truth. Penalized Scores however are much better them both, but Merit Scores overrides all of them.

Table 8 displays a particular finding for K=30 and a=2.

Table 8

Correlations between True Scores Assumed and their Estimators: K=30, a=2

Estimators	Pearson Correlation with True Scores Assumed
Raw Score (X: Raw Score only)	0,849648962
Rewarded Score (XRO=Raw + Reward)	0,816302426
Penalized Score (XC=Raw - Penalty)	0,939280636
Merit Score (XRP=Raw + Reward - Penalty)	0,645305025
Sheer and mere chance scores (SMC)	-0,022540786

Best corrective method for True Scores with T/F items is penalty. Rewarding blank responses in T/F type of testing cannot be recommended.

Gambling cannot be tolerated in education.

Discussion

Penalizing wrong answers in multiple-choice tests has long been framed as a rational correction for chance success. Yet it rests on fragile assumptions about random guessing, equal distractor plausibility, and uniform examinee behavior—assumptions at odds with empirical evidence. The correction formula can yield negative scores and distort construct measurements, while often failing to deter guessing in practice.

One of the earlier proposals to eliminate chance success is to use multiple correct answers. Doğan and Karakaya (2025) examined and compared eight scoring methods for scoring achievement tests with multiple-answer items. Their findings indicated that the multiple-choice item type is applicable to both numerical and verbal courses. They concluded that scoring methods can be determined according to the intended use of the multiple-choice item type, and similar studies can be conducted to expand the use of the item type.

One of the long-standing problems facing test designers and educators is the appropriate number of options on a multiple-choice test. Currently, multiple-choice questions in the medical field typically have three to five options, and it is generally believed that more options are better. Numerous theoretical and empirical studies have provided evidence in favor of using three-choice questions. These studies find that the psychometric properties of three-choice questions are similar to those of four- or five- choice questions, and that the test's validity and reliability, difficulty, and coefficients of variation do not change significantly with reducing the number of options (Esmaeli et. al., 2021). Therefore, reducing the number of questions can save faculty and student time and energy by reducing the time required to design and administer tests. Most studies have concluded that using three-choice questions is cost-effective if the number of options does not alter the test's psychometric properties.

Chance correction formula to minimize a participant's chances of success, all distractors are evaluated at the same level. However, some distractors in a question may have different characteristics. This suggests that applying the same correction level to each distractor in terms of proximity to the correct answer compromises scoring fairness. In this context, considering the disparity among distractors when making score adjustments to ensure scoring fairness is critical. The distraction power of each distractor option can be determined by consulting an expert or by examining the frequency of the options answered on the exam (Polat, 2024). Also, the distraction power of each option can be determined by calculating the ratio of the number of incorrect answers given by candidates who selected a particular distractor to the total number of incorrect answers. In this case, correction scores are calculated inversely proportional to the distraction levels of the options, and scores are determined for each question. Finally, test scores are calculated as the sum of the question scores. Polat (2024)found that students who tended to select highly distracting options achieved higher scores despite having equal numbers of correct and incorrect answers. S/he asserts that this practice increased scoring fairness and pluralism among candidates by accounting for different distractors. Time, labor and monetary cost is not mentioned.

Rewarding blanks offers a principled alternative that can reduce random error, better reflect true knowledge, and avoid the conceptual pitfalls of "negative ability." Its success depends on careful calibration of the blank reward, transparency, metacognitive training, and attention to equity and practicality. When thoughtfully implemented -ideally alongside improved item design and adaptive testing- rewarding blanks can produce scores that are more valid, interpretable, fair, and also parsimonious.

In short, the impulse to penalize students' guesses is itself based on guesses about students. A more evidence-based approach is to align incentives with the realities of student cognition: encourage attempts when knowledge warrants it and make it acceptable -not costly- to admit when one does not know.

Conclusion

Through controlled simulation, this study formalizes and compares several scoring policies for multiple-choice assessments. All predictors correlate strongly with the true score by construction, but their practical value diverges:

- Raw scores conflate knowledge with luck,
- Penalized scores mitigate guessing inflation, improving validity,
- Rewarded-blank scores can reduce anxiety and encourage honest strategy but must be calibrated to avoid incentivizing nonresponse.
- The merit score integrates both reward and penalty, offering a balanced metric that respects both measurement accuracy and humane testing practices.

In sum, when thoughtfully parameterized -especially relative to the number of options (a) the merit score ($V = T + (B/a) – (W+F)/(a-1)$ emerges as a compelling candidate for fair and informative scoring, aligning examinee incentives with the assessment's core purpose: to measure competence rather than luck or risk preference.

Recommendations

There are some principles of designing a reward-for-blank scheme:

- First and foremost, quality of items must be improved. Stem of the item must be relevant to the "construct" being measured. Distractors must be equally plausible for non-masters and clearly implausible for masters. Better item writing reduces random guessing more effectively than scoring penalties alone.
- Second but equally important with the first principle is transparency and clarity. The scoring rules must be shared with all interested parties. They all must be provided with practice, feedback, and training in metacognitive skills (e.g., confidence estimation, elimination strategies). Without guidance, policy shifts may differentially affect participants.
- Rewarding blanks must be calibrated according to the number of options for the items.

If the reward score per blank item is higher than 1/a blind guesses will be discouraged.

If reward score is less than 1/a attempting with no knowledge is still at least as good or only marginally better than skipping. Therefore, reward score must be set as 1/a.

- Partial knowledge/aptitude must be protected.

Anticipated Outcomes of Rewarding Blanks are exemplified below:

- Reduced random guessing noise: Fewer low-confidence attempts decrease chance success, potentially enhancing construct and predictive validity.

- Shift in response patterns: More blanks, especially among lower-ability examinees; fewer spurious corrects from blind guessing.

- Potential reliability tradeoffs: Internal consistency may rise or fall depending on the balance between reduced noise and fewer observed responses.

- Equity considerations: Benefits students with better metacognitive calibration; risks penalizing those taught to “always answer everything.” Mitigated by explicit training and practice.

- Interpretation clarity: Rewarding blanks may be more palatable than negative scores and simpler to explain than correction-for-guessing deductions.

Practical Implementation Steps

- Pilot testing: Run pilots comparing current penalty scheme versus blank-reward scheme on the same item bank.

- Track changes in item statistics, reliability, and validity indicators.

- Behavioral analytics: Analyze skipping patterns by ability, demographics, and time pressure. Identify unintended disparities.

- Threshold calibration: Use expected-value modeling and pilot data to set (S_B) ensuring desired attempt thresholds (e.g., 20–30% confidence).

- Stakeholder communication: Provide clear rules, rationale, examples, and practice tests. Emphasize that partial knowledge attempts are still often valuable.

- Ongoing evaluation: Monitor predictive validity (e.g., course outcomes), fairness metrics, and test security. Adjust reward-or-blank method as needed.

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Teaching Science by Inquiry and TIMSS23 Findings

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Abstract

Inquiry-based teaching is widely promoted as a cornerstone of 21st-century science education, rooted in historical traditions from Socratic dialogue to Dewey's participatory learning. This study examines whether teachers' self-reported emphasis on inquiry practices aligns with national science achievement in the 2023 Trends in International Mathematics and Science Study (TIMSS). I analyzed two datasets: Grade 4 (63 countries; five inquiry practices: asking questions, predicting outcomes, creating representations, using concepts to explain phenomena, conducting experiments) and Grade 8 (47 countries; eight practices, adding discussing data variation, using multiple sources of evidence, and arguing about science questions). The percentage of students whose teachers reported placing "a lot" of emphasis on each practice were given in TIMSS 2023 data. Using Spearman's rank correlations, we tested associations among inquiry practices, between each practice and average national science achievement, and between a composite inquiry index and achievement. I also applied the Friedman test to assess within-country rank patterns of emphasis across practices. We found significant negative correlations between national average science achievement and teachers' reported emphasis on inquiry at both grade levels. The findings highlight limitations of self-reported instructional measures in international assessments and underscore the importance of the unit of analysis; country-level correlations can diverge from individual- or classroom-level effects. Implications include cautious use of self-report indicators for cross-national comparisons and the need for multi-method validation of instructional practices.

Key words: Discovery learning, Eureka, International assessments, Phases of Incubation, Science education

Introduction

Every circle of knowledge sweeps a larger ring of the mysteries. Science declines without curiosity about these mysteries. The pursuit of scientific understanding requires such a pedagogical practice that engages students in authentic inquiry, expecting them to live the scientist's life. A scientist's life is neither calm nor simple: it requires rigorous honesty, emotional strain, and a professional culture sustained by maturity. The public allure of "science," exploited in advertising, obscures the scientist's full humanity and the costs of a research vocation. Education must be a process of demystification. Consequently, educators are responsible for providing realistic guidance so that students grasp both the discipline's great achievements and its tedious, daily realities.

In a scientific era, students must grasp the character of those devoted to investigation and the behavioral patterns that sustain intellectual life. While hoping scientists often arrive with tendencies aligned to inquiry, the science teacher shapes the classroom climate where such behavioral patterns developed. The so-called scientific attitudes (e.g., suspension of prejudice, open-mindedness, honesty, patience) are characteristics of intelligent action. Teachers who embody these virtues can help students learn science, cultivating an environment of joyful inquiry and self-correction in which mistakes are recognized and regularly remedied. Practical life compromises between desirable and possible.

Problem Situation

Conventional instructional practices are not adequate for 21st century students. They are facing a lot of new challenges and opportunities (OECD, 2005; Perkins, 2009, Baykal, 2024). Interactive approaches to teaching and assessment are essential to replace knowledge transmission methods. The quest for active learning roots back to Socrates' interrogative dialogues, and Dewey's (1910) participatory learning experiences. In evaluating whether teachers require more method or more content, the dichotomy is misplaced, for problem seeking, problem solving, and concept formation are inseparable processes.

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Concepts emerge through solving problems, while the concepts sought are guided by the problems identified, creating a recursive matrix that propels further inquiry what scientists call curiosity. Learning, evidenced by consistent changes in behavior, results from experiences in which learners respond to situations, evaluate consequences, and refine their responses.

In Latin “communicare” means “to share” and “inquirere” means “to search for”. Whenever a teacher and a student communicate to seek for significant answers to interesting questions “inquiry” takes place on the stage. John Dewey who had worked as a science teacher, recommended science teachers to use inquiry as the major teaching strategy in their classes (Friesen, S., & Scott, D., 2013). Consequently, effective science teaching arranges experiences that align with learners’ goals and readiness (i.e., their existing knowledge, skills, and attitudes) so that each response functions as a learning act, consolidating concepts and enabling problem solving.

Can teachers help students make "discoveries" the way scientists do? It appears that scientists first go through a process of Exploration, Clarification, and Preparation phase. Here, they read, discover techniques, discuss issues with their peers, and work consciously toward solving the problems. Students rarely discover the "new idea," the "solution," while working on the problem intentionally. They usually admit that the idea comes to them "suddenly," as a "moment of illumination" [Archimedes’ Eureka moment]. It has been proposed that an Incubation phase is necessary before this "illumination" moment (Pedaste et. al., 2015). During the Incubation phase, the brain appears to work on the problem internally. Then suddenly, the solution, approach, or a new pathway emerges. The phases Exploration, Clarification, Preparation, Incubation, Illumination, and Verification seem to be perceivable but indistinct stages in their working process. This is not unique to scientists. That’s what happens in every kind of thought process (Terman, 1954; Brandwein, 1955; Bransford, Brown & Cocking, 2000). A student’s readiness encompasses the knowledge, skills, attitudes, and conceptual applications brought to a task, shaped by prior learning, innate capacity, and physical, emotional, and mental maturity. Teachers should neither underestimate readiness by discounting earlier schooling nor overestimate retained content; instead, they ought to use preassessment to identify existing concepts and limits. Effective instruction creates meaningful learning situations that align with students’ goals, enabling learners to recall prior knowledge, plan activities, and engage with authentic contexts—such as studying an engine to support the desire to drive—rather than relying on decontextualized diagrams. Through such experiences, students learn to refine interpretation, to select salient features, to connect with past experiences, and predicting outcomes, thereby advancing concept formation and long-term understanding.

"*Reason is not a creative force that arrives at something new; rather, it is an adaptive and controlling faculty. Even in the purest realms of logic, intuition is what first brings innovation to light." (Russell, 1954). The problem-solving begins right after, a concept emerges*" into the mind. The acquisition of concepts cannot be controlled by a teacher; however, the environment for such concept acquisition can be controlled. Teachers can organize the classrooms and motivate students to form concepts.

While a Eureka moment cannot be controlled, the pre-Eureka and the post-Eureka phases can be managed. And a single Eureka can be formed out of smaller eurekas. Studies suggest that inquiry-based approaches to learning science help students describe, explain and predict the natural phenomena around them. Inquiry creates a more engaging learning environment. To increase the effects of inquiry-based instruction a group of processes need to be arranged. The application of powerful questioning schemes is mandatory to direct the learning process. Inquiry-based teaching is a process of developing challenging situations in which students are asked to observe and question phenomena; pose explanations of what they observe; devise and conduct experiments in which data are collected to support or contradict their theories; analyze data; draw conclusions from experimental data; design and build models; or any combination of these. Inquiry-based teaching improved student performance in a number of areas but mostly in science (Brederman, 1983; Hattie, 2009; Ernst, 2017; Rude, 2025). In any learning context, outcomes either confirm or contradict a learner’s interpretation, thereby shaping subsequent behavior and understanding. Confirmation brings satisfaction, reinforces the successful response, and expands the learner’s repertoire; disconfirmation prompts trial-and-error, reflective reinterpretation, withdrawal, or even goal substitution that can surface as misconduct. This adaptive cycle parallels the scientific method: anomalies are not paralyzed but become precisely defined problems, investigated systematically and resolved through iterative observation and experiment, gradually modifying theory. Notably, the pathway to conceptual advance often follows a staged pattern—Exploration, Clarification, Preparation, Incubation, Illumination, and Verification—rather than a purely linear, stepwise logic. During Incubation, unconscious processing appears to recombine prior work, culminating in a sudden Illumination or “Eureka” that reorients effort and accelerates Verification. Such disciplined readiness grounded in training, conditioning, and sustained engagement enables learners and scientists alike to persist constructively amid uncertainty, suggesting that concept attainment is frequently catalyzed by insight that emerges after rigorous but temporarily suspended conscious effort.

The synthesis of 72 empirical studies provides robust evidence that guidance is a pivotal determinant of success in inquiry-based learning across K–12 contexts, showing that learners given some form of instructional support (whether prompts,

scaffolds, feedback, exemplars, or structured procedures) engage more skillfully during investigative tasks, extract more accurate and relevant topical information from their explorations, and achieve higher scores on post-inquiry assessments of conceptual understanding and procedural fluency. Notably, these advantages do not depend heavily on the specificity of the guidance: while more specific supports (e.g., step-by-step heuristics) often yield greater immediate performance gains during the inquiry process, both specific and nonspecific guidance (e.g., reflective questions or strategic hints) produce comparable improvements in the quality of learning activities and the durability of learning outcomes, suggesting that guidance primarily functions to reduce extraneous cognitive load, focus attention on productive strategies, and encourage metacognitive monitoring rather than simply "giving away" answers. The effectiveness of guidance is remarkably consistent across age groups—children, teenagers, and adolescents benefit to a similar extent—indicating that developmental stage does not constrain the value of structured support and that teachers can confidently adapt guidance to local goals, prior knowledge, and classroom constraints without sacrificing efficacy. (Lazonder and Harmsen, 2016). For educational designers and K–12 math and science teachers, these findings broaden the design space for inquiry-based curricula: Teachers can integrate open-ended inquiries with scaffolded supports, transition between minimal and more explicit guidance based on formative assessment and foster productive effort while maintaining conceptual depth through effective guidance. In doing so, the inquiry process becomes both accessible and intellectually enriching, ensuring sustainability for diverse learners.

This report investigates the relationship between inquiry practices of teachers as declared by themselves and student achievement at 4th and 8th grades as measured in TIMSS 2023. It questions whether a heavy emphasis on inquiry by teachers, as self-reported in TIMSS, is associated with higher or lower science achievement, and considers whether contextual and cultural factors, as well as methodological issues (such as the unit of analysis being the country, not the individual), might complicate the interpretation of this relationship.

Methodology

This study is a correlational survey on TIMSS 2023 data published in open sources.

There are two data sets: First one is about the 4th graders from 63 countries and the second is about the 8th graders from 46 countries. Inquiry based teaching functions were summarized in 5 consecutive items for 4th graders:

Q41: Encouraging students to ask questions about scientific phenomena,

Q42: Having students predict the outcomes,

Q43: Having students create representations of experiments or investigations,

Q44: Having students use scientific concepts to explain phenomena,

Q45: Having students conduct experiments (hands-on or virtually).

Teachers of 4th Grade participants had been asked how much emphasis they place on these functions when teaching science to students in their classes. There are three optional answers for each question: "a lot", "some", "none" (IEA, 2024). Table 1 displays a seven-column matrix prepared to represent the data for 4th graders. The first column is the list of participant countries. Next five columns display the percentages of students whose teachers responded "a lot" to each item. Seventh column AS4 stands for the average science achievements of 4th Graders in TIMSS 2023.

Table 1

Teachers Emphasize Science Inquiry – Teachers' Reports 4th Graders in TIMSS 2023

Country	Q41	Q42	Q43	Q44	Q45	AS4
Singapore	63	75	17	65	61	607
Korea, Rep. of	42	67	21	53	72	583
Chinese Taipei	69	59	27	53	81	573
Türkiye (5)	64	88	61	60	64	570
Dubai, UAE	92	93	64	78	79	562
England	74	91	38	70	65	556
Japan	59	88	74	58	88	555
Australia	72	81	36	45	54	550
Poland	87	60	31	36	30	550
Hong Kong SAR	54	60	17	46	39	545
Finland	61	20	4	17	5	542

Lithuania	60	56	45	43	57	537
Macao SAR	74	76	33	55	59	536
Sweden	79	65	17	66	51	533
Ireland	71	84	16	24	33	532
United States	73	69	32	40	42	532
Bulgaria	89	59	58	63	35	530
Norway (5)	65	53	12	31	17	530
Czech Republic	71	41	18	11	24	526
Latvia	76	64	48	50	62	526
Romania	90	73	42	42	51	526
Slovenia	69	63	26	13	33	526
Ontario, Canada	80	70	30	44	31	525
Hungary	77	54	18	25	17	524
Denmark	71	68	30	35	42	522
Canada	83	75	29	48	45	521
Slovak Republic	61	62	39	36	51	521
Netherlands	43	32	7	7	17	517
New Zealand	66	69	26	28	49	517
Germany	80	67	24	27	61	515
Italy	94	79	47	57	63	511
Portugal	89	89	36	51	49	511
Serbia	86	72	43	39	41	510
Quebec, Canada	89	80	25	57	60	508
Spain	84	72	51	55	61	504
Sharjah, UAE	95	90	70	80	78	503
United Arab Emirates	89	87	59	74	72	495
Albania	88	77	59	73	67	491
Belgium (Flemish)	51	50	6	7	17	488
France	71	62	33	31	36	488
Cyprus	85	96	39	81	67	487
Belgium (French)	88	87	48	52	62	481
Chile	83	72	65	60	57	479
Bahrain	94	87	55	77	65	475
Qatar	92	92	67	77	72	472
Kazakhstan	75	65	49	57	53	467
Georgia	54	53	34	22	35	465
Montenegro	94	79	51	50	57	461
Armenia	91	52	44	58	42	457
Bosnia & Herzegovina	92	73	26	43	26	448
Abu Dhabi, UAE	85	84	49	69	64	446
North Macedonia	90	73	49	56	60	439
Oman	74	91	71	77	77	433
Iran, Islamic Rep. of	83	77	59	58	76	432
Saudi Arabia	91	85	44	78	71	428
Brazil	83	60	33	35	38	425
Azerbaijan	82	64	57	67	43	422
Jordan	84	79	48	69	64	418
Uzbekistan	87	71	71	79	72	412
Kosovo	90	49	53	35	39	403
Morocco	95	87	38	68	32	390
Kuwait	79	84	39	67	70	373
South Africa (5)	83	67	30	46	38	308

SOURCE: IEA's Trends in International Mathematics and Science Study - TIMSS 2023

Downloaded from https://timss2023.org/results, modified by the author

Table 2 displays the second data set for the 8th Graders in ten columns.

Table 2

Teachers Emphasize Science Inquiry – Teachers' Reports: 8th Graders in TIMSS 2023

Country	OS81	OS82	OS83	OS84	OS85	OS86	OS87	OS88	AS8
Cote d'Ivoire	95	46	46	42	11	38	45	31	183
Oman	92	90	83	62	68	73	57	79	456
Azerbaijan	91	67	74	61	56	63	68	47	411
France	90	66	44	34	61	55	23	60	486
Sharjah, UAE	90	79	68	73	59	81	65	62	499
Uzbekistan	89	71	75	78	66	74	86	71	396
Bahrain	89	82	65	53	56	76	70	58	452
Romania	89	55	54	56	44	61	50	38	466

Qatar	89	78	72	62	60	78	63	62	481
Dubai, UAE	89	86	71	65	57	79	52	61	547
Saudi Arabia	88	81	59	67	50	74	80	57	419
United Arab Emirates	88	81	69	67	58	77	59	60	486
Portugal	88	68	53	40	28	74	55	48	506
Morocco	87	62	57	47	45	67	52	18	327
Palestinian Nat'l	87	70	57	47	37	70	90	53	393
Abu Dhabi, UAE	87	77	63	61	53	71	57	52	443
Jordan	85	72	59	53	44	73	55	53	413
Chile	83	72	53	50	68	75	42	54	455
Italy	83	56	48	43	44	52	52	43	501
Cyprus	82	80	53	43	40	66	63	48	464
South Africa (9)	79	52	31	33	27	46	39	19	362
Iran, Islamic Rep.	78	69	62	62	48	59	71	59	419
Israel	77	74	58	42	40	74	67	52	481
Brazil	76	51	45	42	32	51	54	32	420
Australia	76	71	50	28	41	59	16	56	520
Kuwait	73	73	63	44	35	66	46	62	420
Austria	72	46	28	21	16	30	43	31	512
United States	72	62	43	43	49	58	26	46	513
Hungary	71	43	36	38	28	51	25	24	522
Sweden	70	53	40	23	14	78	66	60	521
Malaysia	68	67	47	38	36	55	40	55	426
Malta	68	60	45	26	18	47	36	44	501
Kazakhstan	67	56	54	55	49	52	55	50	443
Ireland	65	77	50	23	33	37	20	53	525
Norway (9)	62	45	19	14	14	53	42	21	488
Türkiye	62	77	60	53	53	61	68	63	530
Georgia	59	49	46	39	41	44	53	31	448
Singapore	58	42	23	11	11	54	9	30	606
Chinese Taipei	57	39	34	39	42	59	20	52	572
Japan	56	61	66	61	69	69	61	80	557
England	55	56	37	9	35	58	9	54	531
Korea, Rep. of	54	55	46	49	42	68	23	36	545
Hong Kong SAR	52	68	40	19	16	52	21	73	528
Finland	51	26	18	14	14	49	25	39	531
Lithuania	49	46	45	41	37	55	32	42	519
Czech Republic	44	41	32	41	27	20	33	29	527

SOURCE: IEA's Trends in International Mathematics and Science Study - TIMSS 2023

Downloaded from https://timss2023.org/results, modified by the author

First column is for countries; the last column is for the average science achievement of the country on the test for the 8th Graders. The eight columns in between these display the percentages of teachers who responded “a lot” to the following 8 inquiry practices:

Q81: Encouraging students to ask questions about scientific phenomena,

Q82: Having students predict the outcomes of experiments or investigations, xxx

Q83: Having students discuss variation in data from experiments or investigations,

Q84: Having students use multiple sources of evidence to explain scientific phenomena,

Q85: Having students create representations (e.g., models, graphs) to explain scientific phenomena,

Q86: Having students use scientific concepts to explain phenomena,

Q87: Having students argue about science questions,

Q88: Having students conduct experiments (hands-on or virtually),

AS4: Average Science Achievements of 4th Graders

The following inferential questions have been formulated for each data set separately (von Daivier et. al., 2024; Abdi, 2014;

Baykal, 2024; Arifin, Saputro, Kamari, 2025).

Are the intercorrelations between the inquiry practices (country's "a lot" percentages) significantly positive? (Spearman's Rho)

Is each inquiry practice associated significantly with average science achievement? (Spearman's Rho)

Do countries differ in their median emphasis across their inquiry practices, or do they display a significant rank pattern when their inquiry practices ranked within the countries independent of others? (Friedman Test)

Results for 4th Graders in TIMSS 2023

Table 3 displays the intercorrelations (Rho) between the levels of inquiry practices for 4th Graders in TIMSS 2023.

Table 3

Intercorrelations between the levels of inquiry practices for 4th Graders

VarX	VarY	Rho	p (2 tailed)	-
Q41	Q42	0,459	0,000	3,81
Q41	Q43	0,508	0,000	4,67
Q41	Q44	0,516	0,000	4,82
Q41	Q45	0,245	0,053	1,28
Q42	Q43	0,505	0,000	4,62
Q42	Q44	0,700	0,000	9,75
Q42	Q45	0,671	0,000	8,75
Q43	Q44	0,680	0,000	9,07
Q43	Q45	0,641	0,000	7,82
Q44	Q45	0,766	0,000	12,56

The reason for including minus logarithms of p values is to enable the reader to make clearer distinctions between the findings.

Table 4 displays the rank order correlations (Spearman's Rho) between Average Science Achievements of 4th Graders and the inquiry practices that have been exposed.

Table 4

Levels of Inquiry Practices Correlated with Average Science Achievement of 4th Graders in TIMSS 2023

VarX	VarY	Rho	p (2 tailed)	-log(p)
AS4	Q41	-0,504	0,000	4,60
AS4	Q43	-0,373	0,003	2,58
AS4	Q44	-0,248	0,050	1,30
AS4	Q42	-0,117	0,360	0,44
AS4	Q45	-0,048	0,706	0,15

Inquiry practices inferred from teachers' self-assertions (country's "a lot" percentages) may or may not reveal a significant pattern when ranked within each country independent of the others. Table 5 displays Friedman two-way analysis data and Kendall's coefficient of concordance (Kendall's W) and their critical indicators.

Table 5

Friedman two-way ANOVA Test Statistics Testing the Rank Pattern of Inquiry Practices for 4th Graders

Inquiry Practices Applied				Mean Rank
Q4. Having students use scientific concepts to explain phenomena				3,16
Q5. Having students conduct experiments (hands-on or virtually)				2,99
Q2. Having students predict the outcomes of experiments or investigations				2,98
Q1. Encouraging students to ask questions about scientific phenomena				2,95
Q3. Having students create representations to explain scientific phenomena				2,92
N=63	Chi Square= 0,885	df=4	Kendall's W= 0,004	p (2 tailed)=0,927

A composite score would be useful for combining multiple indicators of inquiry instruction. Percentile distributions and measures of central tendency for inquiry practices were correlated with mean achievement scores of 4th Graders. The results are presented in Table 6.

Table 6

Descriptive Statistics of Inquiry Practices Correlated with Average Science Achievement of 4th Graders

Spearman's Rho	Q4minimum	Q4maximum	Q4median	Q4mean
AS4	-0,349	-0,345	-0,235	-0,325
p (2 tailed)	0,005	0,006	0,063	0,009
N	63	63	63	63

Results for 8th Graders in TIMSS 2023

Table 7 displays the intercorrelations (Rho) between the levels of inquiry practices for 8th Graders in TIMSS 2023.

Table 7

Intercorrelations Between the Levels of Inquiry Practices for 8th Graders

VarX	VarY	N	Rho	p (2 tailed)	-log(p)
QS81	QS82	46	0,423	0,000	4,3
QS81	QS83	46	0,483	0,000	5,5
QS81	QS84	46	0,451	0,000	4,8
QS81	QS85	46	0,390	0,000	3,8
QS81	QS86	46	0,380	0,000	3,6
QS81	QS87	46	0,375	0,000	3,5
QS81	QS88	46	0,191	0,066	1,2
QS82	QS83	46	0,632	0,000	9,0
QS82	QS84	46	0,453	0,000	4,9

QS82	QS85	46	0,461	0,000	5,1
QS82	QS86	46	0,526	0,000	6,4
QS82	QS87	46	0,379	0,000	3,6
QS82	QS88	46	0,517	0,000	6,2
QS83	QS84	46	0,699	0,000	10,8
QS83	QS85	46	0,620	0,000	8,7
QS83	QS86	46	0,514	0,000	6,2
QS83	QS87	46	0,517	0,000	6,3
QS83	QS88	46	0,480	0,000	5,5
QS84	QS85	46	0,652	0,000	9,4
QS84	QS86	46	0,487	0,000	5,6
QS84	QS87	46	0,544	0,000	6,8
QS84	QS88	46	0,329	0,002	2,8
QS85	QS86	46	0,458	0,000	5,0
QS85	QS87	46	0,320	0,002	2,7
QS85	QS88	46	0,445	0,000	4,8
QS86	QS87	46	0,373	0,000	3,5
QS86	QS88	46	0,450	0,000	4,8
QS87	QS88	46	0,261	0,012	1,9

Table 8 displays the rank order correlations (Spearman's Rho) between Average Science Achievements of 8th Graders and the inquiry practices that have been exposed.

Table 8

Levels of Inquiry Practices Correlated with Average Science Achievement of 8th Graders in TIMSS 2023

VarX	VarY	N	Rho	p (2 tailed)	-log(p)
QS81	AS8	46	-0,431	0,000	4,5
QS82	AS8	46	-0,170	0,099	1,0
QS83	AS8	46	-0,286	0,005	2,3
QS84	AS8	46	-0,282	0,006	2,2

QS85	AS8	46	-0,120	0,244	0,6
QS86	AS8	46	-0,062	0,550	0,3
QS87	AS8	46	-0,387	0,000	3,8
QS88	AS8	46	0,041	0,691	0,2

Table 9 displays Friedman two-way analysis data and Kendall's coefficient of concordance (Kendall's W) and their critical indicators for 8th Graders.

Table 9

Friedman two-way ANOVA Test Statistics Testing the Rank Pattern of Inquiry Practices for 8th Graders

Inquiry Practices Applied for 8th Graders	Mean Rank
QS88 Having students conduct experiments (hands-on or virtually)	7,52
QS87 Having students argue about science questions	6,25
QS83 Having students discuss variation in data from experiments or investigations	5,73
QS86 Having students use scientific concepts to explain phenomena	4,18
QS82 Having students predict the outcomes of experiments or investigations	3,79
QS81 Encouraging students to ask questions about scientific phenomena	3,45
QS85 Having students create representations to explain scientific phenomena	2,97
QS84 Having students use multiple sources of evidence to explain scientific phenomena	2,11
N=46 Chi-Square=181,4 df=7 Kendall's W= 0,563 p (2 tailed)=0,000 -log(p) = 35,01	

Percentile distributions and measures of central tendency for inquiry practices were correlated with mean achievement scores of 8th Graders. The results are presented in Table 10.

Table 10

Descriptive Statistics of Inquiry Practices Correlated with Average Science Achievement of 8th Graders

Spearman's Rho	Q8Min	Q8Mean	Q8Median	Q8Max
AS8	-,298	-,401	-,363	-,503
p (2-tailed)	,045	,006	,013	,000
N	46	46	46	46

Concluding Remarks

Discussion

There are some methodological flaws (e.g., Simpson's Paradox) that can lead to negative correlations. Relationships that are held at the aggregate (country) level may or may not hold at the individual level. Instructional systems (especially teachers) often adjust teaching and learning protocols in response to low achievement. When basic skills are lagging behind, educators may declare "more inquiry" as a compensation or engagement strategy. This creates reverse causality: lower achievement

leads to more inquiry-like practices, not the other way around. There is another example of such a conflict in TIMSS 2019. Data revealed a negative correlation between science and math achievement and the sense of belongingness to school when countries are taken as units of analysis (Baykal, 2023). International assessments have turned into a competition. It seems that participants who fail to make their countries proud on objective achievement tests mark the most favorable options for their countries in Likert-type questionnaires. Participants from developed countries, however, do not need such a "compensation mechanism." They represent their countries successfully and demonstrate self-criticism alongside self-confidence.

Research supporting inquiry typically involves guided inquiry rather than unguided exploration, explicit goals, prompts, cues, corrections, and reinforcement. Content-integrated inquiry focuses on conceptual development rather than activity for activity's sake. Inquiry-based learning requires strong teacher expertise (Pedagogical Content Knowledge) to design and implement a flexible instructional system. In contrast, self-reported "inquiry" in surveys may reflect minimal guidance or loosely defined project work, sporadic or opportunistic laboratory activities without clear learning progressions, or the substitution of content instruction for activity due to pace or resource constraints.

Teig (2021) synthesized how inquiry-related studies in science education have evolved over the years using data from TIMSS and PISA. More specifically, it systematically examines the patterns and findings of these studies based on three main strands of inquiry research: (1) inquiry as a teaching approach, (2) inquiry as an instructional outcome, and (3) inquiry as an instructional approach and outcome. Findings indicate that most studies focus on the third strand of inquiry research to examine the relationship between inquiry and science achievement.

Conclusion

The apparent contradiction between the robust evidence for inquiry-based science learning and the negative country-level correlations in TIMSS 2023 dissolves under closer methodological scrutiny. Country-level negative correlations do not imply that inquiry causes lower achievement; they likely reflect aggregation biases, reverse causality, and measurement limitations. Not all “inquiry” is equal. The positive effects documented in the literature pertain to well-structured, guided, and conceptually focused inquiry implemented with high fidelity. Self-reported pedagogical practices on international surveys are vulnerable to cultural response styles and social desirability—particularly in high-stakes, competitive contexts. Better evidence requires multilevel analyses, validated observational measures, and assessment designs aligned with the aims of scientific practice.

Recommendations

Rather than challenging the “immense stock of information” on inquiry learning, the TIMSS 2023 paradox should prompt more precise definitions, better instruments, and smarter inferences. Fair assessment of inquiry-based learning must include classroom observations with validated rubrics of inquiry, analysis of lesson plans, homework of students, PCK of teachers.

The path forward is not to abandon inquiry, but to implement it well and to measure it wisely.

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Creative Thinking in The Scientific Research Platform in Turkey

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Abstract

This study investigates postgraduate theses on creative thinking in Türkiye from 2012 to 2021, aiming to reveal research trends and key findings. A total of 226 theses accessible through the National Thesis Center were analyzed using descriptive content analysis. Of these, 68.1% were master's and 31.9% doctoral theses, with the highest number completed in 2019. Gazi University produced the most studies, and science education was the most represented discipline. Among the theses, 46 employed experimental designs to examine methods supporting creative thinking. Results indicate that problem-based learning, project-based learning, creative drama, brain-based learning, differentiated instruction, and technology-assisted practices positively affected students' creativity, critical thinking, problem-solving skills, and academic performance. Enriched programs also enhanced creativity in both typical and gifted students, while some approaches, such as creative relaxation activities, showed limited effects. The findings suggest that creativity is not solely innate but can be developed through appropriate instructional strategies, supportive environments, and teacher guidance. Technological tools, including VR, AR, digital arts, and coding, further support creative development, especially in teaching abstract concepts. Teachers' pedagogical knowledge and ability to foster student-centered learning environments play a critical role in enhancing creativity. In conclusion, research on creative thinking in Türkiye is growing, highlighting the potential of various instructional approaches. However, more original theoretical frameworks and sustainable educational policies are needed. Strengthening teacher education, implementing innovative programs, and integrating technology effectively into pedagogy are essential for fostering students' creative thinking.

Keywords: *Creativity, Systematic Review, Education, Innovation*

Introduction

Despite being physically weaker compared to other species, humans have managed to persist and spread widely across the globe. Puccio (2017) emphasizes that the singular answer to this paradox lies in creativity. The evolutionary trajectory of the genus *Homo*, which emerged approximately 2.5 million years ago, owes its survival to the human ability to employ creative thinking in resolving survival-related challenges essentially, to innovate. Among the seven core competencies sought in 21st-century human resources, "Creative Thinking and Innovation" is explicitly listed (McCartney, Murphy, & McCarthy, 2021). Humanity is designed to create, and this capacity is indispensable for the continuation of its species.

With the advent of the Fourth Industrial Revolution, economic competition has entered a new dimension. Consequently, nations today have been compelled to restructure their economies around innovation (Keleşoğlu & Kalaycı, 2017). All regional stakeholders across the globe, including universities, are expected to contribute to the development of strategies rooted in local dynamics. In Türkiye, universities have moved beyond the sole provision of educational activities to assume a strategic role, actively supporting regional development (Özer, 2011). The intensification of policy debates has placed increasing pressure on governments to invest in intellectual property, both for universities and the broader economy, as a means of generating wealth (HM Treasury & DTI, 1998). The creation and dissemination of intellectual property constitutes the core function and most asset of a university. Managing this asset for commercial profit, however, presents a significant challenge. In parallel with these developments, Technology Transfer Offices (TTOs) have been established in universities across Türkiye, as well as in other parts of the world (Çatal, 2024). These offices have played a supportive role by providing guidance to young entrepreneurs.

To achieve innovation, there is a need for human capital equipped with creative thinking skills (Bessant & Tidd, 2018). This, however, is only possible through a comprehensive national education strategy, scientifically designed programs developed by qualified experts (Aydın, 2020; Temizyürek & Akgün, 2020), teachers trained in creative and critical thinking pedagogy (Aslan, 2007; Tok, 2008), and appropriate instructional materials (Bayrak Özmutlu & Kanık Uysal, 2021). Within the Turkish education system, creative thinking skills were first introduced in the second strategic plan covering the years 2015–2019 (MEB, 2015) and were subsequently incorporated among the core values of the third strategic plan for 2019–2023 (MEB, 2019). This marks a significant milestone in the development of the Turkish educational framework.

Although the extent to which creative thinking skills are developed in practice remains debatable, conducting scientific research in this field is considered essential for its advancement. Based on this perspective, the main purpose of this study is to examine the scientific research conducted in Türkiye between 2012 and 2021 on creative thinking. The study is expected to provide findings on various dimensions of creativity, such as educational programs designed to foster creative thinking, scale development, and the identification of related variables. Furthermore, it is believed that the findings will offer insights into Türkiye's position on scientific publishing platforms relative to the literature from European Union countries and other developed nations (Baer & Kaufman, 2006). In line with this general objective, the following sub-objectives have been established:

1. Postgraduate studies conducted in Türkiye between 2012 and 2021 on creative thinking:
   1.1. What is their academic level?
   1.2. What is their distribution by year of publication?
   1.3. How are they distributed across universities and academic disciplines?
2. In master's theses conducted using experimental methods on creative thinking:
   2.1. What findings have been identified regarding creative thinking?

1.1. Method

1.1.1. Research Design

This research was conducted using the descriptive content analysis method, which is one of the types of content analysis. Descriptive content analysis is a method that enables the evaluation of trends and research findings by examining studies conducted within a specified time frame and on a particular topic (Dinçer & Kapısız, 2013). According to Ültay, Akyurt, and Ültay (2021), the descriptive content analysis method allows the identification of trends in a particular field or topic by thoroughly analyzing qualitative and quantitative studies conducted independently of one another.

1.1.2. Research Sample

The population of this study comprises master's and doctoral theses on creative thinking in the field of education and instruction, which are fully accessible in the National Thesis Center, a public database maintained by the Council of Higher Education (YÖK). Within this scope, all sections title, index, subject, and abstract were included in the search, using the keywords "creative thinking" and "creative thought" in the electronic database. As a result of a search conducted in February 2022 using these keywords, a total of 326 studies were identified. Of these, 226 were deemed suitable according to the inclusion and exclusion criteria of the research, thus forming the sample of the study.

1.1.3. Data Analysis

In conducting the descriptive content analysis, the parameters suggested by Çalık and Sözbilir (2014) were taken into consideration. In line with these parameters, the following steps were followed:

1. A search was conducted in the "advanced search" section of the YÖKTEZ database in the field of education and instruction, using the keywords "creative thinking" and "creative thought." A total of 489 theses were identified, and 123 duplicate theses were removed from the dataset.
2. The remaining 366 theses were coded to ensure validity and reliability. During the coding process, the identification numbers assigned to the theses by YÖKTEZ were used.
3. To classify the coded theses, three separate electronic forms were created.
4. Subsequently, inclusion criteria (Table 1) and exclusion criteria (Table 2) were applied. The theses were screened separately by the researcher and by another researcher. After the screening, the codes of the excluded theses were compared.
5. For theses where discrepancies were found, a faculty member with expertise in the field or holding the title of professor was consulted to reach a decision. As a result of the screening, 140 theses that did not meet the inclusion criteria were excluded from the study.

Within the scope of the study's second research question, the following procedure was implemented:

1. Based on the findings obtained from the analysis conducted for the first research question, an electronic form was created to classify 46 studies conducted with a true experimental design, in line with the predetermined headings.

2. The results of the theses were coded by different researchers into the relevant form, and comparisons were made. In cases where discrepancies were identified, another researcher with expertise in the field was consulted, and a final table was produced.
3. The dependent and independent variables of the theses were also identified using the same method and organized into a table.

Table 1

Inclusion Criteria for the Study

Criterion Type	Inclusion Criterion
Topic	The study must be directly related to the research topic and questions. In this context, subjects such as “creative writing” or “scientific creativity” were not included in the research if they were not explicitly focused on creative thinking.
Publication Date	The study must have been published between 2012 and 2021.
Geographical Scope of Publication	Studies included in the research must have been published in Türkiye.
Validity/Reliability	As far as could be determined, the study should be valid and reliable.
Publication Requirements	The study must have been evaluated by a scientific committee.
Accessibility	Full-text access to the studies must be available.
Language	The language of the published studies must be either Turkish or English.

Table 2

Exclusion Criteria for the Study

Criterion Type	Exclusion Criteria
Instrument	Theses that did not provide complete information about the instruments/scales used were excluded from the research.
Method	Theses that did not clearly and explicitly specify the research method were excluded from the research.

1.1.4. Validity and Reliability

In determining the population and sample of the study, the steps of a systematic review were followed, and the sample was formed in line with clear and explicit criteria. For the theses examined, the identification codes provided in YÖKTEZ were used in the tables, thereby ensuring the transparency and verifiability of the data analysis.

As part of the reliability procedures, for each research question, several theses randomly selected from the research pool were coded by the researcher and by a second researcher using prepared forms, and their results were compared. For outcomes where discrepancies were detected, an expert researcher in the field evaluated the findings and made the final decision. Once it was confirmed that no discrepancies remained, the information of all theses was reviewed and listed in tabular form.

1.2. Results

Within the scope of this study, a search was conducted in February 2022 in the electronic database available on YÖKTEZ to determine the sample. The search retrieved 326 studies using the keyword "creative thinking" and 163 studies using the keyword "creative thought." After removing 123 duplicate studies, 140 studies that did not meet the inclusion criteria were excluded from the remaining 366 studies. Consequently, 226 studies that met the inclusion criteria were included in the sample of the research.

When examining the distribution of the theses by academic level, it was found that, out of 226 theses, 154 (68.1%) were master's theses, while 72 (31.9%) were doctoral theses.

Regarding another research question, it was observed that the highest number of studies (26.11%, f = 59) were conducted in 2019, whereas the fewest (4.87%, f = 11) were carried out in 2015. Examining the other years in order, it was found that 13 studies (5.75%) were conducted in 2012; 19 (8.41%) in 2013; 18 (7.96%) in 2014; 15 (6.64%) in 2016; 25 (11.06%) in 2017; 19 (8.41%) in 2018; 22 (9.73%) in 2020; and 25 (11.06%) in 2021.

An analysis of the distribution of studies by university reveals that Gazi University had the highest number of publications, accounting for 10.6% (f=24) of all studies. In contrast, Afyon Kocatepe, Akdeniz, Başkent, Çağ, Dicle, Ege, Erzincan Binali Yıldırım, Eskişehir Osmangazi, Giresun, İnönü, İstanbul Kültür, İzmir Katip Çelebi, Kafkas, Kahramanmaraş Sütçü İmam, Mersin, Ordu, Ömer Halisdemir, Recep Tayyip Erdoğan, Siirt, Tobb Ekonomi ve Teknoloji, Uşak, and Van Yüzüncü Yıl Universities each conducted the fewest studies, with a share of 0.4% (f=1) per institution.

An examination of theses by scientific discipline reveals that the highest number of studies on creative thinking was conducted in Science Education with 9.3% (f=21), while the lowest number, at 0.4% (f=1) each, was found in the following 39 disciplines: Physical Education and Sports 0.4% (f=1), Computer and Instructional Technologies Education 0.4% (f=1), Educational Psychology 0.4% (f=1), Educational Technologies 0.4% (f=1), Educational Administration and Planning 0.4% (f=1), Educational Administration, Inspection, Planning and Economics 0.4% (f=1), Educational Measurement and Evaluation 0.4% (f=1), Informatics 0.4% (f=1), Philosophy Group Education 0.4% (f=1), Physics Education 0.4% (f=1), Physics Teaching 0.4% (f=1), Gastronomy and Culinary Arts 0.4% (f=1), Entrepreneurship and Innovation Management 0.4% (f=1), Interior Architecture 0.4% (f=1), Elementary Education 0.4% (f=1), Primary Education 0.4% (f=1), Elementary Mathematics Education 0.4% (f=1), Primary School Teaching 0.4% (f=1), English Language Education 0.4% (f=1), English Language and Literature 0.4% (f=1), Innovation, Entrepreneurship and Management 0.4% (f=1), Mathematics Education 0.4% (f=1), Mathematics Teaching 0.4% (f=1), Mathematics and Science Education 0.4% (f=1), Architecture 0.4% (f=1), Special Education 0.4% (f=1), Psychology 0.4% (f=1), Art Education 0.4% (f=1), Social Sciences and Turkish Education 0.4% (f=1), History Teaching 0.4% (f=1), Design 0.4% (f=1), Basic Education 0.4% (f=1), Distance Education 0.4% (f=1), Gifted Education Teaching 0.4% (f=1), Education of the Gifted and Talented 0.4% (f=1), Creative Drama 0.4% (f=1).

Upon examining the findings pertaining to the second sub-problem of the research, it was observed that, following the review procedures, 46 out of the 226 theses included in the sample were conducted using a "true experimental design." The key findings derived from these experimental theses have been summarized below under the designated thematic categories.

1) Effects of Existing Theories and Approaches on Creativity

Studies indicate that diverse instructional approaches significantly enhance students' creativity, critical thinking, and problem-solving skills. Problem-Based Learning (PBL) strengthens mathematical reasoning, as well as creative and critical thinking, while yielding greater gains in problem-solving and addressing global issues compared to traditional methods. Project-Based Learning improves creativity, academic risk-taking, and achievement in biology and social studies. Project-based instruction combined with Orff-Schulwerk pedagogy produces lasting positive effects on children's creativity. Mathematics teaching through the Purdue Model significantly raises verbal and figural creativity scores. In social studies, PBL fosters problem-solving, higher-order and divergent thinking, creativity, critical reflection, and critical thinking. Furthermore, design thinking enhances participants' creativity perceptions and reduces negative emotions.

2) Programs and Activities Based on Established Approaches

Relevant studies demonstrate that differentiated instructional approaches, creative drama, brain-based, and sensory-focused practices exert significant positive effects on students' creativity, critical thinking, problem-solving, and achievement. In social studies, activities based on the Theory of Successful Intelligence and concept cartoons improved creative thinking and attitudes toward the subject. Brain-Based Learning programs significantly enhanced gifted students' achievement as well as their critical and creative thinking skills. Blended learning and the Parallel Education Program supported Turkish language achievement, critical thinking, and creativity. "Learn – Reflect – Design" practices promoted fluency, flexibility, and originality,

while “A Study on Unconventional Topics ” activities yielded further creativity gains. Science-fiction materials designed through comic techniques were effective tools for fostering creativity in teaching physics concepts. In preschool education, brain-based learning, creative drama-art integration, structured sensory training, and psycho-educational programs significantly elevated creativity scores. Both the Effective Thinking Training Program and newly developed creative thinking models strengthened creative thinking and problem-solving skills. Creative drama not only enhanced creativity but also supported social skills, whereas multisensory awareness training particularly stimulated creativity in design and interior architecture. Furthermore, instructional practices using GeoGebra software were found to positively contribute to students’ creative thinking.

3) Studies Employing Creative Thinking Techniques and Activities

Research indicates that instructional techniques centered on creative thinking and problem-solving generally exert positive effects on students’ academic achievement, thinking skills, and attitudes. In social studies, students exposed to creative thinking techniques showed significant gains in achievement and increased enjoyment of the subject, though this effect did not persist in delayed posttests. The Six Thinking Hats technique improved high school students’ creative and critical thinking as well as academic self-efficacy. Creative problem-solving activities enhanced students’ scientific process skills and academic performance; interviews further revealed positive impacts on problem-solving abilities and attitudes toward physics. Association-based activities significantly improved written expression skills. However, creative relaxation exercises did not yield significant differences in children’s self-concept or motor creativity scores.

4) Differentiated Instruction and Its Impact on Creativity

Research demonstrates that differentiated instructional programs designed for gifted and talented students exert strong effects on achievement, creativity, and thinking skills. Differentiated geometry programs enhanced students’ achievement, creativity, and spatial reasoning. A differentiated English program significantly improved achievement alongside critical and creative thinking. In social studies, a differentiated unit program supported academic achievement, attitudes toward the subject, critical thinking, and creativity. Differentiated science and technology practices yielded positive outcomes in both achievement and creativity. In mathematics, differentiated problem-solving instruction and enriched programs increased problem-solving performance, attitudes toward mathematics, academic self-perceptions, and creativity. Moreover, enriched science programs at the primary level significantly strengthened creative thinking, while differentiated instruction in visual arts raised both achievement and creativity scores.

5) Findings from Other Research

Research reveals significant associations between creative thinking, children’s social behaviors, and certain demographic variables. Among children in mixed-age groups, positive behaviors correlated positively with creativity scores, whereas in isolated-age groups, negative behaviors showed negative correlations with creativity. The *Torrance Test of Creative Thinking for Children* was found to be a valid and reliable instrument, with creative thinking tasks showing significant relationships with gender, grade level, and participation in sports or arts activities. Furthermore, pretest–posttest comparisons indicated that a training program designed to enhance counselors’ creative thinking skills significantly increased posttest scores.

1.3. Discussion

Studies show that efforts to foster creative thinking fall into two categories: those directly training skills (e.g., the Six Thinking Hats technique) and those using creative teaching methods (e.g., differentiated instruction). Programs developed with professional expertise and originality successfully enhance creative thinking.

Different Perspectives on Creative Thinking Education: The literature indicates three distinct approaches to creativity education: “creative teaching” (Kaplan, 2019), “creativity training” (Szmidt & Majewska-Owczarek, 2020), and “creative learning” (Beghetto, 2021; Renzulli, 1992; Aslan, 2014). As seen in the theses reviewed for this study, there is evidence that creative thinking skills can be developed under certain conditions; however, this evidence remains insufficient. For sustainable educational programs and the alignment of national education policies, appropriate conditions must be established. It was observed that researchers in the examined theses rarely emphasized this point, which may be interpreted as a gap in the theoretical framework limitation that can be criticized from the perspective of scientific research methodology.

Developability of Creativity: Another finding is that, through various techniques, instructional methods, and differentiation, the creative thinking skills of both average and gifted students can be developed. In the literature, some scholars argue that creativity is innate and cannot be cultivated (Liu et al., 2014), whereas others explain it through the concept of plasticity, suggesting that creativity can be nurtured through appropriate instructional methods, expert guidance, and environments that foster originality (Scott, Leritz, & Mumford, 2004). The literature does not present either position as definitively correct;

instead, many researchers and educators explore how creativity can be enhanced through cognitive, attitudinal, behavioral, and environmental adjustments.

The Role of Technology: Research shows that technological tools, including computer simulations and virtual reality, help students grasp abstract concepts in science and mathematics. Furthermore, robotics and coding activities promote creative thinking. Yıldız (2022) discusses how digital tools, and online platforms influence individuals' creative potential, emphasizing that AI-supported applications, virtual reality (VR), augmented reality (AR), 3D design software, and digital art tools enhance problem-solving, originality, and aesthetic design skills.

Wang et al. (2024), in a review of 62 experimental studies conducted between 2014 and 2023, reported that virtual technologies generally have positive effects, although the magnitude of these effects varies depending on student level, discipline, type of technology, and instructional methods. Similarly, Tang, Mao, Xing, and Naumann (2022), in an analysis of 61 articles, highlighted that digital technologies can both support and hinder creativity in classroom settings, depending on teaching strategies and learning behaviors. Wanga and Burdina (2023) found that students' creativity, as measured by the Torrance Tests of Creative Thinking, significantly improved following a course designed with innovative educational technologies.

Enriched Instructional Techniques: The literature on developing creativity frequently emphasizes enriched instructional strategies. Bloom's taxonomy (Bloom, 1956; Yıldıran & Aydın, 2005) introduced a new perspective on learning, and subsequent curriculum designs (Sönmez, 2020) underscore the value of full learning for fostering creative thinking. Considering contemporary emphases on innovation and entrepreneurship, mastering learning objectives appears essential to producing creative ideas.

Problem-Solving and Decision-Making Skills: Studies show that domain-based activities (e.g., in science and social studies) enhance students' creative thinking, problem-solving, and decision-making skills. Methods like the Six Thinking Hats yield similar positive results. For example, Yonata, Tjahjani, and Novada (2018) investigated the relationship between creative thinking, problem-solving, and higher-order thinking skills (HOTS) in chemistry laboratory work. Their study showed that students' HOTS performance increased from 61% on the pre-test to 100% on the post-test, with students designing original experiments, thereby supporting creative thought.

Holistic Development: The findings of this research and related literature indicate that fostering multiple interrelated skills, including creativity, scientific process skills, critical thinking, and academic achievement is essential for nurturing well-rounded and successful individuals. Yang and Zhao (2021), in a study of 2,355 high school students, found a positive correlation between creative thinking and academic achievement. They reported that convergent thinking had a stronger impact on academic performance than divergent thinking, with self-confidence and internal locus of control serving as mediating factors. This effect was particularly evident among disadvantaged groups.

Teacher Competencies: Teachers play a key role in fostering creative thinking by mastering student-centered methods and creating supportive environments. Therefore, teacher education must improve in quality, expanding programs that develop teachers' own creativity.

Teachers influence students' creative thinking through classroom and extracurricular behaviors, beliefs, and attitudes. Chambers (1973) identified several characteristics of teachers who promote creativity:

- They conduct classes informally, allowing flexibility for students' preferences.
- They prepare thoroughly and rely less on prescribed texts, avoiding reading directly from notes or books.
- They encourage critical thinking and discussion, using disagreements as opportunities for debate.
- They promote the expression of unusual or alternative viewpoints and reward student initiative, originality, and creativity.
- They foster deep problem exploration and insight formation.
- They are more accessible outside class, while avoiding dependent relationships.
- They consistently model originality and creativity through enthusiasm for both their subject matter and learning in general.

Hong, Hartzell, and Greene (2009) examined the relationship between elementary teachers' epistemological beliefs, intrinsic motivation, and goal orientations, and their creativity-promoting teaching practices. They found that teachers with strong learning-oriented goals created classroom environments that engaged students actively, emphasized effort, and framed learning as an active process.

Paek and Sumners (2019) explored how teachers' implicit beliefs (mindsets) about creativity influence their ability to foster it in students. They identified a "Fixed Creative Mindset," which assumes creativity is innate and unchangeable, as having an indirect negative impact on teachers' self-efficacy in teaching creativity, mediated by their perceptions of students' creative potential. The stronger teachers' belief that creativity is inborn, the less they perceived every student as having creative potential, undermining their confidence in teaching creativity. Conversely, a "Growth Creative Mindset," which views creativity as teachable and improvable, mitigated the negative effects of fixed beliefs and enabled teachers to recognize even minimal creative potential in students. Paek and Sumners emphasized that fixed and growth mindsets are distinct constructs, suggesting that teacher education programs can reshape teachers' beliefs and encourage the development of a growth-oriented view of creativity.

1.4. Conclusion

This research delineates the quantitative growth of creative thinking studies in Türkiye and conclusively demonstrates that this skill can be developed through appropriate pedagogical interventions, such as problem/project-based learning, differentiated instruction, and technology integration. As emphasized in the discussion, sustainable success is contingent upon teachers adopting a "growth mindset," the development of original theoretical frameworks, and the effective use of digital tools. Ultimately, fostering creative thinking is not merely a methodological issue but requires a holistic and systematic approach encompassing teacher competencies, educational policies, and classroom practices. These findings provide a critical foundation for future research and educational implementation.

1.5. Recommendations

- Educational curricula should be enriched with activities and techniques that foster creativity and higher-order thinking skills. These practices ought to be widely implemented, particularly beginning at the primary education level.

- In science education, greater emphasis should be placed on the use of computer-assisted simulations and virtual laboratory applications. Such tools not only make the learning process more engaging and tangible but also enhance students' scientific process skills.

- Teacher training programs should prioritize hands-on instruction in creative thinking, problem-based learning, and computer-assisted teaching methods. It is essential that prospective teachers be equipped with the necessary knowledge and competencies to effectively integrate these techniques into their classrooms.

- Academic achievement assessments should move beyond rote memorization and incorporate alternative evaluation methods that measure advanced cognitive skills such as creative thinking, problem solving, and critical analysis.

- Given that the development of creativity is a time-intensive process, instructional practices should be designed as long-term and systematically planned interventions rather than short-term implementations.

- Similar studies should be replicated across diverse subject areas, age groups, and larger sample sizes to enable a more comprehensive analysis of the impact of modern teaching methodologies. In particular, the influence of interdisciplinary approaches on these skills warrants further investigation.

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Investigation of Gifted Student's Statistical Thinking in Mathematical Modeling Task

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Abstract

This study aimed to investigate the differences in the use of statistical thinking between gifted and non-gifted students in mathematical modeling problems. This was designed as a case study, and the task involving a mathematical modelling problem was executed with seventh-grade gifted and non-gifted students in a private school in Ankara province in the spring semester of the 2024–2025 academic year. The study group consisted of two female students. Furthermore, both groups demonstrated the ability to engage in statistical thinking through the mathematical modeling problem in a real-life context. They engaged with the context meaningfully, interpreted data, and reasoned with evidence to support their conclusions. To gain deeper insights into students' reasoning processes and their background, semi-structured interviews were conducted with students after the implementation of the mathematical modeling task. Moreover, the statistical thinking process and answers of the students were evaluated using a framework-based performance analysis focusing on statistical thinking skills. The data analysis shows that there are observable differences between the gifted and non-gifted students in terms of their use of statistical thinking skills during the mathematical modeling task. It was determined that gifted students provided more insightful interpretations and reasoning, whereas non-gifted students tended to give brief or incomplete explanations.

Keywords: *Gifted, Mathematical Modelling Problem, Statistical Thinking, Mathematics Education*

Introduction

As individuals have increased access to information and data-based decision-making processes have spread to every aspect of daily life, statistical thinking has begun to emerge as a fundamental cognitive skill necessary to cope with uncertainty and variability (Franklin et al.,2007). At this point, it involves understanding the answer to the question of why and how. Although this is often viewed as a series of operations, it involves not only using statistical tools and performing operations but also reasoning about data and uncertainty (Wild & Pfannkuch, 1999). Considering these points, educating students who can think statistically has become compulsory and is at the core of modern education. In this way, enabling students to critically analyze data, make decisions, and solve real-world problems can be achieved (Nor Azmay et al., 2023).

In Turkey's 2024 national mathematics primary school curriculum, students are expected to develop statistical thinking skills from 1st grade to 8th grade (T.C. Ministry of National Education [MEB], 2024). With the objectives related to collecting and analyzing data, creating and interpreting graphs in the curriculum, students can have the opportunity to systematically develop their skills in gradually interpreting statistical information and making data-based decisions.

According to Wild & Pfannkuch (1999), statistical thinking is not possible without contextual knowledge, and when examples used in teaching are given and isolated from meaningful contexts, students fail to internalize statistical thinking and apply it. Therefore, presenting students with a statistical problem based on real-world data and having students examine that data, generate different possible solutions, evaluate how well their methods work, and explain and justify their solutions can be effective in activating students' statistical thinking (Garfield, delMas, & Zieffler, 2010). Given these, model-eliciting activities might be effective in engaging students in statistical reasoning and thinking processes. Model-eliciting activities (MEAs) are open-ended problems that allow students to build and test models to solve real-world problems (Garfield, delMas, & Zieffler, 2009). According to Lesh & Doerr (2003), modeling activities are designed to make students' thinking processes observable, so the process is more important than the result. The model development process involves the process of organizing objects, relationships, processes, patterns, or rules, and requires a series of iterative modeling cycles that are repeatedly tested and revised as shown in Figure 1 (reprinted from Lesh & Doerr, 2003).

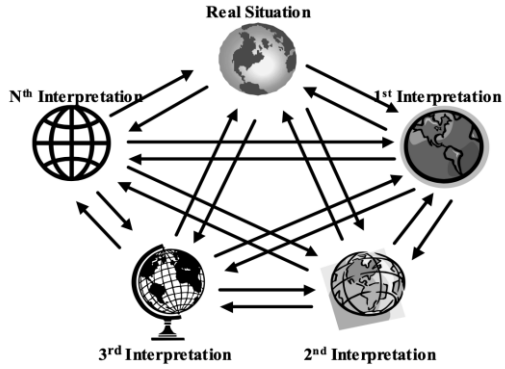

Figure 1. Iterative Cycles. *Reprinted from Lesh & Doerr (2003)*

While problem-solving in traditional approaches is seen as a secondary stage that is abstract and independent of context and should be addressed after the acquisition of knowledge and skills, the modeling approach focuses on students developing their thinking processes by directly participating in meaningful and real-life problems. In addition, in modeling activities, students are expected to understand, interpret, and describe the problem before starting the solution process. In this process, conceptual development progresses by deepening in various stages, without being tied to a strict order, and learning is shaped by the active participation of the student (Lesh & Doerr 2003). It is also important to understand the characteristics of students to ensure their active participation.

Gifted individuals are recognized for their unique achievements and creative contributions (Renzulli, 2011). According to Renzulli (2016), these individuals possess a high capacity to process information, integrate experiences, and derive meaning from them. In the study conducted by Yılmaz and Altun (2016), the mathematical thinking processes used by gifted students while solving probability problems were examined, and it was concluded that they had strong characteristics in mathematical modeling, strategy development, and reflection skills based on daily life problems. Renzulli (2016) states that they also stand out with their task commitment and exhibit high levels of perseverance and determination. In addition, their creative thinking skills are well-developed, and their willingness to take risks and their interest in complex situations are among their distinguishing features (Renzulli & Reis, 2018).

In this context, it can be said that gifted students need activities that will support their statistical thinking processes, connect them to real life, and activate complex thinking skills. Although modelling questions can foster statistical thinking (Garfield, delMas & Zieffler, 2009), current practices often fail to address the cognitive and motivational needs of gifted students (Özdemir & Işıksal Bostan, 2021).

This study aims to investigate how gifted students think and what kind of strategies they use in statistical thinking process. In doing so, it might be an efficient to examine the differences between gifted and non-gifted students' use of statistical thinking in mathematical modeling problems comparatively. So, this study seeks to answer the following question:

To what extent do gifted students and non-gifted students differ in terms of their statistical thinking when engaging in mathematical modelling problems?

Consequently, revealing the differences between the statistical thinking levels of students identified as gifted and non-gifted in mathematical modeling processes is important in terms of designing differentiated teaching approaches according to the students' differences. In this case, the necessity of an education system in which students' needs are addressed homogeneously and differentiated teaching practices are given place according to student needs increases. Therefore, this study can guide teachers, principals, academicians, and administrators.

Method

Research Design

This study was designed as a case study because it aimed to conduct an in-depth investigation and collect comprehensive data on the difference between gifted and ungifted students' use of statistical thinking in mathematical modeling problems (Creswell, 2013).

Research Sample

The participants were selected using the convenience sampling method as they were readily accessible and willing to participate in the study (Creswell, 2013).

They are two female students, one identified as gifted in general ability and both students are studying in the 7th grade at a private school in Ankara. The gifted student attends the Science and Art Center (BİLSEM) in addition to the formal education process. In addition, neither student is enrolled in any additional course or program other than tutoring.

Research Instrument and Procedure

Data were collected using an activity sheet that included a mathematical modeling task and semi-structured interviews. Task adapted from the mathematical modeling problems created by Erbaş et al. (2024) and it involves estimating which country is closest to the location of a ship lost at sea, using comparative analysis of the data. The task is designed so that students compare quantitative data with each other while also experiencing the process of dealing with missing values in data.

The task was implemented outside of school hours in a quiet and comfortable environment. Students were not restricted by time, but both students completed the task and semi-structured interview in approximately half an hour. The student solutions were recorded with audio recordings, aiming to reveal statistical thinking processes with why and how questions. The students' responses to the activity sheets and supporting drawings were collected for use in the study. Moreover, written and verbal consent was obtained to ensure that the students participated in the study voluntarily. The parents of the participants were informed about the process through the informed consent form, and their written consents were obtained. In addition, the study was conducted with the permission approved by the relevant ethics committee.

Data Analysis

The task aims to examine students' statistical thinking skills with a multidimensional approach. The questions are structured based on the four basic statistical thinking constructs defined by Jones et al. (2000), namely Describing data displays (D), Organizing and reducing data (O), Representing data (R), and Analyzing and interpreting data (A).

Describing data display construct includes students' ability to evaluate data or interpret graphs. In order to level student representations, it is stated in the article that the focus will be on reading, demonstrating, and awareness of data (Jones et al., 2000).

In addition, one of the other constructs is organizing and reducing data. It means that students simplify data using the concepts of central tendency and organize data by ordering, grouping, and summarizing (Jones et al., 2000).

Representing data construct involves creating visual displays that can show different representations of data. In order to level student representations, it is stated in the article that the focus will be on data awareness, graphing conventions, and establishing numerical relations between the displays (Jones et al., 2000).

The last construct is analyzing and interpreting data. It makes inferences about variables and involves the student noticing and analyzing information that cannot be directly inferred. Leveling was conducted based on whether students make these inferences or not and the relationship of their answers to the context (Jones et al., 2000).

In addition, the questions are designed to include the “analysis” and “conclusion” stages of the Investigative Cycle (PPDAC) model developed by Wild and Pfannkuch (1999).

Students comprehensively experience statistical thinking processes by applying steps such as analyzing and comparing data, dealing with missing data, making inferences, and interpreting results in the process of generating solutions to the problem. Thus, the activity has a structure that integrates both the cognitive dimensions of statistical thinking and the real-life-based statistical inquiry process.

Also, there are four developmental levels were defined to describe how students think when they encounter statistical information (Jones et al., 2000). While investigating the findings, students' thinking styles were analyzed in detail and evaluated according to these levels. These are Level 1: Idiosyncratic, where superficial ideas are presented, Level 2: Transitional, where they begin to recognize basic patterns, Level 3: Quantitative, where they can analyze and compare in detail, and Level 4: Analytical, where they can make in-depth interpretations, inferences, and generalizations.

Results

The findings revealed that both students performed at different levels of thinking in each construct.

The students differed in terms of their explanations in the describing data displays component. For example, gifted student expressed that *" The values of country B generally fell between the values of A and C. In addition, approximately monthly data first decreased, then remained stable, and then increased."* In other words, she paid attention to multiple aspects by focusing on both countries and months. On the contrary, the non-gifted student stated that *"The annual values of all of them generally decreased first and then increased."* With this explanation, she only looked at the annual total and made a general comment. Considering the levels, while the gifted student showed Level 3 thinking, the non-gifted student showed Level 2.

Also, they differed in terms of typicality and their explanations among Organizing and Reducing Data construct. For example, the gifted student stated that,*"There was more rain in winter and less in summer. Looking at the November and January data, I can say that December will be at least 11 and at most 13. Since the increases and decreases are irregular, I cannot give a definite value, but I can say that it is between 11 and 13."* With these answers, the student provided explanations about finding range and grouped the data according to the seasons. On the other hand, the non-gifted student stated, *"The missing value in December should increase by 3, like the previous increase. Therefore, December will be 13."* She focused on the difference between data and provided a partially valid explanation since there was no definite answer to the modeling problem. Therefore, the gifted student exhibited Level 3 thinking, while the non-gifted student remained at Level 2.

Especially in the data representation, both students preferred to draw a bar graph while representing the data. When this situation was interpreted by considering the interviews with the students, it was seen that it could be related to the students' previous experiences. The students emphasized that using a bar graph was easier, more practical and more understandable. In addition, the students differed in terms of the structures of the bar graph. The gifted student tried to create the most accurate bar graph by focusing on the details. The non-gifted student, on the other hand, acted in a more hasty attitude, focused on finishing as soon as possible and did not pay enough attention to the bar graph design. As seen below, there are some convention problems in the graph drawn by the gifted student, but the student made an effort to reorganize it and thought about it. In the graph of the non-gifted student, in addition to the alignment problems and convention problems, there is no attempt to correct them. Therefore, the gifted student is at Level 3, and the non-gifted student is at Level 2.

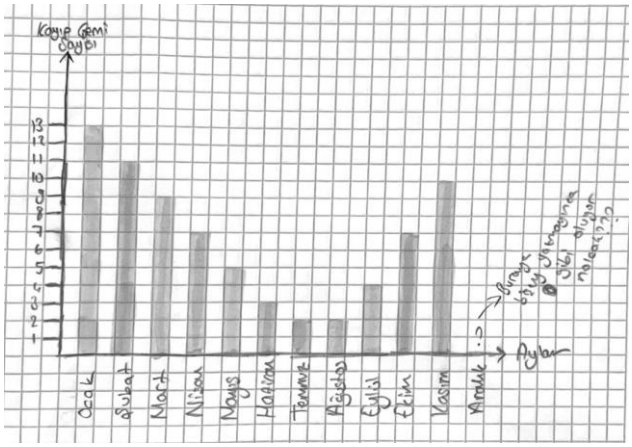

Figure 1. Gifted Student's Bar Graph

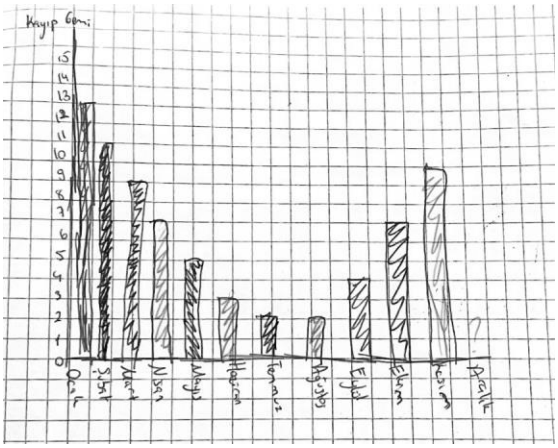

Figure 2. Non-Gifted Student's Bar Graph

In addition, in the Analyzing and Interpreting Data construct, students displayed different ways of thinking when providing detailed explanations about the data. While the gifted student supported the relationships between the data with quantitative explanations, the non-gifted student kept the mathematical relationships in the background by making these explanations more superficial. To illustrate, the gifted student focused on the differences between the data and tried to establish relationships about the changes in the differences, while the non-gifted student focused on the similarities between the data and focused on matching the same data. In other words, the gifted student stated that*"*Since the increases and decreases between the data are irregular, it is not possible to say a pattern. However, approximately, in both country C and the Lost Ship, the data initially decreased by twos towards winter, then remained constant and then started to increase by threes.*"* On the contrary, the non-gifted student said that *"I counted the same data. There seems to be more similar data between the data of country C and the missing ship."* Therefore, the gifted student was placed at Level 3 and the non-gifted student was placed at Level 2.

Discussion and Recommendations

Discussion

As stated by Garfield, delMas, and Zieffler (2009), modeling questions can encourage statistical thinking. In this study, it can be said that the motivational and cognitive needs of the gifted student were met in the mathematical modeling question because the student thought about possible outcomes and willingly questioned possible answers. These findings are consistent with the information stated by Renzulli (2016) that gifted students process and interpret information in depth, and therefore are motivated and cognitively active.

Moreover, considering gifted students' interest in complex situations and well developed creative thinking skills (Renzulli & Reis, 2018), it can be seen that gifted student enjoyed dealing with the open-ended modeling question that included a real-life concept and was motivated throughout the task to attempt productive solutions. These findings also support previous studies in the literature. In the study conducted by Yılmaz and Altun (2016), it was concluded that gifted students had strong characteristics in mathematical modeling, strategy development, and reflection skills based on daily life problems. In addition, since mathematical modeling questions make students' thinking processes observable (Lesh & Doerr, 2003), the thinking styles of the gifted student in this process could be clearly observed. Compared to the non-gifted student, the student focused more on cause and effect relationships when examining the data during the task solution process and gave importance to these relationships when making predictions. Similarly, in the study conducted by Rocha, Almeida, and Perales (2020), executive functions such as working memory, planning, and cognitive flexibility of gifted and non-gifted students were compared, and it was concluded that gifted students showed higher success in problem-solving, reasoning, and memory skills.

Taking into consideration, mathematical modeling problems might meet the cognitive and motivational needs of gifted students.

When the analysis of the interviews and written responses was examined, it was seen that the gifted student was generally at Level 3, while the non-gifted student was at Level 2. Considering what Renzulli and Reis (2018) stated, this difference may have arisen from the gifted students' capacity to process information, their interest in complex situations, and their determination. In addition, whether the context of the modeling problem attracted the students' attention or not may have affected their thinking and, therefore their performance. According to the information obtained from the interviews, the gifted student stated that he liked the task and had fun, while the non-gifted student stated that the ship's disappearance was meaningless and therefore did not attract his attention. In addition, the difference between them may be related to the students' backgrounds. Because both students have different environmental factors and educational backgrounds. For example, the non-gifted student sometimes referred to his teacher at school while explaining his answers and responded by saying, *" These are not on the exam, what good will it do me to find out the results?".*

Recommendation

The findings of this study may help teachers prepare lesson plans and course materials that meet the needs of gifted students. In addition, it may lead teachers to include mathematical modeling problems that engage gifted students motivationally and cognitively in their lessons. Moreover, this study may inspire researchers to conduct future studies on differentiated learning environments that engage gifted students.

Considering the limitations of this study; since the number of participants was 2, the statistical thinking skills of gifted and non-gifted students may not be sufficient to explain the difference. In addition, the study can be conducted with other grade levels as well as 7th grade students. Therefore, future studies can be conducted with more participants from different grade levels.

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The Relationship Between Code-Related Skills and Reading Comprehension of d/Deaf and Hard of Hearing Students

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Abstract

In the field of deaf education, there is an ongoing debate about how d/Deaf and hard-of-hearing (d/Dhh) students develop reading skills. One view argues that all students, including those who are d/Dhh,learn to read in a similar way as hearing students—implying that phonological code-related skills are important. In contrast, another view argues that d/Dhh students rely on visually based processes and that sound-based phonological coding is not realistic for those without functional hearing. This study explores the relationship between code-related skills and reading comprehension in d/Dhh students and examines whether this relationship differs by degree of hearing loss. The publicly available Special Education Elementary Longitudinal Study (SEELS) dataset was used to conduct two analyses. In the first analysis, a Complex Samples General Linear Model (CS-GLM) showed that students' grade level, degree of hearing loss, communication method, and letter-word identification skill explained 59.7% of the variance in reading comprehension scores, with degree of hearing loss is not being a significant factor. In the second analysis, a hierarchical multiple regression revealed that 54.6% of the unique variance in passage comprehension was accounted for by letter-word identification skill, while degree of hearing loss again remained non-significant. These findings provide evidence for the Qualitative Similarity Hypothesis (QSH), suggesting that d/Dhh students read in fundamentally the same way as hearing students. Therefore, educators should consider instructional strategies that include alternative presentations of phonological coding (e.g. Visual Phonics) to help d/Dhh students develop sound-based decoding skills.

Keywords: *code-related skills; reading comprehension; deaf and hard of hearing students; qualitative similarity hypothesis; phonological awareness;*

Introduction

Reading is a complex cognitive process and an essential skill for academic success and daily life. According to the Simple View of Reading (SVR), reading comprehension is the product of decoding and linguistic comprehension. Decoding is the ability to translate printed symbols into words by connecting letters to their sounds, a process requiring phonemic awareness. Phonemic awareness together with phonics provides the foundation for decoding in the early stages of reading development (Adams,1990; Hoover & Gough, 1990). During early years, decoding skill is the dominant contributor to reading comprehension (correlations around 0.55), whereas linguistic comprehension becomes more influential later (correlations around 0.35). Thus, code-related skills (e.g., letter-sound knowledge, phonological awareness) are especially crucial early in literacy development, while language-related skills (e.g., vocabulary, syntax) grow in importance over time. Yet reinforcing decoding skills remains effective even for older struggling readers (National Reading Panel [NRP], 2000).

Emergent and conventional literacy can be broadly divided into code-related and language-related skills. Language-related factors (e.g., vocabulary, syntax) support comprehension, whereas code-related skills (e.g., phonemic awareness, grapheme–phoneme correspondences) enable decoding. Skilled readers coordinate both processes during reading. The importance of each domain shifts developmentally: in early literacy, code-related skills are strong predictors of achievement, while comprehension skills become more central later. Still, foundational code skills remain critical at all ages (NRP, 2000). The National Early Literacy Panel (2008) identified alphabet knowledge and phonological awareness as key predictors of later reading success, underscoring their lasting significance.

Historically, students with hearing impairments have lagged behind hearing peers in reading achievement. On average, d/Dhh students' reading levels advance only about 0.3 grade per year, compared to a full grade per year for hearing peers (Spencer & Marschark, 2010). Many d/Dhh adolescents and adults thus read at significantly lower levels (Paul, 2009). Both language-related and code-related domains contribute to these difficulties (Trezek & Wang, 2017). Considerable debate persists regarding the role of phonological coding for d/Dhh students, especially those with profound hearing loss who primarily use sign language (Alasim & Alqraini, 2020; Allen et al., 2009; Wang et al., 2008).

Two broad perspectives dominate this debate. The first, aligned with the Qualitative Similarity Hypothesis (QSH), argues that d/Dhh children's reading development is qualitatively similar to that of hearing children. According to QSH, d/Dhh students follow the same fundamental stages, though at a slower pace (Paul, 2023; Paul et al., 2013). They make similar errors and use parallel strategies, differing only quantitatively (Paul & Lee, 2010). QSH posits that core components such as decoding and vocabulary are necessary for all learners, regardless of hearing status, though instruction should be adapted to needs (Paul, 2023).

The second perspective contends that d/Dhh children's reading depends on access to hearing, and that profoundly deaf students without functional hearing do not require a sound-based coding system. Proponents argue these students rely on visually based strategies, such as word-shape recognition or sign correspondences, rather than phonological coding (Allen et al., 2009; Miller & Clark, 2011). In this view, phonological decoding is unnecessary for learners who cannot hear sounds. Instead, they may build literacy through robust vocabulary, print knowledge, and visual memory. For d/Dhh students with some functional hearing (e.g., cochlear implants or hearing aids), learning may more closely resemble hearing children, while those without usable hearing may rely primarily on visual routes (Webb et al., 2015).

Code-Related Skills in d/Dhh Readers

Phonological and alphabetic coding skills remain the most debated aspect of reading instruction for d/Dhh students. The NRP (2000) identified phonemic awareness and phonics as two essential components of effective instruction. In hearing children, phonological skills and reading are reciprocal: phonological knowledge facilitates reading, and reading refines phonological representations (Kyle & Harris, 2011; Spencer & Marschark, 2010). For d/Dhh students, phonological skills are often delayed or atypical due to limited sound access. Many have weaker phonological awareness than hearing peers, though more skilled deaf readers show greater use of phonological information (Harris et al., 2017). Severity of hearing loss is linked to phonological skill, though cochlear implants versus hearing aids do not yield major differences (Easterbrooks et al., 2008).

Alphabetic knowledge—naming letters and understanding grapheme–phoneme correspondences—is a strong predictor of later reading (National Early Literacy Panel, 2008). For d/Dhh children, letter knowledge is essential for developing decoding strategies and even phonological awareness through visual or tactile means (Easterbrooks et al., 2008). Research shows that while d/Dhh children's letter-name knowledge is often age-appropriate, their letter-sound knowledge lags. In one study, letter–sound correspondences in the fall predicted comprehension scores in the spring (Easterbrooks et al., 2008). This highlights the importance of early code skills. Some scholars argue that lack of spoken phonology underlies many d/Dhh reading challenges (Lederberg et al., 2019). Werfel et al. (2023) found that preschool d/Dhh children scored lower than hearing peers on phonological awareness and memory tasks, starting school with weaker emergent literacy skills. This gap suggests that targeted support is needed to build phonological codes, possibly through visual or tactile methods such as visual phonics or cued speech.

Encouragingly, interventions show that d/Dhh children can develop phonological codes when taught with appropriate methods. Daza González et al. (2023) implemented a multisensory phonological training program integrating visual, kinesthetic, and vibrotactile techniques. It significantly improved decoding and even syntax skills. After training, students demonstrated a "pseudohomophone effect," though gains diminished without continued intervention. The authors concluded that multisensory teaching can help d/Dhh children achieve higher comprehension by the end of primary school. These findings underscore that phonological routes to reading are attainable for d/Dhh students when instruction is intensive and sustained.

Code-related skills also include visual code systems such as fingerspelling and sign print mapping. Evidence suggests that fingerspelling can bridge orthographic and phonological structures for signing students. Ormel et al. (2022) found that both speech-based and sign-based code skills contributed to reading fluency in a bilingual program. Fingerspelling was a strong predictor, while spoken phonological awareness predicted some word reading but not text fluency. Sign-based phonological awareness also showed some relation to reading. These results suggest that for many deaf learners, alternative visual pathways like fingerspelling play a crucial role alongside traditional code skills.

Couvée et al. (2024) found that early code-related skills strongly predicted later reading outcomes. Word decoding in second grade correlated with kindergarten phonological awareness and letter knowledge. Reading comprehension was linked to nearly all early measures, except fingerspelling. Students with the weakest kindergarten letter knowledge became the poorest readers. Vocabulary knowledge also proved critical. Olujić Tomazin et al. (2025) concluded that vocabulary is the most consistent predictor of text-level comprehension in deaf readers, whereas phonological contributions are mixed. Morphological and syntactic skills also matter, and sign language skills show cross-modal influence: richer sign vocabulary and grammar correlate with better comprehension. Thus, while phonological code skills are important, they are part of a

larger constellation of language abilities. Ensuring that d/Dhh students develop broad vocabulary (spoken or signed) may be the most impactful way to improve comprehension.

Educational Assessments for d/Dhh Readers

Assessing d/Dhh students often involves standardized measures used with hearing peers, with accommodations as needed. This study used data from the Special Education Elementary Longitudinal Study (SEELS), which included direct assessments of reading skills in d/Dhh children. The focus was on two Woodcock-Johnson III (WJ-III) subtests: Letter-Word Identification (decoding) and Passage Comprehension. These measures allowed quantification of decoding and comprehension, and analysis of their relationship for d/Dhh students. Prior research shows d/Dhh students often score lower on comprehension, though variability exists (Antia et al., 2020). The study addressed three questions:

1. How much variance in reading comprehension of d/Dhh students can be explained by code-related skills?
2. Is there a significant relationship between code-related skills and comprehension?
3. Does this relationship differ by degree of hearing loss?

Based on QSH and prior evidence, it was hypothesized that decoding skills would significantly predict comprehension, regardless of hearing loss severity. Degree of hearing loss was not expected to moderate the relationship, meaning even profoundly deaf students should show a positive link between decoding and comprehension.

Method

Data Set

This study uses a public dataset of the Special Education Elementary Longitudinal Study (SEELS). The main purpose of SEELS was to provide details on characteristics, achievements, experiences, and outcomes of students with disabilities from twelve federal disability categories. This dataset provides information about a nationally representative sample of more than 11,000 students. From 2000 to 2006, data were gathered in three waves with multiple data collection methods.

Design

SEELS employed a complex sampling design. Students with disabilities were randomly selected from the nationally representative sample. Low incidence disability categories such as visual impairments and hearing impairments were oversampled to ensure equal precision in measuring all disability categories. Also, weights were used to create population estimates.

Participants

Two separate analyses were conducted for this study. The participants for Study 1 were 483 students with hearing impairments from Wave 1 direct assessment measurement. Data were collected in the 2000-2001 academic year. Study 2 participants were 852 children with hearing impairments. Data for Study 2 were collected in the 2003-2004 (Wave 3) academic year.

Instrument

Research editions of the Woodcock-Johnson III (WJIII) test were conducted for reading assessments that also allow comparison with the general population. Two reading subsets were Letter Word Identification which measured letter and word identification skills that measure code related skills and Passage Comprehension which measures reading comprehension.

Data Analysis

SPSS was used for statistical analysis and descriptive statistics were used for demographic information. For study 1, the Complex Samples General Linear Model (CS-GLM) was conducted for regression analysis. For study 2, a hierarchical multiple regression model was conducted. These studies involved a subpopulation analysis and it is recommended to filter cases

rather than delete, so data was filtered by the disability category of hearing impairments (Hahs-Vaughn, 2006). Also, cases with missing values were filtered.

Results of Study 1

483 students with hearing impairments participated in Wave 1 of the SEELS direct assessment and this is 12.3 % of the total SEELS participants (n= 3912). With the weights on, these students represent 36,042 students from all students with disabilities, and this is only equal to 1.2% of them. Their ages ranged from 7 to 14 (*M* = 10.9, SD = 1.86) years in 2000-2001. Over 53% of students were male (n = 258), and 68.5% of students were white (n = 331). Only twenty-four of them had a cochlear implant (reflecting early 2000s cochlear implant availability) even though 48% of them had profound hearing loss, and one-third of the students' assessment was administered in ASL (n = 163). For more information, Table 1 presents the demographic characteristics of the students (n = 483).

Table 1: Demographics of students with hearing impairments

	frequency	percent
Gender		
Male	258	53.4
Female	223	46.2
Ethnicity		
White	331	68.5
African American	63	13.0
Hispanic	65	13.5
Level of hearing loss		
Mild hearing loss	70	14.5
Moderate hearing loss	127	26.3
Profound hearing loss	232	48.0
Student' grade		
Ungraded	9	1.9
1st to 3rd	141	29.2
4th to 5th	155	32.1
6th and above	177	36.6
Student's Income		
$25,000 and under	172	35.6
$25,001 to $50,000	133	27.5
Over $50,000	151	31.3

Two outcome variables of the study are passage comprehension and letter-word identification. For both variables complex samples descriptive statistics were used to calculate mean scores. The passage comprehension mean score is 83.1523 for students with disabilities and 83.1744 for d/Dhh students. Letter word identification mean score is 83.2697 for students with disabilities and 83.2562 for d/Dhh students. There is no meaningful difference between scores.

Results of the CS-GLM demonstrated that the variables representing students' grades, level of hearing loss, communication method, and letter word identification explained 59.7% (R2 = .597) of the variance in reading comprehension scores. All predictor variables were statistically significant (P < .001) except students' level of hearing loss (P = .580). The results show that the overall modal is significant F (7, 116) = 86.472, p < .001.

Table 2: Test of model effects

Source	df1	df2	Wald F	Sig.
Corrected Model	7	116	86.472	.000
Intercept	1	122	22.081	.000
Assessment administered in ASL	1	122	12.355	.001
Degree of hearing loss	2	121	0.547	.580
Grade	3	120	17.617	.000
Letter-word identification	1	121	370.552	.000

Results of Study 2

852 students with hearing impairments participated in Wave 3 of SEELS direct assessment and this was 11.1 % of the total SEELS participants (*n*= 7650). Their ages between 10 to 17 (*M* = 13.6, *SD* = 1.9) years. Almost 54% of students were male (*n* = 458), and 63.5% of students were white (*n* = 541). For more information, Table 3 presents the demographic characteristics of the students.

Table 3: Demographic of students with hearing impairments (*n* = 852)

	frequency	percent
Gender		
Male	458	53.9
Female	392	46.1
Ethnicity		
White	541	63.5
African American	130	15.3
Hispanic	139	16.3
Level of hearing loss		
Mild hearing loss	88	10.3
Moderate hearing loss	200	23.5
Profound hearing loss	335	53.8
Student's Income		
$25,000 and under	271	31.8
$25,001 to $50,000	210	24.6
Over $50,000	354	41.1

After collecting demographic information filter variable was created to filter cases with missing values. 564 cases have all the information and these cases were used for the rest of the analysis. The outcome variable of the study is passage comprehension and letter-word identification scores are the primary predictor variable. The standardized mean score for the letter-word identification subtest is 80.58, and for passage comprehension is 77.97.

Table 4. Correlation Matrix

	Measure	1	2	3	4	5	6
1	gender						
2	age	0.034					
3	income	-0.067	-0.002				
4	ethnicity	0.014	-0.015	-.293**			
5	hearingloss	0.063	0.052	0.013	0.036		
6	Letter word-identificatio	0.034	-.115**	.168**	-.195**	-.134**	
7	Passage comprehension	0.065	-.130**	.114**	-.228**	-.138**	.793**
	** Correlation is significant at the 0.01 level (2-tailed).						

Table 4 shows the bivariate correlations between variables. Strong positive correlation is between letter-word identification and passage comprehension (r = .793, p <.001). The table below shows a summary of the hierarchical multiple regression model that predicts passage comprehension by letter-word identification and degree of hearing loss, controlling for gender, age, socio-economic status, and ethnicity.

Table 5: Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.279a	0.078	0.071	21.0537	0.078	11.801	4	559	0.000
2	.308b	0.095	0.087	20.87973	0.017	10.354	1	558	0.001
3	.800c	0.640	0.637	13.1703	0.546	845.468	1	557	0.000
4	.800d	0.641	0.636	13.17769	0	0.376	1	556	0.540

In Step 1, gender, age, income, and ethnicity were included as covariates. The first additive model explained 7.8 % of the variance in passage comprehension. The omnibus test suggests that the first model is statistically significant (F (4, 559) = 11.801, p <.001). In Step 2, the degree of hearing loss was added. Improvement to the second model is significant and 1.7 % of additional variance in passage comprehension is accounted for degree of hearing loss (ΔR2 = .017 (F (1, 558) = 10.354, p = .001). In Step 3, letter-word identification scores were added. The third model was accounted for 64 % of the variance in passage comprehension. Improvement to the third model is significant and 54.6 % of additional variance in passage comprehension is accounted for letter-word identification (ΔR2 = .546 (F (1, 557) = 845.468, p <.001). In Step 4, the interaction term letter-word identification times degree of hearing loss was added, and the interaction term was not statistically significant (F (1,556) = .376, p = .540).

The full model accounted for 64.1 % of the variance in passage comprehension. The omnibus test suggests that the full model is statistically significant (F (7, 556) = 141.625, p <.001), but the improvement is nonsignificant. Degree of hearing loss is nonsignificant predictor of passage comprehension (t (556) =-.921, p = .358). Letter-word identification is a significant predictor of passage comprehension (t (556) = 22.840, p <.001). Holding all other variables constant, for every one-point increase in letter-word identification, there is a predicted .741-point increase in passage comprehension. Part correlation for letter-word identification is .581indicating that 33.7 % of the variance in passage comprehension is uniquely explained by letter-word identification scores, after partialing out the effect of all other variables.

It is not worth adding the interaction between letter-word identification and degree of hearing loss to predict passage comprehension when both main effects are already in the model (F = .376; df = 1, 556; p = .540). The third model (no interaction) fits the data well. Degree of hearing loss does not moderate the effect of letter-word identification on passage comprehension. Based on the third model, letter-word identification has a positive impact on reading comprehension (t = 29.077, df = 556, p <.001) for students with hearing impairments. For each unit increase of letter-word identification, passage comprehension is expected to increase by .753%. Passage comprehension scores of students with severe hearing loss are 1.409 % less than students with mild and moderate hearing loss, but the difference is not significant (t =-1.211, df = 556, p = .226).

Discussion

Students with hearing impairments make small progress in reading achievement when compared to typically developing students. For example, Wei et al., (2011) estimated the reading growth of students with disabilities using SEELS data. From all three waves 3, 421 students were included. The authors found that reading achievement changed by disability category such as students who are blind and/or visually impaired and students with speech and language impairments had highest scores but students with hearing impairments and/or autism improved more slowly.

Also, there is an ongoing debate related to the reading development of d/Dhh students (Wang et al., 2008). One group argues that d/Dhh students' reading development is similar to that of hearing learners regardless of individual differences (Mayer & Trezek, 2015; Paul, 2009; Paul et al., 2013). Another group says phonological coding (via sound) is unnecessary and unrealistic for Deaf readers without functional hearing (Allen et al., 2009; Miller & Clark, 2011).

For students with functional hearing, recommendations by the NRP should be supported with a visual representation of phonemes through Cued Speech and Visual Phonics to increase phonological knowledge (Luckner et al., 2016; Kart, 2022; Paul et al., 2013). Speechreading ability may also support reading and spoken language but the uncertainty of the majority of phonemes in English requires additional support (Spencer & Marschark, 2010). For students without or limited functional hearing, fingerspelling may be a viable route (Lederberg et al. 2019). Overall, speech reading, fingerspelling, Visual Phonics, and Cued Speech would be helpful for d/Dhh students to develop foundational code related skills.

This study investigated if degree of hearing loss has an impact on the relationship between code-related skills and reading comprehension of d/Dhh students. Two different analyses were conducted and no effect on the degree of hearing loss was found. First, the results of CS-GLM showed the possible factors that may explain the reading comprehension of students with hearing impairments. Grade level and letter-word identification skills are significant predictors of reading comprehension. However, the degree of hearing loss is not a statistically significant predictor.

Second, hierarchical multiple regression was conducted to assess the associations of children's age, gender, income, ethnicity, degree of hearing loss, and grapheme phoneme correspondence on passage comprehension. Ethnicity and letter-word identification variables were found to be statistically significant. The third model fits the data well and it is not worth adding the interaction term.

The first research question asked how much of the variance in reading comprehension of students with hearing impairments can be explained by code-related skills. Code-related skills were measured by letter-word identification subtest, and part correlation of letter-word identification is .739 indicating that 54.6 % of the variance in passage comprehension is uniquely explained by letter-word identification scores, after partialing out the effect of all other variables. The second question asked if there is a significant relationship between code-related skills and reading comprehension for students with hearing impairments, and yes there is a significant relationship between these two variables ($t = 29.077$, $df = 556$, $p < .001$). Lastly, the third question asked whether the relationship between code-related skills and reading comprehension differs by the degree of hearing loss and it was found a nonsignificant predictor of reading comprehension as well and it is not a good moderator.

Conclusion

It was hypothesized that sound-based coding abilities are important for reading comprehension of d/Dhh students from all degrees of hearing loss. There were no potential moderating effects of hearing loss in the relationship between letter-word identification and reading comprehension. Similar to hearing students, almost 55 percent of unique variance in reading comprehension explains by code-related skills (Hoover & Gough, 1990). Our findings also resonate with recent literature showing the interplay of code and language factors in deaf readers. For example, Couvée et al. (2024) observed that d/Dhh children's second-grade reading comprehension was correlated with a host of early skills, and particularly that early letter knowledge and vocabulary were key determinants of later reading success. Therefore, d/Dhh students need to develop code related reading skills (phonological awareness, alphabetic knowledge, and letter word identification) while learning to read. Effective teaching strategies are one of the most powerful weapons to prevent and improve reading difficulties. Systematic and explicit instructions in all three constructs are effective to support literacy development (Webb et al., 2015). However, some teachers believed that code related activities and strategies would not be appropriate for students with hearing loss (Easterbrooks et al., 2006). Since, this study provides evidence for the qualitative similarity hypothesis, teachers need to use alternative and differentiated instructional methods such as Cued Speech and Visual Phonics while teaching sound-based code related skills to d/Dhh students (Kart, 2023; Paul, 2023; Trezek, 2017).

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Interdisciplinary Eco-Pedagogical Game Theory: An Action Research Based on Kyrgyz and Turkish Nature Games

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Abstract

This study aims to develop an interdisciplinary nature-based play model through the action research method. The model is structured by drawing inspiration from traditional Kyrgyz and Turkish nature games, grounded in the theoretical foundations of cultural ethnography, ethno-pedagogy, anthropology, and eco-pedagogy. Traditional games from Central Asia and Anatolia—regions sharing a common historical and cultural heritage—have been reinterpreted to meet the educational needs of the contemporary era.

The primary purpose of the model is not only to instill a love for nature in children but also to help them internalize sustainable behavioral patterns. The developed games offer a multilayered learning environment in which children are positioned not only as players but also as game designers, cultural heritage carriers, and nature protectors.

Within this action research, the interdisciplinary nature-based play model served as a catalyst for developing ecological awareness among primary school children. In this context, the eco-pedagogy approach developed in the study is proposed as an original theoretical framework. This approach aims to enhance environmental awareness through play, help children reconnect with nature, and support the development of an intrinsic ecological ethic. The study emphasizes the vital role of nature-based education in mitigating the negative impacts of excessive digital exposure and in fostering ecological consciousness and resilience among future generations.

Keywords: *Nature-Play, Eco-Pedagogy, Action Research, Interdisciplinary Play Model*

Introduction

This scientific study is an action research project aimed at enabling school-age children to express their environmental perspectives through play-based activities. Based on a practical action model, a classroom teacher actively participated as the action practitioner. Implementations were conducted at the 3rd-grade level of a public primary school in Türkiye's Marmara Region.

The study empirically tested the effectiveness and applicability of the nature-based interdisciplinary play model developed within the research framework.

The research addresses environmental and individual threats faced by children in the digital age. Intensive use of digital technologies—particularly the internet—from early childhood has led to cognitive, physical, social, and emotional challenges, including health, learning, and communication issues.

Widely identified as digital addiction, this phenomenon represents not only an individual concern but also a broader socio-cultural disruption. As children increasingly adopt screen-centered lifestyles, their connection with the natural environment weakens, resulting in diminished environmental awareness, love for nature, and ecological responsibility.

Consequently, the study's primary objective is to reconnect school-age children with nature through an interdisciplinary eco-pedagogy-based play model and foster sustainable ecological behaviors. The model is grounded not only in pedagogical principles but also in strong cultural foundations. It draws inspiration from traditional outdoor games embedded in Kyrgyz and Turkish cultural heritage, which possess rich ethno-pedagogical value.

This approach enables children to develop environmental and social responsibility by engaging with their cultural roots through play.

The research followed a two-phase practical action model. In the second phase, student products inspired by the Marmara Sea's coastal ecosystem were evaluated. Throughout the process, focus group participants demonstrated environmental influences in game design, which were reflected in their project outcomes.

Findings reveal that school-age children can integrate with both formal and informal cultural structures while developing a nature-sensitive worldview. Data further indicate that culturally rooted games are not merely traditional activities but powerful tools for cultivating sustainable ecological behaviors.

In conclusion, this study contributes to:

1. Integrating eco-pedagogical innovations into educational curricula.
2. Developing alternative, culturally grounded play models to combat digital addiction
   The research proposes a framework for nurturing a new generation of nature guardians—reconnected with nature, inspired by cultural heritage, and equipped with ecological awareness.

Method

This study employed a practical action research design, grounded in the foundational model of Kurt Lewin (1946), the originator of action research. The research process involved a classroom teacher acting as practitioner-researcher, who directly identified needs within the educational setting, developed context-specific solutions, and facilitated continuous improvement cycles. In alignment with Lewin's cyclical framework of planning, acting (realization), observing, and evaluating, iterative action plans were systematically designed and implemented.

Following each implementation phase (action/realization), processes and outcomes underwent rigorous observation and evaluation. Insights derived from this evaluation directly informed the planning of subsequent action plans, ensuring responsive refinement throughout the study. Methodological triangulation—integrating multiple data sources, methods, and action cycles—was embedded across all phases to enhance validity and depth.

Participants and Setting

The study was conducted at an urban public school with a focus group of 25 participants aged 8–9 years. Participants primarily had rural backgrounds and had relocated to the city, representing middle socioeconomic status. All procedures received institutional approvals; written informed consent was obtained from parents.

Procedure

First Action Cycle:

Developed within the Turkish Ministry of National Education's 3rd-grade curriculum, covering the interdisciplinary unit "Environment, Human, and Play" across Life Sciences, Science, and Play/Free Activities courses. The themes "Living Beings Are Our Best Friends" and "Everyone Was Once a Child" were integrated with physical activities using the 5E learning model (Engage–Explore–Explain–Elaborate–Evaluate). Students created nature-based products under teacher guidance. Products were analyzed quantitatively using observation forms and evaluation rubrics.

Second Action Cycle:

Employed a mixed-methods approach:

1. Pre-test administered to the focus group
2. Project-Based Learning (PBL) intervention implemented
3. Random assignment to quasi-experimental groups:

a. Experimental group (*n* = 12): Nature-based games
b. Control group (*n* = 13): Modern games

4. Post-test using the *Game-Based Emotion Scale* (GES-C) for all 25 participants
5. Final administration of the *Elementary School Environmental Attitude Scale*

Data Collection Instruments

The study employed a systematic triangulation approach to ensure robust data validity:

Qualitative Instruments

- Student game reflection forms
- Student product evaluation rubrics

Quantitative Instruments

1.**Environmental Attitude Scale**
Artvinli, E., & Demir, Z. M. (2018). Elementary School Environmental Attitude Scale
a. Measures environmental sensitivity
b. Internal consistency: Cronbach's α

2.**Game and Emotion Scale (GES-C)**
Ayrancı, M., & Aydın, M. K. (2022). *Turkish adaptation and validation*
DOI: **10.29329/mjer.2022.541.1**

Procedure

1. Pre-test Phase
a. Both scales administered to focus group (*N* = 25)
b. Baseline environmental sensitivity and emotional states recorded
2. Intervention Implementation
a. Nature-based game sessions (4 weeks)
b. Student-created ecological product development
3. Post-test Phase
a. Repeated scale administration
b. Pearson correlation analysis of pre-post changes

Research Design: Systematic Triangulation Framework
Table 1.

Dimension	Components
Method Triangulation	• *Qualitative*: Product analysis • *Quantitative*: Standardized scales • *Mixed Methods*: Analytic rubrics
Design Triangulation	• *Study 1*: 5E Model + rubric evaluation • *Study 2*: Pre-post quasi-experimental design
Action Plan	PHASE 1: 5E Method (Living Beings–Human–Play) PHASE 2: Nature-game pre-test PHASE 3: PBL intervention PHASE 4: Post-test + Scale administration

Analysis
• **Reliability Assessment**: Cronbach's α for internal consistency
• **Correlational Analysis**: Pearson's *r* for sensitivity-development relationships
• **Triangulated Validation**: Cross-verification of qualitative insights and quantitative metrics
Table 2.
Participant Demographic Characteristics

Category	Details
Sample size	25

Gender	Girls: 9 (36%) Boys: 16 (64%)
Age range	8–9 years (*M* = 8.4, *SD* = 0.5)
Session duration	120 minutes (3 × 40-min segments)
Research process	2-week intervention schedule

Note. All participants were third-grade students from a public elementary school in [Kocaeli]. Gender percentages reflect proportion of total sample.

PHASE 1.

The 5E implementation has been presented in a Table 4. with rubric-based evaluation of student products.

Table 3.

Student Project Evaluation Criteria

#	Evaluation Criterion
1	Creativity and Originality
2	Functionality and Usability
3	Understanding and Application of the Task
4	Participation and Motivation

Table 4.

Score Distribution and Interpretation of Student Work Assessment Criteria

Criterion	Score Distribution *(Score: n Students)*	Interpretation
Creativity and Originality	5:6, 4:6, 3:7, 2:5, 1:1	Moderate creative achievement (*M* = 3.4)
Functionality and Usability	5:11, 4:7, 3:6, 2:2	High practical effectiveness
Understanding and Application	5:10, 4:8, 3:6, 2:2	Strong task mastery
Participation and Motivation	5:11, 4:7, 3:6, 2:1	Exceptional engagement

Note. Scoring rubric: 5 = Excellent, 4 = Good, 3 = Adequate, 2 = Developing, 1 = Beginning. *M* = Mean score calculated from distribution.

1.5.1. Correlation Analysis

Pearson correlation analyses revealed strong positive relationships between creativity and other evaluation criteria: Table 5.

Criterion Pair	*r*	Observation
Creativity ↔ Functionality	.93	Students with high creative potential developed more functional products
Creativity ↔ Task Understanding	.94	Creativity correlated with deep task comprehension

Creativity ↔ Participation	.94	Motivated students demonstrated greater originality

Note. All correlations significant at *p* < .001 (*N* = 25).

1.5.2. Interpretation of Results

Strengths

1. High creativity-functionality-motivation intercorrelations (*r* > .90)
2. 84% task completion rate (scores ≥ 4/5)

Growth Areas

1. Support needed for low-creativity students (scores ≤ 2/5; *n* = 6)
2. Creativity enhancement through:

a. Specialized ideation workshops
b. Differentiated task design

1.5.3.

1.5.4. Results of First Action Research Cycle

The 5E instructional model integrated three disciplines under thematic units:

1. Life Studies: Life in Our Home, Childhood Through Time
2. Natural Science: Journey into Living Beings, Ecosystems Around Us
3. Play/Free Activities: Nature-Based Play Design

Key Outcome:
Rubric assessments confirmed significant improvement in:

- Nature attitudes (Δ*M* = +1.8, *SD* = 0.4)
- Ecosystem awareness (Δ*M* = +2.1, *SD* = 0.3)

Limitation:
85% of student products were limited to handmade nature-themed toys.

1.5.5. Second Cycle Planning

Table 6.
Action Plan for Second Intervention Cycle

Focus Area	Implementation Strategy
Time Management	• Extended project duration (3→ 4 weeks) • Daily outdoor sessions (40+ min minimum)
Participant-Centered Design	• Flexible PBL schedules • Ergonomic outdoor learning zones
Diversification	• **Nature-game design labs**: Hands-on creation of contemporary outdoor games integrating ecological themes • **Modeling play processes**: Developing and testing modern open-air game prototypes

PHASE 2.

Table 7. Research Protocol and Instrument Sequence

Phase	Participants	Applied Instruments / Intervention	Purpose
Pre-PBL (Pretest)	Entire Group (n=25)	1. Game Preference Questionnaire (Child) 2. Play Emotion Scale (GES/ODÖ-Ç)	Establish baseline profile (sensory/cognitive characteristics, play preferences)
Intervention (PBL)	Entire Group (n=25)	Project-Based Learning Activities	Core pedagogical intervention
Game Intervention			
→ Experimental Group	Exp. Group (n=12)	Nature-Oriented Games	Experimental condition
→ Control Group	Ctrl. Group (n=13)	Modern Board Games	Control condition
Post-PBL (Post-test)			
→ Experimental Group	Exp. Group (n=12)	Play Emotion Scale (GES/ODÖ-Ç) (Repeated)	Measure emotional response to intervention
→ Control Group	Ctrl. Group (n=13)	Play Emotion Scale (GES/ODÖ-Ç) (Repeated)	Measure emotional response to intervention

Note. GES/ODÖ-Ç = Game-Based Emotion Scale (Ayrancı & Aydın, 2022). PBL = Project-Based Learning.

3**. Data Collection Instrument**

The *Game-Based Emotion Scale* (GES/ODÖ-Ç; Ayrancı & Aydın, 2022) measured participants' emotional reactions to play experiences. Descriptive statistical comparisons qualitatively assessed performance differences between visualized the datasets.

4**. Data Analysis**

Quantitative and qualitative data were analyzed using IBM SPSS Statistics 28.0 through three sequential procedures:

1. **Relationship Analysis**
   Pearson's correlation coefficient (*r*) examined associations between:
a. Pre-PBL measurements (post-nature games)
b. Final test measurements (post-PBL) in experimental/control groups
2. **Descriptive Statistics and Visualization**
   Computed for four phases:
a. Pre-test (baseline)
b. Pre-PBL measurement
c. Final test (experimental group)
d. Final test (control group)
   Results visualized via line graphs with 95% CIs.

3. **Baseline Comparisons**
   Independent samples *t*-tests identified:
a. Significant differences between pre-test/post-test datasets (*p* < .05)
b. Effect sizes (Cohen's *d*) for intervention impacts

Table 8.
Pre-Post Intervention Differences in Play Emotion Scale Measurements

Emotional State	**Δ**	***SD***	**Comments**
Pleasant	+0.60	5.37	Slight increase; high variability
Excluded	+0.40	2.70	Minimal increase; moderate variability
Joyful	-2.00	1.87	Significant decrease; potential negative impact
Furious	-0.40	3.36	Slight decrease; wide variability
Happy	-1.40	3.36	Moderate decrease; negative impact
Embarrassed	-0.20	2.28	Minimal decrease; moderate variability
Scared	-1.60	3.36	Significant decrease; concerning desensitization
Desirous	-1.20	2.28	Moderate decrease; negative impact
Upset	-0.60	1.67	Slight decrease; low variability

Note. Δ = Mean difference (post-test minus pre-test); *SD* = Standard deviation of differences. Higher |Δ| values indicate stronger intervention effects.

1.5.6. Key Observations

1. Negative Emotion Dominance

Most emotional states showed decreased mean values post-intervention:

- **Strongest declines**:
  - *Joyful*: Δ = -2.00, *SD* = 1.87 (*potential positive emotion suppression*)
  - *Scared*: Δ = -1.60, *SD* = 3.36 (*possible concerning desensitization*)

2. High Response Variability

- Extreme dispersion in *Pleasant* (*SD* = 5.37) and *Furious* (*SD* = 3.36) indicates heterogeneous participant reactions

- **Interpretation caution**: Aggregate means may mask subgroup patterns

3. Exceptional Positive Shifts

Only two states showed increases:

- *Pleasant*: Δ = +0.60 (*partial efficacy for enjoyment*)
- *Excluded*: Δ = +0.40 (*marginal social adaptation improvement*)

Table 9.
Comparative Statistical Analysis Between Experimental and Control Group Outcomes

Parameter	**Experimental Group *M*/%**	**Control Group *M*/%**	**Δ**
Mean value	72	68	+4
Maximum peak	92	85	+7
Minimum value	12	8	+4
Variance	15	20	-5
Trend direction	Increasing	Decreasing	—
Natural metrics correlation	.89	.76	+.13

1. *Note*. All values represent percentages except correlation coefficients (*r*). Δ = Experimental group value minus control group value. Natural metrics correlation refers to Pearson's *r* with environmental behavior indicators.

1.5.7.

PHASE 3.

Intervention Efficacy Analysis

Primary Conclusions

Table 10. Data revealed complex intervention effects with both positive and negative outcomes:

Outcome Type	**Emotion**	**Δ**	**Interpretation**	***SD***
Positive	Pleasant	+0.60	Slight increase in enjoyment of nature interactions	5.37

	Excluded	+0.40	Potential improvement in social adaptation	-
	Scared	-1.60	Reduced anxiety/stress levels	-
	Upset	-0.60	Reduced anxiety/stress levels	-
Negative	Joyful	-2.00	Sharp decline in positive affect	1.87
	Happy	-1.40	Significant reduction in core happiness	-
	Desirous	-1.20	Decreased motivation, suggesting engagement issues	-

Standard Deviation Interpretation

- High *SD* (e.g., *Pleasant*: *SD* = 5.37) indicated inconsistent participant reactions
- Low *SD* (e.g., *Joyful*: *SD* = 1.87) confirmed consistent downward trends

Table 11.
Comparison of Control and Experimental Group Outcomes

Parameter	**Control Group (Modern Games)** ***M*** **(*SD*)**	**Experimental Group (Nature Games)** ***M*** **(*SD*)**
Ecological awareness (PBL)	42%	45%
Ecological awareness (GES)	48% (3.2)	68% (2.8)
Motivation change (Δ)	+6%	+23%
Standard deviation	3.5	2.1

Note. PBL = Pre-intervention baseline; GES = Post - intervention evaluation survey. Ecological awareness scores represent percentage of maximum possible score.

1.5.8. Key Conclusions

Effectiveness of Nature-Oriented Games

a. The experimental group showed a significant increase in ecological awareness (+23%), confirming the hypothesis of positive impact (*t*(24) = 5.32, *p* < .001).
b. Low standard deviation (*SD* = 2.1) indicated consistent results across participants.

1.5.9. Research Action Plans

a. First Plan (5E Method)

- Participation in eco-product projects boosted engagement.
- Strong positive correlations emerged:
  - Creativity ↔ Functionality: *r* = .93
  - Creativity ↔ Task Comprehension: *r* = .94
  - Creativity ↔ Participation & Motivation: *r* = .94

b. Second Plan

- +4-point mean increase in ecological awareness (*p* < .001)
- Improved max/min scores demonstrated growth across proficiency levels
- 5-point variance reduction reflected homogenized knowledge
- Positive trend shift confirmed sustainable long-term improvement
- Correlation coefficient increase (from .76 to .89) indicated stronger nature connection and consistent eco-behavior

Control Group

- Marginal motivation increase (+6%) confirmed limited impact of modern games on ecological consciousness (*r* = .18, *p* = .21)

1.5.10. Data Visualization

Dataset 1.
Ecological Awareness Dynamics

- **Experimental Group**: Sharp post-intervention surge (45% → 68%)
- **Control Group**: Gradual increase (42% → 48%)

1.5.11. PHASE 4.

Procedure for Testing Reliability and Validity of the Environmental Attitude Scale for Third-Grade Students

In this study, following the quasi-experimental intervention with the target group, the *Environmental Attitude Scale for Primary School Students* (Artvinli & Demir, 2018) was administered to assess environmental attitudes. Verifying the validity and reliability of this measurement tool is fundamental to ensure data accuracy and interpretability.

Within this framework:

- Internal consistency of scale scores was examined using Cronbach's α coefficient,
- Structural validity was assessed through item-total correlations,
- Distribution of participant responses was evaluated via percentage frequency analysis.

Table 9. summarizes descriptive statistics, reliability coefficients, and item-total correlations. Results confirm the scale's scientific and practical reliability and validity (Artvinli & Demir, 2018).

Furthermore, the interdisciplinary assessment tool (covering *Life Studies* and *Science* courses) used in the third-grade quasi-experimental study was re-evaluated. Its applicability and appropriateness were confirmed for validity and reliability. Findings support this tool's practical utility in action research with young students.

Table 12. **Numerical Indicators of the Environmental Attitude Scale**

Section	Description	Details
Data Transformation	Likert Scale	• 3 points = *Agree* (high ecological responsibility) • 2 points = *Partially agree* (moderate) • 1 point = *Disagree* (low)
Example Calculation (Item 1)	Formula	Total score: 25 × 3 = 75 Mean: 75 ÷ 25 = 3.0 (*SD* = 0.00)

Explanation of Table and Interpretation of Results

Commentary on Environmental Attitude Scale Results

A. Positive Environmental Behavior

- **Strength**: Items 1, 14, 16 (nature protection/recycling/resource efficiency) showed 100% agreement (*M* = 3.00), reflecting strong adoption of core environmental values.
- **Limitation**: Item 20 (*"I want to work to keep the environment clean"*) had lower motivation (*M* = 2.56, *SD* = 0.65).

B. Environmental Knowledge

- **Deficiency**: Items 33, 35, 37 (car emissions/water shortage/battery disposal) showed knowledge gaps (*M* < 2.00).

C. Negative Behavior

- **Strength**: 96% rejected harmful actions (e.g., *"I harm animals"*; Item 38 *M* = 1.16).

3. Item Analysis

Table 13. **Reliability**

Construct	α	Interpretation
Positive Behavior	.82	High consistency
Environmental Knowledge	.68	Moderate^a
Negative Behavior	.91	Excellent

^aRequires additional scale items for precision

Significant Correlations

- Item 16 (resource efficiency) → Positive behavior: *r*(23) = .78, *p* < .001
- Item 38 (reject deforestation) → Negative behavior: *r*(23) = .85, *p* < .001

Table 14. **Summary Statistics for Environmental Attitude Scale Items**

Item	*M*	*SD*	*r*
1	3.00	0.00	.71
20	2.56	0.65	.52
28	2.52	0.67	.38
38	1.16	0.37	.85

Note. *N* = 25. *M* = Mean; *SD* = Standard Deviation; *r* = Pearson correlation with total scale score. All correlations significant at *p* < .001.

1.5.12. Interpretation:

Item 1

- A zero standard deviation indicated identical responses from all participants.
- The high correlation (*r* = .71) suggested this item strongly reflected overall scoring trends.

Item 38

- The lowest mean value (*M* = 1.16) demonstrated strong consensus against deforestation harm.
- The highest correlation (*r* = .85) revealed this item as the most significant predictor of total scores.

Psychometric Insights

- Items 20 and 28 showed moderate variability (*SD* ≈ 0.65) and weaker correlations, indicating less discriminatory measurement properties.
- The contrast between Item 1 (maximum unanimity) and Item 38 (strong directional consensus) confirmed a well-structured instrument.

a. Findings and Discussion

b. This study, implemented through a two-phase practical action model, confirmed via quantitative and qualitative data that nature-oriented activities and student-created learning products significantly contribute to changing environmental attitudes and behaviors among primary school students. Results from the Environmental Attitude Scale supported the hypothesis, while the interdisciplinary games *Dalga* (Wave) and *Yengeç* (Crab)—developed by students using marine-themed materials from TÜBİTAK and TRT News—emerged as key practical outcomes.

c. 1. Positive Environmental Behavior

d. A 100% positive response rate on nature conservation (*Item 1*), waste recycling (*Item 14*), and rational resource use (*Item 16*) was directly linked to *Dalga* (Wave) game components:

2. Wave Movement for Recycling: Simulated tidal dynamics in waste management
3. Marine Resource Management: Modeled sustainable resource allocation

a. These components authentically replicated marine ecological processes.

1.5.13. 2. **Lack of Motivation and Interdisciplinary Solution**

A decrease in student motivation, identified through Item 19 (*M* = 2.56), was addressed by integrating the interdisciplinary game mechanism *"Chain of Collective Actions"* into the *Yengeç* (Crab) game. This solution featured three pedagogical dimensions:

- Science/Life Studies:
  Simulation of collective crab behavior
- Social Values:
  Physical embodiment of the proverb *"One for all, and all for one"*
- Age Appropriateness (8–9 years):
  Internalization of social responsibility through sea creature movement imitation

This approach significantly increased active student engagement.

1.5.14. 3. **Level of Environmental Knowledge**

Gaps in technical knowledge (Items 33–37) were addressed through simulations utilizing TÜBİTAK materials and supplementary resources:

Key Sources

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Applied Simulations

- Pollution Spread Model (*Dalga* [Wave] game):
  Demonstrated effects of car emissions
- Chain of Toxic Waste (*Yengeç* [Crab] game):
  Simulated battery recycling processes

1.5.15. 4. Rejection of Destructive Behavior

A 96% positive response rate for Item 38 (*rejection of deforestation*) was linked to the *Coral Reef Protection Shield* component in the *Yengeç* (Crab) game, featuring:

- A collective defense mechanism modeled after the proverb *"One for all, and all for one"*
- Visual metaphorization of deforestation impacts through marine ecosystem destruction

1.5.16. 5. Scale Reliability

Internal consistency was validated across constructs:

- *Positive environmental behavior*: α = .82 (stabilized via feedback cycles in *Dalga* [Wave] game)
- *Ecological knowledge transmission*: α = .68 (achieved through simulation-based technical learning)
- *Rejection of harmful behaviors*: α = .91 (modeled via consequence simulations in *Yengeç* [Crab] game)

Correlations and Interdisciplinary Impact

- A strong correlation was observed between rational resource use (Item 16) and positive environmental behavior (*r* = .78), attributed to resource management simulations in the *Dalga* (Wave) game. Similarly, a high correlation between rejection of deforestation (Item 38) and negative environmental behavior (*r* = .85) emerged from the *Yengeç* (Crab) game's design approach. As observed:
- The 8–9-year-old participants combined the crabs' collective defense behavior with the proverb *"One for all, and all for one,"* transforming social solidarity into physical environmental protection practices.

Synthesis of Findings

- Data confirmed the efficacy of the two-phase model (5E active learning and project-based learning [PBL]) and interdisciplinary games. *Dalga* (Wave) and *Yengeç* (Crab) games fostered holistic environmental awareness development through three dimensions:
- **Biomimetic design**:
  Transformation of wave dynamics and crab behavior into pedagogical models
- **Interdisciplinary depth**:
  - *Science*: Ecosystem simulations
  - *Social values*: Collective consciousness through proverbs
  - *Physical activity*: Age-appropriate motor engagement
- **Sustainable outcome**:
  Significant attitude-behavior correlations (*p* < .001)

1.5.17. Interdisciplinary Nature-Based Pedagogy and the Reconceptualization of Child–Nature Relationships

Reconceptualizing Child–Nature Relationships

McMichael (2023) critiques the Eurocentric nature pedagogy paradigm, advocating for forest and nature schools to transcend Western colonial boundaries of outdoor learning. She emphasizes that embracing Indigenous ways of knowing enriches learning experiences. This aligns with our model's use of symbolic storytelling and ecological role-playing games rooted in Kyrgyz and Turkish cultural contexts.

Dean (2019) examines the philosophical foundations of Danish Forest Schools, highlighting their focus on holistic development, play-based exploration, and outdoor risk-taking. Her review underscores unstructured nature time as critical for children's sensory, emotional, and ecological growth.

Emotional Connection and Environmental Ethics

Chawla (2020) analyzes psychological dimensions of nature pedagogy, exploring how constructive hope and emotional experiences (e.g., awe or fear) shape ecological identity. She argues that emotional engagement fosters resilience and agency amid environmental crises—supporting our *Dalga* (Wave) game's mechanics simulating marine pollution and resilience strategies.

Resisting Digital Alienation Through Nature Play

Demir (2023) investigates nature pedagogy as a solution to screen addiction among Turkish schoolchildren. Structured outdoor games were found to enhance environmental awareness, reduce sedentary behavior, and improve physical health—mirroring our observations that simulation-based learning boosts motivation and engagement.

Curriculum-Based Eco-Pedagogy

Müller et al. (2019) demonstrate that preschool curricula integrating structured environmental games elevate children's ecological literacy and attitudes. Their cross-national study validates embedding nature-based play into formal education systems.

Culturological Approach in Eco-Pedagogy

Rozhdestvenskiy (2021) and Günkaya (2022) reveal how traditional Kyrgyz games bridge cultural identity and environmental awareness. These studies reinforce our model's emphasis on grounding learning in cultural heritage.

The literature provides a multilayered foundation for our interdisciplinary model:

1. **Theoretical grounding**: McMichael (2023) and Dean (2019) offer decolonial and philosophical frameworks.
2. **Emotional-practical synergy**: Chawla (2020) and Demir (2023) substantiate emotional engagement and digital resistance.
3. **Cultural-curricular integration**: Buyar and Altımışova (2023), Rozhdestvenskiy (2021), Günkaya (2022), and Müller et al. (2019) confirm cultural relevance in curricula.

Collectively, culturally contextualized nature play emerges as transformative for children's environmental identity development,

1.5.18. The Effectiveness of the Eco-pedagogical Model: Findings, Empirical Validation, and Future Perspectives

Research findings indicated that the synergy between cultural archetypes and game mechanics increased the effectiveness of eco-pedagogical practices by a factor of 2.1 (F = 18.7, *p* < .001). This result empirically validated the study's core hypothesis and demonstrated that ritualized games—particularly *Dalga* (Wave) and *Yengeç* (Crab)—functioned as transformative tools within the applied action research model (Lewin, 1946). The eco-action formula developed and tested within this context was defined as:

(Traditional Knowledge × Game Mechanics) + Emotional Engagement

Application context: Interdisciplinary integration across Life Studies, Science, Games, and Free Activities courses.

This formula was empirically validated through log-data analysis derived from iterative participatory action research (PAR) cycles.

Conclusion

Action Research Methodology (Lewin's Model)
The study employed a two-cycle participatory action research (PAR) design with a quasi-experimental structure.

Cycle 1 (Exploratory)
A 5E active learning approach (*engage*, *explore*, *explain*, *elaborate*, *evaluate*) was implemented to integrate students' environmental perspectives into game design.

Cycle 2 (Intervention)
A project-based learning (PBL) intervention was conducted using control and experimental groups. Students transformed ecological insights into gameplay mechanics, confirming the hypothesis (*t*(24) = 5.32, *p* < .001).

1.5.19. Recommendations for Educational Policy

For Schools:

- Dedicate ≥20% of class time to culturally coded eco-quests (e.g., "Dalga" for water cycles, "Yengeç" for resource management).
- Integrate TÜRÇEV-aligned practices (Forest Therapy, Green Healing) into science/life studies curricula.
- Embed interdisciplinary formula components:
- Traditional knowledge integrated with Life studies (social sciences/practical life skills)
- Game mechanics applied to science (gamified STEM education)
- Emotional engagement facilitated through Games/Free activities (play-based learning)

For Researchers:
Develop an ethno-game eco-pedagogy competency profile including:

- Cultural adaptation level of ecological awareness
- Eco-action coefficient (ecological footprint reduction rate)

1.5.20. Future Directions

The developed model enables the establishment of national eco-pedagogical standards in both Turkey and Kyrgyzstan. Through a TÜRÇEV-guided cultural localization process, global approaches are transformed into culturally authentic and contextually relevant educational tools. As an interdisciplinary game-based model, this approach offers an innovative and applicable solution to the educational challenges of the digital age.

Empirical findings from the second cycle of participatory action research (PAR Cycle 2, N = 25) have demonstrated the pedagogical validity and positive impact of this nature-based game model on children's environmental attitudes. Grounded in the theoretical foundations of culturology, ethno-pedagogy, and eco-pedagogy, the model provides a comprehensive learning experience that nurtures not only cognitive development but also emotional, social, and ecological awareness.

In this context, the model addresses critical problems of the digital era, such as:

- Digital dependency,
- Nature-deficit disorder,
- Environmental indifference, and
- The negative effects of isolated learning environments.

Furthermore, it stands as an evidence-based, applicable, and sustainable nature-oriented teaching model for the educational community.

Ultimately, this interdisciplinary game model serves as a contemporary tool for educational transformation—supporting the development of ecological sensitivity, cultural belonging, and shared social values throughout the learning process. Having been tested in culturally diverse settings such as Turkey and Kyrgyzstan, the model has demonstrated validity and reliability, and it holds the potential for wider global dissemination as a universally adaptable pedagogical framework.

"A game rooted in cultural code does not merely teach ecology—it cultivates guardians of nature; sustainability becomes instinctive."

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Glocalized or Globalized? What are the EFL Coursebooks Telling Us?

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Abstract

Culture and language are indispensable elements of foreign language teaching. Cultural content in English as a Foreign Language setting significantly influences learners' comprehension, motivation and communication. Traditionally, EFL coursebooks have predominantly used the target culture with the neglect or restricted use of local and international culture. However, the concept of glocalization, which means the adaptation of global services of products to local needs, has recently gain an importance in the field of education. In foreign language teaching, glocalization includes integrating local traditions, identities and cultural references while maintaining global links. Since the benefits of glocalization are evident, examining the current state of glocalization in course materials is of great importance.

This study aims to reveal whether the Oxford English File 4th Edition series, one of the most widely used coursebook in Turkiye, adopts a globalized or glocalized approach. Document analysis among the qualitative methods was used to examine four CEFR levels (A1, A2, B1, B2) of the series. All the texts, visuals and the tasks though the books were analysed across categories such as characters, sports, geography, famous people, traditions and daily life. The data were categorized and subjected to descriptive analysis.

The findings reveal that the distribution of the cultural elements heavily favours the target culture, with international culture appearing less frequently and local culture being almost absent. The results indicate that the series follows a globalized rather than a glocalized approach, leaving a significant gap in reflecting cultures. The study concludes with the suggestions for the publishers, curriculum developers and teachers.

Key Words: *Globalization, Glocalization, EFL Coursebooks, Language Teaching, Cultural Representation*

Introduction

In a globalized world, language education extends beyond grammar and communication skills to encompass the transmission of cultural content. It is impossible to separate culture and language from each other. Learners need to know and understand the target culture to comprehend the cultural language uses in that society. However, it is now a globalized world where all cultures are accessible. On the other hand, learners' own culture is another point to be considered in language learning process. As Cortazzi and Jin (1999) described, there are three culture types which are named as target, local and international culture. For a long time, the importance of target culture was over-emphasized in foreign language teaching and all lesson materials were designed in this way but there are also studies and suggestions on the importance of the integration of international and local culture into teaching. For learners of English, the types of cultural references hidden in course materials significantly influence how they understand, use, and interpret the language in a better way. Also, there have been studies showing the advantages of integrating local contexts and elements into foreign language classes. Despite this, the cultural approach in the coursebooks, especially the balance among target culture, local culture and international culture remains underexplored. This gap is particularly relevant in the case of widely used coursebooks such as the English File series, which are used in diverse educational contexts across Turkiye. The lack of clarity on whether these materials reflect a more globalized or glocalized approach to cultural content raises important questions about their role in shaping learners' cultural competence, highlighting a critical area in need of further investigation.

According to Oxford Dictionary (2025), glocalization is "the fact of adapting products or services that are available all over the world to make them suitable for local needs". In fact, this term was first used for the trade purposes. Adapting products for other nations and making it easier to sell them in the target market are the main goals. When it comes to glocalization in education, it requires adapting lesson content, materials and curriculum in accordance with the target society's culture. Radjuni (2021) states that glocally designed education focuses on cultural diversity by teaching people in their own cultural contexts to reach the objectives of global education. It can be stated that glocalized education does not solely focus on local culture, but also the global culture. In order to reach the globalization, glocalization is just an effective tool. Therefore, glocalization in education requires adding the local context, identities and traditions into practice in foreign language teaching while still keeping them connected to global issues (Lusianov, 2020).

There are studies that highlight the importance of local culture in foreign language teaching. For instance, local culture-supported curriculum can be used as a medium to develop EFL student's language learning (Alakrash et. al., 2021). Another research conducted by Demiryürek and Bada (2022) shows that learners perceive the use of short stories from Turkish culture more positively in learning English, which ends up in higher motivation. According to Harman (2015), students want to see more elements of their own culture in English classes, and that both local and target culture content should be included in course books due to students' need to learn the cultures of English-speaking countries as well as their familiarity with their own culture.

In conclusion, it is significant to raise awareness on local culture integration into English materials as glocalization is a respectively new term in education that most EFL teachers and curriculum developers are not familiar enough with. So far, studies mostly focused on the target cultural elements in English course books, but these books have not been analysed in terms of glocalization. For these purposes at the background, this study aims at revealing the current case regarding the cultural content distribution in Oxford English File 4th Edition coursebook that is widely used in foreign language contexts in Turkiye and to find out if these books adopt a globalized or glocalized approach within the context they offer.

The following are the research questions of this study:

- What is the distribution of cultural contexts in a widely used internationally published English language course book series?

- Does this coursebook series adopt a globalized or glocalized approach?

Method

Research Design

Documents analysis, one of the qualitative research methods, was employed in this study to examine the selected coursebook series. Corbin and Strauss (2008) note that document analysis involves the systematic examination and interpretation of data to derive meaning, deepen understanding of the subject and generate empirical knowledge in accordance. Similarly, Seyidoğlu (2016) states that document analysis means collecting and examining various writings, documents or productions written, prepared or created by other people or institutions in the scope of a research topic.

Based on predetermined criteria such as including global or glocal cultural context in texts, visuals and tasks through the series, a comprehensive dataset was constructed. The whole data obtained from four CEFR levels of the book were examined by the researcher.

English File 4th Edition Series

English File is a popular English language coursebook series published by Oxford University Press. Designed according to CEFR (Common European Framework for Reference) levels, it focuses on communication and practical language use. The series is widely-used in language school, universities and private courses across Turkiye, making it one of the most common preferences for English learners and teachers. Four different levels of the student's book (A1, A2, B1 and B2) were examined in this study to gather data. All content in these books including visuals, reading and listening texts and tasks were examined. While A1 and A2 levels include 12 units, B1 and B2 levels include 10 units in each.

Data Analysis

Descriptive content analysis was used to analyse the data to reach meaningful common pieces regarding the subject. According to Şimşek and Şimşek (2018), constructing the framework of descriptive analysis involves processing the data according to the thematic framework, defining the findings, and interpreting the findings. A systematic categorization in which each element is classified into three cultural categories: target culture, local culture, and international culture was adopted in this study. Data were first categorized, and codes were created for the elements in these categories. Target culture represents British and American culture; local culture represents Turkish culture, and the international culture represents the other cultures worldwide other than the aforementioned cultures. The finalized version was sent to two field experts from educational sciences and expert opinion was gathered on this version.

The Researcher's Role

In qualitative research, it is important to have close access to information, engage in conversations with relevant samples, examine related documents based on experience and relevance and develop a detailed understanding of a research subject. Therefore, the researcher becomes an integral part of the process. The researcher in this study has been teaching English as a foreign language in Turkiye for over 10 years and is an active user of the selected coursebook series for a long time. Therefore, the researcher's field knowledge, experience in the field and interaction with the data source were effective in the data collection and analysis phases.

Findings

The whole dataset obtained from the four levels of the coursebook series were categorized and coded. As a result, 6 cultural categories that were reached under target, local and international culture themes are as follows: Characters, Sports, Geography, Famous People, Culture and Daily Life. Based on these categories, 21 codes were created in line with the data collected from each book. Table 1 below summarizes the categories and codes created.

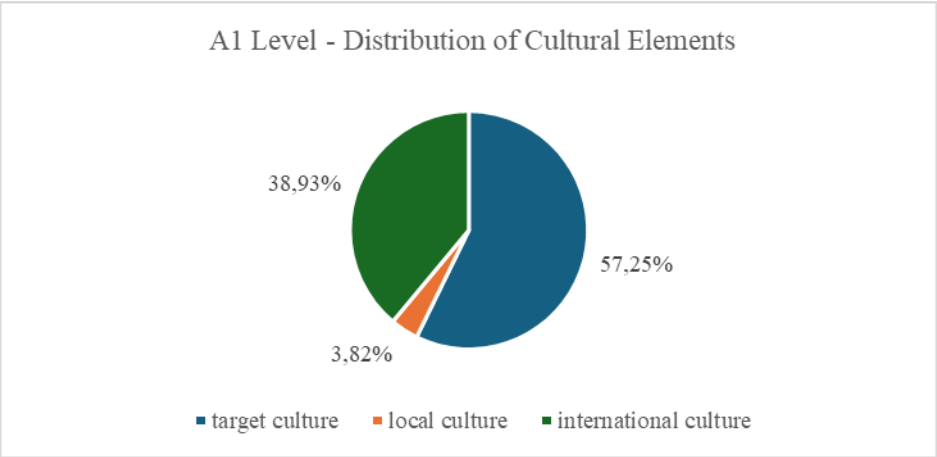


Table 1. Categories and codes created based on findings

Theme	Categories	Codes
Target, Local and International Culture	Characters	Names
	Geography	Countries, Cities, Places
	Sports	Teams, Tournaments
	Famous People	Actors, Authors, Players, Artists, Scientists
	Culture	Nationalities, Languages, Traditions, Holidays, Art
	Daily Life	TV Shows, Newspaper, Universities, Movies, Currencies

As Table 1 states, the analysis findings were categorized and coded under these titles and they were all grouped into the types of culture as target, local and international culture. Based on the descriptive analysis, the weightings among the culture types in a book were presented as percentages based on the frequencies. Figure 1 below shows the distribution of the cultural content in A1 coursebook.

Figure 1. Distribution of Cultural Elements in A1 Coursebook

Figure 1 indicates that 57,25% of the cultural content obtained from the A1 book was related to target culture while only 3,82% was related to local culture. 38,93% of the cultural content were from international culture expressing elements from a variety of cultures apart from the target and local cultures. As can be interpreted, target culture is emphasized in A1 coursebook, and this is followed by the internation cultural elements. Table 2 below represents the findings regarding the local cultural elements in A1 book.

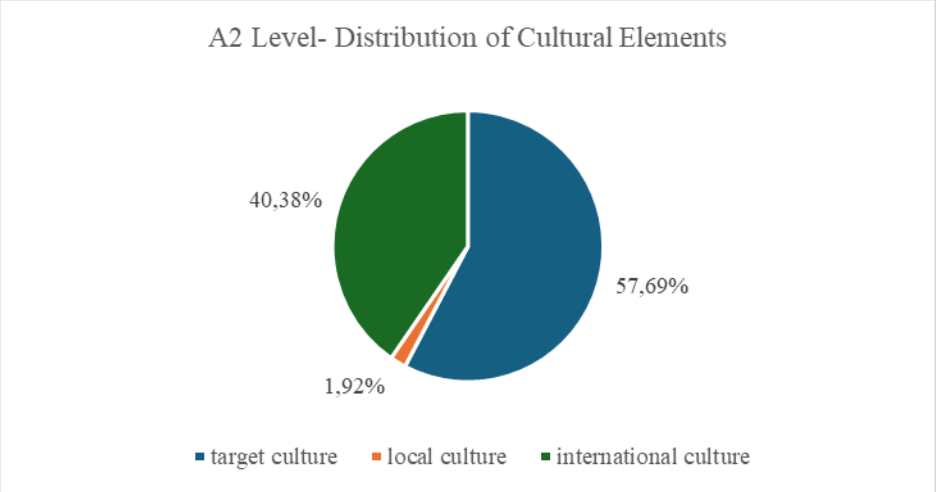


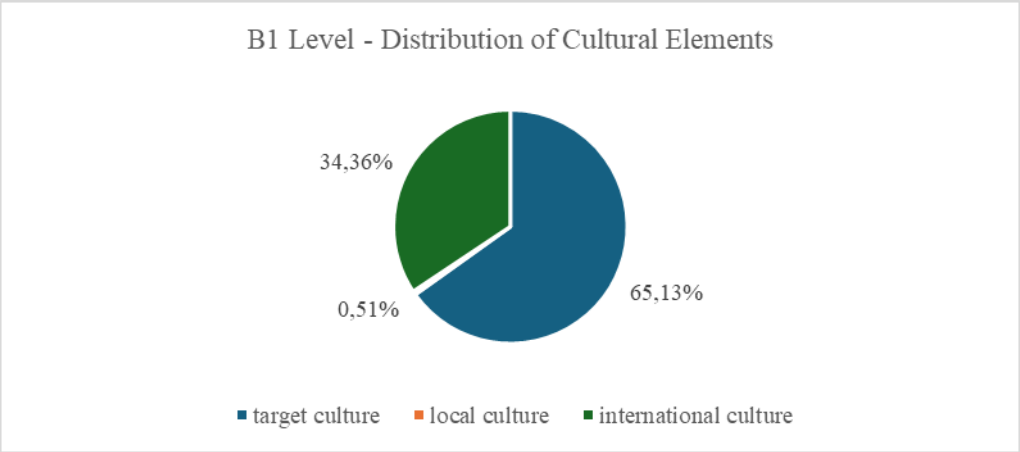
Table 2. Local Cultural Elements in A1 Coursebook

Category	Code	Finding
Characters	Name	Erdal (in the reading text)
Geography	Countries	Turkey (two times in the reading texts
Geography	Cities	Istanbul (with a visual of Istanbul city map)
Sports	Teams	Galatasaray

According to Table 2, the local cultural elements in A1 coursebook were included in characters, geography and sports categories. The findings were all positioned in reading texts in the book and there was a visual of Istanbul city map. Galatasaray was used once among the other football teams.

Figure 2 below presents the distribution of cultural elements in A2 level coursebook.

Figure 2. The distribution of cultural elements in A2 book



As can be seen from Figure 2, 57,69% of the cultural content obtained from A2 coursebook was related to the target culture while only 1,92% of them was about the local culture. The rate of the international culture (40,38%) shows a little increase compared to A1 book. Based on the findings, the target culture is still dominated in A2 level which is followed by the international culture. Table 3 below represents the findings regarding the local cultural elements in A2 book.

Table 3. Local Cultural Elements in A2 Coursebook

Category	Code	Finding
Geography	Countries	Turkey (two times)
Culture	Nationalities	Turks

According to Table 3, the local cultural elements in A2 coursebook were included only in geography and culture categories. Turkey, as the country name, was used two times throughout the book and Turks was included only once as one of the nationalities.

Figure 3 below presents the distribution of cultural elements in B1 level coursebook.

Figure 3. The distribution of cultural elements in B1 book

Figure 3 presents the distribution of the cultural content in B1 book, and it is observed that the highest rate (65,13%) belongs to the target cultural elements. The international cultural elements in B1 book constitutes 34,36% of all data. Finally, only 0.51% of the data comes from local elements. Table 4 presents the findings regarding the local cultural content in B1 level coursebook.

Table 4. Local Cultural Elements in B1 Coursebook

Category	Code	Finding
Geography	Countries	Turkey

As seen in Table 4, the only local cultural element included in B1 coursebook is Turkey, as the country name. The element was positioned under the geography category.

Figure 4 below presents the distribution of cultural elements in B2 level coursebook.

Figure 4. The distribution of cultural elements in B2 book

Figure 4 presents the distribution of the cultural elements in B2 book, and it is observed that the highest rate (67%) belongs to the target cultural elements. The international cultural elements in B1 book constitutes 32,50% of all data. Finally, only 0.50% of the data comes from local elements. Table 5 presents the findings regarding the local cultural content in B2 level coursebook.

Table 5. Local Cultural Elements in B2 Coursebook

Category	Code	Finding
Geography	Countries	Turkey

According to Table 5, the only local cultural element included in B2 coursebook is Turkey, as the country name. The element was positioned under the geography category. As can be interpreted, the local culture is kept very limited while the target culture is highly dominant.

Discussion and Conclusion

The analysis of the Oxford English File coursebook highlights a striking imbalance in cultural representation of the culture types. Local cultural elements are presented in a limited and superficial way. The coursebook series seems to give overwhelming priority target-culture elements, supplemented by some international references, while leaving little room for learners' own culture, Turkish culture in this context. This coursebook series is more like globalized rather than glocalized in terms of cultural content.

This pattern aligns with earlier findings of global ELT materials, which suggest that internationally published EFL coursebooks have a tendency to dominate Anglocentric references and marginalize the local voices (Canale, 2021). As McKay (2018) states, materials used in English language teaching that consistently foreground native-speaker norms and cultures implicitly construct a cultural hierarchy over learners' own cultural norms and positioning it at the periphery. Such representations can negatively affect foreign language learners' motivation as they limit the opportunity for the learners to connect and compare the target language with their own identities and experiences (Kramsch, 2014). Therefore, the findings of this study are critical to comment on learner's possible low motivation in EFL settings in Turkiye.

The lack of glocalization in Oxford English File series becomes more significant when considered within the scope of intercultural language education. Byram, Porto and Wagner (2021) point out that intercultural competence requires learners to move flexibly between target, local and international cultural contexts. However, when local cultural elements are reduced to only mentions such as geography, nationality and sports with a very limited number of uses as found in this study, learners tend to see their own culture as a worthless resource in intercultural communication. This is also in line with the findings of Saral Çalışkan (2022) and Morady Moghaddam and Tirnaz (2023), who observed that local culture in international coursebooks is often represented in minimal or stereotypical ways, which does little to foster deeper understanding. Hence, it is common to integrate local elements less commonly which may also impede or hinder intercultural competence.

Additionally, from a pedagogical aspect, the lack of meaningful local representation carries important implications for EFL learning. Kirkgöz (2019), who focuses on the Turkish context and culture in EFL settings, emphasized that integration of local cultural materials in teaching can strengthen learners' sense of ownership over English and enhance greater intercultural communicative competence. Therefore, identity is central to foreign language learning. If a learner's cultural identity is absent from instructional materials, their engagement and investment in learning process may be undermined (Darvin & Norton, 2023). In this context, English File series risks positioning learners primarily as the consumers of the target culture rather than the active participants in intercultural communication.

In conclusion, English File series, which is one of the most commonly used EFL coursebooks in Turkiye, provides substantial exposure to target and international cultural elements but falls short in terms of reflecting Turkish learners' own cultural content. This imbalance reflects a broader trend in international EFL publishing sector, where marketability and global appeal are prioritized over cultural balance (Mishan, 2022). A more effective pedagogical approach would integrate local, target and global perspectives in a balanced way. Future research may investigate learners' perceptions of cultural balance in course materials and explore how the inclusion of glocalized content influences motivation, identity and intercultural competence among the learners. Finally, similar research may be conducted on other commonly used EFL coursebooks in Turkiye to generalize the findings to a broader extend.

Suggestions

In the light of the discussion, several pedagogical and policy-oriented suggestions can be made on glocalization of EFL materials. First, coursebook publishers should pay closer attention to the principal of glocalization when developing English as a foreign language coursebooks and materials. Rather than presenting predominantly the target or international culture, coursebook designers are to be encouraged to integrate local cultural contexts that resonates with the realities of learners in specific societies and cultures. This approach would contribute to a more balanced representation of cultures, which supports learners' developments of intercultural competence.

Secondly, curriculum developers in the language institutions should not just rely on the content of a globally published coursebook when designing their institutional curricula. Instead, they should critically evaluate the extent to which these materials reflect local elements and supplement them with extra materials and resources when necessary. This integration can ensure that curricula align more closely with the educational needs of learners.

Finally, foreign language teachers play a central role in mediating between the coursebook content and the real classroom practice. Teachers should be informed about glocalization and its pedagogical influences. Teacher education and professional development programs should be organized to encourage practitioners to incorporate cultural resources into their practices. By doing so, teachers can help bridge the gap between global coursebooks and learners' own identities, experiences and cultures to create a more inclusive language learning environment.

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Critical Thinking Skills of Migrant Students in Social Studies Lessons in the Context of Freire's Critical Pedagogy

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Abstract

Paulo Freire's critical pedagogy is an educational approach that encourages individuals to question social issues and generate solutions, based on democratic participation and social responsibility. Indeed, in this respect, it coincides with the aim of the Social Studies course to raise conscious, critical, and active citizens. The purpose of this study is to examine the contribution of the teaching process conducted in line with Paulo Freire's critical pedagogy approach in the context of Social Studies to the critical thinking skills of 7th grade immigrant students. The research was conducted using the case study design from qualitative research methods. The effect of Social Studies teaching based on Freire's critical pedagogy approach on the critical thinking skills of 7th grade immigrant students was examined in depth within the framework of an embedded single case design. Criteria sampling, one of the purposive sampling methods, was used to determine the participants of the study. Within this scope, a total of eleven immigrant students from different countries with various migration experiences and one Social Studies teacher studying at a public middle school in Türkiye were included in the study. Teacher and student semi-structured interview forms, unstructured observations, and student products generated from class activities were used to collect the research data. The data collected in the study were analyzed using content analysis. The findings revealed that Freire's critical pedagogy approach in Social Studies classes developed the critical thinking skills of immigrant students, encouraged their active participation in class, boosted their self-confidence, made them feel part of the class, and improved their questioning and communication skills. Recommendations were made to practitioners, researchers, policymakers, and program developers based on the results of the study.

Keywords: *Critical Pedagogy, Migration, Migrant, Social Studies, Critical Thinking Skills*

Introduction

Today, due to the effects of globalization, societies are more mobile and diverse than ever before. In this process, the phenomenon of migration stands out as a reality that directly affects the lives of millions of people worldwide (Günay et al., 2019). Indeed, migration has emerged as one of the most fundamental forms of mobility in human history and has become more complex today due to globalization, economic inequalities, wars, and environmental crises. According to the official definitions of the United Nations (UN, 2019), migration is the movement of individuals or communities from their usual place of residence to another region or country for a certain period of time or permanently. This movement can be voluntary or forced, legal or illegal, short-term or permanent. However, this definition is limited in explaining the causes, processes, and consequences of migration. In international literature, an "international migrant" is defined as a person who leaves their country and lives in another country for at least one year. Migration can be approached as the experience of the migration process at the individual and societal levels. In this context, the migration experience is not just a physical relocation, but an area where the global, economic, political, and social order is reproduced (UNHCR, 2023). While migrants strive to maintain their ties to their country of origin, they also undergo processes of integration into or differentiation from the new society. This duality is a fundamental characteristic that necessitates examining migration from a social sciences perspective (Massey et al., 1993). On the other hand, the inclusion of immigrant students with different languages, cultures, and backgrounds in the education system requires a holistic approach not only in terms of academic achievement but also in terms of social integration, participation, intellectual development, and values (Nguyen and Benet-Martínez, 2013). In this context, it may be necessary to re-examine subjects such as Social Studies, which contribute to the development of citizenship awareness. In the face of global developments and cultural diversity, the content of this course aims not only to impart knowledge but also to develop values, attitudes, and skills (Öztürk, 2015). In this context, it can be stated that the Social Studies course is a multidimensional field of study that can contribute to students' development of awareness regarding community life, recognition of their rights and responsibilities, respect for different cultures, and acquisition of active citizenship skills.

Social Studies is a course that presents content compiled from social science disciplines, structured in a manner appropriate to the developmental levels of elementary and middle school students (Barr, Barth, & Shermis, 2013). On the other hand, it aims to contribute to students' understanding and internalization of the values of the society they live in and universal values, in addition to providing them with knowledge and skills they can use in their daily lives (Bayram, 2023). The Social Studies course prepares the ground for students to make sense of the social realities they live in and to question these realities from a critical perspective (Parker, 2018). However, realizing this potential is only possible if the course is approached not merely as a means of transferring knowledge but also as a means of encouraging students to think, analyze, and transform. Indeed, Paulo Freire's critical pedagogy approach also aims to provide a learning environment that centers on student active participation and multiple perspectives (Freire, 1998). According to Freire, the traditional education model places the student in the position of a passive recipient of knowledge. In this approach, which he describes as the "banking model of education," the teacher is thought of as depositing knowledge, while the student is thought of as a savings account storing that knowledge. In contrast, the "problem-posing education model" presents another perspective based on the student's life experience, focusing on understanding, questioning, and transforming the world (Kaya and Altan, 2019). In this context, it can be said that the student becomes not only a learner but also a subject who transforms the world. Indeed, in the problem-defining education model, students become aware of their own selves and have the opportunity to develop critical thinking skills; the teacher focuses on methods that will activate students' critical thinking skills rather than directly transferring knowledge; students' thinking processes are supported through strategies such as asking questions and turning topics into problems; in a democratic learning environment, students freely engage in action and critically evaluate both themselves and the world they live in; thus, they understand that the world is not static but a reality that changes over time (Yılmaz, 2016). On the other hand, Paulo Freire's Critical Pedagogy approach offers a transformative and liberating perspective on education (Freire, 2003). This approach replaces the traditional understanding of "the teacher educates the student" with a learning relationship based on mutual interaction, where the roles of teacher and student are intertwined (Freire, 1998; Freire, 2005; Freire, 2018; Yılmaz, 2016; Ferah Özcan, 2021). In his critique of Social Studies, Ross (2017) states that it is "the engine room of the illusion factories where the current social order is reproduced." He argues that Social Studies should become an area where students learn to express themselves as free individuals and strive for a better future with a more equal level of participation. In this context, the Social Studies course is important in terms of applying critical pedagogy and building a democratic, participatory classroom environment (Kalbach, 2000). In this regard, it can be said that the nature of the Social Studies course is similar to Freire's critical pedagogy approach.

A review of the domestic and international literature reveals numerous studies on Freire's Critical Pedagogy (Kirylo et al., 2010; Yılmaz, 2016; Childs, 2017; Efe, 2017; Kaya and Altan, 2019; Kantarcı Bingöl and Aybar, 2020; Ferah Özcan, 2021; Korkutan and Kaplan, 2022; Potur, 2022; Demirci, 2023; Ural and Çalmaşur, 2023; Kayan and Kozikoğlu, 2023). On the other hand, Magill and Salinas (2018) aimed to examine Social Studies teachers' ways of understanding and adopting critical pedagogy in their studies. İstanbullu (2024) aimed to examine Social Studies teachers' views on critical pedagogy. In another study, Yılmaz and Altınkurt (2011) aimed to examine pre-service teachers' views on critical pedagogy in terms of gender,

program of study, and class variables. The results of the study revealed that participants' views differed according to gender, program of study, and class variables. On the other hand, Aksakallı et al. (2018) aimed to examine the effect of critical pedagogy principles on students' academic achievement in science education. The results of the study showed that the academic achievement of students in the experimental group was higher than that of students in the control group. On the other hand, a review of the literature reveals numerous studies on migration and migrant students in Social Studies courses (Topkaya and Akdağ, 2016; Pevlivan Yılmaz, 2019; Uysal, 2022; Gökalp, 2023; İzmir et al., 2023). Although the literature review reveals numerous studies on the phenomenon of migration and migrant students, no research has been found that examines the critical thinking skills of these students in Social Studies classes within the scope of Freire's critical pedagogy. In this context, it is thought that the Social Studies course can provide a learning environment where migrant students can both make their individual experiences visible and critically question their relationships with the society they live in. In this context, the research aims to contribute to both the applicability of Freire's critical pedagogy and the multicultural education approach by implementing a pedagogical approach that incorporates the lives of immigrant students into the educational process and places them in a subject position, while also examining the development of students' critical thinking skills.

The Purpose of Research

The main purpose of this research is to examine how Social Studies lessons based on Paulo Freire's critical pedagogy approach develop the critical thinking skills of 7th grade immigrant students. In line with this purpose, the following questions will be addressed:

1. How do the critical thinking skills of 7th grade immigrant students develop in the Social Studies course conducted based on the critical pedagogy approach?

2. What are the views and experiences of 7th grade immigrant students and teachers regarding the educational process in which the Freirean approach is applied within the scope of the Social Studies course?

Method

Research Design

A qualitative research method was used in this study. Qualitative research is a method that examines events, phenomena, and situations in depth in their natural environment and from a holistic perspective; it analyzes data obtained through data collection techniques such as interviews, observation, and document analysis, based on interpretation and meaning (Creswell, 2018). In this study, the case study design, one of the qualitative research designs, was employed. The focus of the research is the development of critical thinking skills among 7th grade immigrant students through Social Studies teaching based on Paulo Freire's critical pedagogy approach. However, because the study focuses on multiple units of analysis within the examined situation (e.g., students' critical thinking skills, participation processes, observation and interview data), it is designed within the nested single case pattern according to Yin's (2014) case study classification. The embedded units of analysis within this case are: (1) the development of immigrant students' critical thinking skills, (2) students' participation and learning experiences in the course, and (3) the teacher's observations and views on the process. This allowed for an in-depth analysis of the pedagogical process under consideration from multiple perspectives.

Participant Group

The study group consisted of a total of 11 migrant students (one Bulgarian, three Afghan, three Syrian, and four Lebanese students) from different countries with various migration experiences, who were enrolled in the 7th grade at a public middle school during the 2024- 2025 academic year, and one Social Studies teacher. Criterion sampling, one of the purposive sampling methods, was used to select participants in the study (Flick, 2014; Mertens, 2014; Patton, 2005).

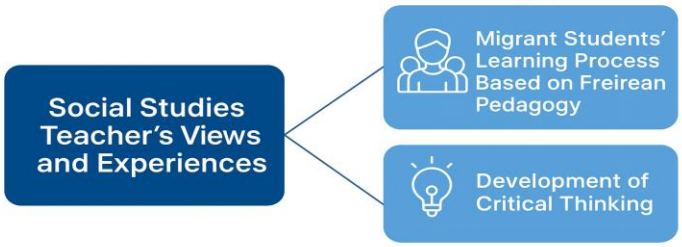
Research Instrument

In the study, the following data collection tools were used: unstructured observation, student diaries, a semi-structured interview form for teachers and students created by the researcher, and student products generated from classroom

activities. Expert opinions were sought during the preparation of the interview form. Based on the feedback received from the experts, the questions in the form were reviewed and restructured. The updated form was submitted to the experts for a second time; based on the experts' approval of its suitability, it was decided that the form was ready for implementation.

Data Analysis

In the study, the data were analyzed using qualitative data analysis techniques appropriate to the structure of the study. The data obtained from interviews with 11 immigrant students in the 7th grade and a Social Studies teacher were subjected to content analysis. In this study, the content analysis process was conducted in accordance with Miles and Huberman's (1994) three-stage approach to qualitative data analysis. In the first stage, data obtained from observations and interviews were made analyzable and meaningful statements were coded. In the second stage, the codes were organized into tables and thematic arrangements to form holistic structures. In the third stage, the results were interpreted based on themes and sub-themes, and the validity and reliability of the findings were ensured. In addition, the data were analyzed independently by three researchers to reinforce reliability. To ensure the validity and reliability of the results obtained in the study, the data



were analyzed independently by the three researchers conducting the study. As a result of comparing the analyses, a consensus was reached, and findings were obtained.

Results

This section examines the data obtained from observations and interviews with eleven 7th- grade immigrant students and a Social Studies teacher. The findings reached in the study were determined as two themes: "Findings regarding the views and experiences of 7th grade immigrant students on the educational process in which the Freirean approach is applied within the scope of the Social Studies course" and "Findings regarding the views and experiences of the Social Studies teacher on the educational process in which the Freirean approach is applied within the scope of the Social Studies course ." Sub-themes and codes were created, and direct quotations were included.

2. Findings and comments regarding the views and experiences of Social Studies teachers on the educational process in which the Freirean approach is applied within the scope of the Social Studies course.

The study includes the views and experiences of a Social Studies teacher regarding the contribution of Freirean pedagogy to developing critical thinking skills in immigrant students. The findings obtained from analyzing the data collected from these interviews are presented in Figure 1 below.

Figure 1. *Social Studies Teacher's Opinions and Experiences*

As seen in Figure 1, the analysis of the Social Studies teacher's views and experiences revealed that the teacher stated that a learning process based on Freirean pedagogy contributed to the learning of immigrant students and the development of their critical thinking skills. The teacher stated that this process had positive effects on students, particularly in areas such as communication, active participation, questioning, and a sense of belonging.

Within the scope of the research, it was observed that the Social Studies teacher expressed the view that students were able to communicate in the learning process based on Freirean pedagogy.

The teacher's statements are as follows:

"*It was often difficult for immigrant students in the classroom to communicate with other students. I really wanted them to communicate with their friends by doing activities in class from time to time, but I noticed that they were still keeping to themselves after class.*

On the other hand, the teacher stated that the Social Studies lesson, implemented within the scope of critical pedagogy, ensured the active participation of the students. The teacher said,

"*Migrant students are generally not very active in class. Even when I specifically tried to involve them, it didn't last long. I noticed that their participation in these lessons lasted longer, and that made me very happy. My students, who were even hesitant to raise their hands, were now the first to raise their hands. I was surprised, but I hope they continue to be like this. Because they have very good ideas*." In this context, it can be said that the Social Studies class conducted within the scope of Freirean pedagogy contributed to the active participation of students.

On the other hand, the Social Studies teacher expressed the students' sense of belonging to the class with these words: "My students generally behaved as if they were strangers in the class, acting as if they were just going to look at a friend and leave. With the interest they showed in this class, I saw that for the first time they found a piece of themselves in the class. After the class, some of my students told me they loved the class and didn't want it to end."

According to the Social Studies teacher's statements, it was found that the lessons conducted within the scope of Freirean pedagogy provided students with critical thinking skills; students developed different perspectives and questioned their prejudices. The Social Studies teacher's views are as follows:

"In the activities we implemented in these lessons, I observed that my immigrant students became more critical thinkers over time. They internalized some of the discourse circulating in the media about themselves and frequently asked why this was the case and tried to understand it. In an activity where we presented a cartoon or a short news story about migration to the class, I asked the students some questions about being a migrant in order to bring out stereotypes, and I noticed a difference in my students' perspectives towards those in the same situation as themselves."

Based on the findings from observations and interviews in the study, it was determined that the Social Studies course, implemented using Freirean pedagogy, contributed to students' critical thinking skills, enabled them to learn through questioning, and helped them recognize prejudices.

3. Findings and comments regarding the views and experiences of 7th grade immigrant students on the educational process where the Freirean approach was applied in the Social Studies course

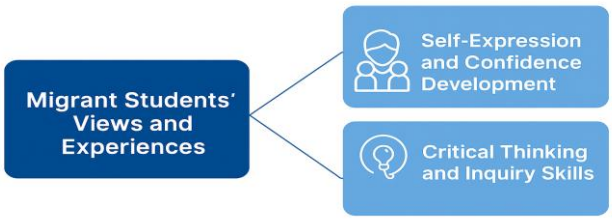


Figure 2. *Views and Experiences of Migrant Students*

In the study, observations and semi-structured interviews were conducted simultaneously to reveal the views and experiences of students regarding the contribution of the Social Studies course, conducted within the scope of Freire's pedagogy, to the critical thinking skills of immigrant students. The findings obtained are presented in Figure 2:

As seen in Figure 2, findings indicate that Freirean pedagogy-based practices implemented in the Social Studies course contributed to students' self-expression and self-confidence development, as well as their critical thinking and questioning skills.

Observations made in the study show that students were more hesitant to express themselves in the first lesson, but were able to express themselves more clearly as the lesson progressed. On the other hand, it was observed that students participated in activities with more confidence. For example, P7 said,

"I already loved this class, but sometimes I didn't understand. My teacher didn't give me a chance to speak when I didn't talk much in class. In this class, questions were constantly asked, and activities were carried out. At first, I was hesitant, but when everyone else participated, I joined in too."

The findings of the study reveal that the Frier pedagogy implemented in Social Studies class contributes to the development of students' critical thinking and questioning skills. For example, P1,

"When our teacher asked us in class, 'What made you think the most today?', I was thinking that not everyone is like us. Then I thought that because we are immigrants, we don't deserve worse things . I mean, when we say to some people that we are Syrian or Lebanese, I don't understand why they look at us differently, but when someone else says they are German, they all look at them as if they admire them. That's what I thought."

The study determined that, within the scope of the students' views, the Freirean pedagogical approach in Social Studies classes contributes to students' critical thinking skills.

Discussion, Conclusion and Recommendations

Discussion

In their study, Magill and Salinas (2018) aimed to examine social studies teachers' perceptions, attitudes, and pedagogical approaches based on critical pedagogy in the context of citizenship education. The results revealed that while some teachers maintained a traditional understanding of citizenship, most adopted a critical citizenship orientation, supporting students in questioning social structures and developing active citizenship skills. Another study conducted by İstanbullu (2024) examined Social Studies teachers' views on critical pedagogy in terms of various variables. Furthermore, it concluded that teachers' views on critical pedagogy did not show significant differences based on variables such as gender, length of professional experience, type of institution, and subject area. On the other hand, Aksakallı, Salar, and Turgut (2018) examined the effect of science teaching based on critical pedagogy principles on students' academic achievement in their study. As a result, it was determined that the academic achievement of the students in the experimental group was higher than that of the students in the control group. In addition, the students described themselves as questioning, independently thinking, and free individuals with a critical perspective in the process of science education based on critical pedagogy. In another study, Efe (2017) used an action research design to determine how critical pedagogy practices were implemented in Turkish and Human Rights, Citizenship, and Democracy courses in the 4th grade of elementary school. In line with the findings obtained in the study, the application of critical pedagogy developed awareness in students' problem-solving, critical, and creative thinking skills; the fact that decisions were made democratically was effective in the processes of students complying with or adopting the decisions taken; artistic activities made the learning process enjoyable, revealed students' latent talents, and supported their self-confidence development. Yılmaz and Altınkurt (2011) examined Social Studies teacher candidates' views on critical pedagogy according to gender, class, and program variables. Within the scope of the Critical Pedagogy Principles Scale used in the study, it was concluded that teacher candidates showed the highest participation in the sub-dimensions of Liberating School, Functions of the School, and Education System.

Conclusion

In the study, qualitative data obtained from teacher and student opinions were collected, analyzed, and the findings of the study were presented. The findings were interpreted, and the results of the study were discussed within the scope of similar studies in literature.

The study concluded that the learning process based on Freirean pedagogy, as perceived by Social Studies teachers, contributes to immigrant students in terms of communication, active participation, questioning, and a sense of belonging. On the other hand, it was concluded that the Freirean pedagogy-based practices implemented in the Social Studies course contributed to migrant students' self-expression, self-confidence development, critical thinking, and questioning skills. The study concluded that the views of social studies teachers supported the characteristics of the problem-posing education

model.

The study concluded that the Social Studies course, conducted based on Freire's critical pedagogy, developed the critical thinking skills of 7th grade immigrant students; furthermore, this process contributed to students' ability to express themselves, gain self- confidence, and acquire questioning skills. On the other hand, it was concluded that the Social Studies course adopted an approach that enabled students' active participation, facilitated communication, and contributed to their sense of belonging in the classroom environment. In this context, it can be said that the application of Freire's critical pedagogy in Social Studies classes positively contributes to students from different cultures' abilities to express themselves, develop mutual understanding, and critically evaluate social issues.

Recommendations

Based on the findings of the study, a number of recommendations have been developed. These recommendations are presented below.

- Social Studies teachers can include activities based on critical thinking in their lesson plans.
- Teachers can be supported with in-service training on critical pedagogy topics.
- This research was conducted in the context of Social Studies. Similar approaches should also be investigated to determine what results they would yield in other subjects such as Science, Turkish, or Visual Arts.
- Studies can be conducted with different age groups and demographic structures.
- Mixed-method research supported by quantitative data can be conducted.
- Policies should be developed to support the adaptation of immigrant students to the educational process.

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Creativeness of Gifted Students in Geometry-Based Multiple Solution Task

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Abstract

The purpose of this study is to investigate the creativity levels of gifted students in geometry-based multiple solution tasks. A case study approach, a type of qualitative research design, was used. The participants are four male seventh-grade gifted students enrolled in private schools. The participants were identified as gifted in general ability. The gifted students also enroll in the Science and Art Center (BİLSEM) in Ankara. A geometry-based multiple solution task and a semi-structured interview protocol were used as data collection tools. The geometry-based multiple solution task was employed to assess the creativity level of gifted students, and the interview was used to gain insight into the thinking processes of gifted students during the study. The data were scored by two authors using a rubric created by Leikin et al. (2009). Three components have been examined while evaluating creativity: *flexibility*, *fluency,* and *originality*. The findings showed that gifted students demonstrated a high level of creativity with the numerous unique solutions they found in geometry-based multiple solution tasks. The findings of this study imply that teachers could consider using geometry-based multiple solution tasks in their classes to enhance the mathematical creativity of gifted students.

Keywords: *Mathematical creativity, Mathematics education, Giftedness, MSTs,*

Introduction

The concept of giftedness has been defined and interpreted in a number of ways. Gifted students exhibit distinct cognitive characteristics compared to their peers (Rinn & Majority, 2018). To contribute to the development of gifted students, it is essential to understand their specific needs. Gifted students' needs differ from those of other students due to their distinctive characteristics, and they seek tasks that are different from what regular classes provide (Özdemir & Işıksal-Bostan, 2019). Thus, a clear conceptualization of the characteristics of giftedness is essential to comprehend these needs. Renzulli (2002) defines the characteristics of gifted students using the three-ring model, which includes above-average ability, creativity, and task commitment. Although many authors view creativity and giftedness as related, the relationship between them is not apparent. Some research states that creativity is a subset of giftedness, others say that creativity is a prerequisite for giftedness, and still others say that the relationships between them are different from these (Hershkovitz, Peled, Littler, 2009). In this paper, the researchers are going to focus on creativity as a prerequisite of giftedness.

Giftedness does not need to be general, as well as creativity. Some students are gifted or creative in specific domains (Winner, 1996). For instance, mathematically gifted students display creativity in the field of mathematics according to Renzulli's three rings model. Even though there are a lot of definitions of general creativity and content-specific creativity, Sriraman (2005) defines mathematical creativity as the ability to deliver novel work that particularly expands knowledge and raises new questions for other mathematicians. Likewise, Leikin (2009) states that it is important to improve mathematical creativity as it fosters students' conceptual understanding. To enhance mathematical creativity, students need to be exposed to "potential" tasks at an early age (Hershkovitz, Peled, Littler, 2009). There are different potential tasks for various areas of mathematics.

Geometry is a field full of potential tasks, and teachers prefer to use differentiated geometry problems over those in other subjects. Also, Small (2009) stated that one of the potential tasks for differentiating in mathematics classrooms is open-ended problems. Open-ended problems are believed to encourage students' creativity more than closed-ended problems. Since open-ended and non-routine geometric problems require more complicated cognitive processing than closed-ended problems, they require students' creative thinking (Carlson & Bloom, 2005; Levav Waynberg & Leikin, 2012; Silver, 1997; Liljedahl et al., 2016, as cited in Schoevers et al., 2021; Schoevers et al., 2021). Thus, to nourish creative thinking in mathematics, students could be provided with non-routine and open-ended questions.

Multiple Solution Tasks are examples of open-ended and non-routine problems. Leiken (2007) defined Multiple Solution Tasks (MSTs) as questions that require different solution types to examine creativity. Thus, students need to think about different solution strategies and see the relations among different mathematics topics. Solutions may change according to the use of different mathematical concepts, properties, tools, and theorems from various branches of mathematics (Levav-Waynberg &

Leikin, 2012). In addition, Levav-Waynberg and Leikin (2012) stated that implementing multiple solution tasks in 10th-grade geometry lessons developed both students' geometrical knowledge and creativity (Schoevers et al., 2021). Geometry-based MSTs can be also used to develop creativity since they require using concepts from the standard school curriculum, requiring no extracurricular knowledge for students (Levav-Waynberg & Leikin, 2009; Schoenfeld, 1985, as cited in Levav-Waynberg & Leikin, 2011). With this regard, in this study, we aim to investigate gifted students' creativity levels in geometry-based multiple solution tasks. Thus, the following question guides the study:

-To what extent do gifted students show creative solutions in geometry-based multiple-solution tasks?

Method

Research Design

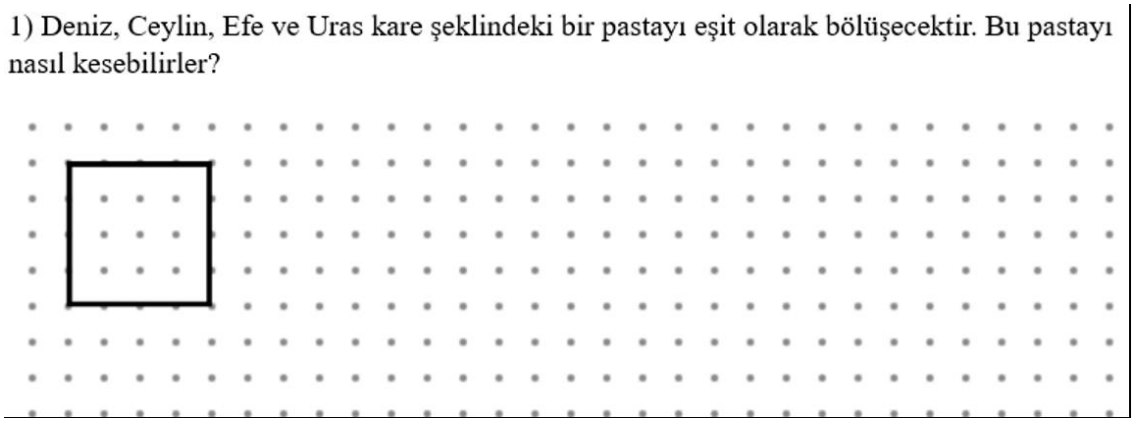
A qualitative research design was applied to a deeper understanding of gifted students' creativity in geometry-based multiple solution tasks. In addition, case-study design is appropriate for the investigation of complex phenomena, such as creativity, and it also offers an in-depth understanding of the topic (Heale & Twycross, 2017). Thus, a case-study design was used in this study as a research approach.

Research Sample

The research was conducted with four male participants who are 7th graders and identified as gifted in general ability. The students enroll in the Science and Art Center (BİLSEM) in Ankara. In addition, all participants enroll in private schools in Ankara.

Research Instrument and Procedure

The geometry-based multiple solution task and an interview protocol were used as data collection tools. The geometry-based multiple-solution task is adapted from an article written by Hershkovitz, Peled, & Littler (2009).



Besides the given MST, an interview was conducted with participants to understand their thinking and perceptions in detail.

Data Analysis

To score the data, the rubric created by Leikin was used (Leikin, Berman, & Koichu, 2009). They used three components while evaluating creativity, such as fluency, flexibility, and originality. Fluency (Flu) refers to the number of solutions, flexibility (Fle) refers to a variety of solutions, and originality (Or) refers to the novelty of solutions (Torrence 1974, as cited in Leikin et al. 2009). In this study, while evaluating students' solutions, the following process was applied. All correct answers get 1 fluency point. The first appropriate solution in each question gets 10 flexibility points. Solutions were grouped, and every first different type of solution got 10 flexibility points while similar strategies got 1 flexibility point. Since the sample size is less than 10, the originality is scored by the conventionality of the solution. Each insight and unconventional solution get 10 originality points. The originality and flexibility scores were multiplied to produce a score for each solution. Then, those scores were added to find a creativity score for the question. Two authors score the data separately and then compare their findings. A hundred percent agreement is provided between the two authors.

Findings

The students' creativity scores vary according to their solutions, as shown in Table 1.

Table 1. Frequency of Solutions and Corresponding Creativity Scores

Scores for each solution / Participants' number of solutions	100 score solutions	10 score solutions	1 score solutions	0.1 score solutions	Total number of solutions	Creativity scores
Participant 1	**10**	**33**	**2**	**2**	**47**	**1332.2**
Participant 2	**9**	**1**	**2**	**2**	**14**	**912.2**
Participant 3	**11**	**52**	**5**	**2**	**70**	**1625.2**
Participant 4	**5**	**1**	**2**	**2**	**10**	**512.2**

Some students generate plenty of solutions, especially participants 1 and 3, with a total of 47 and 70 solutions, and creativity scores are close to each other, with 1332.2 and 1625.2, respectively. The relationship of the scores of participants 1 and 3 is that both students used similar strategies to generate solutions. They create an unconventional solution to the task (*Or* = 10 points, *Fle* = 10 points, and *Cre* = 100 points), and they use this unconventional solution to generate other solutions by translating or rotating this solution. This strategy would affect the uniqueness of the solution. For these kinds of generated solutions, the scoring would be *Or* = 10 points, *Fle* = 1 point, *Cre* = 10 points. Since there were plenty of this kind of solution, the majority of both participants' solutions got 10 points. On the other hand, the second participant's score is also close to theirs, 912.2, with only 13 solutions. Since the students created unconventional solutions that were hard to translate or rotate, they were not able to use that unconventional solution to generate new ones. On the other hand, the last participant's creativity score was lower than other students. However, the solutions of the fourth participant were both unconventional and had high flexibility, although there was a limited number of solutions.

Discussion

Gifted students demonstrated their high level of creativity with the unique and numerous solutions they found in multiple solution tasks. Levav-Waynberg and Leinkin (2011) stated the fact that the geometry-based multiple solution tasks enabled students to create new strategies by adding their creativity to familiar topics with their existing knowledge, without requiring any extra training. Thus, in this study, students might have benefited from their creative thinking as they were asked to develop new strategies in open-ended questions. Data analysis revealed students full focus to overcome the challenges they faced and produce new solutions. The effort they showed was a symbol of their inner motivation. In the interview, they stated that the questions they solved during the study were different from the questions they solved in their normal education and that although they faced some challenges in the activity, they enjoyed trying without getting bored. These findings are parallel to the results of Diezmann & Watters (2001), as students' intrinsic motivation pushes their creativity. In addition, in this study, gifted students' task commitment, one of the characteristics of giftedness, might play an essential role in their creativity. Throughout the task period, students spent time and made an effort to come up with various solutions, which demonstrates their dedication. Hereby, they were able to produce original works. Gifted students demonstrate a high level of creativity; still,

their creativity level needs to be improved. The results show that it can be useful to include geometry-based multiple tasks in mathematics education to enhance mathematical creativity.

Conclusion

This study investigated the creativity levels of gifted students in geometry-based multiple solution tasks. The results demonstrated that gifted students showed a high level of creativity in these tasks. The findings suggest that to assess and enhance the creativity of gifted students, geometry-based multiple solutions might be efficient.

Recommendation

The study obtained a result parallel to the studies in the literature. Teachers may take advantage of the findings of this study, and they may consider applying geometry-based multiple solution tasks in their classes to enhance their students' creativity.

On the other hand, the study has some limitations. One of these is that the sample to which the study was applied was small and included a single grade level. A study with a larger sample size and addressing different grade levels can be conducted in the future.

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Determining Students' Argument Levels Regarding the Effects of Sunlight on Skin Health and Vitamin D

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Abstract

The aim of this study is to determine the level of arguments developed by 6th grade middle school students regarding the effect of sunlight on skin health and vitamin D production. The present study was conducted during the 2023-2024 academic year at a public middle school in Giresun province. The participant group consisted of 30 students, including 22 girls and 19 boys. The research utilized a worksheet designed in accordance with the Argumentation-Based Science Learning (ABSL) approach as the data collection instrument. The students were posed with the following question: "What is your opinion on the significance of exposure to sunlight in relation to vitamin D production and skin health?" Students were tasked with articulating their perspectives on the aforementioned subject in the form of a claim, providing a rationale to support their claims, and substantiating these claims with evidence. Initially, scientific discourse was conducted within each group's respective sessions. Subsequently, these groups engaged in inter-group dialogue, fostering a collaborative environment. Subsequently, students were tasked with presenting statements that would contradict the views previously expressed by their peers. The activity was completed within the time frame of one class period. A descriptive analysis was employed to assess the students' argument levels, while content analysis was utilized to evaluate their statements. Pursuant to the application, it was ascertained that approximately half of the students developed level 3 arguments comprising claims, reasons, and supporting elements. It was also observed that there were students at level 4 who could produce refutations, but their number was limited. It was found that a significant proportion of students drew attention to the negative effects of prolonged exposure to sunlight on skin health, emphasizing the risk of burns in particular. It is recommended that various studies be conducted to improve students' argumentation skills.

Keywords: *Argumentation, ABSL aproach, Science education, Sixth-grade students.*

Introduction

In education, understanding and applying knowledge has become more important than simply memorising it. In contemporary educational systems, the emphasis has shifted from mere memorization of information to the global priority of enabling students to analyze knowledge through an inquiry-based approach, employ critical thinking skills, and make informed decisions (Tümay & Köseoğlu, 2011). In this regard, science education assumes a pivotal role in fostering students' critical thinking and problem-solving skills by facilitating connections between scientific knowledge and daily life (Kaya, 2005). The process of acquiring scientific knowledge is not merely about perceiving and understanding phenomena and changes in the environment. It involves approaching problems encountered in daily life through scientific methods, substantiating claims with evidence, and defending these claims in discussion settings (Skoumios, 2009). Indeed, recent research in the field of science education has revealed that argumentation plays a decisive role in the construction of scientific knowledge. In a meta-analysis study conducted by Yıldırım (2022), it was found that argumentation-based teaching approaches led to significant improvements in many variables. Scientific research is fundamentally defined as the process of justifying and defending ideas, beliefs, and knowledge claims developed to understand nature (Jiménez-Aleixandre, Rodríguez, & Duschl, 2000). Incorporating argumentation into learning processes enables students to participate in scientific discussions and evaluate the relationship between claims and evidence. Moreover, by facilitating the comparison and discussion of different perspectives, it fosters the development of critical and analytical thinking skills (Chin & Osborne, 2008). In this regard, argumentation serves not only as a means of enhancing students' conceptual understanding of scientific phenomena but also as a tool for developing scientific literacy.

One of the most important elements of science education is argumentation. The concept of argumentation has been defined in various ways by researchers in the literature. Firstly, an argument is defined as a series of logical statements created by individuals to explain their ideas and claims (Sampson & Clark, 2008). According to another definition, it is presenting reasons

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to support or refute a proposition and presenting reasons for how it came about (Kuhn, 1992). Argumentation is a written or verbal process of exchanging ideas with the aim of evaluating the validity or truth of a claim. In this process, individuals express their views and re-examine the claims of others using data, justifications, supporting and refuting arguments (Toulmin, 2000). Argumentation stands out as a fundamental teaching approach that supports meaningful learning in science education.

In particular, Toulmin's Argumentation Model is used in educational research. Toulmin (1958) stated that in order to create a quality argument, it must contain three main and three supporting components. 3 main components: *Data, claim, warrant.* 3 supporting components: *Backing, qualification, rebuttal. Data* is the source that creates thought. *The claim* indicates the conclusion or proposition at the centre of the discussion. The element that links the claim and the data is the *warrant*, which explains why this connection is valid. Behind the warrants, general principles or commonly accepted assumptions by society serve as the *backing* element. The *qualifier* determines under which conditions the claim can be considered valid. The *rebuttal* indicates situations in which the claim is invalid or limited (Driver, Newton & Osborne, 2000). Toulmin's Argumentation Model contributes to the careful execution of the process by encouraging analytical thinking, clarifying hypotheses, and promoting discussions as an interaction-based reasoning process. It also enhances individuals' discussion skills and supports their critical thinking abilities (Aldağ, 2006). In science education, Toulmin's model helps students construct and evaluate claims with evidence, supporting critical thinking and deeper understanding of concepts.

The ABSL approach, developed by Hand and Keys (1999), is a model in Science Education that aims not only for students to acquire scientific knowledge but also to construct it through inquiry, research, and discussion processes. The ABSL approach, one of the constructivist learning methods, includes both classroom discussion and writing activities for students and active laboratory practice. Çalışkan (2020) examined the effects of the ABSL approach on the argumentation skills of 7th-grade students. It was determined that students' claim and justification skills increased through activities using videos, audio recordings, and worksheets. Koçak (2019) conducted an application with 6th-grade students. Similarly, it was determined that students' argumentation skills improved, and success and participation increased. The ABSL approach specifically aims to equip students with the outcomes included in the American National Science Education Standards. In this respect, students' cognitive skills are enhanced, enabling them to learn concepts more meaningfully (Ulu 2011). This demonstrates the importance of the ABSL approach.

Argumentation is an approach used to develop students' reasoning skills by thinking like scientists. To develop their argumentation skills, students must explain their claims with justification and connect them with their classmates' different perspectives (Driver et al., 2000). However, this argumentation environment can present some challenges. Students may focus solely on their own ideas, which can lead to errors. If they don't produce sufficient evidence, they may reach erroneous conclusions. They cannot generate new claims based solely on their classroom thinking (Zeidler, 1997). The ABSL approach can overcome these challenges when used appropriately.

This study was conducted to examine students' scientific argumentation skills in a science course taught using the ABSL approach. The aim was to determine the level of argumentation developed by 6th-grade students regarding the benefits of sunlight on skin health and vitamin D production.

Method

Research Design

This research is a case study aimed at determining students' argumentation levels. It was conducted in accordance with a qualitative research approach. The study examined in detail the arguments developed by students and the levels of these arguments.

Research Sample

The research was conducted at a state secondary school in Giresun during the 2023-2024 academic year. A total of 41 sixth-grade students from the same school participated in the research, comprising 22 girls and 19 boys. The students were selected using a purposive sampling method.

Research Instrument and Procedure

In the study, a worksheet including the activity titled *The Magic of the Sun*, prepared based on the ABSL approach, was used as the data collection instrument. Students were asked the following question: 'What are your thoughts on the importance of sun exposure for vitamin D production and skin health?' They were expected to express their ideas regarding the effects of sunlight on skin health and vitamin D production within the framework of a claim, justify these claims with reasons, and provide supporting examples. The implementation was carried out over one class period. In the first stage of the process, students individually recorded their responses on the worksheet, then were divided into groups. Students shared their views in small groups, and finally engaged in scientific discussions with all groups in the classroom regarding the claims, justifications, and supporting evidence they had prepared. During the argumentation process, students were encouraged to question different perspectives and generate new claims and justifications that could refute the views of their peers. The teacher acted as a guide rather than a director of the process, supporting discussions with facilitative questions while refraining from directly intervening in students' statements. The argumentation process was completed through oral discussions, during which students articulated their claims, provided supporting reasons, and considered counterarguments.

Data Analysis

The arguments produced by students in the *The Magic of the Sun* activity, designed based on the ABSL approach, were collected and evaluated through both the activity process and the worksheets. To determine the levels of students' arguments, the argumentation assessment rubric developed by Sadler and Fowler (2006) was used. According to this rubric, level 0, the lowest level, contains no claims or justifications. At level 1, only a claim is present, but the justifications are either absent or scientifically invalid. Those who used both claims and justifications were identified as Level 2; those who used claims, justifications, and supports were identified as Level 3; and those who used claims, justifications, supports, and rebuttals were identified as Level 4. Descriptive analysis was used in the study. Descriptive analysis is a method that interprets findings obtained based on a pre-prepared situation using qualitative data (Yıldırım & Şimşek, 2011). In this regard, the arguments prepared by the students were examined at different levels and categorized after detailed analysis.

The arguments prepared by the students were examined using content analysis. Content analysis is a method of systematically classifying and organizing data into established categories (Schreier, 2012). In this study, the arguments prepared by the students were systematically coded and arranged into thematic categories (*claim, justification, backing, rebuttal*). The students' ideas were analyzed for both content and meaning. The analyses conducted to determine the quality of the students' arguments were presented in detail in a tabular form using percentage and frequency values.

The reliability and validity of the study's data were determined by the researchers together. Cohen's kappa coefficient was used to determine inter-coder agreement during the data analysis phase. As a result of the comparisons conducted by the researchers, the Cohen's kappa value was calculated as 0.84. In cases of discrepancies in coding, the researchers engaged in discussions to review the coding and reach a consensus. This ensured a high level of consistency and reliability in the data analysis.

Results

The levels of students' arguments regarding the question "What are your thoughts on the importance of sun exposure for vitamin D production and skin health?" were determined and are presented in Table 1.

Table 1

Frequency and Percentage of Students' Argument Levels

Argument Level	Argument Characteristic	f	%
0	No claim	0	0
1	Only claim used	5	12.2
2	Claim and warrant used	16	39
3	Claim, warrant, and backing used	18	43.9
4	Claim, warrant, backing, and rebuttal used	2	4.9
Total		41	100

As shown in Table 1, all students in the study provided at least one claim, and no student failed to present a claim. Accordingly, level 0 (no claim) is 0%. In the implementation, level 1 (only claim) students constitute 12.2%, level 2 (claim and warrant) students 39%, level 3 (claim, warrant, and backing) students 43.9%, and level 4 (claim, warrant, backing, and rebuttal) students 4.9%.

The arguments presented by students in their worksheets during *The Magic of the Sun* activity were evaluated as shown in Table 2.

Table 2

Frequency and Percentage of Students' Arguments

Argumentation Element	Student Arguments	f	%
Claim	1. *Prolonged sun exposure damages our skin and causes burns.*	19	46.3
	2. *We need sunlight to obtain vitamin D.*	12	29.3
	3. *If we stay a short time in the sun to get vitamin D, it does not harm the skin.*	5	12.2
	4. *We do not need to stay under the sun to obtain vitamin D.*	3	7.3
	5. *We should stay in the sun long enough, not too long or too short.*	2	4.9
Total		41	100
Warrant	1.1. *Doctors have explained that sunburns are dangerous and can cause permanent damage to our skin. Therefore, sunscreen should be applied when going outside.*	13	36.1
	2.1. *Some vitamins cannot be obtained from fruits or vegetables; we get them from the sun. Vitamin D is present in the sun, especially in summer, and we can obtain it by staying under the sun with sunscreen.*	7	19.4
	4.1. *Vitamin D can also be obtained through medicines prescribed by doctors or certain foods we consume.*	5	13.9
	3.1. *Some harmful rays of the sun can cause cancer. Sunscreen protects our skin from these rays, but vitamin D does not enter our body.*	4	11.1
	1.2. *If we stay too long in the sun, we may burn; if we stay too little, we cannot obtain vitamin D. Both can make us ill*.	4	11.1
	2.2. *If we do not get vitamin D, our bones weaken and we may become unable to walk.*	3	8.3
Total		36	100
Backing	2.1.1. *When we go to the sea, we are exposed to sunlight. We use sunscreen to prevent burns because the skin peels off. At the same time, we obtain vitamin D.*	10	27.8
	1.1.1. *When I went outside without sunscreen, my skin was severely burned. It peeled and was very difficult to heal.*	6	16.7
	3.1.1. *When we use sunscreen, our skin is protected, but if not, it darkens. Some people, however, stay in the sun to tan; using sunscreen prevents harm.*	3	8.3
	4.1.1. *Vitamin D strengthens our bones. There is a saying, 'If the sun does not enter, the doctor enters.' We should get vitamin D from the sun at certain hours while using sunscreen to protect our skin.*	1	2.8
Total		20	100
Rebuttal	2.1. *In response to this warrant: "I saw in a news report that chemicals in sunscreens block vitamin D. To get vitamin D, my mother and I hold our hands in the sun on the balcony for 15 minutes without sunscreen."*	1	50
	2.1. *In response to this warrant: "Some people are allergic to the sun. My cousin was affected by sun exposure. People should not stay in the sun to get vitamin D."*	1	50
Total		2	100

Note: In the table, 1, 2… indicate claims; 1.1, 2.1… indicate warrants corresponding to the claims; 1.1.1, 1.1.2… indicate backing for the warrants. Since some students produced arguments at different levels, the total number may exceed the total number of students in the experimental group.

As a result of the data analysis, it was observed that 46.3% of the students asserted that prolonged sun exposure causes skin damage and may lead to burns. Additionally, some students indicated that sunlight is necessary for vitamin D synthesis. The majority of participants providing warrants emphasized that sunburns pose health risks and that applying sunscreen when going outdoors is important. Furthermore, there were students who highlighted the significance of sunlight as a source of vitamin D. Although scientific elements were present in students' explanations, most of their statements were based on everyday life experiences. Some students also included rebuttals aimed at questioning and refuting their peers' views, and, albeit to a lesser extent, developed counter-perspectives during the argumentation process.

Discussion, Conclusion and Recommendations

Discussion

In the implementation conducted in accordance with the ABSL approach, the levels of arguments developed by sixth-grade students regarding the importance of sun exposure for skin health and vitamin D production were determined. It was

observed that all participating students presented at least one claim, indicating that no student failed to make a claim. According to the analysis results, 12.2% of students developed Level 1 arguments containing only a claim, 39% developed Level 2 arguments with both claim and warrant, 43.9% developed Level 3 arguments incorporating claim, warrant, and backing elements, and 4.9% developed Level 4 arguments encompassing claim, warrant, backing, and rebuttal elements.

The fact that all students were able to present at least one claim is significant, as it demonstrates active engagement in the argumentation process. In particular, the majority of students developing Level 3 arguments indicates that they were able to substantiate their ideas not only with claims and warrants but also by using supporting elements. However, the low proportion of arguments containing rebuttals at Level 4 suggests that students require further development in generating counterclaims and critically evaluating alternative perspectives. Lin and Mintzes (2010) found that most elementary-level students struggled to produce rebuttals even after instruction, and many students were unable to develop consistent counterarguments against alternative viewpoints. Namdar and Demir (2016) examined the argumentation skills of fifth-grade students in classifying living organisms, observing that while students produced counterarguments based on data, their rebuttals were weak. Kutluer (2020) investigated the argumentation levels of eighth-grade students regarding material cycles and environmental issues and reported that students particularly faced difficulties in developing rebuttal elements. Similarly, Türk (2023) evaluated the quality of written arguments created by students during project assignments, finding that although arguments were generally adequate after the activities, only two students developed arguments at the highest level. These findings are consistent with the results of the present study.

When the literature is examined, findings regarding participants' argumentation levels in studies conducted at different educational levels have been reported. Demircioğlu and Uçar (2014) identified the written arguments of teacher candidates regarding the Akkuyu Nuclear Power Plant in their study. It was found that teacher candidates were competent in expressing and defending their ideas but less effective in refuting the arguments of the opposing side. Similarly, Cenk and Ercan Yalman (2023) examined the discussion skills of prospective teachers on various socio-scientific issues using argumentation forms and dilemma cards. The findings indicated that the participants' strongest skill was claim generation. However, their success in presenting evidence and developing supporting elements was more limited. Regarding the rebuttal component, participants demonstrated a considerably low level of performance. These studies are consistent with the results of the present research.

Conclusion

Recent studies have determined that students' argumentation skills can be significantly improved through debate environments and appropriate teaching methods. Evagorou and Osborne (2013) emphasized that high-level arguments typically occur in oral discussions and require students to employ counterarguments and rebuttals. Therefore, in studies aimed at developing high-level arguments, students can be provided with guidelines or prompts to write rebuttals and counterarguments. The argumentation method is regarded as an integral part of science teaching (Jiménez-Aleixandre & Erduran, 2007). In both Turkey and other countries, science curricula should incorporate the argumentation approach. The results show that argumentation in classroom discussions can help students discover different perspectives and develop their reasoning skills.

Recommendations

The study's findings suggest that argumentation can help students develop their perspectives and improve their ability to persuade others in a classroom discussion environment. This method allows students to engage with claims and evidence, fostering meaningful learning. It also allows students to communicate effectively with their peers. Further research is recommended to improve these learning environments.

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Validity and Reliability of AIAS-4 Among Teachers in Türkiye Context: Gender and Teaching Level Differences

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Abstract

Although the rapid advancement in artificial intelligence (AI) technologies has increased the interest in integrating AI into educational environments, the effective adoption of AI in education largely depends on teachers' attitudes towards this technology. This study aims to validate the four-item Artificial Intelligence Attitude Scale (AIAS-4) for use with teachers in the context of Turkey and to examine whether teachers' attitudes differ according to gender and level of education. A total of 135 teachers from various levels of education across Turkey participated in the study and data were collected via an online survey using the Turkish adapted version of the AIAS-4 scale. Confirmatory factor analysis (CFA) supported the unidimensional structure of the scale with excellent fit indices (RMSEA = 0.022, CFI = 0.999, TLI = 1.004, SRMR = 0.019). The findings show that teachers have generally positive attitudes towards AI, but their views differ significantly according to gender and level of education. In particular, faculty-level teachers and male teachers reported more positive attitudes toward the benefits of AI for humanity. These findings highlight the importance of considering demographic factors when developing professional development programs related to AI and suggest that educational policies should address diverse concerns and perceptions about AI to promote effective integration. The validated AIAS-4 scale provides a valid and effective tool for further research and practice to understand teacher perspectives on AI in education.

Keywords: artificial intelligence in education, attitude towards AI, teacher education, scale adaptation

Introduction

AI is defined as a technology that enables the mimicry of human intelligence and is seen to transform various areas of modern society, including engineering, biology, education and psychology (Emmert-Streib et al., 2020). However, understanding and guiding attitudes towards the adoption and use of AI are crucial to strike a balance between the opportunities and risks brought about by the technology (Özer, 2024). AI is used in many different fields, including healthcare (Davenport & Kalakota, 2019), finance (Tkachenko et al., 2024), and education (Xie, 2019). AI applications are encountered routinely in everyday life. The discourse surrounding AI ethics and policy development, emphasized in national and international agendas, holds significance across all educational domains.

It has begun to attract the attention of many teachers, as it plays such an important role in educational activities and various nations are preparing regulations on the use of AI in education and its integration into educational processes (Ayanwale et al., 2022; Yue et al., 2024). However, these kinds of regulations are not accessible to all teachers. We are still in an era where nations are working with people from different levels of education while determining AI's place in education. The lack of knowledge and uncertainties about the future make it difficult to understand how people will exhibit their attitudes. Understanding the attitudes of teachers toward AI from different levels is considered important in many respects.

Primarily, people's attitudes towards the use of artificial intelligence have a significant contribution on impact of this technology (Kim, 2023; Choi et al., 2024). A positive attitude can lead to greater acceptance and broader use of AI, while a negative attitude can hinder or limit the development and spread of AI (Marx et al., 2023). Concerns, ethical issues, and job loss, in particular, can influence people's attitudes towards artificial intelligence technologies (Hopcan et al., 2023). Therefore, it is important to understand and address people's concerns in order to foster widespread acceptance and a positive attitude towards artificial intelligence.

Teachers at both K-12 and university levels need to cultivate a positive attitude towards AI for several reasons. Firstly, as the demand for guidance on AI increases among K-12 teachers, a positive attitude is essential for effectively integrating AI technologies into educational settings (Park and Jones-Jang, 2023). Despite potential challenges stemming from limited experience in computer science or AI, a positive outlook can foster openness to learning and adapting to new technologies. Moreover, a positive attitude towards AI can empower teachers to explore innovative teaching methods and leverage AI tools to enhance student learning experiences. Additionally, the integration of AI into educational programs is becoming increasingly prevalent worldwide, with countries like the United States, Finland, Singapore, and South Korea leading the way

(Education at a glance OECD, 2017; Paek & Kim, 2021). In this rapidly evolving landscape, teachers with a positive attitude towards AI are better positioned to embrace and adapt to changes in educational practices. They can effectively incorporate AI technologies into their teaching methodologies, thereby preparing students for the digital age and equipping them with essential skills for future success.

Positive attitudes among teachers toward the use of artificial intelligence in education can support broader acceptance and integration of these tools in classrooms (Al Darayseh, 2023; Pörn et al., 2024). Teachers with favorable views on AI are more likely to adopt its technologies, explore their benefits, and incorporate them into their teaching practices, which can lead to increased student engagement, personalized learning, and improved academic outcomes (Kuleto et al., 2022). In contrast, negative perceptions may hinder AI adoption in education, often due to concerns like job security, privacy, or unfamiliarity with the technology. Teachers with a cautious stance may hesitate to explore AI tools, try new teaching methods, or dedicate time to integrating these technologies into their classrooms (Choi et al., 2022). To sum up, teachers' attitudes toward AI significantly influence the effective implementation and use of AI tools in education. To encourage positive attitudes, it is crucial to address concerns, offer sufficient training and support, and highlight AI's potential benefits in education. By promoting positive perceptions and tackling barriers, teachers can fully leverage AI's potential to enrich teaching and learning experiences in the classroom. Moreover, findings from cross-cultural studies suggest that women tend to adopt more negative attitudes than men (Bergdahl et al., 2023). Based on this, it is important to assess the current situation of female teachers in Türkiye and discuss potential reasons, in order to provide content focusing on the potential benefits of using AI in educational programs.

Measuring Attitude Toward Artificial Intelligence Scales in the Educational Landscape

Table 1 compares various scales developed to assess attitudes toward AI across different age groups and educational contexts. The scale by Karaoğlan-Yılmaz et al. (2024), designed for university students, includes positive and negative attitude factors. The positive attitude factor comprises items related to the perception that AI may provide benefits in educational settings, while the negative attitude factor includes items addressing concerns that AI could impede the development of critical thinking skills. Similarly, Suh et al. (2022) developed a scale for K-12 students that encompasses cognitive, affective, and behavioral factors. The cognitive factor includes items that gauge students' perceptions of AI's potential to enhance daily life, the affective factor consists of items about the enjoyment associated with learning about AI, and the behavioral factor focuses on students' intentions to use AI as a tool to address everyday problems. Schepman and Rodway (2020) created a scale for individuals over 18, which also evaluates positive and negative attitudes. The positive attitude factor includes items related to a willingness to integrate AI into one's professional work, while the negative attitude factor comprises items reflecting concerns over the unethical use of AI by organizations. Looking at these scales, it is evident that there is a need for validated scales specifically designed for use within the teacher population.

Table 1.

Scales for Attitudes Toward Artificial Intelligence

Scales	Target group	Factors	Number of items	Example item
Suh et al. (2022)	K-12 students	Cognitive	26	"I want to make something that makes human life more convenient through AI"
		Affective		"It is fun to learn about AI"
		Behavioral		"I will use AI to solve problems in daily life"
Schepman and Rodway (2020)	People over 18	Positive attitude	20	"I would like to use Artificial Intelligence in my own job"
		Negative attitude		"Organizations use Artificial Intelligence unethically"
Karaoglan-Yilmaz et al. (2024)	University students	Positive attitude	13	"Using generative AI applications for teaching purposes helps me to solve the problems I face"
		Negative attitude		"Generative AI applications can be a barrier to the development of my thinking skills."

Purpose of the Research

In response to these issues, this study aims to adapt a four-item scale to measure general attitudes towards artificial intelligence in Türkiye, with a particular emphasis on teachers from various educational levels. The main objective is to understand teachers' overall perspectives on AI. A CFA is performed to evaluate the scale's factor structure, providing additional insights into teachers' attitudes toward artificial intelligence. While technology acceptance levels may not differ significantly among teachers, recent studies suggest there may be variations in attitudes toward integrating AI into teaching practices across different teaching levels. Such integration could be seen as an innovative approach. Although these attitude differences may not directly translate to real-world applications, understanding teachers' general attitudes and examining potential differences based on gender and teaching level could be key to developing adaptable educational content that supports integration. Consequently, this study's research questions are formulated accordingly.

1. Is AIAS-4 a reliable and valid instrument for teachers in Türkiye context?

2. What is the level of teachers' attitude towards artificial intelligence?

a. Do teachers' level of attitudes towards artificial intelligence differ by gender?

b. Do teachers' level of attitudes towards AI differ by their teaching levels?

Method

Research Model/Design

The aim of this study is to construct valid and reliable instrument for Turkish version of AIAS-4 and to reveal whether any significant difference in level of general attitude towards artificial intelligence among gender and teaching levels. So, quantitative methodology was used in this study. The Human Research Ethics Committee of the accredited university has approved the study.

Research Sample

The study involved 135 teachers from both K12 and university levels in Türkiye, with data gathered through an online survey using convenience sampling (see Table 2). Among the participants, 60% were female and 40% were male, with ages spanning from 20 to over 60 years. The research aimed to adapt a scale and assess the general attitudes toward AI among teachers. For this purpose, a sample was collected to perform CFA, utilizing convenience sampling as outlined by Büyüköztürk et al. (2008). The data were obtained from teachers across various educational levels, including primary, secondary, high school, and university, within the Türkiye context.

Table 2.

Demographic information

		n (N=135)	%
Gender	Female	81	60
	Male	54	40
Age	20-30	12	9
	31-40	58	43
	41-50	39	29
	51-60	21	15
	61 and above	5	4
Teaching Level	K12	63	47
	Faculty	72	53

Research Instrument and Procedure

In this study, data were collected online through a questionnaire comprising a personal information form and the scale items, as the scale was adapted. The questionnaire included Turkish equivalents of the scale items, and during the preparation of Turkish version, suggestions for translating the English items into Turkish were obtained from two independent linguists.

General Artificial Intelligence Attitude Scale (AIAS-4): This scale used to reveal the general attitudes of teachers towards artificial intelligence. The AIAS-4 developed by Grassini (2023). The scale consists of one dimension and four items. A 10-point Likert rating was used. The factor is general artificial intelligence attitude which was derived three items focusing on technology acceptance and one item focusing on the potential benefits of AI.

Demographic form: A demographic form of three questions was used to obtain demographic information as gender, age, and teaching level.

Research Procedures

Before data collection, approval was obtained from the university's Scientific Research Ethics Committee. The adaptation of the AIAS-4 scale, which is a short and straightforward four-item instrument, followed a systematic process to ensure translation accuracy and cultural relevance. This process included: (1) translating the scale into Turkish, (2) comparing translations from two independent native Turkish-speaking translators, (3) conducting cognitive feedback sessions, and (4) testing psychometric properties in the target population following recommended guidelines (Sousa & Rojjanasrirat, 2011).

Permission for translation was granted, and two translators, one a certified translator and the other a Turkish language teacher, independently translated the scale from English to Turkish. After translation, an English language expert reviewed the Turkish version to ensure alignment with the original scale. Differences in clarity, objectivity, and item intent between the translations were analyzed and resolved.

Given the scale's simplicity, back-translation was not deemed essential. Instead, cognitive feedback discussions were held with two teacher candidates to confirm clarity and cultural appropriateness, serving as an alternative to a pilot study. This feedback confirmed that the items were well-understood and relevant. Data collection was conducted via an online survey, with an estimated completion time of 5 minutes.

Data Analysis

This study conducted CFA as part of adapting the scale. In the descriptive analyses, missing data were excluded, and the data's normality was assessed. Following this, referencing the literature's suggested sample size ideally five to ten times the number of items (Field, 2000). With 135 teachers participating, efforts were made to identify the scale's latent structure (Tavşancıl, 2006). After CFA revealed the underlying structure, convergent and divergent validity tests were conducted to confirm construct validity. Data analysis was carried out in Rstudio using the lavaan and sem packages. The CFA fit indices included the Chi-square/df ratio, Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). Following Hu and Bentler's (1999) criteria, TLI and CFI values of .95 or higher, RMSEA of .08 or below, and Chi-square/df ratio of 3 or less (Kline, 2011), the study's results were evaluated. Additionally, the scale's reliability was assessed using Cronbach's alpha coefficient. Given the non-normal distribution of the sample, the Mann-Whitney U Test was used to examine potential differences across teaching levels.

Validity and Reliability

When looking at the AIAS-4 scale, it was refined into a single-factor, 4-item structure after removing Item 4 due to its poor loading on Factor 2 and weak correlations with other items. This revision aimed to improve the scale's psychometric properties compared to the initial two-factor structure. The revised 4-item version demonstrated high sampling adequacy, with a Kaiser-Meyer-Olkin (KMO) value of 0.83, and Bartlett's test of sphericity showed significant correlations among items ($\chi^2(6) = 583$, $p < 0.001$), supporting a cohesive single-factor structure.

Results

Descriptive Analysis

Table 3 presents descriptive statistics for the four items. Mean scores indicate relatively high levels of participant responses, ranging from 7.16 (Item 4) to 8.78 (Item 3). Standard deviations show moderate variability across items. Skewness values for Items 1, 2, and 3 are negative, with Item 4 showing slightly positive skewness.

Table 3.

Descriptive Analysis (n=135)

Items	Mean	Standard Deviation	Skewness	Kurtosis	Standard Error
Item 1	8.03	1.89	-0.76	-0.28	0.16
Item 2	8.27	1.75	-0.98	0.23	0.15
Item 3	8.78	1.49	-1.19	0.78	0.13
Item 4	7.16	1.81	0.13	-1.02	0.16

Confirmatory Factor Analysis

The construct validity of the scale was assessed using CFA following expert feedback, which confirmed the suitability of the original scale's factor structure. Model fit statistics were evaluated based on a single-factor structure, as outlined in the original scale. Cronbach's alpha (CA) values were examined for reliability, with each item demonstrating internal consistency above 0.6, suggesting that no items needed to be removed. A second CFA was conducted, and CA values were calculated for each factor. While exact standards for fit indices can be difficult to define, values of 0.08 or below for the SRMR and the RMSEA are generally considered acceptable indicators of fit. The fit indices presented in Table 5 were reviewed and interpreted within the context of existing research, with all indices indicating strong model fit, thereby supporting a single-factor structure.

Table 5.

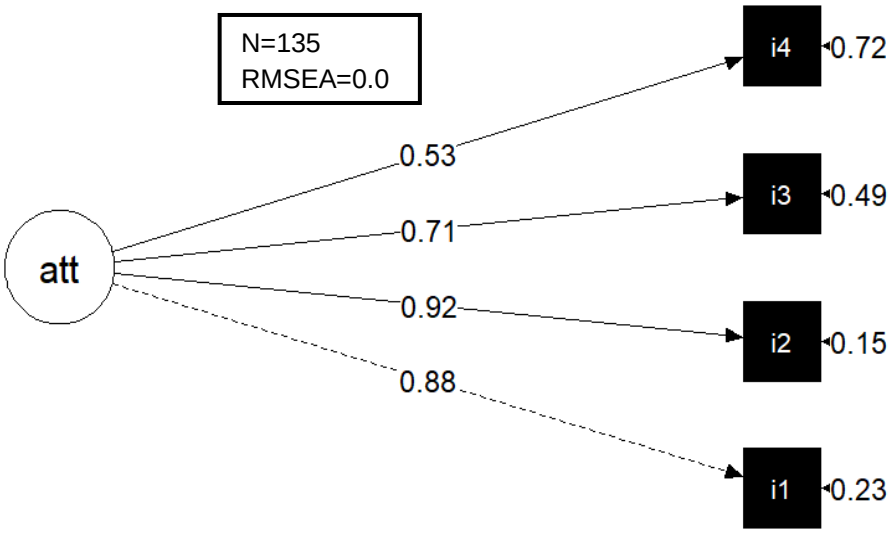
Model Fit Measurements

	Model	Criteria	Good fit	Rationale
RMSEA	0.022	<.08	Excellent Fit	Browne and Cudeck (1993)
CFI	0.999	>.95	Perfect Fit	Hu and Bentler (1999)
TLI	1.004	>.95	Very Good Fit	Hu and Bentler (1999)
SRMR	0.019	≤ .08	Very Good Fit	Hu and Bentler (1998)

Figure 1 illustrates a path diagram depicting each item and its corresponding factor loadings. The internal consistency coefficient, represented by Cronbach's alpha (α), is calculated to be .84. It is noted that a Cronbach's alpha value exceeding 0.6 is considered acceptable (Cortina, 1993).

Figure 1.

One-factor model path diagram



General Artificial Intelligence Attitude Levels of Teachers

Table 6 shows that teachers mostly give high scores to the general attitude dimension in the general artificial intelligence attitude scale. While the first, second, and third items coded as i1, i2, and i3 have an average value of 8, it can be seen that the fourth item is closer to a score of 7. Teachers have given more varied responses to the fourth item, which may be important to focus on in subsequent studies. The first three items in the scale attempt to understand teachers' attitudes towards using AI technologies in teaching, in other words, their acceptance of technology, while the fourth item tries to understand their attitude towards the potential benefits of artificial intelligence. Although each item may be loaded onto a single factor and teachers' general attitudes are being measured, differences in attitudes towards the potential benefits of artificial intelligence can be observed from the responses given. In summary, teachers seem to have a positive attitude towards using artificial intelligence technologies in educational settings, but there may be differences of opinion regarding determining the attitude towards the potential benefits targeted by the fourth item in this scale.

Table 6.

Teachers' General Artificial Intelligence Attitude Levels (percentage, frequency and item average)

		1	2	3	4	5	6	7	8	9	10	X
i1	F	0	0	3	4	10	11	17	28	20	42	8.03
	%	0	0	2.22	2.96	7.40	8.15	12.6	20.74	14.81	31.11	
i2	F	0	0	1	6	6	8	14	30	27	43	8.27
	%	0	0	0.74	4.44	4.44	5.93	10.37	22.22	20.0	31.85	
i3	F	0	0	0	2	5	3	16	22	24	63	8.78
	%	0	0	0	1.48	3.70	2.22	11.85	16.30	17.78	46.67	
i4	F	0	0	1	4	25	23	27	21	12	22	7.16
	%	0	0	0.74	2.96	18.51	17.03	20.0	15.55	8.89	16.30	

Do Teachers' Level of Attitudes Towards AI Differ by Their Teaching Levels?

After determining that the data were not normally distributed with the Shapiro-Wilk test, the Mann-Whitney U test was applied to examine the difference in general attitudes towards artificial intelligence between faculty members (n = 72, median = 8) and K12 teachers (n = 63, median = 8.75) and a significant difference was found (U = 2791.5, p = .02). The effect size was small (0.23), and it was concluded that the general attitudes of faculty members towards artificial intelligence were significantly more positive than those of K12 teachers. In addition, it was observed that the difference was more pronounced in terms of a specific item measuring attitudes towards the contribution of artificial intelligence to humanity (U = 2998, p < .001). In this case, the effect size was medium (.32), and it was seen that faculty members had more positive attitudes on this issue compared to K12 teachers. This finding shows that perceptions of the social impacts of artificial intelligence differed significantly between the two groups.

Table 6.

Comparison of Teachers' Attitudes Towards Artificial Intelligence by Teaching Levels

Comparison	Target group	n	U-statistics	*p*-value	r
Faculty vs. K12-teachers (Mean Value)	Faculty teachers	72	2791.5	.02	.23
	K12 teachers	63			
Faculty vs. K12-teachers (Item Four)	Faculty teachers	72	2998	<.001	.32
	K12 teachers	63			

Do Teachers' Level of Attitudes Towards AI Differ by Their Gender?

The Mann-Whitney U test showed that there was a statistically significant difference in the general attitude levels towards AI between female (n = 81, median = 8.625) and male (n = 54, median = 8.5) teachers (U = 1732, p = .04). The effect size was found to be small (-0.21) and it was concluded that male teachers had more positive general attitudes towards AI. On the other hand, the difference was found to be more pronounced in the analysis conducted for the fourth item (U = 1298, p < .001). The effect size was found to be medium at -0.41 and it showed that male teachers had significantly more positive attitudes towards the potential benefits of AI for humanity than female teachers. This also reveals that gender differences are more pronounced in terms of social effects (see Table 7).

Table 7.

Comparison of Teachers' Attitudes Towards Artificial Intelligence by Gender

Comparison	Target group	n	U-statistics	*p*-value	r
Male vs. Female teachers (Mean Value)	Female teachers	81	1732	.04	-.21
	Male teachers	54			
Male vs. Female teachers (Item Four)	Female teachers	81	1298	.00	-.41
	Male teachers	54			

Discussion, Conclusion and Recommendations

Discussion

One of the important findings of this study, apart from the construct validity of the scale, is that university teachers have more positive attitudes towards AI compared to K-12 teachers. This difference may be due to differences in education levels and, accordingly, the fact that teachers use AI technologies more frequently in their professional practices. Previous research has also shown that as the level of education increases, teacher candidates and university students develop more positive attitudes towards AI (Cojean et al., 2023). However, it is important to evaluate this situation not only in terms of knowledge level but also in terms of experience diversity.

The lower attitude scores of K-12 teachers may be related to the inadequate integration of AI technologies into their curricula or to negative experiences in the past. Therefore, conducting special studies focusing on teachers from different disciplines and at the K-12 level will provide a better understanding of this difference. Another important finding is that female teachers approach AI less positively than male teachers. Studies conducted across different demographic groups show that men generally develop more positive attitudes towards AI (Hopcan et al., 2023). This may also be related to prejudices stemming from gender roles. For example, female teachers may be concerned that AI may carry gender-based biases in areas such as job interviews in the future (Cirillo et al., 2020; Gupta et al., 2021). Although the aim of this study is not to examine these reasons in depth, it is recommended that differences in perceived benefits in the context of gender be addressed in future research.

Conclusion

In the scope of the adaptation study, Grassini's (2023) 10-item Likert-type scale adapted to the Türkiye context was found to be valid for all four items on the teacher population, and none of the items were excluded from the scale. The CFA provided evidence of good model fit.

Recommendations

Future research should examine not only teachers' subjective attitudes towards AI, but also their behavioral, physiological, and internal reactions (Grassini, 2023). Although this four-item scale provides a general overview of teachers' attitudes, measuring physiological responses such as body temperature, facial expressions, or stress during interaction with intelligent systems in lessons may contribute to a deeper understanding of teachers' perceptions of AI.

Limitations

In this study, the sample was selected from teachers working at different levels of education in Turkey using a convenience sampling method. Therefore, the findings cannot be generalized to different demographic or cultural groups. Collecting data online may have increased the probability of including teachers who are familiar with using the internet in the sample. In addition, online participants may have lower motivation than face-to-face participants. The study was conducted with 135 teachers, and although this number is sufficient for a four-item scale, the teachers' branches were not taken into account. It is recommended that teachers' fields be included in the data collection and analysis process in future studies.

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Appendices

Turkish version of AIAS-4

	Turkish	English
Item 1	Yapay zekânın hayatımı geliştireceğine inanıyorum.	I believe that AI will improve my life
Item 2	Yapay zekânın işimi geliştireceğine inanıyorum.	I believe that AI will improve my work
Item 3	Gelecekte yapay zekâ teknolojisini kullanacağımı düşünüyorum.	I think I will use AI technology in the future
Item 4	Yapay zekâ teknolojisinin insanlık için olumlu olduğunu düşünüyorum.	I think AI technology is positive for humanity

Differences in Teacher Experiences and Pedagogical Implications in ChatGPT-Supported Lesson Planning

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Abstract

With the advent of the Fourth Industrial Revolution, the digitalization process has accelerated, and the use of artificial intelligence (AI) tools in education has become increasingly widespread. In this context, large language models, such as ChatGPT, contribute significantly to teachers' processes of preparing lesson plans, creating content, and developing pedagogical practices. The aim of this study is to examine the interaction patterns of science pre-service teachers, teachers, and teacher educators with ChatGPT and the prompts they create based on their experience levels. Using qualitative research methods, the study worked with seven participants: two pre-service teachers, four teachers with different experience levels, and one teacher educator. Participants were asked to prepare a lesson plan with ChatGPT support on the topic of “Acids and Bases” at the 8th-grade level; data were collected through transcripts, reflective writing, open-ended questions, and focus group interviews. The data were analyzed using both inductive and deductive approaches. According to the research findings, pre-service teachers and inexperienced teachers created more superficial, knowledge-focused, and directive prompts, while experienced teachers developed more contextual, creative, pedagogically rich, and critical prompts. Experienced teachers were also found to be more competent in producing content appropriate to the grade level, identifying misconceptions, developing alternative assessment tools, and planning creative activities. It has also been observed that experienced teachers are more careful in critically evaluating the information provided by ChatGPT. As a result, it has been revealed that teachers' levels of experience are a significant factor in the quality of their interaction with AI tools and their ability to effectively integrate these tools into their teaching processes. It is recommended that the effective use of technological tools in education be supported by pedagogical knowledge and experience.

Keywords: *Lesson Planning, AI Integration, Prompt Development, Pedagogical Content Knowledge, Interaction Depth*

Introduction

In today's era of post-digital education and bio-digital technologies, artificial intelligence (AI) has made significant contributions across a wide range of areas in supporting human intelligence (Nam and Bai, 2023). This transformation not only enables educators to transform learning and teaching processes and create content, but also offers the potential to reshape pedagogical practices. AI is used to increase efficiency in education, personalize students' learning experiences, and make teachers' lesson plans more effective (Frank, 2024). The effective integration of AI tools in education supports teachers' professional development, enabling them to work more efficiently by quickly completing time-consuming tasks such as lesson preparation, material creation, and student performance monitoring. This allows teachers to develop pedagogical innovations and strategies tailored to student needs (Wang et al., 2024).

Studies on the use of ChatGPT by teachers and pre-service teachers (PSTs) have mostly focused on the lesson planning process. Corp and Revelle (2023) noted that PSTs used ChatGPT for lesson planning and evaluation purposes, personalizing content by modifying and adding to the responses. Lee and Zhai (2024) found that science PSTs found ChatGPT effective in developing curriculum-appropriate plans, providing content, and encouraging student participation; however, it was insufficient in situations requiring visual information. Goodman et al. (2024) revealed that ChatGPT can produce scientific errors in lesson planning using the 5E model, but it contributes to the development of inquiry skills. Van den Berg (2024) reported that educators in a distance learning program in South Africa used ChatGPT for lesson planning, translation, and preparing assessment questions. Clark et al. (2024) noted that experienced chemistry teachers found it effective in developing instructional strategies and providing level-appropriate explanations, but insufficient in producing visual content. These studies demonstrate that ChatGPT usage varies according to factors such as teachers' experience, subject knowledge, technological proficiency, and pedagogical expertise.

In education, a “prompt” is defined as structured inputs that enable effective interaction with AI-supported systems by reflecting user intent to shape the content, form, and pedagogical appropriateness of the output (Du Boulay et al., 2023). In interactions with large language modelsLLMs), these prompts play a crucial role in determining the accuracy and contextual relevance of the information the model generates. In the field of artificial intelligence, “hallucination” refers to a model confidently producing information that is false, fabricated, or unverifiable (Yingzhe, 2025). Therefore, teachers' ability to obtain pedagogically meaningful and purposeful content using AI largely depends on the quality of the prompts they create and their ability to question the generated responses (Lee & Palmer, 2025). In this context, prompt engineering is seen not only as a technical skill but also as a pedagogical strategy that encompasses teachers' abilities to think critically, structure content, and generate responses aligned with learning objectives (Qian, 2025).

Various studies have shown that interaction with ChatGPT is directly related to the structure and depth of the prompts used, and that this significantly affects the learning process. Sun et al. (2024) found that university students' interactions with ChatGPT differed under prompt-based learning (PbL) versus unprompted learning (UL) conditions. The PbL group received more qualitative feedback with deeper questions, whereas the UL group was limited to superficial interactions. It is emphasized that structured prompts and guiding questions make the interaction productive. Similarly, Feng et al. (2023) noted that properly structured prompts provide higher-quality outputs in data augmentation processes. Spasić and Janković (2023) examined the effect of three standard prompt techniques (role, instructions, and seed-word prompts) on the process of preparing lesson plans at the preschool level with ChatGPT and showed that these techniques could be functional for teachers. In general, the structure and guidance of prompts increase both the quality of feedback and the effectiveness of learning.

In this context, considering that teachers' interaction patterns with AI-supported platforms, such as ChatGPT, differ according to their level of professional experience, understanding these interaction patterns is crucial for a qualitative transformation in educational processes. It is particularly noteworthy how teachers with different years of experience structure their prompts to ChatGPT when preparing lesson plans, as well as the pedagogical depth of these prompts. The level of experience has a significant influence on teachers' interactions with AI tools, teaching strategies, content production, and pedagogical perspectives. Furthermore, the quality of the prompts created by teachers is closely related to their ability to evaluate AI content and customize it contextually. This shows that teacher experience affects not only the use of technological tools but also the quality of the pedagogical relationship established with these tools. In this context, the structure, depth, and pedagogical orientation of the prompts created by teachers, PSTs, and teacher educators with ChatGPT stand out as an area that has not been sufficiently explored in the literature. Accordingly, the research sought to answer the following question:

1. How do the prompts created by science teachers during the ChatGPT-supported lesson planning process differ based on their experience levels, and how do these differences reflect teachers' pedagogical approaches?

Method

Research Design

This study employed a qualitative research method aimed at understanding the contexts, reasons, deep thoughts, behaviors, and reactions that participants expressed when addressing a specific topic (Creswell, 2013).

Research Sample

The participants in this study were selected based on their years of experience as science teachers, in line with the research purpose. Participants were assigned codes from P1 to P7 to protect their anonymity during the analysis process. There were 7 participants in total: 2 PSTs (P1 and P2), 4 teachers with experience of one, six, eight, and eighteen years respectively (P3, P4, P5, and P6), and a science teacher educator with 12 years of professional experience (P7).

Research Instrument and Procedure

This study utilized four different data collection tools. First, participants were asked to prepare a lesson plan lasting several hours on the topic of “Acids and Bases” from the 8th-grade curriculum, following specific guidelines with the support of ChatGPT. During this process, participants documented their written interactions with ChatGPT and submitted them to the researchers. Next, participants were asked to write individual reflective essays reflecting on their experiences and thoughts about the process. Participants also completed a participant information form consisting of open-ended questions. This form contained a total of six open-ended questions (e.g., “How would you assess your technological competence in your profession?” and “Do you have any knowledge of artificial intelligence technologies?”) that inquired about participants' technological competence and experiences with AI. Finally, in-depth qualitative data were collected through an online focus

group discussion. Participants were asked a total of 7 questions, including “How did you integrate the answers you received from ChatGPT into your lesson plan?” and “Did ChatGPT surprise you positively or negatively? Can you give an example?” During this approximately 90-minute interview, detailed insights into the participants' views and experiences regarding the process were obtained.

Data Analysis

Participants' lesson plans were examined in terms of the structure of the requests they used, their levels of interaction, and the pedagogical approaches they adopted. Differences in request structures based on professional experience were analyzed comparatively. Written reflective texts obtained from participants and qualitative data obtained from online focus group interviews were evaluated using inductive thematic analysis (Thomas, 2003). This approach aimed to derive original themes directly from participant statements, overcoming the limitations of structured analysis frameworks.

The themes that emerged during the coding process were classified based on indicators related to participants' interaction patterns with ChatGPT. These indicators encompass multidimensional areas such as pedagogical approach, the nature of prompts, teaching strategies, and appropriateness for the grade level. Participants' prompt creation practices, based on their experience levels, were analyzed comparatively using written reflections and focus group interviews. These comparisons enabled an assessment of the extent to which teachers used ChatGPT effectively and pedagogically efficiently.

As a result, the impact of teachers' professional experience on the forms of interaction they establish with AI-based tools and the pedagogical benefits they derive from these tools has been comprehensively examined. In this context, participants' interactions with ChatGPT were analyzed based on specific pedagogical and structural indicators and evaluated using the binary content coding method (Krippendorff, 2013). In the coding, positive (1) scores represent situations where the teacher adopted contemporary teaching approaches, actively participated in the process, and critically evaluated ChatGPT responses; negative (0) scores represent passive, superficial, instruction-dependent, or traditional interactions.

The criteria are designed to analyze the content, structure, and pedagogical functions of the prompts used by participants in their lesson planning interactions with ChatGPT. In determining these criteria, both the theoretical foundations of AI-supported education, pedagogical strategies, and misconceptions in the literature, as well as the themes derived from participant prompts, were taken into account. Thus, both deductive and inductive approaches were combined in the analysis process to create an original coding system tailored to the study's purpose. This multidimensional approach enabled the comprehensive evaluation of teachers' pedagogical orientations, interaction styles, and content quality in AI-supported lesson planning processes. Interaction types outside the study's focus area were excluded from the analysis. Table 1 details the coding used in the analysis process.

Table 1. *Evaluation Criteria for Participants' Requests*

Indicators	Definition	Positive Coding (1)	Negative Coding (0)
Request Quality	Requests should be clear, focused, original, and appropriate for the pedagogical purpose (Arcet, 2025).	Detailed and open-ended requests	Superficial and general statements
Curriculum Alignment	Alignment of learning objectives with curriculum outcomes (Davis & Krajcik, 2005; Karataş et al., 2025)	Fully aligned with the curriculum, directly related to learning outcomes	Not related to learning outcomes, incomplete or superficial
Conversational Style	Whether interaction with AI is directive, explanatory, or critical (Arcet, 2025).	Providing guidance or a critical approach	Focused solely on seeking information, passive dialogue
Guideline Usage	Level of dependence on lesson plan guidelines (Großmann et al., 2025).	Teacher-determined flow, controlled conversation	Dependent on lesson plan guidelines, scattered or uncontrolled flow
Pedagogical Approach	Whether the requirements are contemporary, student-centered, and focused on active learning (Arcet, 2025;	Active learning, contemporary methods, clear learning outcomes, concrete examples	Traditional, teacher-directed, fragmented, student passive

	Geroimenko, 2025).		
Appropriateness for Grade Level	The appropriateness of the content for the student's age and cognitive level (Großmann et al., 2025).	Appropriate terminology, content, and structure for the student's level	Either too simple or below level, not appropriate for the target age group
Subject Knowledge	Theoretical knowledge integrity and mastery level regarding the subject (Chan & Yung, 2018).	Requests that do not refer to theoretical knowledge and do not reflect subject knowledge integrity and mastery	Requests that address theoretical knowledge in depth and reflect subject knowledge integrity and mastery
Conceptual Misconception	Use of strategies aimed at identifying and analyzing student misconceptions (Halim & Meerah, 2002).	Specific prompts aimed at eliciting misconceptions, attempts at strategy development	General statements were made, only the question “Is there any?” was asked; no solution or analysis was provided.
Creativity / Innovation	The level of inclusion of innovative and open-ended activities that encourage students to think creatively (Geroimenko, 2025; Arcet, 2025).	Requests that include open-ended, creative activities and methods	Closed-ended, rote learning requests that lack creativity
Questioning the Existence of Hallucinations	Efforts to question and verify the accuracy of AI outputs (Yingzhe, 2025).	ChatGPT's responses have been questioned and include verification requests	No questioning has been done; responses have been accepted directly

Pedagogical Content Knowledge (PCK), as defined by Shulman (1987), is an integrated type of knowledge that encompasses both subject-specific and pedagogical aspects, which teachers use to help students learn a subject. During the coding process, certain indicators were elaborated within this framework, and a comprehensive analysis was conducted based on PCK components, including the use of methods and techniques, questions addressing misconceptions, assessment strategies, and alignment with curriculum objectives. This elaboration enabled a more concrete and explanatory assessment of participants' pedagogical competencies and their interaction patterns with ChatGPT by supporting the dual coding system. Table 2 presents a comparative overview of the coding results for the PCK-based prompts of seven teachers within this scope.

Table 2. *Coding Requests Reflecting PCK*

Theme	Codes	P1	P2	P3	P4	P5	P6	P7
Is there a request reflecting PCK?	Method and technique	Teacher-centered, no active learning	Teacher-centered, no active learning	No method-technique component	Aims for active student participation (brainstorming)	STEM and active methods are detailed	No method-technique component	Not asked to ChatGPT.
	Conceptual misconceptions	Specific requests not provided	Addressed at a general level	Addressed at a general level	Adherence to the lesson plan guidelines	Request provided but intervention strategy lacking	Conceptual misconceptions addressed with specific examples	Examined with specific examples and their effects on learning processes
	Areas where students struggle	Not customized.	Not customized.	Not customized.	Detailed	Not customized.	Not customized.	Not asked to ChatGPT.

	Measurement/ evaluation	The measurement method was asked	The measurement method was asked	The measurement method was asked	Clear measurement tool request	Clear measurement tool request	Clear measurement tool request	Clear measurement tool request
	Learning outcomes/curriculum	Not specified	Not detailed.	Not detailed.	Appropriate	Appropriate	Appropriate	Appropriate
PCK level		PCK dominant, critical requests containing pedagogical knowledge	PCK dominant, goal-oriented, coherent requests created	PCK reflection scattered, specific requests limited	PCK dominant, critical requests containing pedagogical knowledge exist	PCK dominant, goal-oriented, consistent requests have been created	PCK reflection scattered, specific requests limited	PCK level high, conversation progressed under teacher leadership

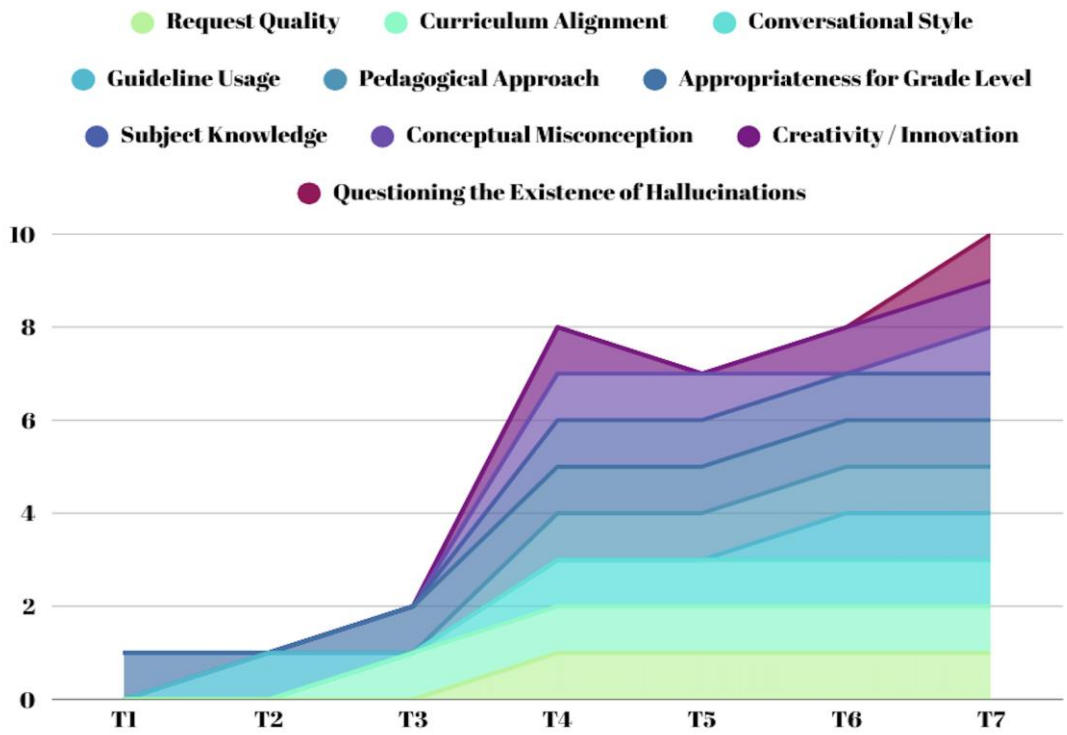
Participants' requests were analyzed according to the themes in Table 2 to assess the extent to which they reflected their PCK. To enhance the reliability of the study, data triangulation was employed by combining information from multiple data sources, including written reflective texts, focus group interviews, and lesson plans (Hammersley, 2008).

Results

The findings reveal significant differences in the interactions of participants classified as PSTs, inexperienced teachers, experienced teachers, and teacher educators with ChatGPT. These differences are evident in the levels of utilization of ChatGPT in the lesson planning process, the level of detail in their prompts, their ability to provide age-appropriate content, their capacity to add creative and innovative content, and their level of critical engagement with ChatGPT in questioning the accuracy of responses. PCK stands out as a crucial factor in determining the depth of teachers' prompts. Despite differences in experience, some specific differences in prompts remained hidden. Prompts about misconceptions regarding acids and bases formed a common theme among all participants, but the level of adaptation of this theme to content and lesson plans varied.

Differences in pedagogical competence among participants indicate that various pedagogical criteria are met at higher levels as experience increases. Experienced teachers are seen not only to generate more demands but also to structure these demands in a more detailed, curriculum-appropriate, grade-level-sensitive, creative, and critical manner. Furthermore, inquiries into misconceptions are becoming more in-depth and are being integrated into the teaching process in a more systematic manner. This trend is supported by Figure 1, which visualizes the level of fulfillment of pedagogical indicators according to experience level.

Figure 1: *Participants' Levels of Meeting Experience-Based Pedagogical Indicators*



The area chart reveals that positive performance in indicators diversifies and increases significantly as experience levels rise. In line with this general trend, the structural and pedagogical differences presented visually in Figure 1 are supported in detail by qualitative data. Below, we will examine how these differences vary between inexperienced and experienced participants in terms of how they use ChatGPT, their level of prompt generation, pedagogical approach, and strategies for integrating technology into teaching.

PSTs and inexperienced teachers have extensively utilized ChatGPT in the lesson planning process and found it to be useful. However, this group generally produced superficial and directive prompts; they struggled to develop in-depth questions related to teaching strategies. It was observed that they used ChatGPT more as a tool for directly acquiring information and receiving general guidance. This situation has increased dependence on artificial intelligence, particularly in areas where pedagogical knowledge is lacking. Indeed, teacher P3, in their first year, expressed this situation in the focus group interview as follows:

"Since I had never taught this topic in class before... I benefited from ChatGPT's suggestions."

Experienced participants used ChatGPT more critically and selectively, evaluating it as a support tool for strategic decisions that would enrich the teaching process. The prompts they generated were curriculum-appropriate, purposeful, and in-depth. This demonstrates that experience and pedagogical maturity are decisive in the effective use of digital tools. Indeed, P4 reflected this approach in their writing, stating:

"...I received partial support from ChatGPT. There was no step where I fully implemented its suggestion."

In terms of request quality, PSTs' and inexperienced teachers' questions were generally superficial and limited, while experienced teachers' and teacher educators' requests were found to be more detailed, context-focused, and pedagogically rich. For example, P2's prompt is as follows: "As an 8th-grade science teacher, how would you assess students' level of understanding of acids and bases and the points they confuse?" This prompt is lacking in providing an in-depth assessment. In contrast, P5's request reflects a more comprehensive approach: "How can I measure students' level of understanding of acids and bases or the points they confuse? Can you prepare a test for me using alternative assessment methods? The test should include 10 questions. Include questions that are appropriate for the STEM model in the activities you suggest in the lesson plans, questions that cover all the learning outcomes, and questions that are skill-based, i.e., questions that include examples from everyday life and develop students' higher-order thinking skills." This situation shows that experienced teachers contribute to the teaching process in a more structured and in-depth way.

In terms of appropriateness for the grade level, it has been observed that experienced teachers question the level of responses while adhering to the curriculum and use ChatGPT in a manner appropriate for the grade level. For example, in one conversation, P7 questioned the level of the AI response by asking, “Is this an 8th-grade misconception you're giving me?” This suggests that experienced teacher educators are more effective at assessing students' readiness levels. In contrast, PSTs and inexperienced teachers tend to deviate from the grade level. For example, P1's request, “Can you write a detailed story with the topic title ‘A fun definition of acids and bases’?” carries the risk of conceptual confusion and deviation from scientific accuracy through the storytelling of abstract scientific concepts. Therefore, such requests are considered pedagogically and level-wise inadequate.

Participants viewed ChatGPT as a useful tool for developing creative and innovative teaching applications. PSTs made more requests related to digital resources. For example, P2's request, “Can you show me a site where I can find simulations related to acids and bases?” reflects this situation. In contrast, experienced teachers produced more original and participatory activities. For example, P5's request, “Can you write the scenario and implementation steps for an activity themed ‘Baby Shampoo That Doesn't Sting the Eyes’ that will draw my students' attention to the topic of acids and bases?” is an example of a creative teaching strategy. The teacher educator requested a concept cartoon for visual support in teaching.

In terms of hallucination questioning, only the experienced teacher trainer P7 critically evaluated ChatGPT's responses. She questioned curriculum alignment and simplified content exceeding the 8th-grade level. In the focus group, she said:

“...I asked, ‘Do you think these are at the 8th grade level?’ Because acid-base strength is not discussed in middle school.” In response, it replied, ‘You're right, the content may be a bit detailed...”

She also questioned the source of responses related to misconceptions and requested references. For example: “Can you show me the sources of these misconceptions?” and “...by providing article references...I want information on what misconceptions they have.” This approach demonstrates that the experienced teacher-educator acted more critically, pedagogically sensitively, and academically consciously in response to the AI outputs.

Discussion

This study examined how science teachers at various experience levels interact with ChatGPT and analyzed how they employ their Pedagogical Content Knowledge (PCK) and integrate it into instructional processes. The findings suggest that teachers’ professional experience has a significant impact on how they utilize ChatGPT, the depth of their inquiry, and the quality of their prompts.

PSTs and novice teachers primarily used ChatGPT as a tool for obtaining information and guidance, struggling with pedagogically deep and critical usage. This aligns with earlier research emphasizing the role of teaching experience in pedagogical decision making (Louws et al., 2017; Podolsky et al., 2019). In contrast, experienced teachers used ChatGPT not only as an information source but also in more complex tasks such as lesson planning, constructing assessment instruments, and designing content aligned with grade level. This suggests that experience supports more purposeful and effective use of AI tools. Yue et al. (2024) also found that experienced teachers demonstrate higher proficiency, especially in pedagogical and content knowledge, within the Technological Pedagogical and Content Knowledge (TPACK) framework.

Although awareness regarding conceptual misconceptions grew across all groups, the degree of integration into content and lesson planning varied by experience. Experienced teachers developed contextual and structured strategies to address misconceptions. In the literature, it is also emphasized that teachers improve their ability to design instruction considering students’ prior knowledge over time (Chan & Yung, 2018). In this sense, teaching experience emerges as a critical factor in PCK development, making interventions to correct misconceptions more effective.

In terms of creativity and innovation, inexperienced teachers and PSTs were observed to use ChatGPT mainly for information retrieval. In contrast, experienced teachers utilized ChatGPT more effectively for designing creative lessons, developing alternative assessments, and creating interdisciplinary tasks. However, this qualitative finding contrasts with the quantitative study by Saharuddin et al. (2025), which reported that older teachers had lower levels of technological and pedagogical knowledge. This suggests that individual attitudes, creativity, and professional experience may be key factors in the successful integration of technology.

While experienced teachers and teacher educators critically evaluated ChatGPT’s outputs, PSTs and novice teachers often accepted responses without questioning them. This observation highlights that AI use is not only related to technical competence but also to critical thinking. Klemke and Jarodzka (2024) emphasize that large language models can generate

misleading content and that such “hallucinations” pose a particular risk for PSTs. Therefore, teacher education should not only teach how AI works but also cultivate an inquisitive and critical mindset.

Conclusion

The central contribution of this research is the demonstration that teachers’ experience levels can alter the **quality** of their interactions with AI tools like ChatGPT. While experienced teachers generate more structured, critical, creative, and pedagogically coherent prompts, PSTs and novice teachers tend to remain limited to superficial, information-seeking interactions. Experience influences not only how teachers use technology, but also how they make pedagogical decisions, identify misconceptions, generate creative content, and engage in critical inquiry via these tools.

Consequently, integrating AI-supported tools into teacher education should extend beyond teaching technical skills to include pedagogical functionality, critical thinking, and content coherence. Teacher training curricula should incorporate applied examples that demonstrate how to utilize ChatGPT in lesson planning, misconception analysis, creative activity development, and assessment.

Recommendations

Future research should explore how teachers from different subject areas interact with AI comparatively. Experimental studies examining the long-term effects of AI on teacher education can guide sustainable and effective use of these tools. In particular, assessing the tangible impacts on student achievement, misconception reduction, and instructional quality will enrich our understanding of AI’s role and functionality in education.

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Exploration of Gifted Students' Spatial Reasoning

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Abstract

The purpose of the study is to investigate the accuracy levels of gifted students in spatial reasoning tasks as well as the strategies that they have used while engaging in these activities by using concrete manipulatives. This study was conducted as a case study, and the research was conducted with the participation of four seventh-grade gifted students attending a science and art center (BİLSEM) in Ankara. The participants were all male students attending private schools. This study consists of two different data collection tools, which are a spatial reasoning activity consisting of three activities with several tasks in it, and an interview. The accuracy levels of gifted students were checked by their answer sheets. The video recordings and interviews were used to determine their spatial strategies. The strategies were coded by two researchers in three categories which are holistic strategies, intermediate strategies, and analytic strategies. The findings of the study showed that gifted students displayed a high level of accuracy and used various strategies while solving spatial reasoning activities with concrete manipulatives. Moreover, they did not only use one strategy per task, but instead they used different strategies together in a task. According to the results, teachers of gifted students could use more activities involving spatial reasoning in their classes.

Keywords: *Spatial strategies, Mathematics education, Giftedness, Spatial thinking*

Introduction

Spatial reasoning is one of the cognitive abilities that is considered under the domain of visual perception. There are different definitions regarding spatial reasoning in the literature. The common one, defined as “the ability to see, inspect, and reflect on spatial objects, images, relationships, and transformations” (Battista, 2007, p. 843). Spatial reasoning plays a significant role in mathematics success as a cognitive ability (Bintoro et al., 2021; Carroll, 1993). Despite this significance, students show a lack of spatial reasoning as well as low success in geometry (Clements, 1998; Dursun, 2010). These situations are associated with the lack of inclusion of spatial reasoning in curricula or limited representations of it (Dursun, 2010; Özçakır, 2017). Hence, lack of spatial reasoning and low success are the important aspects that should be considered.

When the needs and characteristics of gifted students are considered, these deficiencies become more important. In the literature, there are different definitions of giftedness. Renzulli (2002) describes giftedness by using the three-ring model. In this model, creativity, above-average ability, and task commitment are defined as the characteristics of giftedness (Renzulli, 2002). Moreover, they need to engage with higher-order level tasks rather than the rote-memorization, which blunts their potential (Mann, 2005). To enhance their cognitive abilities in the context of mathematics education and to develop their potential, examining their spatial reasoning and strategies is significant since strategies enable researchers to deeply understand spatial reasoning (Glück & Fitting, 2003). The strategies in spatial reasoning are categorized into three main categories in the literature: holistic, intermediate, and analytic (Just & Carpenter, 1985; Özçakır, 2017). A holistic strategy is strategies that use a whole perspective and spatial relations. The analytic strategy’s focus is partial, and there is a systematic approach rather than a spatial relation. The intermediate strategy involves spatial relations, which are limited compared to the holistic strategy; also, partial perspectives are included, which are limited compared to the analytic strategy (Just & Carpenter, 1985; Glück & Fitting, 2003; Özçakır, 2017). The intermediate strategy is in the middle between these two strategies (Just & Carpenter, 1985; Glück & Fitting, 2003; Özçakır, 2017). The choices of strategies of students are shifting from holistic strategies to analytic strategies as the difficulty of the question increases (Glück & Fitting, 2003). Hence, it is important to examine this trend for gifted students in order to create better-fitting activities for their needs and enhance their potential.

Therefore, in this study, it was aimed to investigate the accuracy levels of gifted students in spatial reasoning tasks as well as their strategies while engaging in these activities.

Research Questions

To examine the spatial reasoning of the gifted students, two research questions were asked:

- What are the accuracy levels of gifted students in spatial reasoning tasks while using concrete manipulatives?
- What strategies do gifted students use while solving those spatial reasoning tasks?

Method

Research Design

To obtain a deeper understanding of the spatial reasoning of gifted students, a qualitative research design was applied. Moreover, the case-study design was appropriate as this study aimed to deeply examine the spatial reasoning and spatial strategies of gifted students.

Research Sample

The research was conducted with the participation of four 7th-grade students of a science and art center (BİLSEM) in Ankara. The students who participated in the study were identified as gifted in the general ability field. The convenience sampling method was used in determining the study group. Students who participated in the study worked with concrete manipulatives via linking cubes. In addition, students worked in pairs. No conditions were sought in pairing, and students worked with whomever they wanted.

Instruments and Data Collection

This study consisted of two data collection tools, which included three activities and an interview. In the first activity, eight tasks were assigned to the students. In each of these tasks, the students were asked to match two object images of the same object from four object images presented to them. In the second activity, fifteen object images were given to the students. In the activity, the students were asked to match object images that, when combined, form geometric objects such as cubes and square prisms. In the last activity, the students were given side-view images of geometric objects, and they were asked to create a geometric object from these images. These object images have been generated from the Spatial Visualization Test as examples from each activity given in Figure 1 (Dursun, 2010). During the data collection process, students' work was video recorded to be used in the data analysis process. In addition to these activities, an interview was conducted to understand the spatial strategies and approaches used by the students.

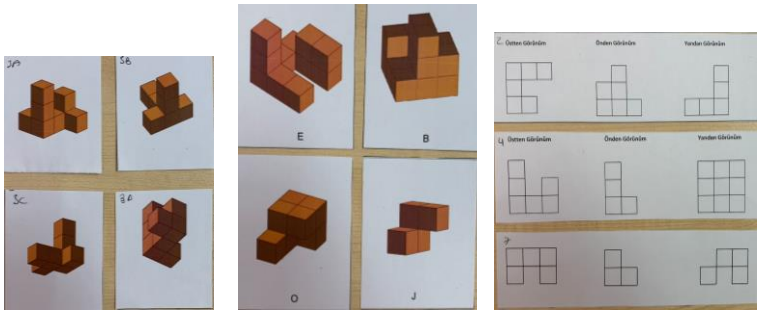

Figure 1. Examples of cards from activities 1, 2, and 3, respectively

Data Analysis

The analysis process was started by checking the students' answers to measure their accuracy levels in tasks requiring spatial reasoning. Then, the scripts of the interviews conducted with the students were extracted via the Transkriptor application to understand the strategies and the approaches used by the students in these tasks. The strategies used by the students were coded separately by the authors, together with the extracted scripts and video recordings. During the coding stage of strategies, students' strategies were categorized under three headings: holistic, intermediate, and analytic, in line with the literature (Just & Carpenter, 1985; Glück & Fitting, 2003; Özçakır, 2017). Then, the authors' codes were compared, and 100% agreement was established between coders.

Findings

Accuracy

The correctness of the answers of the students was examined in three types of tasks as the first activity was matching the same object with rotated two figure cards, the second activity was finding the pairs or triplets that create a geometric object when they are composed, and the last activity was deciding and modelling if the given three perspectives (faces) belong to one object.

Table 1. Accuracy levels of groups

Activities/Groups	Group 1	Group 2	Total
Activity 1	8/8 (100%)	8/8 (100%)	100%
Activity 2	7/7 (100%)	7/7 (100%)	100%
Activity 3	1/2 (50%)	8/8 (100%)	90%
Total	16/17 (94.12%)	23/23 (100%)	97.5%

Table 1 presents the ratio of correct answers to presented items in the task and the percentages of correctness for each of the four groups in each task. In activity 1, groups 1 and 2 have completed each task correctly. In activity 2, similar to activity 1 results, groups 1 and 2 could find all shapes correctly with pairing; however, none of the groups could find the alternative pair for one shape. In activity 3, group 1 could only look at 2 of the tasks and answered one of them correctly (50% accuracy). Group 2 could look at all the tasks, and they also answered all of them correctly (100%). When each group is observed separately, their accuracy levels are mostly over 90%. Also, the accuracy level of group 1 in activity 3 was lower in general when compared to other tasks (50%), according to their other scores.

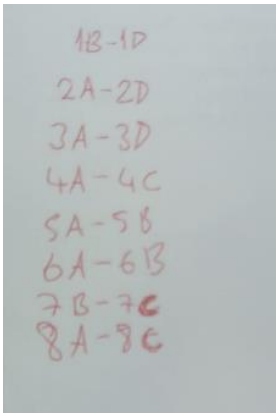

Figure 2. Activity 1 group 1 answers

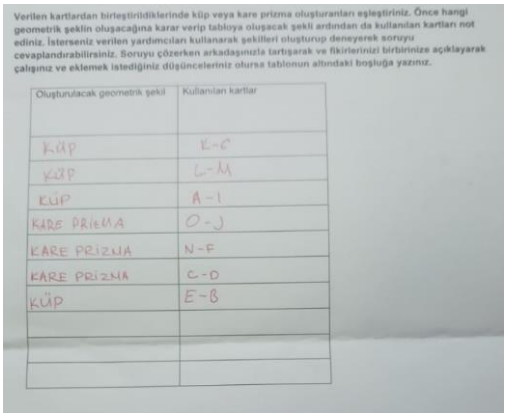

Figure 3. Activity 2 group 1 answers

Figures 2-3 can be given as examples of gifted students' answers for activity 1 and activity 2, respectively, that belong to Group 1. In activity 2, both groups have successfully found all matches. It can be seen that while the accuracy levels of the groups working with concrete materials were stable and high from activities 1 to 3, except for group 1 in activity 3.

Strategies

Students tended to use some strategies when they faced a problem. It was examined that while working with activities, students used some strategies to overcome challenges. In the literature, the strategies for solving spatial ability problems

tended to be grouped under holistic, intermediate, and analytic strategies (Glück & Fitting, 2003; Özçakır, 2017). Moreover, students' strategies were divided into three subcategories under these holistic/intermediate/analytic strategies, which include rotating, counting, and can be listed as follows (Özçakır, 2017):

(Holistic) (1) Mental rotation and manipulation

(2) Counting as a whole

(Intermediate) (1) Partial rotation and manipulation

(2) Counting as partial

(Analytic) (1) Comparing based on key features

(2) Counting systemically

The strategies used by groups are presented in Table 2.

Table 2. Strategies used by groups

Activities/Groups	Group 1			Group 2		
Strategies	Holistic	Intermediate	Analytic	Holistic	Intermediate	Analytic
Activity 1	1	1, 2	1, 2	1	1	2
Activity 2	2	2	1	1	1	1, 2
Activity 3			2	1	1	

Group 1 has used holistic strategies not only in activity 1 by mentally rotating objects as a whole, but also in activity 2 by comparing objects by counting as a whole. For instance, while solving activity 2, they first sorted the objects from the smallest (lower number of cubes) to the largest (greater number of cubes). They explained the reason for their strategy as follows:

"birlikte olamayacak büyük parçalar ve küçük parçalar olmak üzere iki gruba ayırdık"

("We divided the pieces into two groups: large pieces and small pieces that cannot be together.")

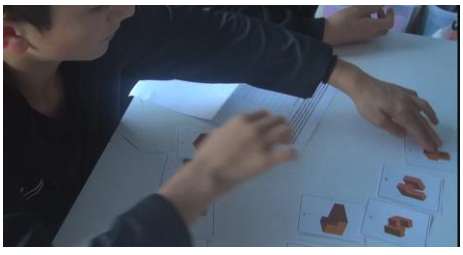

Figure 4. Group 1 activity 2 example strategy

Since they counted the number of cubes of the whole objects and compared with others, their work was categorized under holistic (2) for activity 2. Besides these holistic strategies, they compared the given objects by counting or rotating particular parts of the objects in activity 1. Since they were thinking about some parts of the objects instead of thinking as a whole, these works were categorized under Intermediate (1) and (2). Lastly, they used analytic strategies under two categories (1,2): comparing based on features and counting systematically. For activities 1 and 3, they were systematically counting cubes and

comparing whether they belonged to the same object or created an object according to the activity; hence, these were categorized under the analytic (2) strategy. For activities 1 and 2, they focused on the key features of the objects and compared objects by checking whether the object had or did not have this key feature. Group 2 used a holistic strategy, under the mental manipulation category, for each activity. They were modeling a figure in their mind, then trying to rotate or fit it together with the other mental visualization of another object. Hence, they were not only mentally manipulating but also approaching them as a whole, which shows they used a holistic (1) strategy. Another strategy they used was similar to these mental manipulations, but instead of thinking of objects as a whole, they were only thinking of some parts of the objects, and partially manipulating objects. For instance, they were visualizing one side of the object at first, then they were manipulating the other parts to decide and create if all sides belong to one object. Therefore, their works were categorized under intermediate (1) for activities 1 and 3.

Lastly, they used analytic strategies (1) and (2): comparing based on features and counting systematically. In activity 2, they created the objects by using concrete manipulatives and checked them by their shapes to match their fitting part, as shown in Figure 5. They kind of did trial and error after creating models. Hence, this strategy was categorized under analytic (1) since students focused on the features of the created objects rather than spatially manipulating them.

Figure 5. Examples of usage of manipulatives and checking (analytic (1))

Discussion, Conclusion, and Recommendations

Discussion

The accuracy levels and strategies were investigated in this study with gifted students who were working in pairs. According to the accuracy level findings, the similarity between the groups that used concrete manipulatives was closer to each other despite the deficiency in activity 3, as group 1 did not have enough time to complete all of the tasks.

Students used different strategies for different tasks. While group 2 used holistic strategies in the category of mental rotation and manipulation in all activities, as well as the intermediate strategy in partial rotation and manipulation in all activities, group 1 used these categorized strategies only in activity 1; however, they used the holistic strategy in counting as a whole and the intermediate strategy in counting as partial in activity 2. Both groups used analytic strategies in both categories, comparing based on key features and counting systematically, and group 1 used more analytic strategies as the difficulty of the tasks increased. This is a relatively common outcome and consistent with previous studies as well (Glück & Fitting, 2003). According to Glück & Fitting (2003), the more the difficulty of tasks increases, the more students tend to use analytic strategies rather than holistic strategies in spatial reasoning tasks. This situation has been observed in this study as well, while the activity difficulty increased, students' strategies shifted from holistic to analytic.

Conclusion

This study showed the accuracy levels and strategies of gifted students in three different spatial reasoning tasks. The results demonstrated that gifted students showed high accuracy levels in spatial reasoning activities, in parallel with their characteristics of high intelligence in cognitive abilities. In addition to that, they showed various and diverse strategies and combinations of different strategies in spatial reasoning tasks, as well as for creative and diverse thinking required problems.

Recommendation

According to those results, the gifted students' engagement with these kinds of spatial reasoning tasks was improving their spatial reasoning within the activities as they switched to more holistic strategies as they continued during the tasks and saw their useless strategies. Moreover, they have found that the learning becomes more self-oriented and apart from rote-memorization, which is compatible with gifted students' needs and characteristics (Mann, 2005; Renzulli, 2002; Williams,

2022). Since gifted students follow their own path and play their own drums while learning and need to engage in more complex activities that require high-order thinking instead of memorization-related tasks, these kinds of spatial reasoning activities would fulfill their needs (Mann, 2005; Renzulli, 2002). Therefore, these kinds of spatial reasoning activities, including different aspects of spatial reasoning with concrete manipulative usage support, might be included in teaching designs for gifted students. In addition, since this study aimed to investigate the spatial reasoning and strategies of gifted students deeply, a case study design was used without the purpose of generalization. Hence, for future research, the sample size could be increased to make a generalization and to understand other variables in their performance.

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Bridging Awareness and Classroom Practice through Teacher Education: Professional Development in Mathematical Learning Difficulties

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Abstract

Mathematical learning difficulties (Dyscalculia) are a persistent challenge in mathematics education, demanding targeted professional development to help teachers translate awareness into effective classroom practices. Strengthening teachers' pedagogical competencies in this area is essential for fostering equitable learning opportunities and addressing diverse student needs. This study aims to examine the effects of a teacher education program designed to enhance classroom teachers' awareness of mathematical learning difficulties and to develop their instructional competencies in the context of metacognitive strategies, storytelling, and learning strategies. Conducted using the phenomenological design of qualitative research, the study involved nine classroom teachers (five male, four female) selected through maximum variation sampling. Data were collected using the "Training Process Implementation Feedback Form," developed by the researchers and consisting of five open-ended questions. The responses were analyzed through content analysis; an inter-coder agreement rate of 92% was achieved between the two researchers who independently coded the data. The findings revealed a significant increase in teachers' awareness of dyscalculia, adoption of new approaches such as storytelling and metacognitive strategies, and the development of willingness to apply these strategies in their classroom practices. However, overcrowded classrooms, time constraints, and physical space limitations were identified as major challenges to implementation. The study concludes with a recommendation that such training programs should be expanded to support teachers' professional development and systematically offered during in-service seminar periods.

Keywords: *Mathematical learning difficulties, Teacher education, Phenomenology, Awareness.*

Introduction

In today's educational landscape, cognitive differences that affect students' academic achievement and daily life skills have become a central focus of research (Chinn, 2020; Nieminen et al., 2023). Among these differences, specific learning difficulties hold particular importance, as they directly impact not only individuals' school performance but also their social interactions, emotional development, and participation in society. The multidimensional nature of specific learning difficulties has consequently increased the need for more responsive, inclusive, and individualized approaches in education systems.

One such learning difficulty is mathematical learning difficulty (developmental dyscalculia), which is characterized by marked and persistent challenges in numerical operations, basic arithmetic skills, and quantitative reasoning despite having normal or above-average intelligence (Butterworth, 2018; Shalev & Gross-Tsur, 2001). This difficulty limits not only academic achievement but also reduces individuals' functionality in time management, money handling, and solving everyday problems (Geary, 2011). Therefore, supporting individuals with mathematical learning difficulties requires restructuring educational policies to enhance not only academic but also life skills.

In recent years, the concept of mathematical learning difficulties has gained greater prominence in the educational literature, being addressed not only as an individual but also as a societal issue" (Deruaz et al., 2020). Considering learning difficulties in relation to social participation, economic productivity, and equity in education makes the development of more inclusive policies a necessity. However, this expanded discourse has also been critically examined. In particular, framing mathematical learning difficulties as a threat to social progress has raised concerns about the risk of labeling and excluding individuals with

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such difficulties (Nieminen et al., 2023). Hence, mathematical learning difficulty is a multidimensional phenomenon that must be addressed both in terms of individual support and social awareness.

The early identification of students with mathematical learning difficulties and the provision of appropriate support depend largely on teachers' knowledge, awareness, and pedagogical competencies. However, research indicates that teachers often struggle to recognize mathematical learning difficulties—typically relying on informal tools such as observation—and generally lack sufficient knowledge on the subject (May & Ahmad, 2020; Karademir & Girgin, 2025; Kunwar & Sharma, 2020; Williams, 2013; Fu, 2024). Teachers' insufficient knowledge frequently leads to the misinterpretation of classroom signs and confusion between these signs and general academic failure (Mutlu, 2024; Kunwar & Sharma, 2020). This results in the use of inappropriate instructional strategies and the inability to meet the needs of students with mathematical learning difficulties (Ahmad et al., 2024; Kwakye et al., 2024). For example, a study conducted by Mohammed et al. (2024) found that Egyptian students diagnosed with mathematical learning difficulties demonstrated significantly lower performance in visual-spatial memory compared to their typically developing peers. This finding underscores the necessity for teachers to adapt their instructional strategies to the cognitive profiles of their students. Consequently, teachers must possess not only theoretical knowledge but also mastery of effective instructional practices.

Research has shown that multisensory learning, individualized teaching methods, and technology-assisted approaches are highly effective for students with mathematical learning difficulties (Butterworth et al., 2011; Chinn, 2020; Dowker, 2019; Geary, 2004; Korkmaz et al., 2024; Apostolidou, 2025). Accordingly, teachers' knowledge, awareness, and pedagogical skills regarding mathematical learning difficulties are considered critical for early identification and effective support (Kelly, 2020). Nevertheless, the literature reveals that classroom teachers often lack adequate awareness and knowledge in this area and face challenges in developing appropriate instructional strategies (Chinn, 2020; Jordan et al., 2010; Hacısalihoğlu-Karadeniz, 2013; Mutlu et al., 2022; Sezer & Akın, 2011; Yılmaz et al., 2024). Educational technologies and game-based learning have been shown to both enhance students' interest and support their mathematical understanding (Stasolla, 2025; Hashim et al., 2025). However, the effective implementation of these approaches requires teachers to possess sufficient digital literacy and practical skills (Amelia & Supena, 2022; Mokotjo, 2024). This underscores the need for evidence-based, practice-oriented teacher training programs to support professional development.

Moreover, teachers' development in these areas can be achieved not only through individual effort but also through institutional support and structured professional development programs. Karbasdehi et al. (2019) emphasize that professional development initiatives in this field should not merely provide knowledge but also contribute to transforming teachers' classroom practices. In this regard, teacher education that is research-based, practice-focused, and sustainable is essential to ensuring equitable access to education. In a study by Yoong and Hoe (2022), teachers were generally found to have high teaching competencies for these students; however, these competencies were more closely related to academic qualifications than to age or teaching experience. This finding highlights that the quality of teacher education is a determining factor in supporting students with learning difficulties.

This study aims to investigate how a teacher education program enhances classroom teachers' awareness of mathematical learning difficulties, their reflections on transferring the knowledge gained into classroom practices, and their professional development in this area. Specifically, it seeks to answer the following research questions:

Research Questions

1. How did teachers' professional knowledge, awareness, and use of strategies change during the training process?

2. To what extent did teachers reflect the knowledge and strategies learned in the training into their classroom practices?

3. What challenges did teachers face in this process, and what types of support did they need?

Method

Research Design

This study aimed to gain an in-depth understanding of classroom teachers' experiences during and after participation in a teacher education program on mathematical learning difficulties (dyscalculia). To achieve this aim, the research was conducted using the phenomenological approach, one of the qualitative research designs. The phenomenological design seeks to reveal individuals' lived experiences regarding a specific phenomenon, the meanings they attribute to these experiences, and their levels of awareness (Creswell, 2013; Patton, 2014; Yıldırım & Şimşek, 2022). In this study, teachers' subjective experiences concerning the training and implementation process constituted the primary focus of the research.

Participants

The participants of the study consisted of nine classroom teachers selected through maximum variation sampling. Of these, five were male and four were female. All participants voluntarily attended the training program and agreed to share their experiences with the researchers at the end of the process. They were employed in different schools and possessed varying levels of seniority and professional experience, which contributed to the diversity of the collected data.

Data Collection Tool and Procedure

Data were collected using the "Training Process Implementation Feedback Form," developed by the researchers. The form consisted of five open-ended questions designed to obtain in-depth information about teachers' experiences with the training process, classroom implementation, challenges encountered, changes in awareness, and suggestions for improvement. The questions were as follows:

1. What did you gain as a teacher from what you learned in this project (e.g., storytelling, metacognitive strategies, and learning strategies)?

2. Did you have the opportunity to apply the knowledge, strategies, and teaching approaches you learned in the project to your students?

- If yes, what differences did you observe? Please provide examples.

- What challenges did you encounter during implementation?

3. What differences did you observe between the knowledge acquired during the training and its implementation?

4. How did the knowledge you gained in this project change your awareness of dyscalculia?

5. What suggestions or improvement ideas do you have regarding the training content?

Participants completed the form in writing, and in some cases, follow-up interviews were conducted to elaborate on their responses.

Data Analysis

The data were analyzed using content analysis, one of the qualitative data analysis techniques (Miles & Huberman, 1994). Participants' responses were coded independently by two researchers, after which the codes were compared, and themes were identified through mutual discussion. An inter-coder agreement rate of 92% was achieved, exceeding the 80% minimum threshold recommended for reliability in qualitative research (Miles & Huberman, 1994). Based on the data obtained, themes were generated and interpreted through interpretive analysis.

Ethical Considerations

The study was conducted in accordance with ethical principles. This work has been supported by Van Yuzuncu Yil University Scientific Research Projects Coordination Unit under grant number SBA-2025-11919.

Results

1. Gains Teachers Obtained from the Training Process

The findings regarding the teachers' responses to the question *"What did you gain as a teacher from what you learned in this project (e.g., storytelling, metacognitive strategies, and learning strategies)?"* are presented in Table 1.

Table 1. Gains teachers obtained from the training process

Theme	Codes	Code Description	f
Gains and Instructional Development	Awareness and Knowledge Acquisition on Dyscalculia	Gaining knowledge and awareness about dyscalculia	8
	Acquisition of Teaching Strategies	Gaining diversity in learning strategies	6
	Acquisition of Storytelling Skills	Learning storytelling techniques	5
	Acquisition of Metacognitive Strategies	Learning metacognitive strategies	3
	Planning and Preparation	Making plans for future implementation	3
	Implementation Awareness	Recognizing shortcomings in practice	2
	Reinforcement of Existing Knowledge	Adding to what is already known	2

As shown in Table 1, the majority of participating teachers reported that they had gained significant benefits from the training process. It was found that eight teachers stated that their awareness of dyscalculia increased after the training. Participants indicated that they had the opportunity to recognize the characteristics of students with dyscalculia, learn how to approach these students, and address their own knowledge gaps in this area. The most frequently mentioned gain was acquiring diversity in teaching strategies (f = 6). Five participating teachers highlighted that the storytelling techniques they learned during the project were effective in boosting the self-confidence of students with learning difficulties and considered them a supportive tool for enhancing students' self-expression skills. Some teachers reported gains in recognizing their own shortcomings in implementation (f = 2), noting that they became aware of the need to improve certain knowledge and skills during the application process. In addition to teachers who emphasized gains in metacognitive strategies (f = 3), some indicated that they benefited from reinforcing their existing knowledge (f = 2) and planning for future implementations (f = 3). Examples of responses from participating teachers are provided below:

T1: *It provided diversity in learning strategies. I played the "Who Wants to Be a Millionaire?" game in class, and the students participated enthusiastically and enjoyed it.*

T2: *This project actually helped us notice the students with dyscalculia already present in our classrooms. We learned what kind of attitude we should adopt towards these students.*

T6: *In particular, storytelling can serve as an inspiration for students with learning difficulties who have lost their courage and self-confidence when told concrete examples of others who have experienced the same challenges. I believe it will help them overcome these negative situations. I used to tell my students such short stories before, but after this training, I will tell stories using the appropriate techniques. I hope to achieve beneficial results.*

2. Teachers' Observations and Challenges Encountered During the Implementation Process

The findings regarding the teachers' responses to the question "If you had the opportunity to apply the knowledge, strategies, and teaching approaches you learned in the project to your students, what differences did you observe? Please provide examples. What challenges did you encounter during implementation?" are presented in Table 2.

Table 2. Teachers' observations and challenges encountered during the implementation process

Theme	Codes	Code Description	f
Implementation Status and Challenges	Time and Large Class Size Issues	Experiencing difficulties due to large class sizes, lack of individual attention, and time constraints	5
	Positive Outcomes	Observing increased interest in the lesson and higher student motivation	4
	Inability to Implement	Lack of opportunity to apply the strategies	3
	Development of a Different Perspective	Evaluating students from a different point of view	2
	Difficulty in Understanding	Students' inability to grasp the topic immediately	2
	Physical Limitations	Distractions and unsuitable environmental conditions	2

As shown in Table 2, three participating teachers stated that they had not yet had the opportunity to implement what they had learned during the project, while the remaining teachers reported applying what they had gained from the training with

their students. Among those who implemented the strategies, five indicated that they faced difficulties, particularly due to large class sizes and time constraints. Four teachers reported positive outcomes from their applications, noting that students' interest in lessons increased, their enjoyment of mathematics improved, and their motivation to learn was heightened. Some participants stated that the training had helped them develop a different perspective (f = 2), enabling them to observe students more effectively and gain new insights into understanding them. Physical limitations in the classroom environment (f = 2) emerged as another challenge, with teachers noting that the physical conditions led to students becoming distracted. Additionally, some teachers reported that students experienced difficulty understanding the material (f = 2) and that they had to repeat explanations several times. Selected excerpts from participants' responses are presented below:

T3: *Yes, I did. I had some opportunity to apply storytelling. However, I realized that it was challenging to implement with students. I struggled because the number of students in the classroom was large, and I had to conduct the activity within a limited time frame.*

T4: *Unfortunately, I did not have many opportunities to implement it because our classrooms are very crowded. I could not work individually with my students. I noticed that when I applied different teaching approaches and strategies, students' attention became more dynamic. My students also began to enjoy mathematics lessons more. However, the large class size limits the opportunity for one-on-one engagement. The physical limitations of the classroom are among the challenges I face, as they cause students to become distracted during lessons.*

T7: *Yes, I started implementing it. For example, my student, who was previously reluctant to learn mathematics, has now become more willing. However, during implementation, my student did not understand what I explained at first. I had to explain the topic several times, and the student experienced difficulties in following the solution steps.*

3. Differences Between the Training and Its Implementation

The findings regarding the teachers' responses to the question *"What differences did you observe between the knowledge you gained during the training and its implementation? What are these differences? Please explain."* are presented in Table 3.

Table 3. Differences between the training and its implementation

Theme	Codes	Code Description	f
Training–Implementation Differences	Gap Between Expectation and Reality	Easy to apply in training, but challenging in practice	3
	Change in Behavior and Attitude	Positive changes observed in students	2
	Change in Perception	Shift in perception toward students with dyscalculia	2
	Time and Space Constraints	Limited opportunities for implementation	2
	Individual Differences	Impact of differences among students	2

As shown in Table 3, teachers observed several differences between the knowledge gained during the training process and the realities they encountered during implementation. Three teachers emphasized that, although everything seemed feasible during the training, the physical and social conditions of schools and classrooms limited the application of the strategies, and the approaches learned could not be fully transferred into the classroom environment. In contrast, in terms of behavioral and attitudinal change (f = 3), teachers reported observing positive developments in their students. They also noted a change in their own perceptions toward students with dyscalculia (f = 2) when implementing the strategies after the training. Students were described as becoming more willing to learn and exhibiting behavioral improvements. In addition, teachers stated that individual differences among students (f = 2) had a significant impact, contributing to the differences between training and implementation. Selected excerpts from participants' responses are provided below:

T2: *I learned a lot during the training. The most valuable contribution for me was understanding how children with dyscalculia perceive things. Since I now understand why they struggle with mathematics, my attitudes and behaviors toward them have changed.*

T7: *During the training, I acquired the necessary knowledge. In practice, I saw that this knowledge helped students understand better. There were changes in their behavior—they became more eager to learn.*

T8: *During the training, everything seemed doable and achievable. However, factors such as school conditions, the state of the classrooms, and students' readiness levels can become obstacles to implementation. I believe that with good planning, the training received can be beneficial.*

4. Change in Dyscalculia Awareness

The findings regarding the teachers' responses to the question *"How did the knowledge you gained in this project change your awareness of dyscalculia? Can you compare your awareness before and after the project?"* are presented in Table 4.

Table 4. Change in Dyscalculia Awareness

Theme	Codes	Code Description	f
Change in Dyscalculia Awareness and Approach	Awareness Before and After	Increased awareness following the training	9
	Change in Approach	Changes in behavior and approach toward students	3
	Increased Depth of Knowledge	Moving from superficial to detailed knowledge	3
	Increased Motivation and Patience	Development of willingness to teach and greater patience	2
	Sharing and Dissemination	Willingness to share with colleagues	2

As shown in Table 4, all participants reported a significant increase in their awareness of dyscalculia following the project. They stated that, prior to the project, they were largely unaware of students with dyscalculia, whereas after the training they were able to better understand these students and learned how to approach them appropriately. Some teachers also noted that this heightened awareness led to changes in their approach toward students with dyscalculia (f = 3). These teachers reported improvements in their ability to support students' learning efforts, to understand the challenges faced by children with dyscalculia when learning mathematics, and to adjust their behavior accordingly.

Three participants emphasized an increase in the depth of their knowledge about dyscalculia. While they had previously heard the term, they now possessed more detailed knowledge of mathematics teaching methods for students with dyscalculia. In addition, participants highlighted that the project increased their motivation and patience when teaching mathematics to students with dyscalculia (f = 2), and fostered a willingness to share what they had learned with their colleagues (f = 2).

Selected excerpts from participants' responses are provided below:

T3: *I realized that when teaching mathematics, we should start with concrete objects in the initial stages. I can also say that the knowledge I gained from this project increased our chances of identifying students with learning difficulties.*

T4: *I gained more knowledge about dyscalculia. My perspective on how to behave toward and approach a student with dyscalculia has changed. I have shared the information I learned with other teacher colleagues.*

T6: *The concepts we learned in this project were not unfamiliar to me. However, I learned the details of concepts I had only known superficially. I believe that if I can apply the correct mathematics teaching methods for students with dyscalculia, they will be very beneficial—methods I was previously unaware of. In addition, my motivation and patience for teaching mathematics to students with dyscalculia have increased.*

T7: *After this project, I began to attach greater importance to the issue of dyscalculia. I learned information that I can apply to such students throughout my teaching career. Before the project, it seemed unimportant, but after the training I realized that it is highly important and that it is a type of training every teacher should receive.*

5. Suggestions Regarding the Training Provided

The findings regarding the teachers' responses to the question *"What suggestions or improvement ideas do you have regarding the training content? Could you share them with us?"* are presented in Table 5.

Theme	Codes	Code Description	f
Suggestions for the Training	Dissemination to All Teachers	Request to extend the training to all teachers	5
	Timing Suggestion	Request to conduct the training during teachers' seminar periods	4
	Duration Extension	Perception that the training duration was too short	2
	Active Participation	Desire for teachers to be more actively involved in the training	2
	Application Examples	Request for more activity and practice examples	2
	Awareness for Identification	Request to raise awareness for identifying undiagnosed students	2

As shown in Table 5, most participants recommended extending the training to all teachers (f = 5), highlighting its importance for early diagnosis and intervention in dyscalculia. Suggestions included offering it during seminar periods (f = 4), extending its duration (f = 2), increasing active participation (f = 2), making sessions more interactive, and adding more activity examples (f = 2).

T1: *I can say that the training was useful. All teachers should be given these seminars. We have students in our classes with dyscalculia who do not have an official diagnosis. Teachers need to gain awareness so these students can be identified.*

T2: *I think this training should be mandatory for all classroom teachers. In this way, all teachers would become aware of these children, be informed about their needs, and change their approach toward them.*

T3: *The knowledge we gained in this seminar is very valuable, and therefore, I believe the project should be implemented across the province of Van and throughout the country for all teachers. These trainings could be delivered to more teachers during seminar periods through online education.*

Discussion

This study examined the effects of training provided to classroom teachers on dyscalculia, storytelling, metacognitive strategies, and learning strategies with respect to their professional knowledge, awareness, and classroom practice skills. The findings revealed a marked increase in teachers' awareness of dyscalculia, which in turn positively influenced their communication with students and the instructional approaches they adopted. This outcome is consistent with previous research showing that teacher training on specific learning difficulties enhances teachers' awareness and pedagogical intervention skills (Chinn, 2015; Hacısalihoğlu-Karadeniz, 2013; Karademir & Girgin, 2025).

The majority of participants stated that the knowledge and strategies gained through the project made a substantial contribution to their professional development. Specifically, they reported significant growth in their understanding of dyscalculia and positive changes in their attitudes and approaches toward students with this difficulty. Storytelling and metacognitive strategies were perceived as effective tools for increasing students' learning motivation, echoing the literature emphasizing the role of diversified teaching approaches in engaging students with learning difficulties.

However, participants also encountered barriers in the implementation phase. The most commonly reported challenges included large class sizes, insufficient opportunities for individual attention, limited time, and inadequate classroom facilities. This is in line with Blatchford et al. (2011), who noted that the physical and organizational conditions of the learning environment directly affect the feasibility of innovative teaching strategies. Despite these challenges, teachers who implemented the training observed positive behavioral changes and increased learning motivation among their students.

Conclusion

The study demonstrated that targeted training programs focusing on dyscalculia, storytelling, metacognitive strategies, and learning strategies can significantly improve teachers' awareness, pedagogical skills, and classroom practices. Teachers' enhanced awareness translated into more positive and supportive approaches toward students with dyscalculia, alongside the adoption of varied instructional strategies aimed at increasing engagement and motivation. Nevertheless, persistent constraints—such as overcrowded classrooms, insufficient resources, and time limitations—remain obstacles to effective implementation. Overall, the findings underscore the value of structured, research-informed teacher education initiatives, while also pointing to the need for systemic changes to support their sustainability and impact.

Recommendations

Training on dyscalculia and learning difficulties should be made compulsory for all classroom teachers and scheduled during professional development seminar periods to maximize participation and impact. Programs should include more practical examples, activity suggestions, and opportunities for active teacher engagement. Increasing teachers' awareness will support early identification of undiagnosed students and improve timely interventions.

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Investigation of Science Teacher Candidates' Artificial Intelligence Literacy Levels[7]

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Abstract

The study aimed to examine the artificial intelligence literacy levels of science teacher candidates in terms of class variables. The survey model, one of the quantitative research methods, was used as the research method. The research was conducted with 130 teacher candidates at Harran University, Faculty of Education, Department of Science Education, in the 2024-2025 academic year. The "Artificial Intelligence Literacy Scale" was used as the data collection tool in the study. The scale was administered to teacher candidates via online tools. The data obtained in the study were interpreted by calculating percentages and frequencies and creating tables. The results of the study show that science teacher candidates can distinguish between smart and non-smart devices and know how artificial intelligence technology can help, but they experience some hesitation. They do not show a negative attitude towards identifying the artificial intelligence technology used in the applications and products they use, but their level of knowledge on the subject is not yet fully developed. They do not have a negative attitude towards skillfully using artificial intelligence applications or products in their daily work, but their competence in using these technologies effectively and at an advanced level is limited. Teacher candidates generally do not experience significant difficulty in learning a new artificial intelligence application, can relate artificial intelligence applications to work efficiency, and have begun to view these technologies as supportive tools. It is understood that teacher candidates do not merely use artificial intelligence applications passively, but have developed the ability to evaluate the products they experience and observe their limitations, and have developed a certain awareness in comparing artificial intelligence applications and making choices according to task compatibility. Furthermore, it is seen that they have the ability to choose from the alternatives offered by artificial intelligence and that they have a positive attitude in this regard. In addition, it has been found that a significant portion of teacher candidates have a sense of ethical responsibility and adopt a positive attitude towards complying with these values when using artificial intelligence. It has been observed that the vast majority of teacher candidates are sensitive to issues of privacy and information security and do not adopt an attitude of disregarding these principles when using artificial intelligence. Teacher candidates have been seen to adopt a cautious and responsible approach to the misuse of artificial intelligence technologies.

Keywords: *Science Teacher Candidates, Artificial Intelligence, Artificial Intelligence Literacy, Science Education*

Özet

Çalışma Fen bilgisi öğretmen adaylarının yapay zekâ okuryazarlık düzeylerinin sınıf değişkeni açısından incelemeyi amaçlamıştır. Araştırmanın yöntemi olarak nicel araştırma yöntemlerinden tarama modeli kullanılmıştır. Araştırma 2024-2025 akademik yılında Harran Üniversitesi Eğitim Fakültesi Fen Bilgisi Öğretmenliğindeki 130 öğretmen adayı ile yürütülmüştür. Araştırmada veri toplama aracı olarak "Yapay Zekâ Okuryazarlığı Ölçeği" kullanılmıştır. Öğretmen adaylarına ölçek çevrim içi araçlar aracılığıyla uygulanmıştır. Çalışmada elde edilen veriler yüzde ve frekans değerleri hesaplanarak tablolar oluşturularak yorumlanmıştır. Çalışmanın sonucunda Fen bilgisi öğretmen adaylarının akıllı cihazlar ile akıllı olmayan cihazları birbirinden ayırt edebildikleri, yapay zekâ teknolojisinin nasıl yardımcı olacağını bildikleri ancak kısmen tereddüt yaşadıkları görülmektedir. Kullandıkları uygulama ve ürünlerde kullanılan yapay zekâ teknolojisini tanımlama konusunda olumsuz bir tutum sergilemedikleri, ancak konuya ilişkin bilgi düzeylerinin henüz tam olarak gelişmediği görülmektedir. Günlük işlerinde yapay zekâ uygulamalarını veya ürünlerini ustalıkla kullanma konusunda olumsuz bir tutum içinde olmadıkları ancak bu teknolojileri etkili ve ileri düzeyde kullanma konusundaki yeterliliklerinin sınırlı olduğu görülmektedir. Öğretmen adaylarının genel olarak yeni bir yapay zekâ uygulamasını öğrenmede ciddi bir güçlük yaşamadıkları, yapay zekâ uygulamalarını iş verimliliğiyle ilişkilendirebildikleri ve bu teknolojileri destekleyici araçlar olarak görmeye başladıkları görülmektedir. Öğretmen adaylarının yapay zekâ uygulamalarını yalnızca pasif bir şekilde kullanmakla yetinmeyip, deneyimledikleri ürünleri değerlendirme ve sınırlarını gözlemleme becerisi geliştirdikleri, yapay zekâ uygulamaları arasında karşılaştırma yapma ve görev uyumuna göre seçim yapma konusunda belirli bir farkındalık geliştirdikleri anlaşılmaktadır. Ayrıca yapay zekânın sunduğu alternatifler arasından seçim yapabilme yetisine sahip oldukları ve bu konuda olumlu bir tutum sergiledikleri görülmektedir. Bunun yanında öğretmen adaylarının önemli bir kısmının etik sorumluluk bilinci taşıdığı ve yapay zekâ kullanımı

[7] This study was prepared based on a section of Semiha Uçar's Master's thesis, supervised by Assoc. Prof. Dr. Mehmet Yakışan, and was presented orally at the XIIth International Eurasian Educational Research Congress (June 25-28, 2025).

sırasında bu değerlere uyma konusunda olumlu bir tutum benimsedikleri ortaya çıkmaktadır. Öğretmen adaylarının büyük çoğunluğunun gizlilik ve bilgi güvenliği konularına duyarlı oldukları, yapay zekâ kullanımı sırasında bu ilkelere dikkat etmeme gibi bir tutumu benimsemedikleri gözlenmiştir. Öğretmen adaylarının yapay zekâ teknolojilerinin kötüye kullanımına karşı dikkatli ve sorumlu bir yaklaşım benimsedikleri görülmüştür.

Anahtar Sözcükler: *Fen Bilgisi Öğretmen Adayları, Yapay Zekâ, Yapay Zekâ Okuryazarlığı, Fen Eğitimi*

Introduction

From past to present, with the advancement of technology, the concept of artificial intelligence has taken giant strides that deeply affect everyone, especially with the involvement of global companies and social media (Sucu and Ataman, 2020). Considering that artificial intelligence is the most important technology humanity has achieved, examining the effects of previous technological products on individual and social life will shed light on understanding the concerns created by artificial intelligence (Kazak, 2023). Artificial intelligence, which saves lives in the right hands, has the potential to bring about the end of the world and humanity if it falls into the wrong hands (Şahiner, Ayhan and Önder, 2021).

Today, multifaceted and diverse literacy methods are used in many countries (Güneş, 2019). The concept of literacy can be defined as encompassing both the act of reading and the process of writing. Viewed as a means of communication that has gained meaning in society, literacy can change and be renewed according to social progress and the needs of the era.

One of the categories that make up the skills needed in the 21st century is digital literacy. Digital literacy means accessing accurate information using tools such as computers, tablets, and smartphones, using this information effectively, sharing and transferring information, and also producing new information (Aksoy, Karabay and Aksoy, 2021). One of the technological literacies is artificial intelligence literacy. Artificial intelligence literacy refers to a broad area of competence that goes beyond technological skills and also includes the social and ethical dimensions of artificial intelligence. This concept enables individuals to understand artificial intelligence technologies, review their potential effects, and use artificial intelligence-supported products carefully (Erdoğan and Ekşioğlu, 2024). Artificial intelligence literacy is a set of competencies that includes the ability to critically examine artificial intelligence technologies; establish effective communication and collaboration with these technologies; and use artificial intelligence as an effective tool on various online platforms (Dağaşan, 2025). Gökçearslan and Durak (2024) define artificial intelligence literacy as the skills that enable individuals to collaborate effectively with artificial intelligence, communicate with it, use it as an effective tool, and critically evaluate artificial intelligence. Çelebi, Demir and Karakuş (2023) state in their study that there are many similarities in the literature regarding the definition of artificial intelligence literacy. Artificial intelligence is a powerful technology that affects many areas and raises important ethical issues in every field where it is applied (Keskin and Sevli, 2024). Ünal (2024) found in his research that studies on artificial intelligence literacy are concentrated in the fields of education and computer science. The main reason for this can be explained by the increase in the use of artificial intelligence technologies by both educators and students, in addition to having knowledge about the technical features of artificial intelligence. It has been determined that they believe it is important to encourage the reasons for supporting the correct and effective use of artificial intelligence (Kandır, Temel, 2025).

Artificial intelligence studies, which emerged as a result of imitating human intelligence, can be defined as machines that model human learning (Coşkun and Gülleroğlu, 2021). Thanks to artificial intelligence, teaching methods will change, enabling teachers to improve themselves by learning new technologies and become eager to apply these technologies in their classrooms (İşler and Kılıç, 2021). The effects of artificial intelligence on individual and social life are increasing day by day; teachers' knowledge, skills, and awareness levels regarding this technology are of critical importance, especially in the field of education. Although there are some studies in the literature on the artificial intelligence literacy of teacher candidates in general, there is a lack of comprehensive research specific to science teacher candidates. However, science is an important field where technological innovations can be directly integrated into classroom applications. In this regard, it is necessary to conduct this research to determine the artificial intelligence literacy levels of science teacher candidates, fill the existing gap in the field, and understand the level of interaction of future teachers with technology. Conducting this study, which examines the artificial intelligence literacy levels of science teacher candidates in terms of class variables, is important for determining the artificial intelligence literacy levels of future science teacher candidates and for planning and organizing teaching at the teacher training degree level. Therefore, such a study will contribute to the field. This study aims to identify the current status of teacher candidates and contribute to educational policies, program development processes, and teacher training approaches in this field.

Method

Research Model

The survey model, one of the quantitative research methods, was used in this study. The survey model is a research method that identifies individuals' characteristics such as knowledge, skills, and attitudes regarding an issue, without any attempt to change or influence the current situation.

Study group

The research was conducted with 130 volunteer teacher candidates (106 females, 24 males) studying at Harran University Faculty of Education Science Teaching in the 2024-2025 academic year. The distribution of science teacher candidates participating in the study according to class level is given in Table 1.

Table 1

Distribution of science teacher candidates participating in the study according to grade level

Grade Level	f	%
1st Grade	11	8,5
2nd Grade	46	35,4
3rd Grade	40	30,8
4th Grade	33	25,4
Total	130	100

Data Collection Tool

The "Artificial Intelligence Literacy Scale" was used as the data collection tool in the study. The literacy scale was developed by Wang, Rau, and Yuan (2022) and adapted into Turkish by Çelebi et al. (2023), consisting of 12 items. The scale has 4 sub-dimensions (awareness, use, evaluation, ethics) and uses a 7-point Likert scale. The scale was administered online to teacher candidates. The data obtained in the study were interpreted by calculating percentages and frequencies and creating tables.

Results

The frequency and percentage calculations of the items of the artificial intelligence literacy level scale used in the study were made according to the grade level, and the data obtained are presented in the tables below.

Table 2

Frequency and percentage data for the first item

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	0	0	0	0	1	9,1	1	9,1	5	45,5	4	36,4	11	100
2nd Grade	0	0	0	0	5	10,9	4	8,7	7	15,2	12	26,1	18	39,1	46	100
3rd Grade	0	0	0	0	1	2,5	4	10	3	7,5	15	37,5	17	42,5	40	100
4th Grade	0	0	0	0	1	3	3	9,1	7	21,2	10	30,3	12	36,4	33	100
Total	0	0	0	0	7	5,4	12	9,2	18	13,8	42	32,3	51	39,2	130	100

When examining the responses of science teacher candidates to the statement "I can distinguish between smart devices and non-smart devices" according to their grade levels, it is seen that the "Agree" and "Strongly agree" options are the most

preferred responses at all levels. Approximately 80% of teacher candidates in the 3rd grade showed the highest level of agreement with this statement. On the other hand, no teacher candidates selected the “Disagree” or “Strongly disagree” options across all four grade levels. The findings indicate that the majority of teacher candidates recognize the concept of smart devices and believe they have a high level of technological awareness.

Table 3

Frequency and percentage data related to the second item

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	1	9,1	1	9,1	2	18,2	1	9,1	5	45,5	0	0	1	9,1	11	100
2nd Grade	8	17,4	8	17,4	8	17,4	7	15,2	8	17,4	3	6,5	4	8,7	46	100
3rd Grade	4	10	5	12,5	7	17,5	7	17,5	8	20	6	15	3	7,5	40	100
4th Grade	7	21,2	11	33,3	7	21,2	4	12,1	2	6,1	0	0	2	6,1	33	100
Total	20	15,4	25	19,2	24	18,5	19	14,6	23	17,7	9	6,9	10	7,7	130	100

When examining the responses of science teacher candidates to the statement “I don't know how artificial intelligence technology can help me” according to their grade levels, it is observed that the options “Strongly disagree,” “Disagree,” and “Partly disagree,” which carry a positive meaning in this negative statement, are highly preferred across all grade levels. Fourth-grade teacher candidates were found to prefer the options “Disagree” and “Strongly disagree” the most for this statement. Science teacher candidates stated that they knew how artificial intelligence technology could help them.

Table 4

Frequency and percentage data for the third statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	2	18,2	1	9,1	5	45,5	2	18,2	0	0	1	9,1	11	100
2nd Grade	2	4,3	3	6,5	5	10,9	12	26,1	14	30,4	6	13	4	8,7	46	100
3rd Grade	3	7,5	2	5	6	15	8	20	11	27,5	7	17,5	3	7,5	40	100
4th Grade	0	0	1	3	4	12,1	9	27,3	9	27,3	7	21,2	3	9,1	33	100
Total	5	3,8	8	6,2	16	12,3	34	26,2	36	27,7	20	15,4	11	8,5	130	100

When examining the responses given by teacher candidates to the statement “I can describe the artificial intelligence technology used in the applications and products I use,” it is seen that the most preferred options are “Undecided” and “Partly agree” 63.7% of 1st graders, 56.51% of 2nd graders, 47.5% of 3rd graders, and 54.6% of 4th graders selected these

two options. This indicates that teacher candidates do not exhibit a negative attitude toward recognizing applications involving artificial intelligence, but their level of knowledge on the subject is not yet fully developed.

Table 5

Frequency and percentage data for the fourth item

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	1	9,1	3	27,3	2	18,2	5	45,5	0	0	0	0	11	100
2nd Grade	0	0	6	13	7	15,2	4	8,7	15	32,6	11	23,9	3	6,5	46	100
3rd Grade	5	12,5	3	7,5	4	10	11	27,5	10	25	5	12,5	2	5	40	100
4th Grade	0	0	1	3	5	15,2	9	27,3	7	21,2	7	21,2	4	12,1	33	100
Total	5	3,8	11	8,5	19	14,6	26	20	37	28,5	23	17,7	9	6,9	130	100

When examining the responses of science teacher candidates to the statement "I can skillfully use artificial intelligence applications or products to assist me in my daily tasks" according to their grade levels, it is observed that they experience uncertainty across all grade levels. These findings reveal that teacher candidates do not generally have a negative attitude toward artificial intelligence applications, but they perceive their competence in using these technologies effectively and at an advanced level as limited.

Table 6

Frequency and percentage data for the fifth statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	1	9,1	1	9,1	4	36,4	2	18,2	2	18,2	0	0	1	9,1	11	100
2nd Grade	5	10,9	7	15,2	6	13	15	32,6	10	21,7	2	4,3	1	2,2	46	100
3rd Grade	6	15	7	17,5	13	32,5	6	15	2	5	6	15	0	0	40	100
4th Grade	4	12,1	10	30,3	8	24,2	6	18,2	4	12,1	0	0	1	3	33	100
Total	16	12,3	25	19,2	31	23,8	29	22,3	18	13,8	8	6,2	3	2,3	130	100

When examining the responses of science teacher candidates to the statement "Learning to use a new artificial intelligence application or product is generally difficult for me" according to their grade levels, it is seen that the most preferred responses are "Undecided," "Partly disagree," and "Disagree" The "Strongly agree" option was the least preferred response across all grade levels. These data reveal that teacher candidates generally believe they do not experience serious difficulties

in learning a new artificial intelligence application, but that the number of those experiencing indecision or moderate difficulty in this process is not insignificant.

Table 7

Frequency and percentage data for the sixth item

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	0	0	2	18,2	0	0	6	54,5	2	18,2	1	9,1	11	100
2nd Grade	1	2,2	2	4,3	2	4,3	8	17,4	13	28,3	12	26,1	8	17,4	46	100
3rd Grade	2	5	0	0	2	5	8	20	11	27,5	11	27,5	6	15	40	100
4th Grade	0	0	2	6,1	0	0	4	12,1	6	18,2	15	45,5	6	18,2	33	100
Total	3	2,3	4	3,1	6	4,6	20	15,4	36	27,7	40	30,8	21	16,2	130	100

When examining the responses of teacher candidates to the statement “I can use artificial intelligence applications or products to increase my work efficiency” according to their grade levels, it is seen that the most preferred responses across all levels are “Partly agree,” “Agree,” and “Strongly agree” This indicates that the majority of teacher candidates can relate artificial intelligence applications to work efficiency and have begun to view these technologies as supportive tools.

Table 8

Frequency and percentage data for the seventh statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	1	9,1	0	0	2	18,2	5	45,5	3	27,3	0	0	11	100
2nd Grade	1	2,2	2	4,3	3	6,5	10	21,7	10	21,7	14	30,4	6	13	46	100
3rd Grade	0	0	2	5	4	10	8	20	11	27,5	11	27,5	4	10	40	100
4th Grade	0	0	2	6,1	1	3	11	33,3	8	24,2	5	15,2	6	18,2	33	100
Total	1	,8	7	5,4	8	6,2	31	23,8	34	26,2	33	25,4	16	12,3	130	100

When examining the responses of science teacher candidates to the statement "After using an artificial intelligence application or product for a period of time, I can evaluate its capabilities and limitations," it is observed that the options "Partly Agree," "Agree," and "Strongly Agree" stand out across all levels. This reveals that the vast majority of teacher candidates believe they have developed the ability to evaluate the products they have experienced and observe their limitations, rather than merely using artificial intelligence applications passively.

Table 9

Frequency and percentage data for the eighth statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	0	0	2	18,2	2	18,2	5	45,5	2	18,2	0	0	11	100
2nd Grade	0	0	1	2,2	6	13	9	19,6	13	28,3	12	26,1	5	10,9	46	100
3rd Grade	1	2,5	0	0	3	7,5	12	30	12	30	8	20	4	10	40	100
4th Grade	1	3	2	6,1	3	9,1	9	27,3	10	30,3	4	12,1	4	12,1	33	100
Total	2	1,5	3	2,3	14	10,8	32	24,6	40	30,8	26	20	13	10	130	100

When examining the responses of science teacher candidates to the statement "I can select the most appropriate artificial intelligence application or product for a specific task" according to their grade levels, it is observed that the most preferred options are "Partly agree" and "Agree" This indicates that the majority of teacher candidates have developed a certain awareness of comparing artificial intelligence applications and selecting them according to task suitability, and believe they possess this skill.

Table 10

Frequency and percentage data for the ninth statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	0	0	0	0	1	9,1	7	63,6	3	27,3	0	0	11	100
2nd Grade	1	2,2	2	4,3	5	10,9	10	21,7	10	21,7	15	32,6	3	6,5	46	100
3rd Grade	1	2,5	1	2,5	3	7,5	6	15	15	37,5	7	17,5	7	17,5	40	100
4th Grade	0	0	2	6,1	2	6,1	7	21,2	9	27,3	9	27,3	4	12,1	33	100
Total	2	1,5	5	3,8	10	7,7	24	18,5	41	31,5	34	26,2	14	10,8	130	100

When the responses of teacher candidates to the statement “I can choose the appropriate solution from among the various solutions offered by artificial intelligence” were examined according to grade level, it was found that the most preferred options across all levels were “Partly agree” and “Agree” This reveals that the vast majority of teacher candidates believe they have the ability to choose from the alternatives offered by artificial intelligence and that they have a positive attitude towards this.

Table 11

Frequency and percentage data for the tenth statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	0	0	0	0	0	0	5	45,5	5	45,5	1	9,1	11	100
2nd Grade	2	4,3	2	4,3	6	13	6	13	14	30,4	10	21,7	6	13	46	100
3rd Grade	1	2,5	1	2,5	6	15	5	12,5	9	22,5	14	35	4	10	40	100
4th Grade	0	0	4	12,1	3	9,1	5	15,2	6	18,2	10	30,3	5	15,2	33	100
Total	3	2,3	7	5,4	15	11,5	16	12,3	34	26,2	39	30	16	12,3	130	100

When examining teacher candidates' responses to the statement “I always adhere to ethical principles when using artificial intelligence applications or products,” the most frequently selected options were “Agree” and “Partly agree,” indicating that teacher candidates, particularly those in the 1st grade, strongly agree with this statement. This reveals that a significant portion of teacher candidates possess a sense of ethical responsibility and have adopted a positive attitude toward adhering to these values when using artificial intelligence.

Table 12

Frequency and percentage data for the eleventh statement

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	5	45,5	1	9,1	2	18,2	0	0	1	9,1	1	9,1	1	9,1	11	100
2nd Grade	10	21,7	13	28,3	9	19,6	5	10,9	8	17,4	1	2,2	0	0	46	100
3rd Grade	16	40	9	22,5	6	15	3	7,5	3	7,5	1	2,5	2	5	40	100
4th Grade	15	45,5	7	21,2	1	3	4	12,1	3	9,1	2	6,1	1	3	33	100
Total	46	35,4	30	23,1	18	13,8	12	9,2	15	11,5	5	3,8	4	3,1	130	100

When examining the responses of science teacher candidates to this statement, which contains the negative expression ‘I never pay attention to privacy and information security issues when using artificial intelligence applications or products,’ according to their grade levels, it is seen that the most preferred options are “Strongly disagree”, “Disagree” and “Partly

disagree” It is understood that the vast majority of teacher candidates are sensitive to privacy and information security issues and do not adopt an attitude of disregarding these principles when using artificial intelligence.

Table 13

Frequency and percentage data for the twelfth item

Grade Level	Strongly disagree		Disagree		Partly disagree		Undecided		Partly agree		Agree		Strongly agree		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1st Grade	0	0	0	0	0	0	1	9,1	1	9,1	3	27,3	6	54,5	11	100
2nd Grade	2	4,3	1	2,2	5	10,9	6	13	9	19,6	13	28,3	10	21,7	46	100
3rd Grade	1	2,5	0	0	4	10	3	7,5	10	25	14	35	8	20	40	100
4th Grade	0	0	1	3	5	15,2	1	3	6	18,2	10	30,3	10	30,3	33	100
Total	3	2,3	2	1,5	14	10,8	11	8,5	26	20	40	30,8	34	26,2	130	100

When examining the responses of science teacher candidates to the statement “I am always careful to prevent the misuse of artificial intelligence technology” according to their grade levels, it is observed that the most preferred responses are “Agree” and “Strongly agree” This reveals that teacher candidates adopt a careful and responsible approach towards the misuse of artificial intelligence technologies.

Discussion and Conclusion

The study shows that science teacher candidates at all grade levels can mostly distinguish between smart and non-smart devices, partly know how artificial intelligence technology can help them, and do not exhibit a negative attitude towards recognizing the artificial intelligence applications they use; however, their level of knowledge on the subject is not yet fully developed. It has been determined that teacher candidates generally perceive their AI-related competencies as limited based on the statement, “I can skillfully use AI applications or products to assist me in my daily work.” It has been observed that learning to use a new AI application or product is not difficult for science teacher candidates, and they show a positive tendency to use AI applications or products to increase work efficiency. While most teacher candidates stated that they could evaluate the capacity and limitations of an artificial intelligence application or product after using it for a while, some teacher candidates were found to be uncertain about this. They stated that they could select the most appropriate AI application or product and solution from among those offered for a specific task, that they had developed a certain awareness in making choices, and that they believed they possessed this skill. It was observed that a significant portion of teacher candidates possess ethical responsibility awareness and adopt a positive attitude towards adhering to these values when using artificial intelligence, and that the vast majority are sensitive to privacy and information security issues. Furthermore, it has been revealed that they always demonstrate a careful and responsible approach to prevent the misuse of artificial intelligence technology. It is observed that prospective teachers have similar levels of literacy regarding artificial intelligence and that the ratios of their responses to all items are at similar levels. Banaz and Demirel (2024), in their study examining Turkish teacher candidates according to different variables, found that there was no significant difference between candidates' literacy levels based on gender and grade level, but there was a significant difference between their AI literacy and their AI news following habits. Erdoğdu and Çakır (2024) stated in their study with social studies teacher candidates that the teacher candidates' artificial intelligence literacy levels were generally at an “intermediate” level. They also found that the teacher candidates' scores in the awareness, use, evaluation, and ethical dimensions were above the scale average. According to the results of a study conducted with high school, associate degree, and undergraduate students, the students' artificial intelligence literacy levels were found to be low. In light of these results, it was stated that high school, associate degree, and undergraduate students were not sufficiently informed about artificial intelligence literacy and that educational activities in this area were inadequate (Elçiçek, 2024). In a study that determined teacher candidates' awareness of artificial intelligence technologies,

teacher candidates (those studying science and computer and instructional technology education) stated that the advantages of using artificial intelligence technologies outweigh the disadvantages in terms of their future impact (Çam, et al., 2021).

Recommendations

Artificial intelligence literacy is becoming increasingly important in the modern digital environment. Studies can be conducted to determine the level of artificial intelligence literacy among teacher candidates as well as other members of society. Research could be conducted on how artificial intelligence literacy is formed in different cultural environments. An assessment could be made of the differences in the perspectives of Western and Eastern cultures on artificial intelligence and its education. The possible effects of children's interaction with artificial intelligence from an early age on their mental and emotional development could be investigated.

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Teachers Working in Public Schools' Opinions on the KPSS

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Abstract

This study aims to examine the views and experiences of teachers working in public schools regarding the Teacher Candidate Selection and Appointment Exam (formerly known as KPSS, now AGS and ÖABT as of 2025) using a qualitative approach. Using a phenomenological design, semi-structured interviews were conducted with 15 teachers with up to five years of experience working in different subjects (science, social sciences, physical education). The data were analyzed using thematic analysis with the MAXQDA program, revealing three main themes: the exam preparation process, the post-appointment process, and suggestions. The findings show that during the exam preparation process, teachers faced difficulties such as uncertainty, the broad scope of the exam, psychological exhaustion, financial problems, and time management; while family and friend support, expert guidance, and the desire to be a teacher were the main sources of motivation. In the post-appointment process, teachers stated that the exam had limited contribution to professional practices and career readiness, particularly falling short in measuring practical skills and classroom applications. In the recommendations section, it was emphasized that the exam should be more application-oriented, field-specific selection processes should be developed, communication skills should be evaluated, and regulations that would increase the prestige of the profession should be implemented. These findings support teachers' application-oriented demands in the transition to the AGS and ÖABT systems, which will replace the KPSS as of 2025. The study contributes to the literature by understanding the impact of teacher selection processes on professional competencies, offering recommendations for improving the examination system, and adding the post-appointment perspective of appointed teachers to the literature. Consistent with similar qualitative studies (e.g., KPSS preparation experiences during the pandemic), this study enriches the literature by thoroughly examining the psychological and social dynamics of teachers regarding the examination process and evaluating their professional perceptions after appointment.

Keywords: Teacher selection exam, qualitative research, professional competence, thematic analysis

Introduction

In today's information society, rapidly advancing science and technology necessitate the restructuring of education systems to enable individuals to adapt to innovations (Demir, 2007). Education is a fundamental element that enables the development of society, and teachers play a key role in student success through their curricula and interactions (Çelikten, Şanal, & Yeni, 2005; Taşdemir, 2007; Engin-Demir, 2009; Sünbül, 1996). According to Şişman (2007), the education system achieves its goals through the harmonious unity of students, teachers, and resources (Paliç and Keleş, 2011; Nartgün, 2008). Effective teaching requires teachers to be equipped with general knowledge, subject knowledge, and pedagogical knowledge; according to Shulman (1987), subject knowledge refers to the teacher's understanding of the subject, while pedagogical knowledge refers to the ability to convey this knowledge (MEB, 2011). Therefore, teacher education and quality assurance are of critical importance within the scope of state policy for the development of professional competencies (Aykaç and Bilgin, 2014). Ensuring these competencies depends on teacher selection processes effectively evaluating professional skills. Reviewing the literature, studies have examined teachers' perspectives on exams (Gündoğdu, Çimen, Turan, 2008), their perceptions (Memduhoğlu and Kayan, 2017), and their exam anxiety. However, these studies have generally focused on candidates preparing for exams.

This study aims to compare the perspectives of teachers working in public schools regarding KPSS preparation and post-appointment, to examine the impact of the exam on professional skills, and to inform stakeholders. It differs from existing studies by adding the post-appointment perspective of appointed teachers to the literature. Therefore, the following sub-objectives were addressed within the scope of the research:

1) What are the experiences of appointed teachers as candidate teachers during the KPSS preparation process, the difficulties they encounter, and their sources of motivation during this process?

2) What are appointed teachers' perceptions of the connection between the KPSS process and their professional lives, and what are their views on the contribution of this process to professional skills?

3) What are appointed teachers' suggestions regarding the areas in which the KPSS needs improvement, and what are their views on the impact of the exam on the quality of the teaching profession?

Method

Research Model

This study was conducted using a phenomenological design and Husserl's (1931) descriptive phenomenological approach (Swanborn, 2010; Tekindal, 2021) to gain an in-depth understanding of teachers' subjective meanings regarding their KPSS experience. Philosophical inquiry explores individuals' experiences and the essence of events; interviews are used to reveal these experiences (Yıldırım & Şimşek, 2005). The researchers ensured the authenticity of the data by minimizing biases through the bracketing technique in an environment of trust and empathy (Tufford and Newman, 2012) and verified the validity of the findings through member checking (Creswell and Poth, 2018). This approach made it possible to understand teachers' perceptions of the exam process in detail.

Working Group

The research working group was selected using homogeneous sampling, aiming for an in-depth analysis of a small and homogeneous sample (Neuman, 2014). Fifteen teachers with up to 5 years of experience were selected from different disciplines (science, social sciences, physical education); this ensured the examination of the discipline-based effects of the KPSS and the fresh recall of the exam experience (Creswell and Poth, 2018). Participants were aged 18-43 (mean 30.4), 9 women, 6 men; 12 bachelor's degree holders, 3 master's degree holders; 12 single, 3 married. Although a limited sample is appropriate for in-depth analysis in qualitative research, the generalizability of the findings is contextual (Maxwell, 2013). Participants, selected on a voluntary basis, were informed about the purpose of the study and ethical principles via a consent form.

Data Collection Tools

There are two data collection tools in the study. The first is the Personal Information Form developed by the researchers, which contains the participants' personal information; the other is the Semi-Structured Interview Form. These tools are designed to collect in-depth data on teachers' KPSS experience and understand the demographic context, in line with the nature of qualitative research.

Personal Information Form

The personal information form prepared by the researchers was designed to determine the demographic characteristics of the volunteer teachers participating in the study. This form provided information about the participants' age, gender, seniority, and the type of school they worked at. The design of the Personal Information Form was based on a literature review to ensure that the demographic characteristics were appropriate for the context of the study. This process was carried out to verify the clarity and appropriateness of the form.

Semi-Structured Interview Form

Before creating the interview form, the relevant literature was reviewed and studies were evaluated. The questions asked to teachers were prepared with content validity confirmed by three experts, and the semi-structured interview form was developed in this way. The questions were designed to cover fundamental themes such as the KPSS preparation process, professional experiences after appointment, and areas where the exam needs improvement. The questions were updated to include the 2025 reforms of the KPSS. Expert opinion was obtained from three academics experienced in educational sciences and qualitative research methods, and the content validity of the questions was thus confirmed (Kallio et al., 2016). The interview form was tested with a pilot interview, and the compatibility of the participants' responses to the questions with the research objectives was evaluated (Tracy, 2013). During the data collection process, the confidentiality and anonymity of the participants were protected, and all data were used solely for research purposes (Merriam and Tisdell, 2016). The interviews were conducted in a secure environment.

Data Collection

The data collection process was designed using a qualitative approach to understand teachers' experiences with the KPSS; it was conducted through semi-structured interviews and a Personal Information Form (Creswell & Poth, 2018). Face-to-face interviews conducted after the pandemic were recorded with consent for 45-60 minutes to reveal participants' perceptions of

KPSS preparation, post-appointment experiences, and exam development (Patton, 2015; Kallio et al., 2016). Participants voluntarily participated with informed consent; confidentiality and anonymity were ensured, and data were used solely for research purposes (Tracy, 2013). For reliability, transcripts were verified through member checking (Lincoln and Guba, 1988), biases were reduced using bracketing techniques, and reflective journals were kept (Tufford and Newman, 2012). These strategies ensured that the data collection process was both valid and reliable.

Data Analysis

Data analysis was conducted using thematic analysis to gain an in-depth understanding of teachers' KPSS experiences; this method facilitates understanding the process by systematically identifying patterns emerging from participants' experiences (Braun and Clarke, 2006). In the data analysis process, MAXQDA was preferred over alternative software such as NVivo to perform thematic analysis. First, the interview transcripts were imported into the program, and each participant's statements were coded separately using open coding. Then, relationships between the codes were sought to create categories and themes. In this process, axial coding was applied after open coding, and main themes and sub-themes were structured by determining the relationships between the codes. In addition, the validity of the findings was supported by using direct quotations from the participants' statements. The finalization of the themes was achieved through discussions among the researchers and repeated comparisons with the data (Saldaña, 2015). To ensure the reliability of the coding process, an analysis conducted by two independent researchers calculated an inter-coder reliability coefficient above 0.85 (Miles and Huberman, 1994). Furthermore, the validity of the findings was supported by direct quotations from participants' statements. As a triangulation method, the consistency of the data was checked by comparing the views of teachers from different disciplines (Creswell and Poth, 2018). To reduce researcher bias during the analysis process, a reflective journal was kept, and coding decisions were supported by notes in this journal (Finlay, 2002). In reporting the findings, themes and categories were visualized with figures to ensure the systematic presentation of data (Flick, 2018). With the permission of the teachers during the interviews, a voice recorder was used, and the voice recordings were later transcribed and stored in a secure digital environment. After obtaining the teachers' consent, the coding and thematization processes were initiated. The interviews were first coded individually and then classified into relevant themes according to their characteristics.

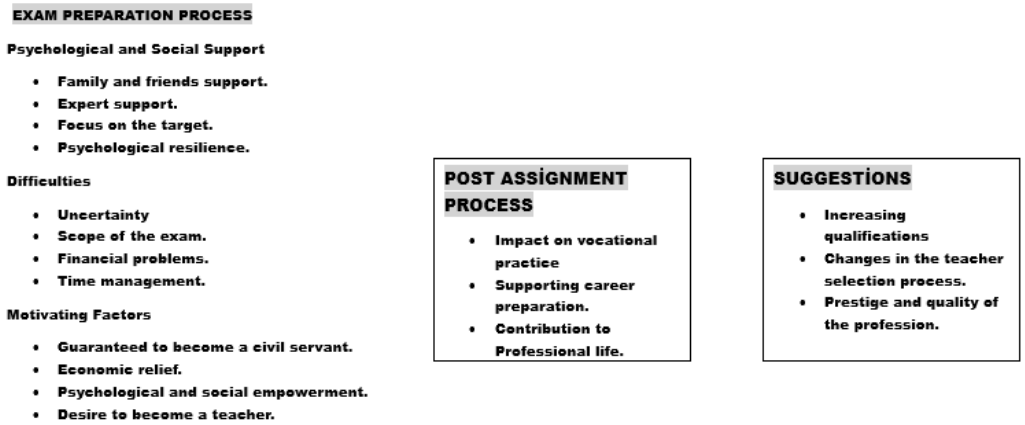
Ethics Statement

This study was found to be ethically appropriate by the Haliç University Social and Humanities Research Ethics Committee at its meeting held on December 25, 2024, under number 10.

Findings

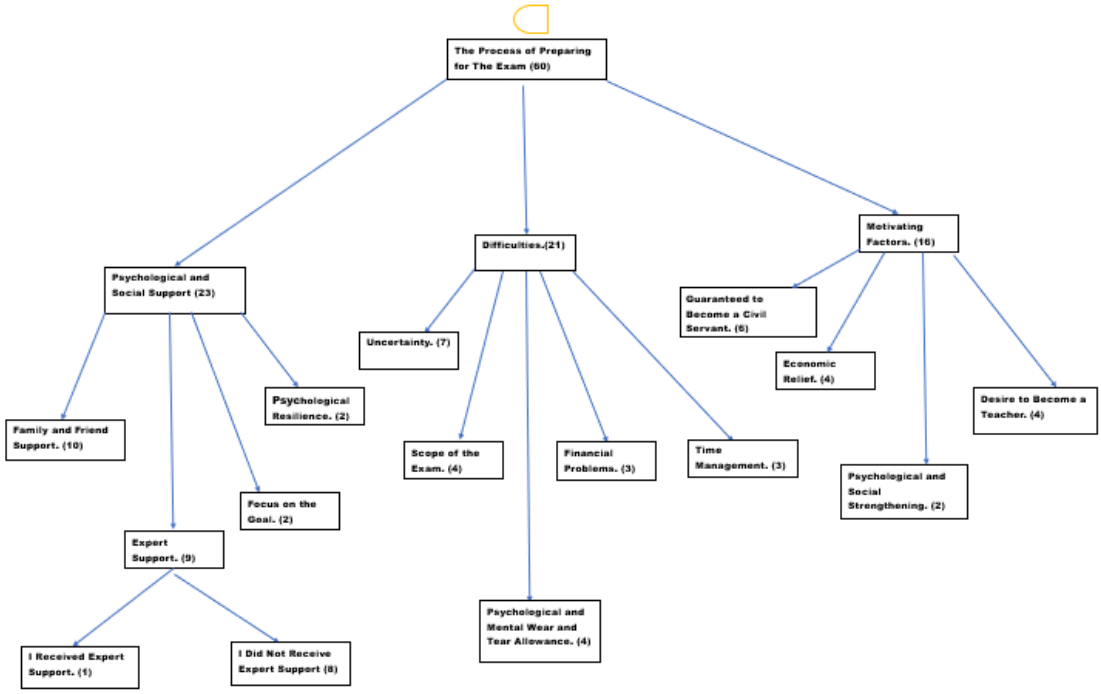
Analysis of the data collected in relation to the research questions revealed three themes. These themes, as shown in Figure 1, consist of the exam preparation process, the post-appointment process, and suggestions. There are a total of 9 categories associated with these themes. There are a total of 32 codes associated with these categories.

Figure 1. Opinions Regarding the Exam



Three categories were identified under the theme of Exam Preparation Process. The categories are psychological and social support, challenges, and motivating factors. A total of 13 codes were obtained from these three categories. This theme and codes are shown in Figure 2.

Figure 2. Opinions Regarding the Exam Preparation Process



Four different codes were found in the social support category within the Exam Preparation Process theme. These codes are, in order, "family and friend support, expert support, goal focus, and psychological resilience." Analysis of the n values in the figures shows that family and friend support had the greatest effect on the exam preparation process (n=10). This clearly shows that teachers valued family and friend support during exam preparation.

"What kind of psychological and social support did you receive during the exam process? How did this support affect the process?" Examples of participants' views are listed below:

Participant 1: *"I did not receive professional psychological support. Socially, I made sure to spend time with my family and friends in a way that did not affect my study hours and to continue doing the activities I enjoyed. This was very helpful in keeping my motivation up."*

Four different codes were found in the category of difficulties in the Exam Preparation Process theme. These codes are, in order, *"uncertainty, exam scope, psychological and mental exhaustion, financial problems, and time management."* It appears that the greatest difficulty experienced by teachers preparing for the exam is uncertainty (n=7).

Examples of participants' views in response to the question *"What were the biggest challenges you faced while preparing for the KPSS? How did you manage to overcome these challenges?"* are listed below:

Participant 2: *"Psychologically, uncertainty is the biggest problem. The uncertainty of not knowing the exact number of positions available was very exhausting for me."*

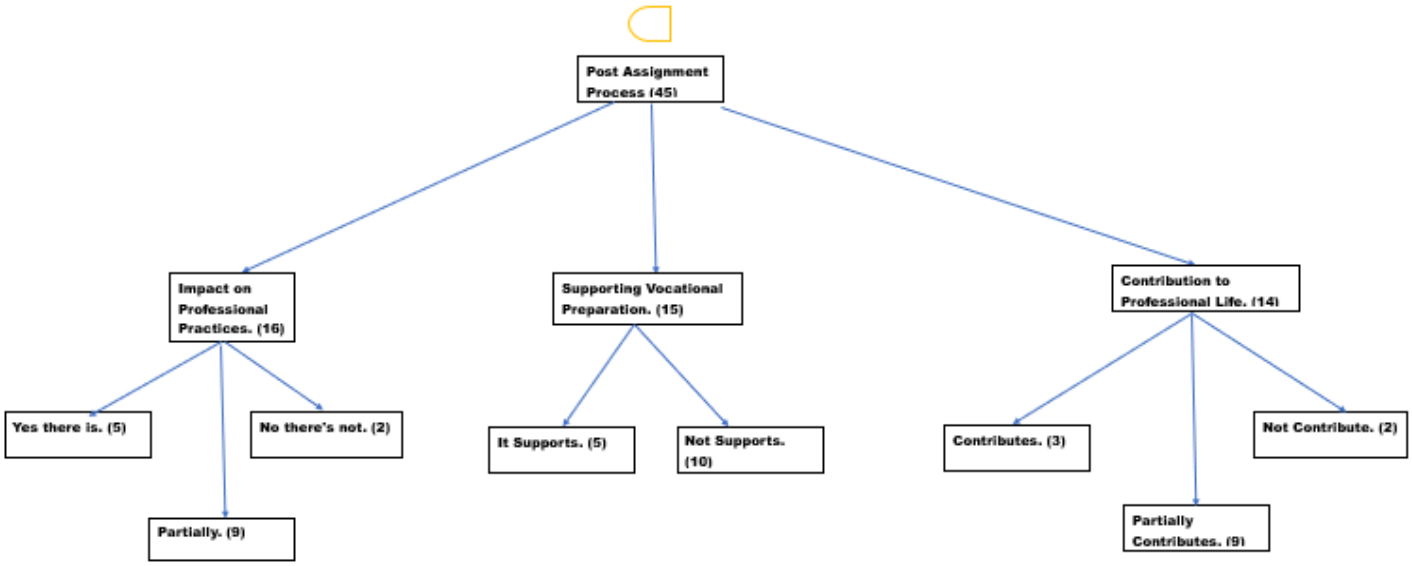
Four different codes were found in the category of motivating factors within the main theme of Exam Preparation Process. These codes are, in order, *"guarantee of becoming a civil servant, economic relief, psychological and social empowerment, and desire to become a teacher."* When these codes were examined, it was seen that the guarantee of becoming a civil servant was the biggest motivating factor (n=6).

Examples of participants' views in response to the question *"What were the most important motivating factors for you in preparing for the KPSS?"* are listed below:

Participant 3: *"The professional guarantee and the conditions of civil service were the biggest motivating factors for me. I saw that my friends who took the exam before me and were appointed were mentally better off and that the conditions in the private sector were more difficult. Becoming a civil servant was a professional guarantee*."

Three categories were identified under the theme of Post-Appointment Process. The categories are, in order, *"impact on professional practice, supporting preparation for the profession, and contribution to professional life."* A total of 3 categories were obtained from 8 codes. This theme and codes are shown in Figure 3.

Figure 3. Opinions Regarding the Post-Appointment Process



There are a total of 3 codes in the *Impact on Professional Practices* category. These codes are, respectively, *"yes, partially, and no."* When the codes in the Impact on Professional Practices category were examined in the post-appointment process, it was observed that teachers most frequently expressed their opinions in the "partially" code (n=9).

Examples of participants' views in response to the question *"How did the areas you focused on during the KPSS process (e.g., subject knowledge, pedagogical knowledge, general culture) affect professional practice?"* are listed below:

Participant 4: *"My pedagogical knowledge and subject knowledge greatly contributed to how I should approach students, both in my individual meetings and in my classroom guidance work. However, I did not see a direct impact from general culture and other areas."*

There are a total of 2 codes in the *Supporting Preparation for the Profession* category. These codes are *"supporting" and "not supporting,"* respectively. When the codes in the Supporting Professional Readiness in the Post-Appointment Process category were examined, it was seen that teachers most frequently expressed their opinion in the does not support (n=10) code.'

''Do you think the KPSS supports your preparation.

n process for the teaching profession? Why?'' Examples of participants' views on this question are listed below:

Participant 5: *"I don't think so. Unfortunately, the knowledge gained during this process loses all its importance after the exam. At that moment, we are only focused on the exam. Let me pass and be done with it. That's all we think about. After entering the profession, we don't say, 'Let me solve this problem using a method from this area of education.''*

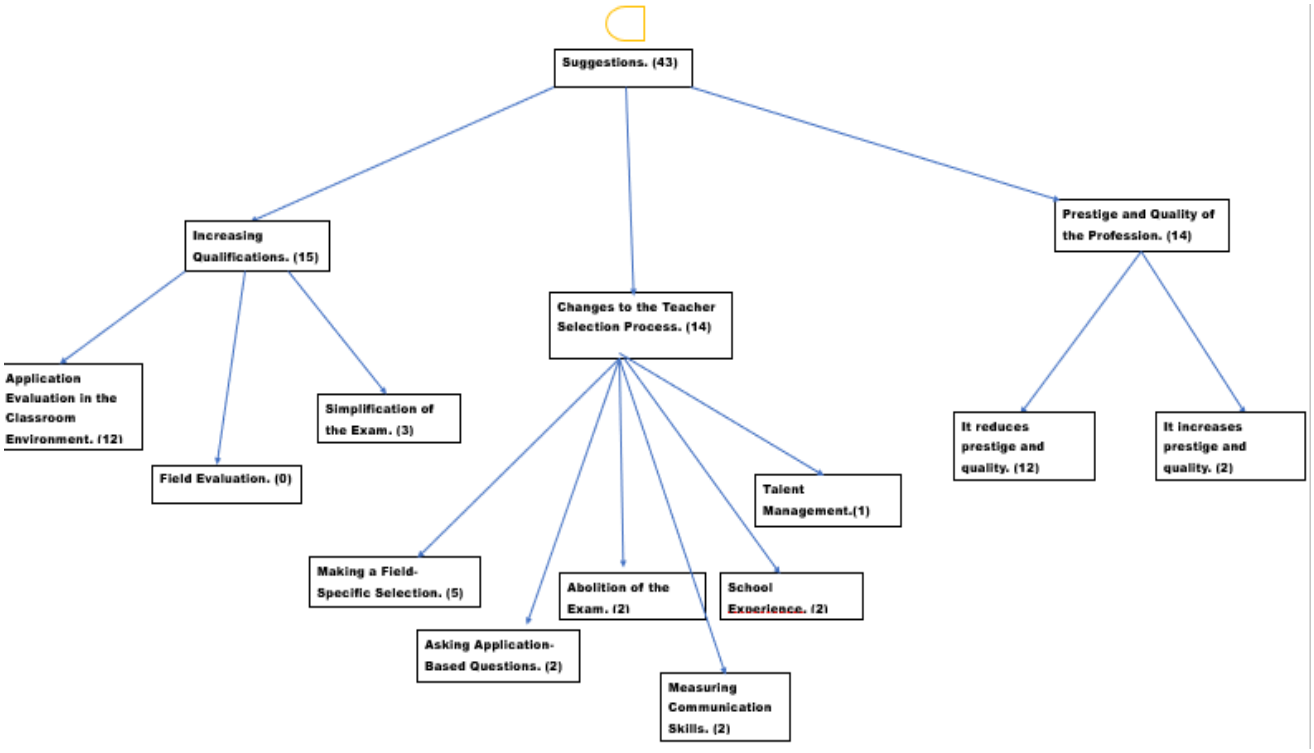
There are a total of 3 codes in the *Contribution to Professional Life* category. These codes are, in order, *"contribution exists, partial contribution exists, and no contribution exists."* When the codes in the Contribution to Professional Life category were examined after the appointment process, it was seen that teachers most frequently expressed their opinion in the "partial contribution exists" (n=9) code.

Examples of participants' views in response to the question *"How do you think the information you learned while preparing for the KPSS contributed to your professional life after appointment?"* are listed below:

Participant 6: *"Of course, some of the information had an impact. But I can't say that about all of it. The knowledge in my field and educational sciences was used. But other subjects had no impact on my life."*

Three categories were identified in the recommendations theme. The categories are, in order, *"improving qualifications, changes in the teacher selection process, and the prestige and quality of the profession."* A total of 3 categories were obtained from 11 codes. This theme and codes are shown in Figure 4.

Figure 4. Opinions Regarding Recommendations



A total of 3 codes were found in the *Enhancement of Qualities* category within the Recommendations theme. These codes are, *respectively, "application and assessment in the classroom environment, field assessment, and simplification of the exam*." Upon examining the codes, it was observed that teachers most frequently expressed their opinions (n=12) regarding the enhancement of qualities through application and assessment in the classroom environment.

Examples of participants' views on the question "What content or methods should be added to increase the contribution of the exam to the qualifications of the teaching profession" are listed below:

Participant 7: *"Practical training could be added. Some branches especially need this. After graduating in their field, everyone should do field practice related to their field."*

A total of 6 codes were found in the category of changes in the *teacher selection process* within the theme of suggestions. These codes are, in order, *"making field-specific selections, asking application-oriented questions, abolishing the exam, measuring communication skills, school experience, and talent management."* Upon examining the codes, it was observed that the most *frequently expressed opinion regarding changes* in the teacher selection process was the code for field-specific selection (n=5).

Examples of participants' views in response to the question *"What changes would you suggest to make the KPSS a more effective teacher selection process?"* are listed below:

Participant 8: *"Teachers' mastery of their own fields should be given more importance. In addition, some tests could be conducted to improve professional knowledge and communication skills."*

A total of 2 codes were found in the category *of prestige and quality* of the profession within the theme of suggestions. These codes are, respectively, *"decreases prestige and quality"* and *"increases prestige and quality."* Upon examining the codes, it was observed that teachers most frequently expressed their opinions under the code *"decreases prestige and quality"* (n=12) in the category of prestige and quality of the profession.

Examples of participants' views on the question *"How do you generally assess the impact of the KPSS on the teaching profession? What do you think about the exam's impact on the prestige and quality of the profession?"* are listed below:

Participant 9: *"The exam generally exhausts and upsets teachers. It is an extra burden, and this burden is in front of everyone's eyes. For this reason, the exam always appears to be a factor that lowers the quality and prestige of teachers."*

Discussion

This study examined the experiences and perceptions of teachers working in public schools regarding the KPSS process using a qualitative approach, revealing three main themes: exam preparation, post-appointment processes, and recommendations for improving the system. The findings reflect teachers' views questioning the psychological and structural difficulties they encounter during the exam process, its impact on professional competence, and the contribution of the current system to the quality of the teaching profession. Göçer (2024) states that the subjective nature of the interview processes after the exam reduces teacher candidates' trust in the system and increases ethical concerns. In this context, the study offers a framework that integrates both national and international literature to understand these processes that shape teachers' individual and professional development.

The uncertainties and psychological and mental exhaustion experienced by teachers during the exam preparation process can be explained by Lazarus and Folkman's (1984) processor stress model. According to this model, when individuals perceive uncertain situations as a threat, their stress levels increase, and this situation can negatively affect their motivation. Similarly, the emergence of family and friend support as the most important source of social support during the exam preparation process can be related to the concept of self-efficacy in Bandura's (1997) social learning theory. It has been observed that teacher candidates' perceptions of self-efficacy are strengthened by environmental support, and this increases their motivation to prepare for exams.

When evaluating the effects of the post-appointment process on teachers' professional development, the findings can be grouped into three main themes. In the Impact on Professional Practices category, the fact that the majority of teachers chose the "partially" code indicates that this process has had a limited impact on classroom practices. This situation can be explained by Schön's (1983) reflective teacher model; since the development of professional competencies can remain superficial when not supported by experience. Similarly, in the Supporting Preparation for the Profession category, the fact that the vast majority of teachers expressed their opinion in the "does not support" code shows that post-appointment processes do not provide sufficient professional guidance. When evaluated within the framework of Vygotsky's (1978) zone of proximal development theory, this finding reveals that teachers need structured support systems to develop their professional skills. In the Contribution to Professional Life category, it was observed that teachers most frequently selected the "partially contributes" option. This situation can be related to Knowles' (1984) andragogical principles in the context of adult learning; teachers can only contribute to their professional development by making sense of their own experiences.

When examining teacher candidates' suggestions regarding the examination system, it is observed that these suggestions group under three main categories. In the Enhancement of Qualifications category, the vast majority of teachers emphasized the need to develop practice-based assessment tools rather than theoretical knowledge, highlighting the code "application and assessment in the classroom environment." This can be explained by Kolb's (1984) experiential learning theory; since the development of teacher candidates' professional competence is more effectively achieved through direct experience and practice. In the Changes in the Teacher Selection Process category, participants drew attention to the need for "field-specific selection." This finding is consistent with professional orientation approaches based on the principle of specialization (Darling-Hammond, 2006); a field-focused, competency-based, and practice-based selection system is needed to improve the quality of the teaching profession. A study on the experiences of those who participated in the KPSS Social Sciences ÖABT (Dere and Demirci, 2022) reveals that the ÖABT improves teacher quality, but the subjectivity of the interview processes limits this effect. Furthermore, in the category of Professional Prestige and Quality, a significant proportion of teachers expressed the view that it "lowers prestige and quality," revealing that the current system weakens public trust in the teaching profession.

The findings of this study show that the psychological and structural difficulties teachers face in the KPSS process, the limited contribution of professional qualifications, and the prestige-reducing effect of the current system require fundamental changes in teacher selection and support processes. In particular, the theoretical structure of the exams, the lack of post-appointment guidance, and the weakening of social perception highlight the urgent need for reform to improve the quality of the teaching profession.

Results

The analysis of the data collected in response to the research questions revealed three themes. These themes are the exam preparation process, the post-appointment process, and suggestions.

In the exam preparation process theme, it was observed that *family and friend support* had the greatest impact in the *Social Support* category, *uncertainty* was the most significant factor in the challenges category, and the *guarantee of becoming* a civil servant was the most important motivating factor in the motivating factors category.

In the post-appointment process theme, it was observed that in the Impact on *Professional Practices* category, most respondents expressed the opinion *"partially,"* in *the Supporting Preparation for the Profession* category, they expressed *"does not support,"* and in the Contribution to Professional Life category, they expressed "teachers contribute partially."

In the Recommendations theme, in the *Enhancement of Qualifications* category, it was seen that teachers most *frequently expressed their opinion in the code for application and evaluation in the classroom* environment to enhance qualifications; in the Changes in the *Teacher Selection Process* category, it was seen that they most frequently expressed their opinion in the code for *field-specific selection;* in the Changes in the Teacher Selection Process category, it was seen that they most frequently expressed their opinion in the code for field-specific selection; and in the *"Prestige and Quality of the Profession"* category, the most common opinion expressed was that it lowers prestige and quality.

Recommendations

In light of the findings of this study, in order to improve the teacher selection system, the teacher preparation process should focus on classroom applications and assessments in real learning environments in addition to theoretical knowledge. Exams should be simplified and restructured to be application-oriented, specific to the candidates' fields of study, in-depth, and directly related to the profession. Interview or simulation-based assessments should be developed to measure social skills such as communication, empathy, and classroom management. In the post-appointment process, mentoring programs, orientation training, and regular professional development opportunities should be offered to strengthen the professional competence of new teachers. To increase the social prestige of the teaching profession, employment rights should be improved and supportive policies developed. Furthermore, the experiences and opinions of teachers in the field should be incorporated into selection and placement policies to create more inclusive models.

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Statistics in Language Research: Reflections from Researchers

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Abstract

Language researchers often struggle with statistical concepts due to inadequate training, emotional barriers, and limited practical engagement. This study aims to explore how language researchers perceive statistics in their research practices and to identify the key factors that shape their statistical development. Adopting a qualitative design, data were collected through semi-structured interviews and written reflections from nine researchers and analyzed thematically. The findings show that while researchers recognize the foundational role of statistics in establishing academic credibility, they frequently report anxiety, insufficient training, and superficial use of statistical tools. The study also concludes that statistical competence is linked not only to technical skills but also to ethical responsibility and scholarly identity. It is recommended that statistical instruction in applied linguistics should be redesigned to include hands-on, discipline-specific training supported by early exposure, reflective learning, and institutional mentorship.

Keywords: *Language research; statistics; perceptions*

Introduction

Foreign language research is of vital importance for several reasons. From the broadest perspective, foreign language research provides pedagogical innovation and decision-making in the learning and teaching processes. In this way, research contributes to teaching and learning, enables target groups to conduct critical assessments, and informs the refinement of instructional practices, language teaching policies, curriculum development, and policy-making (Denkci Akkaş et al., 2022). In other words, it is impossible to understand learners' and teachers' needs, interests and expectations, and classroom dynamics without systematic inquiry (McDonough & McDonough, 1997). Moreover, research strengthens knowledge creation, facilitates the adaptation of new teaching materials, informs curriculum revisions, and promotes the implementation of evidence-based methodologies in foreign language learning and teaching. Considering that language research is influenced by other fields such as education, linguistics, psychology, sociology, and computer sciences (Mackey & Gass, 2015), research facilitates the integration of theoretical and practical aspects of the mentioned fields into foreign language learning in an interdisciplinary and multidisciplinary way; thus, it contributes to the theory and practice in a broader perspective (Kumaravadivelu, 2003). Additionally, research obtains evaluation criteria regarding psychological measurement, testing, and assessment. In this way, it is possible to understand teaching and learning experiences (Dikilitaş & Bostancıoğlu, 2019), teaching effectiveness (Elmas & Aydin, 2017), and professional development (Harmer, 2001). In conclusion, foreign language research promotes sustainable improvements and contributions to language education (Nassaji, 2012). On the other hand, the benefits of foreign language research depend on the research methodologies, specifically statistical analysis, which plays a considerable role in ensuring the accuracy, reliability, and validity of the findings.

As previously stated, statistics play a significant role in foreign language research for several reasons. From a general perspective, statistical knowledge is essential for language researchers to obtain more rigorous and sophisticated results in the research process, ensuring the validity and reliability of their findings (Loewen & Gass, 2009). More specifically, statistical literacy enables language researchers to read, understand, and conduct studies that involve statistical procedures, allowing them to systematically produce and interpret data, reach meaningful conclusions, and make informed inferences, deductions, and implications (Brown, 1991). Furthermore, statistics plays a crucial role in summarizing data, making generalizations about language learning and teaching processes, and identifying patterns and relationships within linguistic datasets (Woods et al., 1986). In addition, a solid understanding of statistical research methods, techniques, and procedures is necessary for selecting the appropriate analytical tools based on the research question, methodology, and data type. It is also important for language researchers to critically evaluate statistical findings in existing studies to assess their credibility, relevance, and applicability to language education (Brown, 1988). On the other hand, while statistics serves as a fundamental component of foreign language research, enhancing the precision, interpretability, and impact of empirical studies in the field, it is a challenging area for language researchers.

As stated above, statistics is problematic for language researchers for several reasons. From a general perspective, while it is critical to have research skills for them to improve their teaching, receive and support professional development, revise curriculum, transfer research skills to students, and develop robust instruments, statistical procedures used in the research process are seen as complex and difficult by language teachers, postgraduates and researchers (Amirian & Abbasi-Sosfadi,

2021). In other words, since statistics courses or handling statistical procedures are accepted as frightening by postgraduates, they suffer from statistics anxiety that stems from statistics exams and the complexity of the statistics courses (Amini Farsani & Babaii, 2020). Moreover, language researchers believe that they have adequate training in descriptive statistics but limited training in inferential and advanced statistics, which results in a limited understanding and interpretation of data (Gönülal, 2018). Since statistical information relies on complex statistical procedures, language researchers generally prefer conducting descriptive studies over inferential ones (Lazaraton, 2000). Although the use of multivariate analyses, multiple statistical analyses, and univariate analyses increases over time (Plonsky, 2014), language researchers often experience inconsistent reporting practices, such as failing to provide effect sizes, confidence intervals, or statistical assumptions (Amini Farsani & Babaii, 2020). In conclusion, language researchers who experience difficulties in understanding and interpreting the findings in research papers tend to avoid using them in their studies. Furthermore, failing to comprehend the current research contexts, procedures, and trends may result in a decrease in research quality and create a barrier to following recent developments in the field. The mentioned challenges may stem from researchers' perceptions which may influence their knowledge and approach to statistics; however, there is a lack of research addressing how their perceptions affect learning, understanding, using and interpreting statistics in the language research context, as can be understood from the research synthesis provided below. However, before presenting the synthesis of the previous studies, a theoretical background should be drawn within the scope of language research, statistics, and perceptions.

Theoretical framework

As stated below, there is a need to establish a theoretical background for a better understanding of language research, statistics, and perceptions. First, Nunan (1992, p. 3) defines *language research* as "a systematic process of inquiry consisting of three elements or components: a question, problem, or hypothesis, data, analysis, and interpretation of data." Within this scope, research involves a problem and background, a hypothesis or research question, a synthesis of existing studies, methodology, reporting, and interpretation of the findings (Seliger & Shohamy, 1989). It is a systematic, empirical, and objective process that aims to examine phenomena, acquire new knowledge, and validate current theories within the scope of basic, applied, and practical types (Denkci Akkaş et al., 2022; Elmas & Aydin, 2017). Second, *statistics* is a branch of mathematics that includes data collection and analysis, interpretation, and presentation of data (Narayanan, 2015). It is a fundamental tool in the research process, involving descriptions, inference, validation, and data-driven decisions (Myers et al., 2013). Third and last, *perception* is organizing and interpreting sensory information to understand the information in the environment (Schacter et al., 2009). They are shaped by the learner's memory, attention, expectations, and learning experiences (Bernstein et al., 2008). According to the Social Cognitive Theory, agency is based on perceptions, as it can influence human behavior (Fishbein & Ajzen, 1975). Moreover, perception is the end product, which depends on the interaction between stimulus, knowledge, and expectations from this constructive perspective (Démuth, 2013). As a concluding remark, it can be stated that language research, statistics, and perceptions seem closely interrelated, since statistics are essential for language research. However, researchers' perceptions may also influence their engagement and application of statistics, which directly affect the research quality, production, and interpretation.

Previous studies

Research shows that language researchers mainly find their statistical training inadequate. For instance, in an earlier study, Lazaraton et al. (1987) focused on language researchers' knowledge levels and attitudes toward statistics, finding that 67% of 121 researchers believed the courses were inadequate. A recent study by Loewen et al. (2014) also concluded that 55% of 198 participants with Ph.D. degrees in applied linguistics and second language acquisition stated that their statistical training was insufficient. Similar results indicating the adequacy of statistics for language researchers were also reported by Crowther et al. (2020) and Gönülal (2020), who noted that their training in statistics remained limited.

Research also indicates that language researchers are only familiar with basic statistics rather than complex ones. For instance, Lazaraton et al. (1987) noted that, although researchers were acquainted with basic statistics such as central tendency and dispersion statistics, validity, reliability, correlation, random assignment, and null hypothesis, some statistical terms, including power, Scheffe, and Rasch models, were less commonly known and understood. Loewen et al. (2014) also concluded that researchers had a well-developed understanding of descriptive statistics, but experienced difficulties with more complex statistics. In addition, Gönülal (2020) found that doctoral students' statistical training was limited to basic statistical procedures in a more theoretical sense, and that their understanding descriptive and inferential statistics was almost 70% whereas interpreting inferential statistics was 50%. While the usage of different statistical techniques in language research over time was seen as a reason of changes about the use of statistics in the field, Crowther et al. (2020) found that researchers believed that running complex statistical procedures without comprehending their background was not indicative of in-depth statistical knowledge.

According to research results, several affective factors may influence language researchers' opinions about statistics. For example, Loewen et al. (2014) stated that researchers overestimated their self-confidence regarding statistical knowledge. Gönülal (2020) also noted that researchers' perceptions of being a statistics user were at the average level, whereas not

taking a discipline-specific statistics course was disadvantageous. Within this scope, Gönülal (2020, 2018) emphasized that taking more statistics courses and self-training were factors that predicted statistical literacy. Moreover, Loewen et al. (2014) (2014) found that quantitative orientation was one of the strongest predictors regarding researchers' attitudes toward statistics and statistical self-efficacy. Lastly, Amirian and Abbasi-Sosfadi (2021) found that language researchers believed statistics courses and handling statistical procedures were intimidating due to insufficient background and procedural knowledge about statistics, which resulted in statistics anxiety.

Overview of the current study

Language research is crucial for effective teaching and learning, as it integrates interdisciplinary insights, enhances language education, and informs policy development. Thus, statistical literacy and knowledge are essential for improving research quality, interpreting data, and ultimately making informed decisions among researchers. However, current research indicates that most researchers struggle with statistical procedures since they find statistics complex. Moreover, language researchers often complain about the inadequacy of statistical training, specifically advanced statistics. In other words, while researchers are familiar with basic statistics, they often encounter difficulties in applying complex statistical procedures. These problems result in decreasing self-confidence, negative attitudes toward statistics, and statistics anxiety. From this perspective, it is evident that while language research, statistics, and researchers' perceptions may be interconnected, current research lacks findings on how researchers perceive statistics. Considering that their perceptions may directly relate to certain variables such as research engagement, quality, self-confidence, self-efficacy, anxiety, methodological preferences, training needs, and professional development, there is a need to explore how language researchers perceive statistics in their research practices. In this way, it will be possible to identify problems in the process, contribute to statistical training, promote interdisciplinary integration, sustain research development, and finally understand the relationships between perceptions and practice. With these concerns in mind, the current study aims to explore how language researchers perceive statistics in their research practice.

Method

Research context

The study aims to explore how language researchers perceive statistics in their research practices. For this purpose, the study employed a synthetic approach and heuristic method at a conceptual level, aiming to construct a comprehensive understanding without preconceived assumptions or research questions. At an operational level, a qualitative research design was preferred to identify the patterns and themes without experimentation and manipulation. Interviews, reflections, and focus group interviews were used to obtain data saturation and triangulation. This process would allow participants to express their views in detail and provide a thematic analysis in a systematic and flexible framework (Seliger & Shohamy, 1989).

Participants

The participants in the study nine were language researchers. Eight of the participants (88.9%) worked at public universities, while one (11.1%) was affiliated with a foundation university. Their ages ranged from 27 to 43 years, with a mean age of 34.3 years. The group consisted of six female (66.7%) and three male (33.3%) researchers. In terms of academic qualifications, four participants (44.4%) held a Ph.D. degree, while the remaining five (55.6%) held either a doctoral or master's degree. Their research experience ranged from 3 to 21 years, with an average of 8.4 years. All participants had received formal statistical training. However, their self-perceived levels of statistical knowledge differed. Accordingly, two participants (22.2%) reported high proficiency, five (55.6%) described their knowledge as moderate, and two (22.2%) rated it as low. The participants were purposefully selected to represent a range of academic statuses, institutional affiliations, and levels of research experience in order to explore diverse perspectives on statistical literacy in language research. This purposive sampling aimed to capture the views of both early-career and experienced researchers, as well as achieve a balance in terms of gender and software familiarity.

Tools

The study employed a background questionnaire, semi-structured interviews, and written reflections as data collection tools. First, the background questionnaire gathered information on participants' age, gender, academic qualifications, institutional affiliation, and years of research experience. Second, to explore participants' perceptions of statistical literacy and its role in language research, data were collected through two tools: semi-structured interviews with three participants and written reflections from six others. This combination was chosen for both methodological and practical reasons. First, interviews allowed for in-depth probing and clarification, while written reflections enabled participants to articulate their experiences

thoughtfully and reflectively. Second, written responses ensured consistency, comparability, and adaptability in expression across participants, facilitating systematic analysis (Seliger & Shohamy, 1989).

Procedure

After informing the participants about the purpose and scope of the study, they were assured that their participation was voluntary, their privacy would be protected, and the data collected would be used solely for academic purposes. They were also informed that the study posed no social or psychological risks. Participants first completed a background questionnaire to provide demographic information. Following this, data were collected through semi-structured interviews with three participants and written reflections from six others. Both formats were guided by a structured set of open-ended questions designed to elicit detailed responses across six thematic areas, including general perceptions of statistics in language research, the difficulties encountered in statistical application, the adequacy of their statistical training, the influence of statistical literacy on research design and methodology, psychological factors, and future needs regarding statistical support and collaboration. This design enabled both consistency and depth in exploring the participants' experiences, attitudes, and suggestions regarding the role of statistics in language research.

Analysis

After developing the structured questions in line with the aim of the study, participants were selected through purposive sampling based on their academic status and experience in language research. Prior to full data collection, a pilot implementation was carried out with two researchers to ensure the clarity, coherence, and relevance of the questions. Once finalized, three participants were interviewed, and six participants submitted written reflections at their own pace via email. The collected data were analyzed using thematic analysis to identify recurring patterns, categories, and themes related to perceptions of statistical literacy in language research. To ensure trustworthiness and validity, the data were independently analyzed by three coders. Each coder reviewed the data separately, identifying thematic structures, before comparing and consolidating their findings. This triangulated coding approach helped to enhance the trustworthiness and validity of the results by providing a more comprehensive interpretation of the data (Denzin, 2017).

Results

The findings obtained from the study are presented under eight main themes. The first theme, *'perceptions,' reflects participants' views on the significance of statistical competence in enhancing research quality and academic credibility, whereas the second theme, 'emotions,'* presents insights into the emotional challenges experienced by researchers. The third theme, *training,* focuses on participants' reflections on their formal education by highlighting gaps in practice-oriented learning and the need for discipline-specific training. The fourth theme, *practice,* addresses the strategies researchers adopt when selecting statistical procedures. The fifth theme, *software*, reveals the participants' reliance on user-friendly statistical software and their concerns about superficial understanding. The sixth theme, *institutional and peer influence*, emphasizes how academic advisors, mentors, and peer communities shape researchers' statistical engagement, while the seventh theme, *ethics, and academic culture*, explores how ethical awareness and academic norms are intertwined with statistical literacy. Last, the theme of *future directions* presents the participants' suggestions for improving statistical learning and supporting novice researchers in developing confidence and competence.

Perceptions

Participants emphasize the foundational role of statistics in language research. First, they perceived statistical procedures not only as analytical tools but also as essential to establishing empirical credibility. Second, they regarded statistical literacy as a key component of scholarly legitimacy and academic authority. Third, the participants stated that their confidence developed more through practical engagement than formal instruction. They also noted that statistical competence enabled them to undertake more complex research and to collaborate across disciplines. Fourth, some participants explained that this competence became central to their academic identity. Finally, they viewed statistical proficiency as an indicator of autonomy and methodological depth, as one of the participants noted:

"In my view, statistics is not just a technical add-on. It shapes how research questions are framed and answered. When I started using more advanced statistical tools, I noticed my studies were taken more seriously in peer-reviewed journals. It felt like I had finally joined the real academic conversation."

Emotions

Participants report frequent emotional difficulties related to statistics. For instance, they described anxiety as a significant barrier that impeded their productivity and delayed their research output. In particular, several participants recalled feelings of helplessness when dealing with statistical content. Then, they shared that the fear of making mistakes in public academic

settings often led them to avoid quantitative approaches. In some cases, negative feedback during early statistical attempts caused long-term disengagement. They also mentioned how statistical challenges affected their motivation and research decisions. A few suggested that junior researchers should engage gradually with statistics to reduce pressure. Finally, others stated that participating in this study motivated them to revisit previously avoided areas in statistical learning. Nevertheless, a few participants stated that reflecting on these experiences later led them to adopt new learning strategies and reengage with statistical content, as stated by one participant:

"I always had this underlying fear that someone would find a mistake in my analysis and it would invalidate my entire study. That fear held me back from submitting papers or even trying more complex methods. It wasn't until I made peace with not being perfect that I actually began learning how to handle statistics more confidently."

Training

Participants criticize the quality of their formal statistical education. First, they reported that university courses were often overly abstract and disconnected from the realities of language research. They also explained that instruction focused on memorization and formulas without practical application. Next, they expressed a strong preference for example-based learning that used real data and discipline-specific content. Moreover, they emphasized that statistical training should be extended and integrated throughout academic development rather than being limited to a single course. Additionally, participants found visual aids and reflective writing to be helpful in understanding complex concepts. Some said that self-study and informal mentorship filled the gaps left by formal instruction, as one participant noted below:

"In my graduate program, we had one statistics course, and it was all about formula derivations with no real connection to what I'd do in my own research. I didn't realize how unprepared I was until I had to analyze my own data. I learned more from YouTube and peer discussions than I ever did in class."

Practice

Participants demonstrate varied approaches to applying statistics in research. For example, they admitted that they often neglected assumption testing and diagnostic procedures. Then, instead of selecting methods based on data characteristics, they tended to follow examples from previous studies. Next, they reported avoiding complex analyses, such as regression or factor analysis, due to their limited understanding. Several participants also described how the lack of proper training led them to rely heavily on descriptive statistics. Several researchers have raised concerns about statistical misinterpretation in published studies. Finally, they emphasized that overconfidence without proper knowledge was as problematic as statistical inexperience, as clarified by one researcher:

"I used to just copy the statistical method from a similar article, thinking that if it worked there, it would work for me too. I didn't even know what assumptions I was supposed to test. Only recently did I understand how risky that is—how easy it is to draw wrong conclusions when you don't understand the procedure."

Software

Participants rely heavily on SPSS for statistical analysis. They stated that they chose SPSS for its simplicity and user-friendly interface. However, most admitted using it only at the basic level and avoiding syntax-based functions. In many cases, they described relying on the software without a full understanding of its underlying logic. In addition, participants reported that visual outputs helped improve their understanding but remained underutilized. They also noted confusion over statistical terminology. Last, many explained that they associated software proficiency with competence, even though they recognized this as a limited view, as explained by one participant below:

"I was confident with SPSS at first, but it was just a false sense of mastery. I knew how to click buttons, but I couldn't explain why I chose a test or what the output meant beyond the p-value. It took a long time before I realized that knowing software is not the same as knowing statistics."

Institutional and peer influence

Participants describe how institutional and peer environments shape their statistical development. First, they reported that the orientation of academic advisors had a lasting influence on their attitudes toward statistics. In some cases, helpful mentors and peers supported their learning, while in others, dismissive feedback discouraged further engagement. In addition, several researchers noted that collaboration with statistically skilled colleagues improved their work but did not promote independence. They also pointed out that institutional support was lacking, and formal consultation services were rare. Finally, a few described how peer review feedback served as an unintended but valuable form of statistical training, as noted by one of the participants:

"My supervisor always downplayed the importance of statistics, saying qualitative research was more authentic. I internalized that bias until a reviewer challenged my entire methodology. That was a turning point—I had to learn statistics on my own, and I wished I'd had a mentor earlier."

Ethics and academic culture

Participants associate statistical competence with a strong sense of ethical responsibility in the research process. For example, they emphasized that accurate and appropriate use of statistical methods was not merely a technical requirement but a moral obligation that ensures transparency, fairness, and integrity in reporting research outcomes. Misapplication or superficial understanding of statistical procedures was viewed as a serious threat to the validity of findings, potentially leading to misleading conclusions and ethical breaches. In addition, several participants stressed that ethical scholarship entails a duty to understand the tools one employs, particularly in quantitative research where numerical outcomes are often perceived as objective or conclusive. In this context, statistical literacy was seen as a safeguard against distortion and a critical component of methodological rigor. Furthermore, some participants reflected on the broader academic culture, asserting that statistical competence enhanced their credibility and authority as researchers. They noted that peers, reviewers, and institutional stakeholders often equated statistical precision with scholarly professionalism, which in turn shaped their own academic identity and sense of accountability, as stated by one of the researchers:

"Being statistically literate is more than a skill—it's a responsibility. If I misreport something or misuse a test, that's an ethical failure. I realized that my fear of statistics was also an excuse not to be accountable for my results. That realization changed how I approached every part of the research process."

Future directions

Participants suggest several ways to improve statistical learning. First, they called for hands-on workshops, contextualized instruction, and visual materials to support comprehension. Within this scope, they expressed that early exposure to statistics would lead to stronger long-term competence. In addition, some shared regrets about missed opportunities, and advised new researchers to be proactive and reflective. They also described effective instruction as clear, scaffolded, and relevant to language research. Furthermore, several participants emphasized the importance of interdisciplinary collaboration as a means to enrich statistical thinking. Ultimately, they advocated for a research culture that promotes persistence, openness, and peer dialogue in statistical learning, as clarified by one researcher:

"What I needed was someone to say, 'It's okay not to know everything right away—just keep going.' If I'd had more hands-on, supportive environments earlier in my academic career, I think I would have embraced statistics instead of fearing it."

Conclusions and Discussion

Based on the results of the current study, which aims to explore how language researchers perceive statistics in their research practice, eight main conclusions can be drawn. The first conclusion is that language researchers are aware of the foundational role of statistics in language research. For them, statistical procedures are not only analytical tools but also essential to establishing empirical credibility and academic legitimacy. Confidence in statistics also develops more through practical engagement than through formal instruction, and statistical competence enables individuals to engage in complex research and interdisciplinary collaboration. The second conclusion is that statistics evoke frequent emotional difficulties. Such as anxiety, self-doubt, and avoidance, which are often shaped by early negative experiences, fear of mistakes, and peer judgment. These emotional barriers influence their research decisions. The third conclusion is that formal statistical training is widely criticized. For them, university courses are abstract and disconnected from research needs, focused too heavily on memorization. Thus, they prefer real data samples, visual aids, and practical applications within the scope of self-learning and peer support. The fourth conclusion is that statistical practices in research often deviate from the best standards. Thus, they neglect assumption testing, overuse descriptive methods, and select techniques based on precedent rather than suitability. These practices are attributed to gaps in training and a lack of confidence, as they raise concerns about misinterpretation in published work. The fifth conclusion is that participants heavily rely on SPSS, valuing its simplicity but using it at a basic level without understanding its logic or terminology. They associate software proficiency with statistical competence despite acknowledging this as a limited and potentially misleading perception. The sixth conclusion is that institutional and peer influence plays a critical role in shaping statistical development. From this perspective, supportive and discouraging advisor relationships improve outcomes without fostering independence. They also suffer from insufficient institutional support and identify peer review as a valuable learning mechanism. The seventh conclusion is that participants are aware of ethical responsibility and academic professionalism. They view the misuse or superficial understanding of statistics as an ethical failure, emphasizing the role of statistical literacy in ensuring research integrity and scholarly credibility. The final conclusion is that participants suggest improvements for future statistical learning. From this point of view, they advocate for hands-on, discipline-specific instruction, early exposure, and interdisciplinary collaboration. They also emphasize the importance of supportive academic environments that foster gradual learning and encourage persistence in statistical development.

Pedagogical implications

Considering the conclusions drawn from the study, several pedagogical implications are noteworthy. First, the results align with prior studies (Gönulal, 2020; Lazaraton et al., 1987; Loewen et al., 2014) that emphasize inadequacies in formal statistical training, thereby supporting the need for curriculum reform in applied linguistics programs. More specifically, the current study illustrates that statistical training in language research remains largely theoretical and disconnected from practical applications by reinforcing earlier claims that discipline-specific, hands-on training is essential for meaningful statistical engagement. Second, the current findings extend previous literature by foregrounding the emotional dimension of statistical learning, including anxiety and avoidance, which are shaped by early academic experiences and peer judgment (Amirian & Abbasi-Sosfadi, 2021). In other words, the study adds nuance to the understanding of statistics-related affective barriers and emphasizes the importance of supportive learning environments. Third, the study confirms the trend observed in earlier work (Crowther et al., 2020) that overreliance on software such as SPSS may lead to superficial engagement with statistical logic, highlighting the need for integrated instruction that balances software literacy with conceptual understanding. Fourth, the current study introduces new insights into the ethical dimensions of statistical misuse by expanding on existing frameworks, connecting statistical competence with academic responsibility and research transparency. In other words, while the current literature primarily focuses on skill acquisition and self-efficacy (Gönülal, 2020; Gönülal, 2018; Loewen et al., 2014), the present study situates statistical literacy within broader academic values, such as integrity and credibility. As a final point, the study contributes to the call for interdisciplinary and reflective approaches to statistics instruction by underlying researchers' demand for early exposure, peer learning, and scaffolded instruction. Overall, the present study is significant since it contributes to the current literature by offering an integrated view of cognitive, emotional, and ethical dimensions in the statistical development of language researchers and bridges conceptual and pedagogical gaps that remain underexplored in applied linguistics research.

Practical recommendations

Some practical recommendations can also be made for the target groups. First, researchers in applied linguistics should be encouraged to begin working with statistics early in their academic careers. In this way, they will develop reflective learning strategies and peer collaboration, which can help reduce anxiety and build confidence over time. Second, course instructors and curriculum developers are advised to redesign statistical instruction with an emphasis on applied, discipline-specific content. Rather than focusing solely on formulaic instruction, instructors should use real-world language data, visual tools, and scaffolded activities that contextualize statistics within authentic research needs. Third, university administrators and research support units should establish accessible mentorship programs and discipline-relevant statistical consultation services. Institutional investment in ongoing professional development, interdisciplinary collaboration, and emotional support mechanisms can further enhance researchers' statistical literacy. Fourth, academic advisors and thesis supervisors should adopt a balanced approach by guiding students toward methodological independence while fostering ethical awareness and encouraging transparency in statistical choices. Fifth, scholarly journals and peer reviewers are encouraged to prioritize statistical rigor by requiring comprehensive reporting of methods, assumptions, and rationale, as constructive reviewer feedback can serve as an informal learning opportunity for researchers. Sixth, professional associations and accreditation bodies should publish clear statistical competence frameworks and offer training modules on the ethical and practical use of statistics in language research. Seventh, developers of statistical software, such as SPSS, can enhance researcher support by embedding interactive learning features and incorporating linguistic research tools that aid users in making informed methodological decisions. As a final recommendation, it is worth noting that incorporating research and statistics courses into undergraduate language programs may enable students to gradually develop statistical literacy over time rather than confronting it abruptly at the postgraduate level. Embedding reflective tasks, collaborative data projects, and exposure to real-world datasets at earlier levels can foster a more meaningful connection between statistics and language research. Encouraging interdisciplinary collaboration, even at the undergraduate level, may also enhance students' ability to transfer statistical knowledge across contexts, ultimately contributing to a more ethically grounded and methodologically robust research culture.

Limitations and recommendations for further research

The study is not without limitations. First, the research relied on a qualitative design and included a relatively small sample of nine participants. Second, the data were collected through written reflections and interviews, which, while rich in detail, may not fully capture participants' actual statistical practices or cognitive processes in real-time research contexts. Third, the study focused exclusively on self-reported perceptions of statistical competence, training, and ethical responsibility rather than triangulating these views with observational or performance-based measures. Lastly, the study focused on language researchers, which may limit the transferability of the findings to other disciplines within the broader field of educational research.

Several recommendations can be made for future research. First, further studies should adopt mixed-methods or longitudinal research designs to triangulate self-reported data with actual performance or observed practices, thereby ensuring a more

comprehensive understanding of statistical competence among language researchers. Second, researchers should prefer to expand the sample size and include participants from different educational and disciplinary backgrounds for comparison. Third, future research should explore intervention-based studies that evaluate the impact of hands-on, discipline-specific statistical training programs on researchers' skill development, emotional responses, and ethical awareness over time. Fourth, comparative studies between novice and experienced researchers or between different institutional contexts may reveal how statistical attitudes and practices evolve throughout an academic career. Lastly, further research may also focus on the integration of artificial intelligence or advanced digital tools in statistics education, examining how these technologies influence statistical literacy, decision-making, and ethical practice among language researchers.

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Evaluation of Differentiated Activities in the 5th Grade Science Textbook Prepared According to the New Maarif Model

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Abstract

The Turkish Century Education Model aims to culminate in our country's economic development by encompassing national and moral values and supports the notion that education is a continuous whole, extending from the past to the future. This Education Model, for the first time, introduces units, summary e-content, measurement and evaluation applications, and differentiated activities to the QR code application found in textbooks. Differentiated activities designed for each branch and subject are designed for both students and teachers in the textbooks. The purpose of this research is to evaluate the differentiated activities in the 5th grade science textbook prepared according to the new education model according to certain criteria. The research method was determined as document analysis, a qualitative research technique. For this research, "5th-grade science textbooks 1 and 2" were examined. The "Differentiated Activity Review Form" developed by the researchers was used as the data collection tool. The data analysis of the research was evaluated using content analysis. The 5th-grade science textbook contains a total of 43 differentiated activities across seven QR codes. The results of the study revealed that the most differentiated activities were "enrichment" activities. Even with different units, enrichment activities were generally shaped around STEM practices, while support activities consisted of modeling. It was determined that differentiated activities were primarily focused on the "content" dimension. Differentiated activities primarily targeted the skill areas of "scientific inference, scientific model creation, and scientific inquiry." These activities also encompass the scientific process skills of "model creation and inference" and the 21st century skill of "communication. Differentiated activities aim to engage students in learning based on their interests and skills. It's noteworthy that these textbooks prioritize enrichment activities. Therefore, it's recommended that differentiated activities be diversified to address students' other interests, skills, and needs.

Keywords: *Turkish century education model, differentiation, book review, QR code*

Introduction

The Turkish Century Education Model encompasses national and moral values, aims to maximize our country's economic development, and supports the idea that education is a continuous whole, extending from the past to the future. This model addresses the student profile of "Competent and Virtuous Person," the virtue-value-action framework of "Peaceful Person - Livable Environment - Peaceful Family and Society," the skills framework encompasses conceptual, subject-matter, social-emotional learning, and literacy skills, and finally, the holistic education approach (MEB, 2024a). Innovations initiated in the 5th grade of the New Education Model at the middle school level are also reflected in the textbooks. 5th-grade textbooks for all major subjects (Turkish, mathematics, science, and social studies) are divided into two parts: Book 1 and Book 2. When the 5th grade science textbook is examined, after the Turkish Flag, Address to Youth and Atatürk Portrait and the table of contents section, there are the sections "Getting to Know Our Book", "Safety Symbols", "Laboratory Safety" and "Science, Engineering and Entrepreneurship Applications". In the pages of the "Getting to Know Our Book" section, the stations at the beginning of each unit (preparation, curiosity, pre-assessment, information, reinforcement, performance, bridge, end of chapter, research, activity and scholars), measurement and evaluation, QR codes (unit, summary e-content, measurement and evaluation and differentiation) and the section sections summarizing the subject from the student's perspective are presented in summary form with pictures (MEB, 2024c). An examination of the textbooks reveals that the QR code application, along with the Maarif Model, is also included in the textbooks. When scanned and read through EBA, the QR code applications include topic summaries, songs related to the topic, games related to the topic, and interactive activities. One of the QR code applications also includes differentiated activities. Differentiated activities designed for each branch and topic are presented in the textbooks as various examples for both students and teachers. Pre-assessment stations, self-assessment stations for student evaluation of projects, various exercises related to the topic and outcome, and QR codes containing differentiated activities at the end of each unit have also been added to the textbooks (MEB, 2024b). QR codes were first used in private educational institutions in 2018 and then began appearing in test books and textbooks at schools affiliated with the Ministry of National Education in the 2017-2018 academic year. The QR codes in test books typically include answer keys and video explanations of question solutions, while those in textbooks contain animations, videos, and audio files (MEB, 2018a; MEB, 2018b). However,

with the New Maarif Model, for the first time, QR code applications in textbooks also include units, summary e-content, measurement and evaluation, and differentiated activities.

Differentiated instruction is an educational philosophy that acknowledges the diversity of student learning styles and emphasizes the need for personalized instructional approaches in K-12 classrooms. According to Loeser (2024), this model recognizes that each student has a unique learning profile shaped by their readiness, interests, and learning styles and requires educators to move away from traditional “one size fits all” methods. Differentiated instruction involves ensuring that all students are appropriately challenged and engaged by modifying core curriculum components such as content, process, and product to meet the needs of individual students. As classrooms become increasingly diverse, differentiated instruction serves as a vital strategy for creating an inclusive learning environment that respects and values student individuality.

There are many studies in the literature on examining textbooks (Bayir & Livdumlu Kahveci, 2021; Goodarzi, Weisi & Yousofi, 2020; Yucel & Karamustafaoglu, 2020; Yilmaz, Gunduz, Diken & Cimen, 2017; Yilmaz & Yildirim, 2023; Akkaya, Kara & Cigvin, 2024). When the literature was reviewed, no study was found evaluating the differentiated activities in the new textbooks. Indeed, the Maarif Model has just begun to be implemented for 1st, 5th, and 9th grades in the 2024-2025 academic year. With the new Maarif Model, there has been a noticeable change in the 1st, 5th, and 9th grade textbooks. One of the most important of these changes is the addition of the QR code application to the textbooks. It can be thought that thanks to the QR code application, students will be able to use technology more actively while learning the objectives. QR code applications do not only include activities presented to students by teachers in the classroom. Additionally, students can access various activities at home using QR code applications from PDF versions of textbooks on EBA. The differentiated activities included in the QR code applications included in textbooks with the New Maarif Model are expected to address students' interests and skills, fostering meaningful learning and making them more memorable. Therefore, the purpose of this research is to evaluate the differentiated activities in the 5th-grade science textbook prepared according to the New Maarif Model according to several criteria. These criteria include activity types, skill areas covered by the activities, science process skills covered by the activities, and 21st-century skills included in the activities. The research sub-problems are:

- What types of differentiated activities are found in the 5th grade science textbook?
- Which skill areas are addressed by the differentiated activities in the 5th grade science textbook?
- Which scientific process skills are covered by the differentiated activities in the 5th grade science textbook?
- Which 21st-century skills are included in the differentiated activities in the 5th grade science textbook?

Method

The research method was determined as document analysis, a qualitative research technique. Document analysis is the process of methodically examining or evaluating documents, both in print and electronic formats. Like many other qualitative research methods, this method involves examining and interpreting data to gain understanding, gain insight, and reach a conclusion (Bowen, 2023). The data used in the study were obtained from the "differentiated activities" in the QR code applications included in the "5th-grade science textbook 1" and "5th-grade science textbook 2," distributed by the Ministry of National Education for the 2024-2025 academic year (Figure 1). One of the researchers works at a public school affiliated with the Ministry of National Education and serves as a 5th-grade science teacher there. This allowed the researcher to directly access the 5th-grade science textbooks.

Figure 1.

QR code display in textbook

The researcher developed "Differentiated Activity Review Form," a semi-structured form, and was used as the data collection tool. The form analyzed the types of activities listed in the QR codes, the skill areas they addressed, the science process skills they addressed, and the 21st-century skills they encompassed. This form was submitted for approval to two expert researchers, who then selected and evaluated a unit from the textbook before using it. The data analysis for the study was determined as content analysis. The data was supported by frequencies and percentages and enriched with codes and themes.

Findings

In this section, differentiated activities found in the 5th-grade science textbook are examined in terms of "differentiated activity types," "skill areas," "scientific process skills," and "21st-century skills."

Table 1 below shows the distribution of differentiated activities found in the 5th-grade science textbook.

Table 1.

Distribution of differentiated activities according to the Maarif Model

	Frequency (f)	Percentage (%)
Enrichment	*26*	*60.46*
Support	*17*	*39.53*
Content	*19*	*44.18*
Process	*6*	*13.95*
Evaluation (product)	*16*	*37.20*
Learning environment	*0*	*0*

According to Table 1, the 5th-grade science textbook contains a total of 43 differentiated activities across seven QR codes. Of these, 26 are enrichment activities, and 17 are support activities. When these activities are examined in terms of content, process, product, and learning environment, 19 activities are content-based, 6 are process-based, and 16 are assessment-based. The absence of a differentiation activity related to the learning environment dimension is noteworthy.

The explanation of the QR code application is shown below.

Figure 2.

QR code application definition

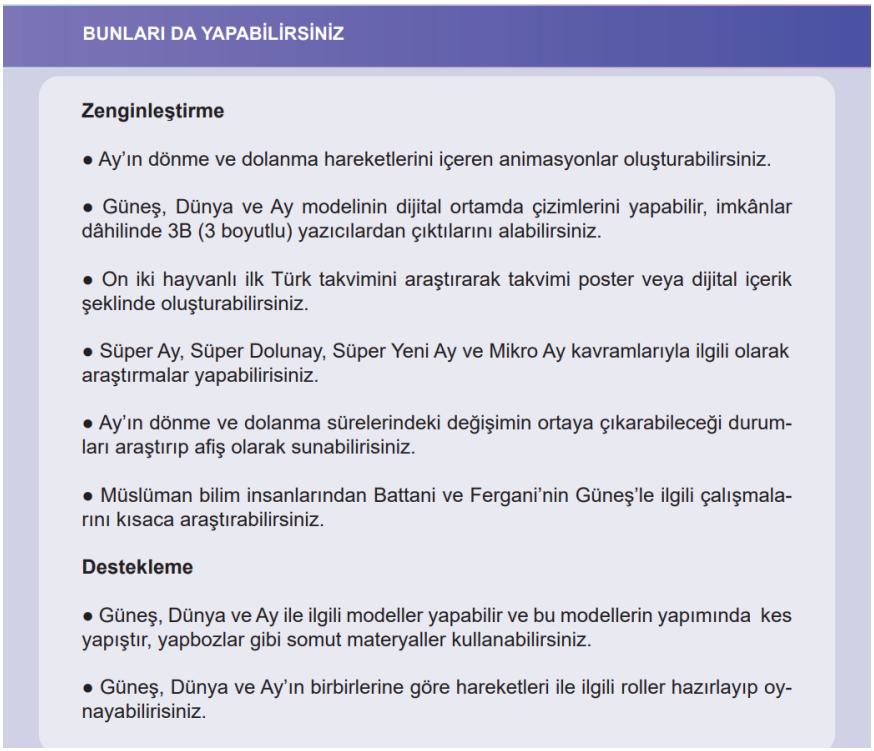

Table 2.

Skill areas, scientific process skills and 21st century skills of differentiated activities

Skill areas		Frequency (f)	Percentage (%)
	Making scientific inferences	*4*	*21.05*
	Predictions based on scientific data	*1*	*5.26*
	Forming hypotheses	*2*	*10.52*
	Creating scientific models	*4*	*21.05*
	Using evidence	*1*	*5.26*
	Scientific inquiry	*4*	*21.05*
	Performing experiments	*1*	*5.26*
	Classification	*2*	*10.52*
Scientific process skills			
	Modeling	*6*	*31.57*
	Making inferences	*2*	*10.52*
	Drawing conclusions	*5*	*26.31*
	Classification	*2*	*10.52*
	Presentation	*2*	*10.52*
	Designing experiments	*1*	*5.26*
	Prediction	*1*	*5.26*
21st century skills			
	Communication	*7*	*20*
	Scientific literacy	*5*	*14.28*
	Critical thinking and problem solving	*3*	*8.57*
	Creativity	*5*	*14.28*
	Collaboration	*6*	*17.14*
	Social and cultural	*5*	*14.28*

	awareness		
	Cultural literacy	*2*	*5.71*
	Curiosity	*2*	*5.71*

According to Table 2, differentiated activities in the New Education Model most frequently target the skill areas of "scientific inference, scientific model creation, and scientific inquiry." These activities also most frequently incorporate the scientific process skills of "model creation and inference." Finally, differentiated activities are most often based on the 21st-century skills of "scientific literacy, creativity, communication, collaboration, social and cultural awareness."

Discussion, Conclusion and Recommendations

This study examined the differentiated activities in the 5th-grade science textbook prepared according to the new education model according to certain criteria.

With the new education model, QR codes and differentiated activities are included in textbooks for the first time. No QR codes or differentiated activities were found in textbooks prior to the new program. However, a study by Alevli (2023) evaluated the activities in middle school Turkish textbooks in terms of differentiated instruction. It was noted that the activities reflecting the differentiated instruction approach in current Turkish textbooks are limited.

According to the results of the study, differentiated activities were determined to be the most numerous in terms of enrichment type and content. The high number of enriched activities may be due to the increased inclusion of activities for Bilsem students in textbooks. Bilsems implement enriched activities specifically for gifted students (MEB, 2022). However, it is a known fact that the number of inclusive students is higher than that of gifted students in MEB schools (Demirbilek & Levent, 2020). The lack of differentiated, supportive activities in textbooks may indicate that mainstream students are being overlooked, with Bilsem students being prioritized while students who lag their peers are being overlooked. Enriched activities are implemented for gifted students at Bilsem. Activities designed for students with support needs are deemed inadequate. However, the differentiated activities found in the QR code application, which are targeted at students' interests and needs and are being implemented for the first time, are considered beneficial. Creating more activities in the content dimension than in the other dimensions (process, assessment, and learning environment) can encourage students to learn the subject in depth, without experiencing either boredom or complexity. However, an examination of the skill areas reveals that scientific inference, scientific modeling, and scientific inquiry are the most prevalent areas. It was observed that the inference component of the activities was predominantly presented to students. Inference making can also support students' scientific literacy in differentiated activities. An effort may have been made to encourage a student to make scientific inferences after conducting research for the enrichment activities. When it comes to science process skills, modeling skills were seen to be at the forefront of the activities. Since science is a subject that also relies on visuals, modeling may have been emphasized in these activities. Finally, when considering 21st-century skills, communication and collaboration are seen to be at the forefront of differentiated activities. Given that activities are conducted with groups and families, and students are guided through peer or self-assessment forms, as targeted by the Maarif Model, it would be appropriate to include communication and collaboration skills embedded in numerous activities.

A study by Demir & Ozyurt (2021) examined social studies textbooks in the context of 21st-century skills and found that critical thinking and problem-solving skills were the most prevalent skills in the objectives, activities, and questions. This result is like our research and can be interpreted as follows: Differentiated activities aim to teach students according to their interests and skills. In this context, critical thinking and problem-solving skills can be particularly effective in enrichment activities. A study conducted by Balci (2024) aimed to examine middle school science textbooks in terms of domain-specific skills. According to the results of the study, the skills "changing and controlling variables and conducting experiments" were the most frequently mentioned among the science process skills. This result is similar to the results of our study. A study conducted by Bayir & Kahveci (2022) aimed to examine middle school science textbooks in terms of science process skills. Based on the data obtained from the study, the activities in the textbooks included the skills of observation, comparison, communication, collecting and recording data, prediction, and interpreting data. This result is like the results of our study.

A study conducted by Kucuk, Balik, Akdogan, & Aslan (2022) examined 5th-grade middle school science textbooks within the scope of communication and multiple intelligences. According to the results of the study, 106 of the 567 statements regarding the sub-dimensions of multiple intelligences theory were found to be related to communication. Ozdemir (2023) analyzed the visuals in middle school science textbooks in terms of gender. The results of the study found that the textbooks featured more images of boys, that boys were more represented in many occupational groups, that they were depicted more frequently in different settings, and that they were featured in more visuals than girls in most actions. A study conducted by Bilican, Senler, & Aydeniz (2023) aimed to examine science activities in terms of data processing skills. According to the findings of the study, "data collection skills" was the skill most emphasized in the activities.

This study examined the differentiated activities in 5th-grade textbooks. It is believed that the results of the study will contribute to the preparation, modification, and even improvement of textbooks for other grades. According to the researchers, the differentiated activities in the 5th-grade science textbook were found to be incomplete and superficial. Despite the presence of different units, it was determined that the enrichment activities were generally shaped around STEM applications, while the deepening activities consisted solely of modeling. Therefore, it is recommended that the ministry commission preparing the textbook redesign the differentiated activities to meet their intended purpose. Additionally, based on the results of this study, researchers can be advised to examine the differentiated activities found in the QR codes of textbooks across all branches prepared according to the New Education Model. It was determined that enrichment activities were less than deepening activities. Researchers could conduct a review to examine the reasons for the lower number of deepening activities, the lack of support activities, and the underlying factors. In the section examining skill areas, it was observed that the experimentation skill area was included in only one activity. Differentiation activities focused on the experimentation skill area, based on a specific science unit as a research topic, could be written and published as a book chapter. Finally, none of the differentiated activities included the methods targeted by Tomlinson (2000), such as stations, centers, and multiplexes. A suggestion is that differentiated activities could be reorganized based on these methods.

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Descriptive Analysis of Video Modeling to Teach Safety Skills to Children with ASD

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Abstract

Individuals with autism spectrum disorder may experience difficulties in recognizing dangerous situations, protecting themselves, and responding appropriately, which placing them at social and physical risk. One of the methods used to teach safety skills is video modeling. This method is notable for being both cost-effective and efficient. The aim of this research was to examine studies published between 2010 and 2025 that focused on teaching safety skills to individuals with autism spectrum disorder using video modeling. A total of 13 single-subject studies that met inclusion criteria were reviewed as a part of this study. The reviewed studies primarily addressed skills such as avoiding strangers, preventing abduction attempts, seeking help when lost, and ensuring safety during earthquakes and fires. In most cases, video modeling was found to be effective; however, some studies reported limited maintenance and generalization of the acquired skills. Interventions that used peer and adult models were generally rated high in social validity. The method showed particularly successful outcomes among children aged 6 to 12. Nevertheless, the narrow focus on certain safety skills (avoiding strangers and preventing abduction attempts) indicates that other critical areas may have been overlooked. Therefore, there is a need for future research to explore a wider range of safety skills using diverse and comprehensive approaches.

Keywords: *Avoiding strangers, Seeking help, Earthquakes, Fires.*

Introduction

Individuals with autism spectrum disorder (ASD) may experience difficulties in skills such as recognizing dangerous situations, protecting themselves and avoiding hazardous environments, identifying inappropriate behaviors of others, and reporting these situations to relevant authorities or trusted individuals. Such challenges may lead them to live a life dependent on others physically, socially, and emotionally. Furthermore, compared to their typically developing peers, they may be disadvantaged in skills such as avoiding strangers, seeking help when lost, protecting themselves from household or community accidents, and responding to natural disasters (e.g., earthquakes, floods, fires, landslides, avalanches) or human-induced disasters (e.g., war, mobilization) (Dixon et al., 2010; Leland et al., 1994; Xiang et al., 2005). Safety skills are of vital importance not only for individuals with autism but for all members of society. Teaching these skills requires instructional practices developed by experts, which may vary according to the type of disability.

In teaching safety skills to individuals with autism, behavioral skills training, errorless teaching methods, power card strategies, and technology-based applications are frequently used, among which video modeling is particularly common. Video modeling represents a low-cost instructional approach that can be easily implemented using simple video players such as tablets and smartphones (Genç-Tosun & Kurt, 2014). In video modeling, the individual watches a video demonstrating the target skill prepared specifically for them and imitates the observed behavior (Kutlu et al., 2023). Research has shown that video modeling can be effectively used in teaching social skills, safety skills, self-care skills, and play skills (Kurt et al., 2024; Thomas et al., 2020). Video modeling offers practitioners several advantages in teaching a variety of skills to children with ASD (Genç-Tosun & Kurt, 2014; Charlop-Christy et al., 2000). First, participants can watch video recordings of the target behavior multiple times. Second, these videos can be reused with other individuals who have similar needs. Finally, video modeling is highly efficient in terms of both time and cost (Charlop-Christy et al., 2000; Nikopoulos & Keenan, 2006). Video modeling stands out as an effective instructional method frequently employed to teach safety skills to individuals with autism spectrum disorder. However, there remains a need for systematic analysis of which types of safety skills are most often targeted and the evidence regarding their effectiveness. Although the literature includes review studies on various safety skills, no study to date has comprehensively examined safety skills taught exclusively through video modeling. This reveals a significant gap in the literature regarding the application of video modeling in special education.

Method

In this study, published research on safety skills taught to individuals with autism spectrum disorder (ASD) through video modeling was reviewed. A total of 223 studies were identified in Web of Science, Scopus, Google Scholar, and Anadolu University Library databases between 2010 and 2025 using the keywords “safety”, “safety skill”, “autism”, “autism spectrum disorder” along with their Turkish equivalents. According to the inclusion criteria, 13 studies were selected for descriptive analysis, which included participants with ASD, utilized video modeling, provided instruction on safety skills, and employed a

single-subject research design. The reviewed studies were analyzed in terms of participant characteristics, dependent and independent variables, and findings.

Results

The studies included in this review demonstrate that video modeling has been employed to teach safety skills to individuals with autism spectrum disorder (ASD) and has generally produced effective outcomes. Only one study reported that video modeling was not effective (King & Miltenberger, 2017). The reviewed research addressed a range of safety skills, including avoiding strangers, preventing abduction attempts, providing first aid in household accidents, avoiding poisoning, avoiding firearms, seeking help when lost, coping with peer bullying, fire and rain safety, earthquake and post-earthquake evacuation safety, and street-crossing behaviors. However, the majority of the studies focused on avoiding strangers and preventing abduction attempts. Studies reporting maintenance data indicated that these skills were generally sustained for one to four weeks, while in some cases, maintenance extended up to one year. Generalization data revealed that the acquired skills could be transferred across different individuals, settings, and situations; however, some studies noted that supportive practices, such as direct instruction, were necessary to ensure the continuation of these skills in real-life contexts. In studies reporting social validity findings, both participants and their families and teachers generally evaluated the interventions as meaningful, feasible, and acceptable. Furthermore, when the studies were analyzed in terms of the type of model used in video modeling, nine employed peer models, two used adult models, one used both peer and adult models, and one did not specify the type of model. Overall, these findings indicate that video modeling is an effective intervention with high social validity for promoting the acquisition and maintenance of safety skills among individuals with ASD. Table 1 provides detailed information on the articles reviewed within the scope of this study.

Table 1. *Study Characteristics*

Authors	Design	Participants	Dependent variable	Independent variable	Results	IOA	TF	M	G	SV
Akmanoğlu & Tekin İftar, 2011	Multiple probe across participants	6-11 y 2 m 1 f	Responding to the lures of strangers	VM+ GG+ CBI (peer)	**The findings showed that the instruction helped participants learn to protect themselves from strangers' deception attempts. Participants were able to maintain the skills during follow-up and use them in new settings. Parents expressed positive views about the purpose, method, and results of the study.**	+	+	+	+	+
Ergenekon, 2012	Multiple probe with probe trials across behaviors	7-9 y 3 m	Basic first-aid skills against home accidents	VM (peer)	**The findings showed that the first aid skills teaching package was effective, and that the participants were able to maintain and generalize the acquired skills by applying them to cuts, scrapes, and minor burns on both their own bodies and different parts of the researcher's body. Social validity data collected through social comparison indicated that before the intervention, participants were unable to perform these target behaviors, whereas their typically developing peers were able to perform them successfully at a rate of 78%.**	+	+	+	+	+

Authors	Design	Participants	Dependent variable	Independent variable	Results	IOA	TF	M	G	SV
Godish et al., 2017	Non-concurrent multiple baseline across participants	7-8 y 4 m	Abduction prevention	VM+ IST (peer)	**The findings showed that video modeling was effective in teaching abduction prevention skills to all participants, and that in the case of one participant, in-situ training was needed to ensure maintenance of the skills.**	+	+	+	-	+
King & Miltenberger, 2017	Multiple baseline across participants	6 y 1 m 2 f	Avoiding poison hazards	VM+ IST (peer)	**The findings showed that video modeling was not effective for any of the participants, but in-situ training was effective for two participants. The third participant required additional reinforcement. Two of the three participants maintained the safety skills at the 1-, 3-, and 5-week follow-up assessments.**	+	+	+	-	+
Morgan & Miltenberger, 2017	Multiple baseline across participants	6 y 3 m	Firearm avoidance	VM + IST (peer)	**The study found that video modeling was effective for one participant, but in-situ training (IST) was necessary to ensure maintenance of the skill. For the second participant, IST was effective in terms of both skill acquisition and maintenance. For the third participant, the adapted IST procedure was effective when implemented by the trainer, but not when implemented by the mother.**	+	+	+	IST	+
Carlile et al., 2018	Multiple probe across participants	3-14 y 6 m	Help-seeking when lost	VM+ Paket (-)	**Participants acquired the skills of making a FaceTime call or presenting an ID card when lost, both in simulated and real settings. The skills were generalized to new community environments and maintained at 1- and 2-week follow-ups. Social validity data indicated that the procedures and outcomes were found acceptable by both direct and indirect beneficiaries as well as community members.**	+	+	+	+	+
Rex et al., 2018	Multiple baseline across participants	8-13 y 4 m 2 f	Assertively responding to bullying (physical, verbal and social exclusion)	VM (peer + adult)	**The findings showed that all six children learned to respond appropriately and confidently to peer bullying scenarios through video modeling. Four of the six children also successfully demonstrated the learned responses during real-life bullying trials.**	+	-	-	IST	-

Authors	Design	Participants	Dependent variable	Independent variable	Results	IOA	TF	M	G	SV
Abadir et al., 2021	Multiple probe across participants with an embedded adapted alternating treatments design	12 y 4 m	Abduction-prevention	VM (peer)	**Participants demonstrated differentiated responses to deception attempts from both strangers and familiar people, and generalized these responses across different community settings, individuals, and deception attempts. Three of the four participants maintained the skills for at least one week after acquisition. Families, teachers, and behavior analysts evaluated the procedures as clear, acceptable, non-intrusive, appropriate, cost-effective, and favorable.**	+	+	+	+	+
Ishaq & Shoaib, 2022	AB	14-18 y 1 m 2 f	Rain and fire safety tasks	VM on smartphone app (adult)	**All participants learned rain and fire safety after the intervention. It was observed that the participants maintained these skills two weeks after the implementation.**	-	-	+	-	-
Bell, 2022	Multiple baseline across participants	6-12 y 4 m 2 f	Abduction-prevention	VM (peer)	**All participants showed improvement in responding appropriately to both abduction scenarios presented via tape and real-life deception attempts by strangers after the intervention. One year later, 90% of the participants had maintained and generalized these skills**.	+		+	IST	
Kutlu & Kurt, 2023	Adapted alternating treatments design	10-13 y 4 m	Responding to the lures of strangers	SÖ/ SÖ+ VM (peer)	**The findings indicated that both methods were equally effective in teaching protection skills from strangers for three participants, while for the fourth participant, the method using only social stories was more effective. There was no significant difference between the methods in terms of efficiency. Social validity data showed that participants and their families generally held positive views about the study.**	+	+	+		+
Kurt et al., 2024	Multiple probe across participants	9-10 y 3 m	Earthquake and post-earthquake evacuation safety skills	VM (peer)	**The results showed that video modeling was effective in teaching 'drop, cover, hold on' and evacuation skills to three participants. The skills were generalized to new settings for all participants and maintained for up to four weeks for the two participants whose maintenance was assessed. Social validity data collected from participants, their families, and a teacher were generally positive.**	+	+	+	+	+

Authors	Design	Participants	Dependent variable	Independent variable	Results	IOA	TF	M	G	SV
Kaya & Ergenekon, 2024	Multiple probe design with an inter-participant probe phase	8-9 y 3 m	Safe street crossing using the traffic light	VM (adult)	**The findings indicated that the video modeling intervention was effective in teaching children with ASD the skill of crossing the street using pedestrian traffic lights. The children maintained the acquired skill three and five days after the sessions and were able to generalize it to real-life settings. Social validity data obtained from the mothers of the participating children were positive.**	+	+	+	+	+

f: female, G: generalization; IOA: interobserver agreement, m: male, M: maintenance; SV: social validity; TF: treatment fidelity, y: years, GG: graduated guidance, VM: video modeling, CBI: community-based instruction, IST: in situ training

Discussion

This study involved a review of published studies that focused on teaching safety skills to individuals with autism spectrum disorder (ASD) using video modeling. The reviewed studies demonstrate that video modeling-based instructional practices have been used to promote the acquisition of various safety skills in individuals with autism spectrum disorder (ASD). These skills include avoiding strangers, preventing abduction attempts, administering first aid in household accidents, avoiding poisoning, staying away from firearms, seeking help when lost, responding to peer bullying, ensuring safety during fire, rain, and earthquakes, as well as crossing the street. The fact that the majority of participants successfully acquired the target behaviors supports the view that video modeling is a functional method, particularly for teaching social, daily living, and safety skills. On the other hand, the limited levels of generalization and maintenance reported in some studies highlight the importance of transferring interventions to real-life contexts. This underscores the necessity of combining video modeling with other intervention approaches that take into account the individual characteristics of participants, especially when teaching safety skills related to high-risk and dangerous situations. From the perspective of generalization, it can be argued that such skills should not only be taught and assessed in structured settings but also within real-life environments.

The studies reviewed indicate that video modeling has been applied across different age groups. Participants' ages ranged from 3 to 18 years, with the method being more commonly and effectively implemented among children aged 6-12. Its applicability across diverse age groups and its generally positive outcomes can be considered a significant advantage of video modeling.

The reviewed studies demonstrate that video modeling-based instructional practices have been used to promote the acquisition of various safety skills. These skills include avoiding strangers, preventing abduction attempts, administering first aid in household accidents, avoiding poisoning, staying away from firearms, seeking help when lost, responding to peer bullying, ensuring safety during fire, rain, and earthquakes, as well as crossing the street. However, the majority of the studies primarily focused on teaching skills related to avoiding strangers and preventing abduction attempts. This emphasis is particularly meaningful given the heightened risk of social vulnerability among individuals with autism. Employing video modeling to teach these critical safety skills not only ensures effectiveness but also provides high social validity. Nevertheless, the current emphasis on a limited range of safety behaviors, particularly those related to abduction prevention, reflects a significant gap in the literature. Addressing this gap requires empirical studies that apply video modeling to a wider variety of safety skills, thereby providing a more comprehensive understanding of its effectiveness.

In conclusion, video modeling emerges as a highly effective and practical approach for promoting the acquisition and maintenance of safety skills in individuals with ASD. Its impact, however, may be influenced by factors such as participant characteristics, the type of model employed in the videos, and the context of implementation. Future research that systematically addresses these variables will not only strengthen the evidence base but also enhance the inclusivity, applicability, and generalizability of video modeling interventions across diverse settings and populations.

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Perceived Difficulties among EFL Learners in the Turkish Educational Context

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Abstract

Despite the considerable benefits of learning English as a foreign language (EFL), learners in the Turkish educational context continue to face persistent challenges that hinder their language development. This study aims to explore Turkish EFL learners' perceptions of the difficulties they face in the learning process from a holistic perspective. This qualitative research analyzed 750 user-generated entries from Sourtimes.org through thematic analysis to identify recurring patterns in learner experiences. The study concluded that learners struggle with methodological issues, linguistic differences, exam-focused assessment practices, emotional barriers, and limited opportunities for real-life language use. Based on these conclusions, the study recommends a shift toward communicative, learner-centered instruction, which is supported by improved assessment strategies and increased exposure to authentic language use.

Keywords: English as a foreign language; learning; perceptions; problems; Turkish educational context

Introduction

English, as a lingua franca, is used by approximately 1.5 billion people as a native and non-native language (Dyvik, 2023; Statista, 2024), playing a crucial role in today's interconnected world, offering cultural, academic, professional, cognitive, and emotional benefits to individuals. In the broadest sense, proficiency in English facilitates communication and collaboration across various domains, including education, science, technology, tourism, aviation, business, and diplomacy (Rumsey, 2024). Within this scope, English dominates the digital landscape, accounting for 59% of all online content (Statista, 2024), and is central to accessing global information and engaging with popular culture, including films, television, and literature (Harmer, 2001). Thus, English is the primary language of instruction in many universities and academic programs, providing learners with opportunities for international education and career mobility (Park, 2022). From a cognitive and psychological perspective, EFL learning enhances critical thinking, problem-solving, and memory skills (Bialystok, 2011; Li, 2016; Liang & Fung, 2021) and supports emotional growth, cognitive flexibility, and affective functioning (Kennedy, 2006). Moreover, it fosters learners' self-confidence, self-efficacy, sense of accomplishment, and personal resilience, promotes intercultural awareness, cultural sensitivity, and empathy, enabling individuals to engage in meaningful cross-cultural communication and develop a deeper understanding of diverse cultures (Byram, 2012; Mercer, 2016; Verga & Kotz, 2013; Wang & Guan, 2020). These multifaceted benefits underscore that EFL learning is not merely a linguistic activity but a transformative process that contributes to personal, academic, and professional success in a globalized society (Pennycook, 2014). On the other hand, EFL learning is also problematic, specifically from the perspective of learners who encounter challenges during the learning process, specifically in the Turkish educational context.

The EFL learning process is influenced by a complex interplay of linguistic, social, psychological, emotional, and educational factors, resulting in challenges among learners that constitute effective learning. For instance, phonological, syntactic, and structural differences between Turkish and English may result in problems with vocabulary retention (Şakırgil, 2012), pronunciation mistakes and errors (Demirezen & Topal, 2015), and grammatical problems (Abushihab, 2014; Gazioğlu & Aydin, 2024). From a social perspective, limited exposure to English in learners' everyday environments restricts their opportunities for meaningful interaction, resulting in classroom use rather than functioning as a tool for real-life communication (Nikula, 2005). Psychologically, many learners experience foreign language anxiety and demotivation, particularly in speaking situations where mistakes are visible (Aydin, 2008; Aydin & Zengin, 2008). These emotional barriers result in a lack of persistence, curiosity, and risk-taking, as well as a failure to use the target language in a communicative context (Dewaele, 2005).

Literature Review

While the current research lacks data on the problems encountered by EFL learners from a holistic perspective, studies mainly focus on the specific elements. For instance, the studies dealt with the problems regarding basic language skills, namely listening (Namaziandost et al., 2019), speaking (Islam et al., 2022), reading (Hezam et al., 2022), writing (Sasmita & Setyowati, 2021), grammar (Alhaysony & Alhaisoni, 2017), vocabulary (Afzal, 2019), and pronunciation (Utami, 2020). Within an analytical approach, studies also focused on the problems concerning learning styles (Ghufron & Ermawati, 2018), learning environments (Azmi, 2017), thinking skills (Al Zahrani & Elyas, 2017), and learning styles (Maryono & Lengkanawati, 2022). On the other hand, few studies appeared on the difficulties in EFL learning from learners' perspectives using a holistic approach.

Among those studies, Jdetawy (2011) reviewed the current literature on the challenges faced by Arab EFL learners and concluded that learners mostly struggled with basic language skills due to the dominance of Arabic as an instructional language and limited exposure to the target language. In another review study, Akbari (2015) noted that EFL learners lacked proficiency in the target language, which stemmed from issues with teaching methods, assessment and evaluation processes, curriculum, and language policy. Considering the problems in EFL learning within the Turkish educational context, Solak and Bayar (2015) investigated the current challenges in EFL teaching and learning among both low- and high-achieving learners in a qualitative study involving 22 participants. They found that the factors concerning the methods and approaches, the lack of practice, individual and linguistic differences, teaching materials, parental perceptions, and learning environment.

Overview of the Current Study

While EFL learning is vital in today's world, offering cultural, academic, professional, cognitive, and emotional benefits to individuals, the learning process is influenced by various factors that pose challenges to EFL learners. Moreover, research primarily focuses on specific points within the scope of the challenges encountered by EFL learners, while few studies concentrate on the problems in the process as a whole. The results of a limited number of holistic studies suggest that basic language skills may be problematic due to the dominance of the native language, limited exposure to the target language, ineffective teaching methods, assessment and evaluation processes, curriculum, and language policies. The only study examining the problems in the Turkish educational context concludes that factors such as teaching methods, approaches, lack of practice, individual and linguistic differences, teaching materials, parental perceptions, and learning environments are problematic among Turkish EFL learners. Considering that the mentioned study uses a limited number of participants, there is a need for further examination of the factors by adopting a broader perspective to gain a better and deeper understanding of the complexities perceived by Turkish EFL learners, utilizing a synthetic approach and heuristic purpose. With these concerns in mind, the current study aims to explore perceived challenges in the EFL learning process in the Turkish educational context.

Method

Research Context

The study, which examines learners' perceptions of problems in the EFL learning process within the Turkish educational context, employed a synthetic approach and a holistic purpose at a conceptual level. It aims to provide a comprehensive understanding of the difficulties learners face without imposing predetermined assumptions, hypotheses, or research questions. At the operational level, the study follows a **qualitative research design** to explore learners' perceptions and experiences in a naturalistic setting without experimental manipulation. Thus, the study uses **user-generated written data** to capture authentic reflections. The collected data are analyzed using **thematic analysis**, ensuring a systematic and structured approach to identify recurring patterns and themes within learner experiences (Seliger & Shohamy, 1989).

Participants

The participants in this study consisted of individuals from Turkey who contributed entries to *Sourtimes.org* regarding their experiences in the EFL learning process. The dataset comprised 750 user-generated entries, spanning the period from January 11, 2017, to March 10, 2025, and reflecting a broad range of perspectives from learners with diverse educational backgrounds and experiences. As this study analyzed **publicly available discourse**, it did not focus on demographic characteristics such as age, gender, or education level. However, the participants' comments indicated that they had different English proficiency levels. There were several reasons behind the selection of these participants. First, the online nature of the dataset allows for spontaneous and authentic reflections, enabling an exploration of naturally occurring discourse without intervention. Second, the **longitudinal aspect** of the entries enabled an analysis of recurring themes and evolving perceptions over time. Third, this approach ensured that the study reflected **a diverse and natural sampling** rather than being restricted to a specific institutional setting or pre-selected group.

Tools

The study utilized a **user-generated content dataset** from *Sourtimes.org* (https://eksisozluk.com/ingilizce-ogrenmeyi-zorlastiran-nedenler--5276224) as its primary data source, consisting of **750 entries**. For several reasons, the study relied on **naturally occurring written discourse** rather than structured interviews or surveys. First, **user-generated content provided authentic and spontaneous reflections**, as participants expressed their views voluntarily without the researcher's influence. The approach also ensured **unfiltered insights** into learners' difficulties in the learning process. Second, written online discourse enables longitudinal analysis by allowing for the tracking of recurring themes and evolving perceptions over time.

Third and last, the approach allowed for data collection regarding **flexibility, adaptability, consistency, and comparability**, as the entries could be systematically analyzed through thematic analysis.

Procedure

Ethical considerations were carefully addressed as the study utilized publicly available user-generated content to ensure responsible data usage. Thus, written permission was obtained from Sourtimes.org to use the entries for research purposes. Since no direct interaction with participants occurred, no personally identifiable information was collected during the research process. Ethical guidelines for the responsible use of online data were followed to maintain the anonymity of contributors and respect the integrity of publicly shared discourse. Additionally, as the study involved analyzing naturally occurring online discussions, no social or psychological risks were associated with participation.

Data analysis

After compiling the dataset from *Sourtimes.org*, **750 user-generated entries** from **January 11, 2017, to March 10, 2025,** were examined to identify recurring themes and patterns. The data were analyzed using **thematic analysis** to ensure a structured and comprehensive exploration of learner perceptions. Thematic analysis was chosen for its ability to **identify patterns in naturally occurring discourse** while maintaining flexibility in capturing diverse experiences. Three independent coders analyzed the data separately to ensure **validity, reliability, and trustworthiness**, categorizing entries into themes and comparing their findings. The rationale behind using multiple coders was to achieve **data triangulation**, allowing for cross-checking of codes and themes.

Findings

Methodological Issues

The reliance on the Grammar Teaching Method in the EFL teaching process limits students' ability to develop communicative language skills. For instance, many learners reported that the dominant approach in schools focused primarily on grammar instruction and translation-based exercises, which constituted barriers to preparedness for real-world communication. Within this scope, they described how lessons were structured around memorizing grammatical rules and filling in the blanks rather than encouraging meaningful and contextual language use. One student stated, *"For years, we studied English by learning grammar rules, but the moment I needed to have a conversation, I didn't know how to start a sentence."* According to learners, this method created a disconnection between structural knowledge and practical application, making it difficult for them to use English in spontaneous communication and interactions.

Another significant challenge is the lack of interaction and student-centered learning environments, which prevents learners from actively using the target language in the classroom. Many students reported that English lessons were teacher-dominated, with limited opportunities for student participation and engagement. One learner noted, *"Even in English classes, our teachers mostly lecture in Turkish. We rarely get a chance to actually speak English."* Moreover, the absence of communicative activities such as discussions, debates, or role-playing made learners feel that English remained a subject to be studied rather than a language to be spoken. They also expressed frustration that their only exposure to English was passive, as they mostly read and wrote rather than engaged in speaking and writing. In addition, students often criticized teacher training and methodology inadequately, which resulted in ineffective instruction. They also reported that their teachers relied on outdated methods and could not create engaging lessons. One student explained, *"Our English teacher simply read from the textbook and told us to memorize lists of words. There was nothing fun or engaging about learning English."* According to learners, this problem failed to provide the motivation or practical skills needed to use English effectively.

Interlanguage Effect

The structural differences between English and Turkish pose significant challenges for learners in achieving grammatical proficiency. Many learners reported struggling with English word order, tenses, and articles, as these features do not exist in the same way in Turkish. One student stated, *"I always mix up English sentence structures because in Turkish, we don't follow the same rules."* Furthermore, they described the subject-verb-object order in English as conflicting with the more flexible syntax in Turkish, making it difficult to construct sentences naturally. Similarly, learners found articles like 'a' and 'the' particularly confusing, as Turkish does not have an equivalent grammatical structure.

Pronunciation difficulties appear to be a significant issue in developing confidence in speaking English. Many students believed that certain English sounds do not exist in Turkish, making them hard to produce. One learner explained, *"I still can't*

pronounce 'th' correctly. No matter how much I practice, it always sounds wrong." They also expressed frustration that English spelling and pronunciation often do not match, making it challenging to predict how words should be spoken. The inconsistency between spoken and written English, as seen in words like *'though,' 'thought,' and 'tough,'* was frequently mentioned as a source of confusion.

Vocabulary retention also remains another major problem. Many learners reported that, although they had memorized long lists of vocabulary, they struggled to recall words in conversation. One student remarked, *"I know many words when I see them in a text, but when I need to speak, my mind goes blank."* They attributed this issue to the lack of contextual learning, explaining that words were introduced without a meaningful context, which made it difficult for them to be internalized. Instead of learning words through stories, real-life conversations, or multimedia content, students stated that they were forced to memorize isolated words, which did not help in practical usage.

Testing and Assessment

The format of English language exams prioritizes rote memorization over genuine language acquisition, making it difficult for learners to develop functional proficiency. Many students believed that exams focused on multiple-choice questions of grammar, vocabulary, and reading rather than testing communication skills. One learner expressed frustration: "*I always get high scores on grammar tests, but when I try to speak English, I freeze."* They explained that this system reinforced a superficial understanding of the language, where learners memorized rules for the test but quickly forgot them afterward. Additionally, high-stakes testing poses a serious problem for students, affecting their motivation to learn English for communication purposes. Many learners described the pressure of university entrance exams and language proficiency tests as overwhelming. One student stated, *"We don't learn English to use it; we learn it to pass exams. And once the exam is over, we forget everything."* In conclusion, they believed that the exam-oriented approach discouraged target language learning, as students focused on test strategies rather than improvement.

Affective Factors

Speaking English in front of others increases anxiety levels for learners and hinders their development of fluency. Students described feeling extreme nervousness when asked to speak English in class, fearing that they would make mistakes and be negatively evaluated by their peers. One learner stated, *"Every time I try to say something in English, I feel like everyone is watching me, waiting for me to mess up."* Thus, anxiety led many students to avoid speaking altogether, reinforcing their lack of self-confidence. In addition to speaking anxiety, fear of making mistakes stemmed from negative past experiences made them feel humiliated for errors and mistakes. Several learners also reported that their teachers or classmates mocked them when they mispronounced words, leading to increased self-consciousness. One student explained, *"After being laughed at once, I stopped speaking in English class completely."* These experiences discouraged learners from taking risks and reduced their willingness to engage in open communication.

Learners experience disengagement, demotivation, and amotivation during the learning process. First, they believed that their teachers failed to demonstrate the real-world value of English, which made it difficult for them to stay engaged. One student noted, *"I don't see the point of learning English because I never use it in my daily life."* They also stated that they lost interest in language learning without a clear purpose. Second, they stated that repetitive and uninspiring lessons further discouraged students. For instance, many learners described their classes as boring and monotonous, where they were given the same exercises repeatedly without any engaging activities. One student said, *"Every lesson feels like the last one—grammar rules, exercises, and a test. It's tiring."* To this end, the lack of variety resulted in low motivation and disengagement from the learning process.

Lack of Exposure and Practice

Learners have limited opportunities to practice English outside the classroom, which makes it challenging for them to improve their fluency. From this perspective, students stated they had little to no real-life exposure to English, as their daily environments were Turkish-speaking. One learner remarked, *"We only use English in class, and even then, most of the lesson is in Turkish."* As a result, the lack of immersive experiences prevented learners from gaining confidence in using English spontaneously. Moreover, many learners struggled to think in English, as they instinctively translated from Turkish before speaking. They stated that this habit slowed down their speech production and caused grammatical errors. For instance, one student explained, *"I always translate my sentences in my head before I speak, and by the time I finish, the conversation has already moved on."* Thus, the overreliance on translation made fluent speaking difficult, as learners could not process English naturally.

Conclusions and Discussion

The study, which aims to examine EFL learners' perceptions of the problems encountered in the EFL learning process within the Turkish educational context, concludes that learners experience difficulties due to methodological issues, linguistic differences, assessment practices, affective factors, and limited exposure to the target language. First, the reliance on the GTM restricts learners' ability to develop communicative language skills. Teaching practices that focus on grammar instruction and translation-based exercises often fail to prepare students for real-world communication adequately. Furthermore, teacher-centered instruction, minimal classroom interaction, and the lack of student-centered learning environments limit students' opportunities to engage in active language use. This situation stems from ineffective teacher training, as many teachers continue to employ outdated methods that do not engage learners or foster their ability to use English in meaningful contexts. Second, linguistic differences between English and Turkish create difficulties for learners, particularly in grammar acquisition, pronunciation, and vocabulary retention. Thus, learners often experience difficulties with word order, tenses, and articles, resulting in frequent grammatical errors. Pronunciation barriers complicate oral communication, as certain English phonemes do not exist in Turkish, making them hard to articulate. Additionally, vocabulary learning remains challenging due to the emphasis on rote memorization rather than contextualized learning, preventing students from effectively recalling and using new words in real-life situations. Third, assessment practices in the Turkish educational system reinforce the limitations of traditional language teaching methods. Since exam formats prioritize memorization over practical language skills, focusing on grammar, vocabulary, and reading comprehension rather than speaking and listening proficiency, learners are unable to communicate effectively in English. Moreover, high-stakes exams create pressure that results in prioritizing short-term exam strategies over long-term language learning. As a result, learners often express frustration at their inability to use English effectively despite achieving high scores on standardized assessments. Fourth, psychological barriers have a significant impact on learners' self-confidence and willingness to communicate in English. For instance, students experience anxiety when speaking in front of peers and fear of negative evaluation. Past negative experiences also lead to avoidance behaviors that reinforce the lack of fluency. Additionally, learners feel amotivated and demotivated due to the perception that English is only an academic requirement. Lastly, the limited opportunities for real-life exposure to English significantly decrease fluency in the target language. Since English is rarely spoken outside the classroom, students struggle to gain confidence in using the language in natural settings. In other words, the absence of immersive experiences reinforces the production of English learning.

Some pedagogical implications can be noted within the scope of the conclusions reached in the study. Similar to earlier findings, the present study finds that Turkish EFL learners struggle with linguistic challenges, such as grammar, pronunciation, and vocabulary (Abushihab, 2014; Demirezen & Topal, 2015; Şakırgil, 2012), and are affected by limited exposure to English (Jdetawy, 2011; Nikula, 2005), emotional barriers (Aydin, 2008; Dewaele, 2005), and ineffective instructional methods (Akbari, 2015). However, unlike most prior studies that treat these issues in isolation, this study offers a comprehensive and learner-centered perspective that integrates methodological, linguistic, psychological, and systemic challenges. In other words, the current study builds upon earlier work by providing detailed insights into how outdated teaching methods, exam-oriented assessment practices, and a lack of real-life language use collectively hinder communicative competence. Moreover, the study highlights the emotional consequences of these challenges, such as anxiety, demotivation, and low self-confidence, which are rarely examined in previous studies. In conclusion, the study presents a holistic view of EFL learning difficulties specific to the Turkish educational context, thereby contributing to the related literature by offering a comprehensive, learner-centered perspective that integrates methodological, linguistic, psychological, and contextual factors affecting EFL learning in this context.

Based on the study's conclusions, several practical recommendations can be made. First, students should be encouraged to engage in active language use beyond the classroom through online interactions, language exchange, and authentic materials. They should adopt meaningful, context-based strategies rather than relying solely on memorization and develop self-regulation skills to maintain motivation. Second, teachers should avoid overusing the Grammar-Translation Method and adopt communicative, learner-centered approaches that promote interaction and communication. Teachers should also address affective factors such as anxiety and low self-confidence in creating a supportive classroom environment. Third, program developers should design curricula that integrate all language skills by emphasizing communicative competence, revise assessment practices to include speaking and listening tasks, and incorporate up-to-date teacher training modules. Fourth and last, policymakers should focus on reforming language education policies by supporting communicative teaching methods, reducing the dominance of exam-oriented practices, and providing educational resources and professional development opportunities.

The study is not without limitations. First, the data collected in the study is confined to the use of user-generated content from Sourtimes.org, which allows users to make authentic and spontaneous reflections. Second, the study does not include demographic data such as age, gender, or educational background. Third, the study is based solely on self-reported experiences, which may not fully capture learners' actual behaviors or the effectiveness of instructional practices in real classroom settings.

In light of the findings, several recommendations for further research can be made. First, research should utilize descriptive, correlational, and mixed-methods studies to provide a more comprehensive understanding of the difficulties faced by EFL learners. In this way, it will be possible to understand how demographic variables relate to the difficulties in the learning process. Second, more qualitative research is necessary within the scope of classroom observations, teacher and learner interviews, and reflections to validate and compare self-reported data with classroom practices. Third, experimental and longitudinal studies are necessary for observing actual behaviors rather than learners' perceptions. As a final point, considering that the EFL learning process seems problematic, further research should also focus on educational contexts.

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Left Out and Logged In: Understanding FoMO in University Student Life

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Abstract

Fear of Missing Out (FoMO) has been associated with distraction and excessive social media use, but its predictors in the university classrooms are under-researched. This study investigated the prevalence of FoMO among university students and examined the influence of demographic factors and digital behaviours. A quantitative survey design was employed with 273 students at a private, internationally recognised university in Northern Cyprus. No specific sampling technique was used; instead, the study aimed to reach the entire student population. Data were collected using the University Students' Online Survey, which included demographic and behavioural items and the Turkish adaptation of the FoMO scale. Analyses included descriptive statistics, t-tests, and one-way ANOVA. Results showed that younger students and students in earlier years of study reported significantly higher FoMO scores, while higher academic achievement was associated with lower FoMO scores. Excessive social media use predicted higher FoMO, but there were no significant differences by device type, primary purpose of the Internet, or preferred platform. Situational factors, such as phone placement and reasons for checking the phone during class, were associated with higher FoMO. These findings suggest that FoMO is influenced by developmental and behavioural factors rather than specific technologies or platforms. Addressing students' digital habits and encouraging academic engagement could help reduce FoMO-related distraction and improve wellbeing in higher education.

Keywords: FoMO, university students, digital habits, social media use, academic engagement, Northern Cyprus

Introduction

The incorporation of digital technologies into everyday life has profoundly changed university students' thinking, emotional responses, and behaviour. Among the various phenomena of the digital era, Fear of Missing Out (FoMO), defined as the desire to stay connected on social media to avoid missing social interactions or experiences, has emerged as a notable psychological construct influencing university students' well-being, social connectedness, and academic behaviour (Przybylski et al., 2013).

FoMO is associated with the feeling of being excluded from desired experiences (social exclusion) or with a persistent desire to be continuously connected to others' actions and interactions (Zhang et al., 2020). Franchina et al. (2018) conceptualise FoMO as an intrapersonal trait that drives people to keep up to date with the activities of others, especially via social networking platforms. Those exhibiting strong tendencies towards FoMO tend to spend excessive time online, which can lead to procrastination of daily tasks, lower productivity, reduced academic performance (Wakefield and Frawley, 2020), and increased cognitive distraction (Al-Furaih and Al-Awidi, 2021).

A growing number of studies report significant and positive correlations between FoMO and various forms of problematic smartphone use, such as ignoring people around you in favour of mobile phone use (Franchina et al., 2018; Wolniewicz, 2020). Research has consistently shown that higher FoMO is related to greater cognitive distraction (Al-Furaih and Al-Awidi, 2021) and increased time spent on social media (Al-Saggaf et al., 2024). These results emphasize the importance of studying FoMO and its impact on behaviour, particularly in educational contexts where concentration, engagement, and achievement are critical. Despite increasing academic interest, the specific dynamics of FoMO in the classroom have not yet been sufficiently explored.

FoMO is widely recognised as a multidimensional experience. It includes personal FoMO (PFoMO), which involves internalised fears of missing out on experiences or self-affirming opportunities, and social FoMO (SFoMO), which refers to social comparison and perceived exclusion from interactions with peers (Zhang et al., 2020; Çelik and Özkara, 2022). These dimensions have been linked to various maladaptive outcomes, including Internet addiction (Harorli and Harorli, 2024), impaired metacognition (Rosen et al., 2018), and increased susceptibility to distraction and disengagement during academic tasks (Al-Furaih and Al-Awidi, 2021).

While smartphones and social media platforms offer benefits such as instant access to information and enhanced communication (Al-Furaih and Al-Awidi, 2021), their constant use, especially during class time, is associated with distraction, poor self-regulation, and decreased academic performance (Rosen et al., 2018; O'Brien et al., 2023). This is particularly problematic when smartphone use is driven by FoMO, rather than instrumental needs.

Problem Statement

Although FoMO has been shown to correlate with distraction and excessive social media use, little is known about how demographic, academic, and digital behaviour-related factors contribute to the prevalence of FoMO among students, particularly in university classrooms. A clearer understanding of the prevalence and predictors of FoMO may offer important insights into the psychological processes behind student disengagement and help to develop more effective interventions to promote academic concentration and well-being.

Recent empirical work has emphasised the dual role of FoMO as both a result of excessive digital engagement and a driver of problematic use. For example, Rosen et al. (2018) found that FoMO mediates the relationship between excessive smartphone use and academic impairment through reduced attention to learning and maladaptive metacognitive attitudes towards technology in the classroom. Similarly, Al-Furaih and Al-Awidi (2020) demonstrated that higher levels of FoMO were significantly associated with distracted attention and disengagement in learning during lectures. Harorli and Harorli (2024) confirmed these relationships and showed a moderate to strong positive correlation between FoMO, internet addiction, and time spent online among university students. However, few studies holistically explored FoMO in the classroom, examining not only prevalence but also modulation by demographic and behavioural variables such as age, year of study, internet use patterns, and smartphone habits in class. While previous research suggests that FoMO decreases with age and academic maturity (Çelik and Özkara, 2022), the interplay with specific behaviours such as where students place their phones during lectures or the reasons why they check them has not yet been sufficiently explored.

This study seeks to address the existing gaps by examining the prevalence and predictors of FoMO among university students in a classroom context, focusing specifically on the influence of demographic factors (e.g., gender, faculty, year of study), the relationship between FoMO and digital habits (e.g., device use, daily internet access, app preferences), and the impact of smartphone behaviour in the classroom on PFoMO and SFoMO.

Using a validated Turkish adaptation of the FoMO scale (Çelik and Özkara, 2022), this study offers empirical evidence on how internal and socially oriented FoMO dimensions vary across different subgroups and behaviours of students. By incorporating findings from recent literature and our quantitative data, this study contributes to knowledge of the cognitive and emotional foundations of FoMO and provides information for developing strategies to promote healthier digital habits in the academic environment.

This study aims investigate university students' FoMO in the classroom, and identify the main influencing factors. More specifically, this research seeks to

- Determine the prevalence of FoMO among university students,
- Examine the influence of demographic variables such as gender, faculty/school and year of study,
- Investigate the influence of digital habits on FoMO, such as daily internet use, and the most used applications on the phone.

Method

Research Design and Context

This study employed a quantitative survey design to examine the influence of demographic and behavioural factors on university students' FoMO. A survey design was selected as it allows for the assessment of FoMO prevalence and facilitates comparison of FoMO levels across demographic and behavioural groups. It offers a reliable and efficient method for obtaining a broad overview of students' FoMO experiences within a university context. Data were gathered through an online survey of students at a private, internationally accredited university in Northern Cyprus. The institution, recognised as one of the leading providers of higher education in the region, has approximately 20,000 students and offers 54 undergraduate and 60 postgraduate degree programmes. Classes are conducted in both Turkish and English. The university's diverse academic environment and international student body provided an appropriate setting for the study of FoMO and its correlates in a contemporary higher education context.

Participants

The study's target population was the university students. A total of 273 students participated in the online survey, which was conducted over five months from December 2023 to May 2024. No specific sampling technique was used, instead, the study aimed to reach all students enrolled at the university.

Instrument

The University Students' Online Survey (USOS) was used to collect data. The USOS was divided into three sections. The first section gathered demographic information through 12 questions aimed at capturing students' gender, age, year of study, academic performance (GPA), and daily use of technological tools. This section also explored students' preferred applications,

media tools, the frequency with which they felt the need to check their phones, and where they typically kept their phones during class.

The second section was the FoMO scale in USOS. FoMO scale contained 9 items measured using a 7-point Likert scale (1 = Strongly Disagree to 7 = Strongly Agree). This scale, developed by Zhang et al. (2020) and adapted into Turkish by Çelik and Özkara (2022), was designed to assess FoMO in the context of social media. The 9 items were divided into two subscales: PFoMO (items 1–5) and social FoMO (items 6–9). The survey was estimated to take 10 to 15 minutes to complete.

The Cronbach's alpha coefficients for PFoMO and SFoMO were 0.86 and 0.92, respectively. The total possible score for this scale ranges from 9 to 63. The reliability of the FoMO scale was assessed using Cronbach's alpha, with values of 0.91 for the total scale, 0.89 for PFoMO, and 0.89 for SfoMO for this study. These results were indicated high internal consistency.

Data Analysis

The data analysis aimed to investigate university students' levels of FoMO and its associations with various factors. Descriptive statistics were used to summarise FoMO scores and participants' demographic characteristics. To examine the effects of demographic factors on FoMO, independent samples t-tests and one-way ANOVA were conducted. Statistical analyses were carried out with a statistical software package for the social sciences, with the significance level set at $\alpha = 0.05$.

Results

Profile of University Students

A total of 273 university students participated in the study, consisting of 128 female students (46.9%) and 145 male students (53.1%). Age distribution analysis indicated that the most of students were between the ages of 18–20 (N=116, 42.5%) and 21–23 (N=127, 46.5%). In terms of academic standing, second-year students constituted the largest group (N=103, 37.7%), followed by first-year students (N=95, 34.8%) and third-year students (N=64, 23.4%). Regarding faculty representation, the Faculty of Engineering had the highest number of participants (N=106, 38.8%), followed by the Faculty of Education (N=66, 24.2%) and the Faculty of Pharmacy (N=59, 21.6%). An analysis of students' academic performance (GPA) revealed that the largest proportion of students had GPAs within the 2.00–2.49 range, representing 27.8%, closely followed by 27.5% of students within the 0.00–1.99 GPA range.

Digital Behaviours Profile

Habitual

As part of the demographic survey, participants were asked about their use of technological devices, daily internet usage, and the applications to which they devoted the most time. The results demonstrated that smartphones were the most frequently used devices, with 89.7% of students reporting substantial usage. In addition, a majority of students reported spending 4 to 6 hours daily on the internet (N=116, 42.5%). With regard to smartphone applications, social media platforms were the most commonly used (N=174, 63.7%), followed by video, music, and film applications (N=34, 12.5%). When asked about the most frequently used social media platforms, Instagram emerged as the most popular (45.1%), followed by WhatsApp (18.7%).

In-Class

Students were further inquired about their smartphone behaviours during lectures, including the frequency of phone checks, their placement during class, and the reasons behind their usage. The findings revealed that 32.2% of students checked their smartphones approximately twice per lecture, while 28.8% indicated they checked their phones 3–4 times on average. The majority of students (49.3%) placed their smartphones on their desks during lectures, with the primary reason for checking phones being to view message notifications (36.6%).

Prevalence of FoMO among University Students

To assess the prevalence of FoMO among university students, the FoMO scale was employed, which consists of several items designed to capture the intensity of participants' FoMO experiences.

Descriptive analysis of the FoMO scale revealed that the total score ranged from 9 to 63, with a mean of 26.32 (*SD* = 12.31) out of a maximum possible score of 63. This indicates a moderate level of FoMO in the student sample. The scale consists of two sub-dimensions: PFoMO and SFoMO, which assess different aspects of the construct. Scores for the PFoMO subscale, which measures internalized emotional and cognitive reactions to missing out, ranged from 5 to 35, with a mean of 16.14 (*SD*=7.68), indicating that participants reported moderate tendencies to experience FoMO on a personal level. Similarly, scores for the SFoMO subscale reflecting concern about one's social status and integration ranged from 4 to 28, with a mean of 10.18 (*SD*=6.02), suggesting comparatively lower levels of social FoMO. Taken together, these results suggest that while students exhibit a noticeable level of FoMO, their concerns are more about themselves than about perceived social exclusion or disconnection. The relatively large standard deviations in both subscales also indicate considerable individual differences in the experience of FoMO among the participants. Table 1 displays the mean and standard deviation for each scale item.

Table 1. *The mean and standard deviation values for each item on the FoMO scale.*

Item	Mean ($\bar{X}$)	SD
I feel anxious when I do not experience events/opportunities	3.35	1.817
I believe I am falling behind compared with others when I miss events/opportunities	3.15	1.847
I feel anxious because I know something important or fun must happen when I miss events opportunities	3.28	1.832
I feel sad if I am not capable of participating in events due to constraints of other things	3.26	1.858
I feel regretful of missing events/opportunities	3.10	1.872
I think my social groups view me as unimportant when I miss events/opportunities	2.59	1.751
I think I do not fit in social groups when I miss events/opportunities	2.70	1.843
I think I am excluded by my social groups when I miss events/opportunities	2.42	1.634
I feel ignored/forgotten by my social groups when I miss events/opportunities	2.47	1.719

The analysis of the FoMO scale items revealed varying degrees of emotional and cognitive responses associated with the FoMO. Among all items, the highest mean score was observed for the item "I feel anxious when I do not experience events/opportunities" ($\bar{X}$= 3.35, *SD*= 1.82), indicating a mild yet relatively more common experience of general anxiety in relation to missing events. Similarly, participants reported elevated feelings of anxiety over the perceived importance or enjoyment of missed events, as reflected in the item "I feel anxious because I know something important or fun must happen when I miss events/opportunities" ($\bar{X}$= 3.28, *SD*=1.83). Emotional discomfort was also evident in the item "I feel sad if I am not capable of participating in events due to constraints of other things" ($\bar{X}$= 3.26, *SD*=1.86), suggesting that social limitations can provoke negative affective reactions.

Participants moderately agreed with the perception of falling behind compared with others when they miss events/opportunities ($\bar{X}$= 3.15, *SD*=1.85), and a similar trend was found for feelings of regret ($\bar{X}$= 3.10, *SD*=1.87), indicating that FoMO may be partially driven by social comparison and self-reflection. On the other hand, items addressing social implications of missing events such as being perceived as unimportant ($\bar{X}$= 2.59, *SD*=1.75), feeling excluded ($\bar{X}$= 2.42, *SD*=1.63), or ignored/forgotten ($\bar{X}$= 2.47, *SD*=1.72) by social groups, received lower mean scores, suggesting that participants generally do not associate missing events with social rejection or diminished social standing. Likewise, the item "I think I do not fit in social groups when I miss events/opportunities" ($\bar{X}$= 2.70, *SD*=1.84) indicated only a weak sense of social misfit. Overall, the findings suggest that participants' FoMO is more closely linked to internalized emotional and comparative concerns than to fears of overt social exclusion.

FoMO and Gender

An independent samples t-test was conducted to examine gender differences in university students' FoMO scores. Results indicated that female students ($\bar{X}$ = 25.63, *SD*=1.168) had lower FoMO scores than male students ($\bar{X}$ = 26.94, *SD* = 11.462). No significant mean differences was found between females and males, *t*(271) = -0.879, p =0.05.

To further investigate gender differences, t-tests were also performed for each FoMO sub-scale. For the PFoMO sub-scale, no significant difference was found between females ($\bar{X}$ = 15.81, *SD*=8.025) and males ($\bar{X}$ = 16.43, *SD*=7.383), *t*(271) = -0.659, p =0.243. Similarly, the SFoMO scale showed no significant difference between female ($\bar{X}$=9.81, *SD* = 6.254) and male students ($\bar{X}$ = 10.51, *SD*=5.811), *t*(271) = -0.955, p =0.505.

FoMO and Age

This study examined the effect of age on university students' FoMO, as measured by the FoMO scale. A one-way ANOVA revealed a significant difference in FoMO scores across four age groups: 18-20, 21-23, 24-26, and more than 26 ($F(3, 269) = 2.926$, $p < 0.05$). Due to an insignificant Levene's test, Tukey's post-hoc was used. Results showed that university students in age 18-20 ($\bar{X}$= 28.33, *SD*=13.095) had significantly higher FoMO scores compared to those 21-23 ($\bar{X}$= 24.24, *SD*=11.207). ANOVA results revealed no significant difference between FoMO sub-scales. The results of the ANOVA test revealed no

significant difference between PFoMO and age (F(5,267)=2.027, p>0.05), SFoMO and age (F(5,267)=3.181, p>0.05), respectively.

FoMO and Academic Year

This study examined the effect of academic year on university students' FoMO. A one-way ANOVA revealed a significant difference in FoMO scores across four academic year groups (first, second, third and fourth), F (3,269) = 6.569, p < 0.05). Due to an insignificant Levene's test, Tukey's post-hoc test was used. The test indicated that the mean score for university students in first year of study ($\overline{X}$=28.97.20, SD=12.127) was significantly different from the mean score for university students in third year of study ($\overline{X}$=22.20, SD=11.931) and fourth year of study ($\overline{X}$=16.60, SD=6.637). Furthermore, ANOVA indicated that the mean score for university students in second year of study ($\overline{X}$=27.36, SD=12.159) was significantly different from the mean score for university students in third year of study ($\overline{X}$=22.20, SD=11.931) and fourth year of study ($\overline{X}$=16.60, SD=6.637). The mean differences were significant at the 0.05 level.

ANOVA results revealed significant difference between FoMO sub-scales. The results of the ANOVA test revealed significant difference between PFoMO and academic year (F(3,269)=5.154, p<0.05), SFoMO and academic year (F(3,269)=5.378, p<0.05), respectively. ANOVA indicated that the mean score for university in first year of study ($\bar{X}$=17.56, SD=7.466) was significantly different from the mean score for university students' in third year of study ($\bar{X}$=13.97, SD=7.614) and fourth year of study ($\bar{X}$=10.30, SD=4.448) in PFoMO sub-scale. Furthermore, ANOVA results indicated that the mean score for university in first year of study ($\bar{X}$=11.41, SD=6.359) was significantly different from the mean score for university students' in third year of study ($\bar{X}$=8.23, SD=5.503) and fourth year of study ($\bar{X}$=6.30, SD=2.710) in SFoMO sub-scale.

FoMO and Academic Achievement (GPA)

This study investigated whether the extent of FoMO in university students differs according to academic performance (GPA). Students were categorised into four GPA groups: 3.00–4.00, 2.50–2.99, 2.00–2.49 and 0–1.99. A one-way ANOVA revealed a significant main effect of academic performance on total FoMO scores, F(3, 269) = 5.877, p < 0.05. Levene's test for homogeneity of variances was not significant (p = .923), indicating that the assumption of homogeneity was met. Post-hoc comparisons using Tukey's HSD test showed that students with GPAs of 3.00–4.00 reported significantly lower overall FoMO scores than students with GPAs of 2.50–2.99 and 0–1.99. No statistically significant differences were found between the groups with GPAs of 3.00–4.00 and 2.00–2.49, as well as other group comparisons. These results suggest that higher academic achievers (GPA 3.00–4.00) tend to have lower levels of FoMO than their lower achieving peers. The results for the sub-dimensions of FoMO also confirmed this pattern. A significant effect of academic performance was found for PFoMO, F(3, 269) = 4.770, p < 0.05. The Tukey post-hoc test showed that the students in the group with a GPA of 3.00–4.00 had significantly lower PFoMO scores than the students in the groups with a GPA of 2.50–2.99 and 0–1.99. No other significant differences were found. Similarly, a significant effect of academic performance was observed for SFoMO, F(3, 269) = 5.427, p < 0.05. Students in the 3.00–4.00 grade point average group had significantly lower SFoMO scores than students in the 2.50–2.99, 2.00–2.49, and 0–1.99 grade point average groups.

FoMO and Devices

This study also investigated whether students' FoMO levels varied depending on the primary device they used to access the internet: smartphone, laptop, PC or tablet. A one-way ANOVA was conducted to assess the differences in overall FoMO scores and their subscales (PFoMO, SFoMO) between these device groups.

The results of the ANOVA showed no significant differences in FoMO total scores between the different device groups, F(3, 269) = 1.714, p = 0.164. Similarly, no significant differences were found for PFoMO, F(3, 269) = 1.487, p = 0.218, or for SFoMO, F(3, 269) = 1.469, p = 0.223.

These results indicate that the type of device predominantly used (smartphone, laptop, PC or tablet) has no significant influence on the students' FoMO experience, regardless of whether the total FoMO scores or the subscales are considered.

FoMO and Time Spend

The results of the one-way ANOVA conducted to examine differences in FoMO levels based on daily social media use showed a statistically significant difference in overall FoMO scores between groups, F(3, 269) = 2.65, p = .049. Participants who reported spending more than 6 hours per day on social media ($\bar{X}$ = 28.55, SD = 12.87) had significantly higher overall FoMO scores than those who used social media for less than 1 hour per day ($\bar{X}$= 16.20, SD = 8.04). Similarly, the analysis showed a significant difference in PFoMO scores between usage groups (F(3, 269) = 3.91, p = .009), with the highest mean score again observed among those who spend 6 or more hours on social media ($\bar{X}$ =17.55, SD = 7.98) and the lowest among those who use it for less than 1 hour ($\bar{X}$ =8.60, SD = 4.34). These results suggest that people who spend more time on social media tend to experience higher levels of general and personal FoMO. However, no statistically significant difference was found for the social FoMO, F(3, 269) = 0.84, p = 0.476, suggesting that momentary or context-dependent FoMO is not strongly influenced by the amount of time spent on social media.

FoMO and Purpose of Internet Use

ANOVA was conducted to examine whether FoMO levels differed significantly based on participants' primary purpose of internet use. The analysis showed that there was no statistically significant difference in overall FoMO scores among the different usage purpose groups, F(6, 266) = 1.39, p = 0.219. Similarly, no significant differences were found for the PFoMO scores, F(6, 266) = 1.75, p =0 .110, nor for SFoMO scores, F(6, 266) = 0.76, p = .602. These findings suggest that individuals' FoMO experiences do not vary meaningfully depending on whether they primarily use the internet for messaging, social media, emailing, browsing, watching videos, conducting research, or educational purposes.

FoMO and Platforms

An ANOVA was conducted to investigate whether the FoMO level of the individuals differed significantly depending on the social media platform they used most frequently. The analysis revealed that there was no statistically significant difference in overall FoMO scores between platform groups, *F*(6, 266) = 0.90, p = .495. Similarly, there was no significant difference in PFoMOscores, *F*(6, 266) = 1.46, p = .191, and also not for the social FoMO values, F(6, 266) = 0.85, p = .535. These results indicate that the participants' FoMO values do not differ significantly depending on whether their preferred platform is WhatsApp, Instagram, TikTok, X (Twitter), YouTube, Snapchat or Facebook/Telegram.

FoMO and Behaviours during a Class Period

An ANOVA was conducted to investigate whether FoMO scores differed depending on where participants placed their phones during class. The analysis revealed a statistically significant difference in SFoMO scores between the four groups (*F*(3, 269) = 3.17, p = 0.025), suggesting that the location where the phone is kept during class is related to variations in social FoMO. Participants who kept their phone under their seat reported the highest SFoMO scores ($\bar{X}$ =15.18, *SD* = 8.93), compared to those who kept their phone on their desk ($\bar{X}$ =9.60, *SD* = 5.92) or in their pocket ($\bar{X}$ = 10.57, *SD* = 5.76). However, no significant group differences were found in either the FoMO scores (F(3, 269) = 1.73, p = .160) or the PFoMO scores (*F*(3, 269) = 1.20, p = 0.312).

Post-hoc comparisons using Tukey's HSD test revealed that participants who kept their phone under their seat reported significantly higher SFoMO scores ($\bar{X}$ =15.18, *SD* = 8.93) than those who kept their phone on their desk ($\bar{X}$ =9.60, *SD* = 5.92), p = .016. No other pairwise comparison reached statistical significance, although the difference between the "under the seat" and "in the pocket" groups approached significance (p = .050). These results suggest that individuals who do not have immediate visual or physical access to their phone during class may experience higher social FoMO. However, no significant group differences were found in personal FoMO scores (*F*(3, 269) = 1.20, p = .312) or overall FoMO scores (*F*(3, 269) = 1.73, p = .160).

ANOVA was conducted to investigate whether FoMO scores differed depending on the main reason participants check their phone during class. The analysis revealed a statistically significant difference in SFoMO scores between the six groups, *F* (5,267) = 2.59, p = .026. Post-hoc comparisons using Tukey's HSD test revealed that participants who used their phones primarily for social media reported significantly higher SFoMO scores than participants who used their phones primarily for messaging, p = .023. No other pairwise comparisons reached statistical significance. In contrast, there was no statistically significant difference in PFoMO scores, F(5, 267) = 1.14, p = .341, or in Total FoMO scores, F(5, 267) = 1.60, p = .160. These results suggest that only social FoMO scores are sensitive to users' motivations for checking their phones, while personal and overall FoMO scores are unaffected.

Discussions

The demographic and behavioural profiles of the university students in this study offer important insights into the broader context in which digital engagement and potential FoMO experiences occur. The sample, mainly first- and second-year students aged 18–23, represents a developmental stage marked by increased social networking and identity exploration, both known to correlate with higher digital activity. The overrepresentation of engineering students and the moderate distribution of academic achievement (with many students having grade point averages below 2.50) may suggest varying levels of academic engagement and potential academic stress, which could influence media use as a form of escapism or social compensation.

In line with global trends, the overwhelming reliance on smartphones (89.7%) and the dominant use of social media apps (63.7%), particularly Instagram, emphasise the central role of digital platforms in students' lives. Notably, almost a third of respondents reported checking their smartphones multiple times during lectures, primarily to read news, indicating habitual digital distraction that impairs attention and academic focus. These patterns reflect normalised constant connectivity and may suggest underlying social anxiety or perceived obligations to remain digitally accessible, potentially reinforcing FoMO tendencies. Together, these findings highlight the need to understand how digital habits relate to academic identity, social belonging, and psychological well-being.

The data suggest that FoMO is primarily intrapersonal and emotional, and is reinforced by internal expectations rather than external judgements. FoMO should not only be seen as a social media-driven phenomenon, but also as an expression of psychological needs for self-affirmation, productivity, and experiential fulfilment. The answers on the FoMO scale indicate that the fear of missing out or having fun is more widespread than the explicit fear of social exclusion. Lower scores on items relating to social rejection suggest that FoMO is more about missing out on personally meaningful experiences than fear of exclusion.

Age and year of study also influence FoMO levels. Younger students (18–20) report higher FoMO scores than older peers, possibly due to greater social media engagement and increased susceptibility to social comparison. Shane-Simpson and Bakken (2024) similarly found that younger students experience higher FoMO and engage more with distraction-prone platforms such as Instagram and Snapchat during class. First- and second-year students report significantly higher FoMO than third- and fourth-year students, reflecting their earlier stage of building social networks and adjusting to university life. These younger students also score higher on the personal and social FoMO subscales (PFoMO and SFoMO), suggesting greater concern with social relationships and the sense of well-being derived from social experiences. These findings illustrate the natural developmental process of university students, in which older and more academically advanced students experience lower FoMO as they consolidate social networks, clarify academic goals, and gain emotional maturity.

Academic performance was negatively associated with FoMO. Students with higher GPAs (3.00–4.00) have lower overall, personal, and social FoMO scores, possibly due to better time management, academic self-efficacy, and focus on educational goals. This relationship appears strongest at the extremes of academic success. Similarly, the results of the study conducted by Al-Furaih and Al-Awidi (2020) indicated that FoMO among university students is linked to greater distractibility and lower participation in learning. Supporting students with lower GPAs may help reduce the negative effects of FoMO on mental health and academic engagement.

Interestingly, the present study found that the type of device used (smartphone, laptop, PC, tablet) did not significantly affect FoMO levels. This suggests that FoMO is influenced more by individual differences, social dynamics, and usage behaviour than by the device itself. This finding is supported by previous research on smartphone use and FoMO. For example, Song and Kim (2021) examined the relationships between types of smartphone use, FoMO, adolescents' social support and their smartphone usage in Korea. Their cross-sectional study revealed that FoMO and specific types of smartphone use were positively associated with increased screen time, while educational activities and parental support were negatively associated. Although their study focused on usage type rather than device type, it highlights that behavioral and intrapersonal factors, rather than the physical device, are key determinants of FoMO-related outcomes. Therefore, the present study contributes to the existing literature by demonstrating that device type alone does not appear to influence FoMO levels, emphasizing the psychological and behavioral nature of this phenomenon in university students.

The results further demonstrate that the level of FoMO does not differ significantly depending on which social media platform is used most frequently. This suggests that the FoMO experience is not exclusively linked to a specific platform such as Instagram, TikTok or WhatsApp, although it is generally assumed that certain platforms are more likely to trigger such feelings. This indicates that FoMO is a general response to digital social engagement rather than a function of specific platform features. One possible explanation is that users often use multiple platforms simultaneously, making it difficult to isolate the psychological impact of a single platform. These findings are consistent with O'Brien et al. (2023), who emphasise that platform-independent digital behaviours, such as frequency and motivation for use, are stronger predictors of FoMO than the media environment itself.

The results offer empirical evidence that greater time spent on social media is linked to higher levels of FoMO and PFoMO. Participants who reported spending more than six hours per day on social media platforms had significantly higher FoMO scores than those with minimal use, particularly on the dimensions of overall FoMO and PFoMO. This suggests that individuals who use social media for extended periods of time are more prone to persistent concerns about being excluded from the experiences of others, as well as increased sensitivity to personal marginalisation. Conversely, the groups did not differ significantly with respect to SFoMO, suggesting that short-term or FoMO may not be influenced by duration of use alone.

The results of the study show that the physical location of the mobile phone during class is associated with significant differences in university students' SFoMO scores. Specifically, participants who kept their mobile phone under their seat reported significantly higher SFoMO scores than those who placed their phone on their desk. This suggests that limited visual or physical access to the phone may increase worry about missing out. When individuals cannot easily monitor or check their phone, their awareness of potential digital interactions or notifications may increase, resulting in a higher SFoMO score. While comparisons with other groups (e.g., phone in pocket) did not attain statistical significance, the pattern suggests a possible link between accessibility and the level of FoMO. In contrast, no significant differences were found in PFoMO or FoMO total scores, indicating that stable, trait-based FoMO experiences are not as sensitive to momentary contextual factors such as phone placement. These findings contribute to understanding how environmental conditions can temporarily exacerbate digital anxiety, particularly in environments where phone use is restricted or undesirable.

The present findings suggest that the underlying reason for checking the phone is associated with significant differences in SFoMO levels. Specifically, participants who reported social media as their primary reason for using their phone during class had significantly higher SFoMO scores than those who primarily used their phone for messaging. This difference may be because social media platforms are real-time, interactive, and constantly updated, which can heighten the feeling of missing out on immediate social content or events. Messaging, by contrast, is often more asynchronous and less immersive, potentially resulting in lower social FoMO. Although other reasons, such as receiving notifications, searching for academic content, or habitual checking, did not show significant differences, the descriptive patterns suggest that socially oriented phone use may increase social FoMO more than task-oriented or passive use.

Although previous studies have mainly examined adolescents rather than university students, they provide relevant conceptual support for these findings. For example, Song and Kim (2022) reported a positive relationship between social media use and FoMO among Korean adolescents, while more educational or structured uses showed negative associations. Similarly, Zhang (2023) highlighted that FoMO is strongly linked to mobile phone engagement and motivations for social interaction. These studies suggest that FoMO is more strongly driven by behavioural and psychological factors, particularly socially oriented digital engagement, rather than merely by phone use, a pattern that appears to extend beyond adolescence to university students as well.

Conclusions

This study explored the FoMO among university students in classroom contexts, aiming to identify its prevalence and associated demographic and behavioural predictors. The findings highlight the complex interplay between developmental status, academic factors, and digital behaviour in shaping students' FoMO experiences. The ubiquitous use of smartphones and social media, combined with academic pressures and social needs, creates an environment in which habitual digital connectivity intersects with psychosocial demands. The results suggest that FoMO among students is largely driven by internal emotional processes related to self-concept and productivity rather than by fear of social exclusion. This finding aligns with the theoretical framework proposed by Zhang et al., which conceptualizes FoMO as self-concept vulnerability rather than merely peer-related anxiety.

Since younger students (18-20 aged) and those early study years (1st and 2nd study year students) are particularly vulnerable to FoMO, the importance of targeted interventions that address emotion regulation, cognitive reframing, and coping mechanisms have resurfaced. Interventions should go beyond reducing social comparisons and address the psychological needs for social connection and academic identity.

As academic achievement appears to inversely affect FoMO, supporting students' academic skills and psychological resilience seems beneficial. Since device type does not influence FoMO, efforts to mitigate FoMO should focus on personal and social factors rather than technical variables. Future research should explore causal relationships between FoMO and academic outcomes, the role of media usage intensity, and develop holistic intervention strategies that address both behavioural and emotional dimensions. Ultimately, promoting a balanced relationship with digital media may enhance students' academic performance, psychological wellbeing, and social satisfaction. Interventions aiming to reduce FoMO and its academic consequences should prioritise self-regulation, mindfulness, and time management training, especially for undergraduates in the early study years.

Moreover, as platform use does not account for variations in FOMO, future research should investigate the motivational, cognitive, and emotional foundations of FOMO beyond digital access. Mixed-methods and longitudinal approaches are necessary to examine how digital behaviour, psychological wellbeing, and academic engagement interact over time. In this study, we considered both the habitual and in-class digital behaviours of university students. The findings indicate that students' FOMO levels are not significantly influenced by their primary reason for using the Internet. Whether the Internet is used for communication, entertainment, education, or information seeking, students tend to experience similar levels of general, personal, and social FOMO. These results highlight the need to move beyond superficial patterns of overuse in educational contexts. Future research could benefit from incorporating mixed methods to explore the subjective experiences underlying digital engagement, and from investigating interaction effects between purpose of use, frequency, and individual differences such as personality traits or tendencies towards social comparison.

Regardless of whether people primarily use WhatsApp, Instagram, TikTok, YouTube or other platforms, their experiences of FoMO appear to be consistent. These findings highlight the importance of considering broader psychosocial and individual factors, rather than attributing FoMO mainly to the type of platform. Future research should examine how individual differences such as personality traits, digital habits or coping strategies interact with media use and influence FoMO. In addition, longitudinal studies could help clarify whether platform-specific characteristics contribute to FoMO over time or whether the effect is more stable and consistent across platforms.

The study found that SFoMO scores varied according to where students kept their phones during class, with the highest scores among those who placed their phones under their seats. This suggests that greater physical distance from the device

may increase SFoMO. However, no significant differences were observed in PFoMO or overall FoMO, indicating that these scores remain relatively stable regardless of contextual factors. These findings highlight the impact of phone accessibility on digital engagement and may help teachers manage device-related distractions without unintentionally increasing students' FoMO. Further research could examine whether enhancing students' self-regulation or awareness of digital habits can mitigate these effects. Educators may also benefit from strategies that reduce the social-emotional friction caused by digital restrictions, such as integrating purposeful phone use into lectures or providing in-class breaks for digital check-ins, thereby balancing academic focus with students' need for connectedness.

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Prospective Teachers' Views on Professional Teaching Knowledge Courses in the Context of Teaching Practice

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Abstract

Teachers' ability to create effective learning environments in their subject areas is closely related to the Professional Teaching Knowledge (PTK) courses, which constitute one of the three core components of teacher training programs. This research aims to examine prospective teachers' views on PTK courses in subject-matter teaching in the context of their Teaching Practice experiences. A basic qualitative research design was used. The research was carried out with prospective teachers who study chemistry and mathematics teaching programs. The data were collected with a form created by researchers. By subjecting data to descriptive analysis, two themes were formed as "PTK courses considered important in subject-matter teaching" and "views on the impact of PTK courses in subject-matter teaching". As a result of research, "Instructional Principles and Methods, Educational Psychology, Classroom Management, Instructional Technologies" are listed among courses that have an important impact on subject-matter teaching; "Introduction to Education, Educational Philosophy, Turkish Education History, Turkish Education System and School Management" are listed among courses that have no impact. Regarding impact of PTK courses on practice, participants mostly expressed their views on transformation of theoretical knowledge into practice, but they also provided explanations with reasons for inability to use theoretical knowledge in practice. In this sense, research findings are thought to guide researchers and educators in terms of updating and regulating content and practices of teacher training programs.

Keywords: *Subject-matter teaching, Professional teaching knowledge course, Teaching practice experiences, Prospective teachers*

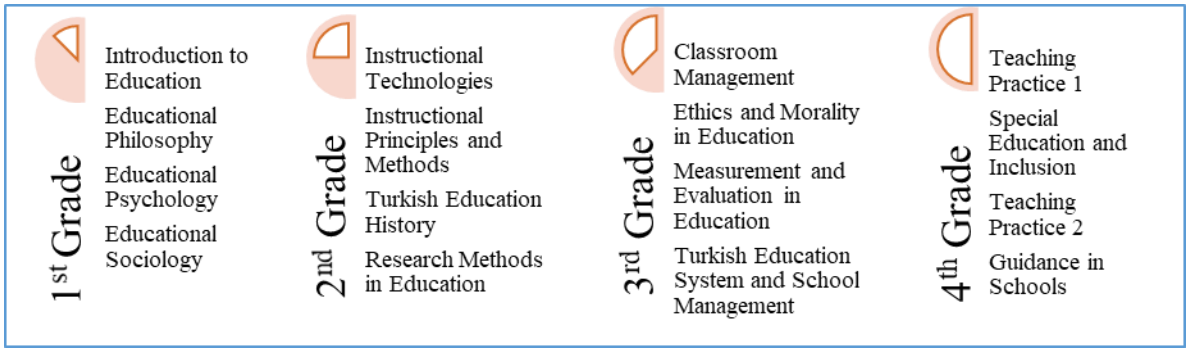
Introduction

Teacher training programs include three areas: subject-matter knowledge, professional teaching knowledge, and general cultural knowledge. Teachers are expected to specialize primarily in subject-matter knowledge. However, it is not enough to specialize in subject-matter knowledge for effective teaching (Işıksal Bostan & Osmanoğlu, 2016). Teaching is a special profession that requires specialization in a certain field, based on instructional knowledge and skills, and some personal characteristics required by the profession (Hotaman, 2010; Taşgın & Sönmez, 2013). Considering the needs of society in different periods, the knowledge, skills, and qualifications expected of teachers have also varied. In the literature, research on the knowledge that teachers are expected to possess has been discussed mainly in terms of "subject-matter knowledge, professional teaching knowledge, and general cultural knowledge" (Gess-Newsome, 1999; Nakiboğlu & Karakoç, 2005). The preparation of teachers for this profession by having the specified qualifications and their professional development is ensured primarily through undergraduate education (prospective training) and then through in-service training.

In Türkiye, following the teacher training function was transferred to the universities in 1982, teacher training undergraduate programs were reorganized in 1997, 2006, 2009, and 2018 (Council of Higher Education [CoHE], 2018a). "The New Teacher Training Undergraduate Programs", which came into effect in 2018, were determined by the CoHE and were expected to be implemented by all teacher training programs. This is one of the most significant features of this program that distinguishes it from other teacher training undergraduate programs from the past to the present. The teacher training program, which has been in effect since the 2018-2019 academic year, is a program that includes courses in "field education, professional teaching knowledge, and general culture". The program includes 45-50% of Field Education (FE) courses, 30-35% of Professional Teaching Knowledge (PTK) courses, and 15-20% of General Culture (GC) courses (CoHE, 2018a). In the category of FE courses, there are courses that will ensure the formation of both "knowledge of subject-matter" and "subject-matter teaching knowledge". On the other hand, PTK courses provide prospective teachers with information on how to teach the knowledge they have acquired in FE courses, considering the developmental characteristics of students, and how to organize the environment in which teaching will take place (CoHE, 2007). The PTK courses in the teacher training undergraduate program in Türkiye are given in Figure 1.

Figure 1

PTK courses included in the teacher training undergraduate program in Türkiye



PTK courses are included in each teaching training program and the order in which these courses are taken may vary, but a common core program is carried out. Among these courses, prospective teachers take all PTK courses except Teaching Practice 1 and Teaching Practice 2 with prospective teachers from other programs.

Teaching Practice is an important part of teacher training programs as a course that bridges theory and practice (Zhao & Zhang, 2017). In Türkiye, prospective teachers take Teaching Practice 1 and Teaching Practice 2 courses in the last two semesters of their senior year, in which they practice subject-matter teaching. Unlike other PTK courses, with these courses, prospective teachers experience for the first time being together with students in a real classroom environment, the experience of teaching, feeling, and acting like a teacher, in other words, "the teaching experience".

Teaching Practice courses are carried out in cooperation with the higher education institution and the Ministry of National Education (MoNE). In line with the identified learning outcomes, prospective teachers attend placement schools for 6 hours a week for 12 weeks. Placement schools are determined by the course instructor at the higher education institution, and the necessary permissions are obtained from the MoNE and governorships for students to attend these schools. The activities to be carried out by the prospective teachers within the scope of this course are carried out in cooperation with both the course instructor at the higher education institution and the teacher in charge at the placement schools. In line with the learning outcomes of these courses, prospective teachers carry out activities such as making observations in placement schools and writing reports on their observations, micro-teaching practices in higher education institutions, preparing lesson plans, and lecturing with the participation of course supervisors at the placement school at least twice each semester (MoNE, 2021). Lectures also cover preparing lesson plans, developing appropriate materials, organizing the classroom environment, classroom management, and assessment and evaluation. Thus, prospective teachers are expected to exhibit exemplary teacher duties, responsibilities and behaviours in a real classroom environment, as well as to transform their learning outcomes related to the PTK courses into behaviours and gain teaching experience in their own fields.

The efficiency of the courses they take in the undergraduate educational processes and their inclusion in teaching programs that will contribute to their professional development have a fundamental role in the training of teachers, who are the determining factor in the structuring of a quality educational process, as qualified teachers in their fields (Ekici, 2008; Wong & Tsu, 2007). One of the most important aspects of teacher quality is that teachers of a particular subject have specific understandings and skills that integrate knowledge of the content of that subject area with students' learning of that content (Etkina et al., 2010). The teacher's knowledge of the subject-matter is necessary but not sufficient for effective instruction. The fact that field courses and pedagogical courses are not sufficiently combined during undergraduate education causes prospective teachers to have difficulty integrating their knowledge and transforming their field knowledge into a form that students can understand (Stein, 2006). Teaching Practice courses are important for prospective teachers to use the knowledge they have acquired effectively.

Providing the necessary support to prospective teachers in teacher training programs can also improve their subject-matter teaching knowledge (Ekiz-Kiran et al., 2021). It is also stated that a teacher who has not taken PTK courses will experience various difficulties in the subject teaching process (Yüksel, 2009). Considering the importance of subject-matter teaching practices for prospective teachers, it is undeniable that the evaluation of the elements that affect the development of subject-matter teaching by prospective teachers during undergraduate education and its contribution to the improvement of programs. Examining the courses that have an impact on the professional development of prospective teachers from the perspective of prospective teachers is important both to examine the current situation and to guide program and course content updates in the future. There are studies in the literature of Teaching Practice courses conducted with prospective teachers (i.e., Aslan & Sağlam, 2018; Bektaş & Ayvaz, 2012; Purba & Maulana, 2023). In the studies, it is generally seen that the views of prospective teachers about the teaching practice process, the problems experienced during the implementation process, the expectations, and the factors affecting the quality of the process spent in the teaching practice are examined. This research aims to examine prospective teachers' views on PTK courses in subject-matter teaching in the context of their Teaching Practice experiences.

Method

Research Design

In this research, the basic qualitative research design, one of the qualitative research designs, was used. In the basic qualitative research design, researchers are interested in how people interpret their lives, the meanings they attach to their experiences, and how they construct their own worlds and aim to develop a better understanding of people's experiences (Daniel & Harland, 2018; Merriam & Tisdell, 2016).

Participants

The research was conducted with 14 prospective teachers studying at a state university in Türkiye. 5 of the prospective teachers continue their education in the mathematics teaching program and 9 of them continue their education in the chemistry teaching program. 12 of the prospective teachers were female and 2 were male. The prospective teachers who participated in the study successfully completed the Teaching Practice 1 course and completed both teaching processes in the placement schools as part of the Teaching Practice 2 course. To protect the confidentiality of the prospective teachers, they were coded as PST1, …, PST14.

Data Collection Tool and Process

The data of the research were collected with a form created by the researchers. This form included one open-ended question. The question in the form is as follows: *"What are your opinions on PTK courses in subject-matter teaching based on your experience of Teaching Practices courses? Explain with reasons."*

The form was sent by e-mail to prospective teachers who had volunteered to participate in the research. Data collection ended once the teachers had confirmed their participation and returned the completed form.

Data Analysis

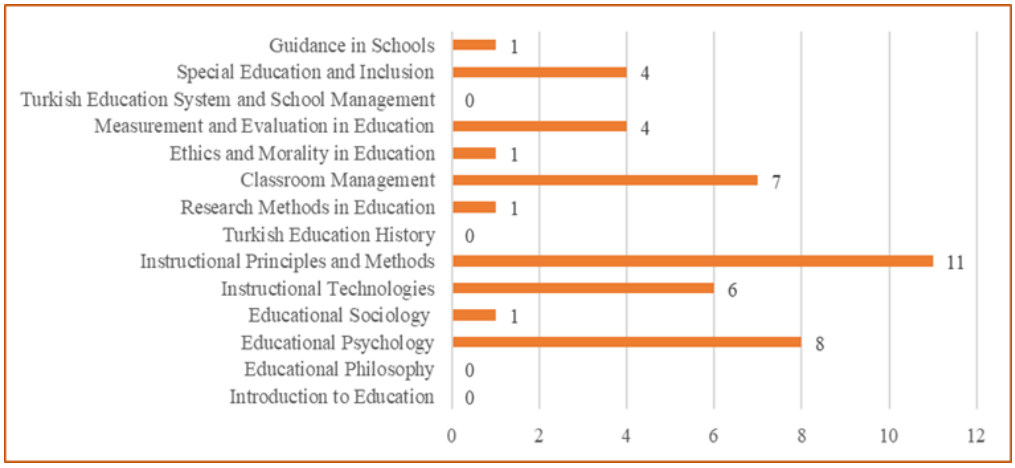
The data obtained from the research was subjected to descriptive analysis. Descriptive analysis allows the data obtained to be organized according to the themes revealed by the research questions. In this type of analysis, the aim is to present the findings to the reader in an organized and interpreted form (Yıldırım & Şimşek, 2016). Accordingly, codes, categories and themes were determined by the researchers in line with the responses given in the form. The findings obtained after this process were presented in tables and figures using descriptive statistical techniques (frequencies and percentages). Because direct quotations are frequently used in descriptive analysis to reflect the views of individuals in a striking way (Yıldırım & Şimşek, 2016), the responses of the prospective teachers were given directly.

Results

By analyzing prospective teachers' views on PTK courses in subject-matter teaching in line with their experiences within the scope of Teaching Practice courses, two themes emerged: "PTK courses considered important in subject-matter teaching" and "views on the impact of PTK courses in subject-matter teaching". The courses in the theme of PTK courses considered important in subject-matter teaching are given in Figure 2.

Figure 2

Theme: PTK courses considered important in subject-matter teaching



According to Figure 2, Instructional Principles and Methods (f=11), Educational Psychology (f=8), Classroom Management (f=7), Instructional Technologies (f=6) are the most important PTK courses in subject-matter teaching. These courses were followed by Measurement and Evaluation in Education (f=4) and Special Education and Inclusion (f=4). Introduction to

Education, Educational Philosophy, Turkish Education History, Turkish Education System, and School Management courses were among the courses that were not considered important/had no impact on subject-matter teaching. The views of prospective teachers on the first theme are as follows:

"Instructional Principles and Methods course contributes to the subject-matter teaching process. Because we learn different strategies and techniques in this course. By making lesson plans with these techniques, we can increase the motivation of students and make the lessons more permanent. For example, while explaining the topic of chemical equilibrium, I was able to strengthen the students' relationships with their friends and enable them to access information by researching and make them work in cooperation instead of lecturing." (PST2)

"The Instructional Technology course - with the help of technology - helps us to present abstract things to students in a concrete way. For example, we can show geometric proof with GeoGebra. In this way, it helps us to use technological devices on the relevant subject..." (PST9)

The prospective teacher coded PST3 stated that the Micro-teaching course, which can be taken as an elective, is one of the courses that has an important impact on subject-matter teaching.

"There are two courses whose contribution I absolutely cannot deny. Instructional Principles and Methods and Micro-teaching. In addition to these, the courses that contribute the most are Educational Psychology, Instructional Technologies and Classroom Management." (PST3)

The emerging categories and codes related to the theme "Views on the impact of PTK courses in subject-matter teaching" are given in Table 1.

Table 1

Theme: Views on the impact of PTK courses in subject-matter teaching

Category	Code	Prospective Teacher	f	%
Transformation of theoretical knowledge into practice	Ability to lecture with effective classroom management/dominance	PST2, PST4, PST5, PST11, PST12	14	61
	Ability to apply the learned instructional technologies by adapting them to their own field	PST2, PST4, PST12		
	Ability to develop and apply different measurement tools	PST2, PST4		
	Creating an interactive environment where students are active	PST7		
	Ability to put into practice the measurement and evaluation process	PST11, PST12		
	Ability to be aware of student characteristics/individual differences	PST14		
Inability to use theoretical knowledge in practice	Differences between what is learned in theory and the classroom/school environment	PST2, PST3, PST8, PST9, PST13, PST14	9	39
	Not having the opportunity/chance to apply what is learned theoretically	PST1, PST6, PST8		

When Table 1 is examined, the theme of "views on the impact of PTK courses in subject-matter teaching" includes two categories: "Transformation of theoretical knowledge into practice" (f=14, 61%) and "inability to use theoretical knowledge in practice" (f=9, 39%). In the category of transforming theoretical knowledge into practice, prospective teachers explained that the theoretical knowledge they acquired within the scope of PTK courses in their undergraduate education found a place in the subject-matter teaching process in practice with the experiences of "classroom management, developing measurement tools, measurement and evaluation process, making use of instructional technologies, being aware of student characteristics and creating learning environments where students are active". The views on this theme are as follows:

"I can apply subjects that I learned in the Classroom Management course such as teacher-student relationship and classroom rules at the placement *school. Thanks to the applications we learned on the Instructional Technologies course, I can say that I observed that students' interest and enthusiasm for the lesson increased. Since the different measurement tools, we prepare*

enable students to see different questions, it is possible to see differences in both the interpretation of the results and the behaviour of the students." (PST2)

The category of inability to use theoretical knowledge in practice was shaped by the prospective teachers' explanations about the difference between what was learned in theory and the classroom/school environment, and that they could not find the opportunity/chance to apply what was learned in theory. Examples of the explanations of prospective teachers are as follows:

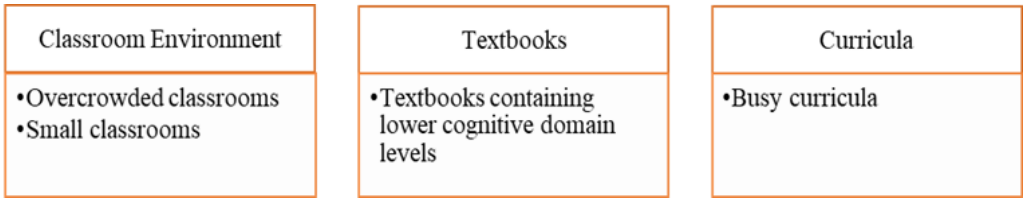
"We have not had the chance to apply a lot of things we have learned theoretically." (PST1)

"The courses we took were, of course, based on theory. However, at the placement school, I tried to get used to the situation for a certain period when I realized that the courses I took, and the classroom environment were not the same." (PST14)

When the views of prospective teachers regarding this category were examined, it was determined that they related the reasons why theoretical knowledge could not be used in practice with the "classroom environment, textbooks and curricula" factors.

Figure 3

The reasons why theoretical knowledge cannot be used in practice



Examples of prospective teachers' views on the reasons why theoretical knowledge cannot be used in practice are as follows:

"It is not possible to apply the instructional models, methods and techniques we learn in the Instructional Principles and Methods course because the classes are small and crowded." (PST2)

"Since the class was too crowded, I could not use the methods/techniques I learned theoretically in the Teaching Practice course. Since the content of the textbooks is more at the level of knowledge and comprehension, it becomes difficult for us to expect students to go up to application and analysis steps." (PST6)

Discussion

Placement schools are the first place where prospective teachers put into practice the knowledge, skills, and experiences of all the courses they have taken during their undergraduate education through their senior year and continue to take in their senior year and can experience teaching subject-matter in a real classroom environment. They carry out this within the scope of Teaching Practice 1 and Teaching Practice 2 courses. Within the scope of the theme titled "PTK courses considered important in subject-matter teaching", prospective teachers stated that they contributed to subject-matter teaching for only 10 of the 14 PTK courses in the teacher training program (Includes Teaching Practice 1 and Teaching Practice 2 for a total of 16 courses). According to prospective teachers, "Instructional Principles and Methods" is the most contributing PTK course in subject-matter teaching. This course is followed by "Educational Psychology, Classroom Management, Instructional Technologies, Measurement and Evaluation in Education, Special Education and Inclusion, Educational Sociology, Ethics and Morality in Education, Research Methods in Education and Guidance in Schools" courses with decreasing frequencies. Prospective teachers gain knowledge about how to teach the information they have acquired from field knowledge courses through PTK courses considering the developmental characteristics of the students, and how to arrange the environment in which the teaching will be done (CoHE, 2007). In literature, the significance of "field knowledge, knowledge of instructional strategies, methods and techniques, knowledge of students, knowledge of curriculum, knowledge of student learning, instructional knowledge, and evaluation of teaching" in the subject-matter teaching process is explained (Shulman, 1986,1987). In this context, in the teaching of subject-matter knowledge, it is seen that the types of knowledge specified in these classifications and definitions coincide with the PTK courses of Instructional Principles and Methods, Measurement and Evaluation, and Educational Psychology mentioned by prospective teachers. Prospective teachers stated that Introduction to Education, Educational Philosophy, Turkish Education History, Turkish Education System and School Management courses were not considered important in subject-matter teaching. In the studies carried out on PTK courses, it was similarly observed that Turkish Education System and School Management, Educational Philosophy, and Turkish Education History courses were mentioned among the courses with low impact and less necessary courses (Akcaoglu et al., 2020; Süral, 2015). Within the scope of this research, a prospective teacher stated that Micro-teaching course, which is an elective course, is among the courses that are important for subject-matter teaching. It has also been revealed in various studies that Micro-teaching and

participating and practicing in courses aimed at subject-matter teaching lead to improvement in the knowledge and skills of prospective teachers in subject-matter teaching (Aydin et al., 2014; Jenkins & Veal, 2002; Kartal et al., 2017).

It was determined that 61% of the views of prospective teachers about the impact of PTK courses in subject-matter teaching were about the transformation of theoretical knowledge into practice and 39% about the inability to use theoretical knowledge in practice. The views regarding the transformation of theoretical knowledge into practice, effective classroom management/dominance and lecturing, using instructional technologies by adapting them to their field, developing and applying different measurement tools, and making practices related to the measurement and evaluation process came to the fore. These views describe the impact of PTK courses in the field. Eraslan (2009) determined that prospective teachers benefited from the PTK courses during the practice, felt themselves as the teacher of the class, and had the opportunity to get to know the classroom-school environment and students closely. De Jong (2000) stated that one of the main elements in the formation of subject teaching knowledge is the observations of prospective teachers during their student period. It has been stated in various studies that participating in courses related to subject-matter teaching and practicing support the development of subject-matter teaching knowledge of prospective teachers (Jenkins & Veal, 2002; Van Driel et al., 2002).

Regarding the inability to use theoretical knowledge in practice, the statements about the difference between what is learned in theory and the classroom/school environment and not having the opportunity to apply what is learned theoretically drew attention. The prospective teachers with these views associated the reasons for their explanations with the overcrowded classrooms, small classrooms, busy curricula, and the fact that the textbooks contain lower cognitive domain levels. These factors appear to emerge in the context of placement school conditions. It can be said that these views may be caused by inexperience in the profession and are related to areas where what is learned in theory does not coincide with practice. The integration of subject areas of prospective teachers and their pedagogical knowledge begins with their experiences (Van Driel et al., 2002), and placement schools offer them the opportunity to observe and experience in this sense. The differences in views among prospective teachers may also be since they have had subject-matter teaching experiences in different placement schools or in different classrooms. It is also seen that two prospective teachers held views on both categories. This can be explained by the fact that they had teaching experiences in different classrooms and the impact of applying conditions such as student level and class size on the process. It should be taken into consideration that the different instructional knowledge of the prospective teachers who participated in this research or the learning outcomes and skills they have acquired from the PTK courses they took may have influenced their comments.

Conclusion

Qualified teachers should have a good level of subject-matter knowledge, pedagogical knowledge, and subject teaching knowledge (Van Driel et al., 2002). The primary task in providing prospective teachers with subject-matter teaching knowledge falls upon teacher educators, the teacher training program applied in this process, and the effective and efficient execution of this program. As a result of the research, while prospective teachers emphasized the importance of PTK courses in the curriculum such as “Instructional Principles and Methods, Instructional Technologies, Educational Psychology, Classroom Management, and Measurement and Evaluation in Education” in teaching subject-matter knowledge, some courses (i.e. Introduction to Education, Educational Philosophy, Turkish Education History, Turkish Education System and School Management) were not included at all. In this context, it may be suggested that the question of which courses should be included in teacher training programs should be reconsidered. In addition, although prospective teachers explained that they were able to transform the theoretical knowledge they acquired within the scope of PTK courses into practice, they also explained that they could not find the opportunity to apply what they learned in theory by associating it with the factors of classroom environment, curricula and textbooks. It is thought that lack of experience plays a role in these views. In general, it is thought that this research will guide researchers and educators in terms of updating and organizing teacher training programs and re-evaluating the scope and process of Teaching Practice courses.

Recommendations

The prospective teachers may not have gained enough experience on how to apply the knowledge they have acquired in the PTK courses in their own subject-areas during the process of taking the courses. In this sense, in the teacher training undergraduate programs, it is significant to provide opportunities for prospective teachers to integrate their subject-matter knowledge and pedagogical knowledge and to make content-specific observations and practices within the scope of compulsory and elective courses.

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