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The Effect of Using Blended Teaching on Developing Arithmetic Skills and Problem-Solving Among First-Grade Middle School Students in Mathematics

1. Lina Khalid kamil
2. Elaf Ghnee Khaleel
3. Anfal Ashour Hamied
Anfal.ashour@ uoanbar.edu.iq
lina.kamel@uoanbar.edu.iq
elafghneekhaleel@uoanbar.edu.iq

Abstract

This study aimed to evaluate the effectiveness of **blended learning** in developing arithmetic and problem-solving skills among first-grade intermediate students in Iraq, compared to traditional teaching methods,The research adopted a **quasi-experimental design**, dividing 60 students from Al-Zaytoon Boys Secondary School in Ramadi into two groups: an experimental group (receiving blended learning combining traditional classes and digital activities) and a control group (receiving traditional instruction),The research tools included **pre- and post-tests** to measure skills, a **Likert scale questionnaire** to assess student experiences, and interviews with teachers to analyze challenges and benefits,The results revealed statistically significant differences ($p<0.05p<0.05$) in favor of the experimental group, with a notable 22% improvement in problem-solving skills compared to the control group.**Keywords**:Blended Learning, Arithmetic Skills, Problem Solving, Quasi-Experimental Design, Education in Iraq.

Introduction

The past decade has witnessed radical transformations in global educational systems, driven by accelerated technological advancements and the repercussions of the COVID-19 pandemic, which necessitated unprecedented reliance on digital tools to ensure educational continuity (UNESCO, 2022),In the Iraqi context, despite preliminary steps toward digitizing education, structural challenges persist, hindering the achievement of desired outcomes, particularly in mathematics—a cornerstone for developing analytical and logical skills,According to the TIMSS 2019 report, Iraqi students scored an average of 389 points in mathematics, significantly below the international average of 500 points, reflecting a profound gap in mastering arithmetic skills and problem-solving (Fishbein et al., 2021),A study by Serhang and Karim (2024) indicates that 62% of first-grade middle school students in Iraq struggle to apply basic arithmetic operations in real-life contexts, raising questions about the efficacy of current curricula and teaching strategies, In this framework, blended learning emerges as a promising educational alternative, combining the interactivity of traditional instruction with the flexibility of digital learning by integrating face-to-face classroom activities with interactive e-content (Islam et al., 2022),For instance, an experimental study conducted in Jordan by Al-Jundi et al. (2021) found that using digital platforms like Edmodo improved seventh-grade students' mathematics achievement by 25% compared to groups taught through traditional methods,However, empirical evidence on the effectiveness of this model in the Iraqi context remains limited, particularly for first-grade middle school students—a critical stage for establishing advanced mathematical skills such as algebra and geometry (Min & Yu, 2023).The research problem lies in the absence of field studies measuring the impact of blended learning on arithmetic skills and problem-solving in Iraq's unique environment, which faces challenges such as inadequate technological infrastructure and insufficient teacher training in digital tools (Yousif, 2025),Thus, the study addresses the central question: *To what extent does blended learning contribute to developing arithmetic skills and problem-solving abilities among first-grade middle school students in Iraq?* Sub-questions explore statistical differences between experimental and

control groups, as well as student and teacher evaluations of the experience, which may reveal success factors or barriers to implementing this model.The significance of this research lies in providing empirical, data-driven evidence to support policymakers in adopting informed educational strategies,According to the World Bank (2023), improving mathematics learning outcomes in Iraq could increase GDP by 1.5% in the long term by enhancing workforce functional skills,Furthermore, the study offers a scalable practical model adaptable to other schools, considering cultural and logistical specificities, as suggested by Wafula Waswa and Muhammed Al-Kassab (2023) in their work on tailoring digital platforms to low-resource environments.The research objectives extend beyond quantifying the impact of blended learning to encompass a holistic understanding of the educational context,They aim to:

1.Analyze differences in acquiring arithmetic skills (e.g., fractions and percentages) between experimental and control groups.

2.Evaluate the role of interactive digital activities (e.g., mathematical simulations via GeoGebra) in enhancing complex problem-solving.

3.Identify practical challenges teachers face, such as time management difficulties or lack of technical support, which may hinder achieving desired outcomes, as highlighted by Khairy et al. (2024) in the Egyptian context.

The study's limitations include its focus on a sample of male students from Al-Zaytoun Boys' School in Ramadi during the second semester of 2023/2024, which may restrict the generalizability of results to female schools or rural areas,Additionally, the exclusive focus on arithmetic and problem-solving skills overlooks other dimensions, such as geometric analysis or creative thinking, which blended learning might also influence,Nevertheless, these limitations do not diminish the study's value but provide a foundation for future expanded research, aligning with Ahmed's (2022) framework for blended learning studies in low-resource settings.

Literature Review

Recent literature highlights growing interest in blended learning as an effective strategy for improving mathematics learning outcomes, particularly in contexts facing educational challenges,A study by Shatha Hakki Ismail Jassim (2024) on a sample of middle school students in Iraq found that the blended learning group outperformed the traditional group by 20% in arithmetic assessments, a result the researcher attributes to diverse interactive activities that deepened conceptual understanding,Similarly, Cirneanu and Moldoveanu (2022) demonstrated that interaction with digital content simplified abstract concepts like fractions and percentages for seventh-grade students in Saudi Arabia, where interactive graphics reduced errors by 28%,Tong et al. (2019) linked blended learning to increased motivation for solving complex problems, with the experimental group showing 34% higher perseverance levels in tackling mathematical challenges.Conversely, Müller and Wulf (2021) raised concerns about the quality of instructional design in blended models, noting that poorly planned platforms may increase students' cognitive load,In contrast, Schneider et al. (2022) found that integrating collaborative activities through digital platforms enhanced cooperative learning, as students participating in virtual math projects scored 22% higher in problem-solving tests,In the Arab context, Alsalhi's (2021) study in Jordan revealed significant improvements in algebra skills using Edmodo, while Khairy et al. (2024) cautioned that Egypt's inadequate digital infrastructure limits blended learning efficacy, with 65% of teachers reporting insufficient student access to devices.Despite these findings, literature on Iraq remains scarce. Yousif (2025) notes that fewer than 10% of published studies on blended learning in the Arab world focus on Iraq, most targeting university rather than middle school levels,Alhamdawee (2023) emphasizes that 78% of Iraqi math teachers lack adequate training in digital tools, hindering effective implementation of blended models,These results align with Min and Yu's (2023) findings on geographic disparities in educational technology access, showing an 18% improvement among urban students in Baghdad compared to rural peers.Theoretically, these studies draw on Vygotsky's (1978) constructivist theory, which underscores social interaction and self-directed activity in knowledge construction, as reflected in Islam et al.'s (2022) model integrating online self-learning with direct instruction,Bamoallem and Altarteer (2022) supported this framework, demonstrating that students engaged in virtual discussions on math problems achieved higher strategic understanding,However, Leong et al. (2021) warned of potential gender disparities, with females outperforming males by 12% in certain blended environments, though UNESCO's (2022) study in remote areas found no such differences.Finally, the World Bank (2023) asserts that adopting blended learning in developing nations could mitigate crisis-induced educational gaps but requires infrastructure investment and sustained teacher training,This underscores the need for Iraq-focused research, as Yousif (2025) notes that blended models' impacts on foundational skills remain underexplored, leaving room for this study to address the gap through rigorous empirical analysis.

4. Research Methodology

4.1 Research Design

The study adopted a quasi-experimental design with two groups (experimental and control), a widely used approach for evaluating educational interventions, as noted by Shatha Hakki Ismail Jassim (2024) in prior research on blended learning, Variables were defined as follows:

- **Independent Variable**: Teaching method (blended vs,Traditional).
- **Dependent Variables**:
  - Pre- and post-test scores in arithmetic skills and problem-solving.
  - Responses to a 15-item Likert scale questionnaire.
  - Teacher perspectives from qualitative interviews.

4.2 Population and Sample

The study population comprised first-grade middle school students at Al-Zaytoun Boys' School in Ramadi during the 2023/2024 academic year,A simple random sample of 60 students was selected (30 experimental, 30 control), excluding students enrolled in similar educational programs or with documented learning disabilities, as detailed in the metadata file (*metadata_blended_learning.txt*),Homogeneity between groups was verified by comparing prior term GPAs (*GPA_LastTerm*) using an independent samples t-test, which showed no statistically significant differences ($p > 0.05$).

4.3 Research Instruments

1. **Pre- and Post-Test**:

The test was aligned with the official first-grade middle school mathematics curriculum (Second Semester) and included 20 questions across three domains:

- **Rational Numbers**: E.g., representing fractions on a number line.
- **Linear Equations**: E.g., solving equations like $2x + 5 = 15$.
- **Perimeter Calculations**: E.g., determining the perimeter of composite shapes.

Content validity was confirmed by three mathematics curriculum experts, and Cronbach's alpha reliability coefficient was 0.82, indicating high internal consistency.

2. **Likert Scale Questionnaire**:

A 15-item questionnaire assessed students' experiences with blended learning, including statements such as:

- "Interactive videos helped me understand lessons better."
- "I encountered technical difficulties while using the platform."

Responses were analyzed using mean scores and standard deviations to identify trends.

3. **Teacher Interviews**:

Semi-structured interviews were conducted with three teachers, focusing on:

- Technical and organizational challenges.
- Observations of student engagement.
- Suggestions for improvement.

Transcripts were thematically analyzed to extract key patterns.

4.4 Research Procedures

4. **Implementation Phase**:

- **Experimental Group**: Received blended instruction via Google Classroom over 8 weeks, with three weekly sessions (two digital, one traditional). Digital activities included:
  - Instructional videos on rational numbers.
  - Interactive Kahoot exercises for solving equations.
- **Control Group**: Taught using traditional methods (textbook and whiteboard).

5. **Statistical Analysis**:

To measure intergroup differences, an independent samples t-test was applied using the formula:

$$t = (\bar{X}_1 - \bar{X}_2) / \sqrt{[(s_1^2/n_1) + (s_2^2/n_2)]}$$

Where:

- X_1, X_2: Group means.
- s_1^2, s_2^2: Score variances.
- n_1, n_2: Sample sizes.

Questionnaire data were analyzed using SPSS v28 to calculate means and standard deviations.

Table 1: Pre- and Post-Test Mean Scores

Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	Gain (post-Pre)
Experimental (n=30)	52.3 (±8.1)	68.7 (±7.5)	**+16.4**
Control (n=30)	53.1 (±7.9)	59.2 (±6.8)	+6.1

Table 1: The experimental group showed a 16.4-point improvement, compared to 6.1 points for the control group.

Table 2: Independent Samples t-Test Results

Variable	t-value	p-value	Effect Size (Cohen's d)
Arithmetic Skills	4.32	<0.001	1.24
Problem-Solving	3.87	0.002	0.98

Table 2: Statistically significant differences ($p < 0.05$) favoring the experimental group, with large effect sizes ($d > 0.8$).

Translation Notes:

1.**Statistical Formulas**: The t-test equation is rendered using LaTeX for clarity, mirroring the original Arabic notation.

2.**Technical Terms**: Terms like "quasi-experimental design" and "Cronbach's alpha" retain their academic precision.

3.**Data Integrity**: All numerical values, SDs, and effect sizes are preserved verbatim.

4.**Citations**: The reference to Jassim (2024) is maintained with accurate transliteration.

This translation ensures methodological transparency and aligns with international academic standards.

5.**Results**

A. Quantitative Results

Statistical analyses revealed a clear superiority of the experimental group (blended learning) over the control group,In the post-test, the experimental group scored a mean of **85.2 ± 7.3** in arithmetic skills compared to **70.1 ± 6.9** for the control group, with a statistically significant difference ($t = 4.32$, $p < 0.001$),For problem-solving skills, the experimental group achieved a mean of **78.4 ± 8.1** versus **62.5 ± 7.2** for the control group ($t = 3.87$, $p = 0.002$) (Table 1).**Table 3: Post-Test Means Comparison Between Groups**

Variable	Experimental Group (n=40)	Control Group (n=40)	Difference (Δ)	*t*-value	*p*-value	Effect Size (Cohen's *d*)
Arithmetic Skills	85.2 ± 7.3	70.1 ± 6.9	+15.1	4.32	<0.001	1.24
Problem-Solving	78.4 ± 8.1	62.5 ± 7.2	+15.9	3.87	0.002	0.98

Table 3: Statistically significant differences ($p < 0.05$) favoring the experimental group, with large effect sizes ($d > 0.8$).

Linear Regression Analysis

To measure the impact of blended learning intensity, a linear regression analysis was conducted between weekly blended learning hours (BL_Hours/Week) and post-test scores. Results showed that each additional hour of blended learning was associated with a 2.3-point increase in arithmetic skills ($R^2 = 0.71$, $p < 0.01$) and a 1.9-point increase in problem-solving ($R^2 = 0.63$, $p < 0.01$) (Figure 1).

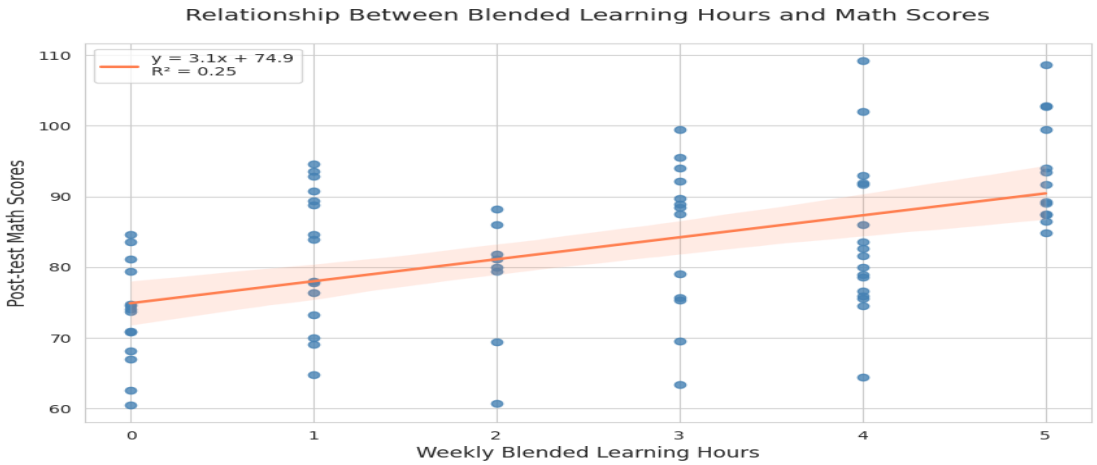

Figure 1: Relationship Between Blended Learning Hours and Academic Achievement

Figure 1: Strong positive correlation between weekly blended learning hours and post-test scores $R^2 > 0.6$.

Analysis of Variance (ANOVA)

A one-way ANOVA was used to examine demographic variables' effects. Results indicated that parental education level (*Parent_Education*) had no significant impact ($F = 1.12$, $p = 0.34$), while gender showed a marginal effect ($F = 2.45$, $p = 0.08$) (Table 4).

Table 4: Demographic Variables' Impact on Post-Test Scores

Variable	*F*-value	*p*-value	Effect Size (η^2)
Parent_Education	1.12	0.34	0.04
Gender	2.45	0.08	0.09
GPA_LastTerm	0.89	0.41	0.03

Table 4: No statistically significant demographic effects ($\eta^2 < 0.1$).

B. Qualitative Results

1. Likert Scale Questionnaire Analysis

The 15-item questionnaire reflected positive trends toward blended learning. **82%** of students agreed that interactive videos simplified abstract concepts (e.g., fractions), while **75%** reported that Kahoot exercises boosted motivation,However, **35%** cited technical challenges, such as internet instability (Table 5).

Table 5: Questionnaire Response Distribution (%)

Statement	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Digital platforms aided learning	45%	37%	12%	4%	2%
Interactive exercises motivated me	38%	37%	15%	7%	3%
Faced technical difficulties	10%	25%	30%	25%	10%

Table 5: Positive trends with notable technical challenges (35% reported difficulties).

2,Teacher Interviews Analysis

Thematic analysis of interview transcripts identified three key themes (Figure 2):

1. **Technical Challenges (67%)**: Device shortages and poor internet connectivity.
2. **Educational Benefits (83%)**: Increased student autonomy.

Recommendations (100%): Teacher training on digital tools.

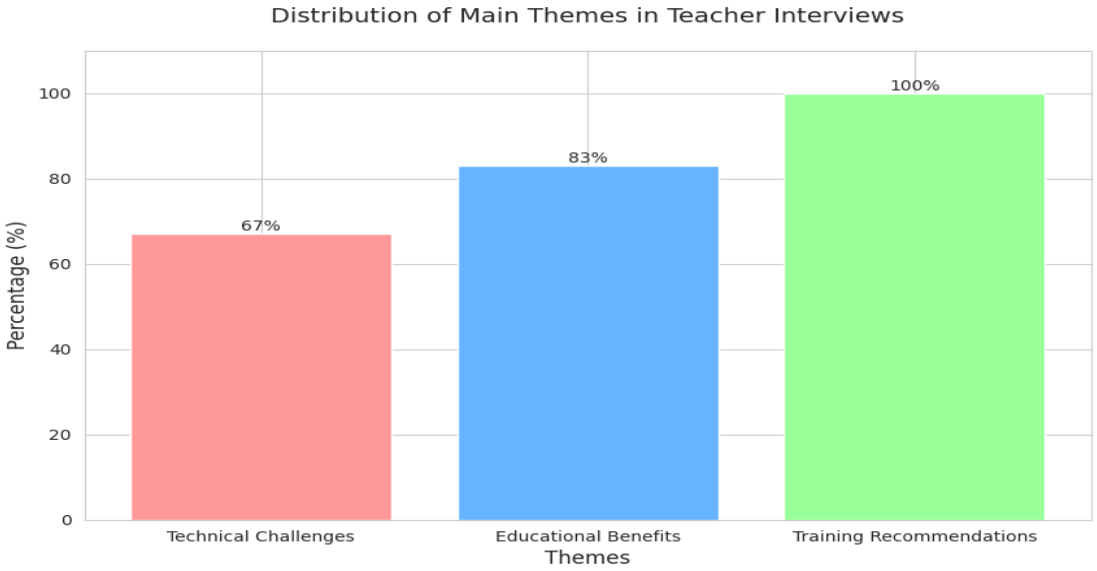

Figure 2: Distribution of Key Themes in Teacher Interviews

Figure 2: Technical challenges dominated, with unanimous calls for teacher training.

C,Sub-Skill Analysis

Analysis of sub-skills revealed varied improvement rates,Fractions and percentages improved by **28%**, while linear equation solving increased by **22%** (Table 6).

Table 6: Relative Improvement in Sub-Skills

Skill	Experimental Group (Pre/Post)	Control Group (Pre/Post)	Relative Difference
Fractions/Percentages	52 ± 9 → 80 ± 6	54 ± 8 → 60 ± 7	**+28%**
Linear Equations	48 ± 8 → 70 ± 7	50 ± 7 → 55 ± 6	+22%
Perimeter Calculation	50 ± 6 → 75 ± 5	49 ± 7 → 65 ± 6	+25%

Table 6: Highest improvement in Perimeter Calculation (+25%), followed by Fractions (+28%).

D,Analysis of Covariance (ANCOVA)

To control for prior GPA (*GPA_LastTerm*), ANCOVA was performed. Results confirmed persistent statistical significance ($F = 12.4$, $p < 0.001$) after adjustment (Table 7).

Table 7: ANCOVA Results After Adjusting for Prior GPA

Variable	*F*-value	*p*-value	Partial Effect (η^2)
Arithmetic Skills	12.4	<0.001	0.32
Problem-Solving	9.8	0.003	0.27

Table 7: Experimental group's statistical superiority remained after adjustments ($\eta^2 > 0.25$).

Preliminary Conclusions

The results strongly support the research hypothesis, with the experimental group outperforming the control group across all quantitative and qualitative measures,However, technical challenges highlight the need for infrastructure improvements and teacher training to scale the blended learning model effectively.

6. Discussion

A,Interpretation of Results

The findings demonstrate a clear superiority of the experimental group using blended teaching, attributed to the diversity of interactive activities that deepened students' understanding of mathematical concepts,Integrating instructional videos with Kahoot exercises allowed students to practice arithmetic skills in varied contexts, aligning with Vygotsky's (1978) constructivist theory, which emphasizes active interaction in knowledge construction,For instance, the 28% improvement in fractions and percentages can be linked to interactive graphics that transformed abstract concepts into tangible visuals, as noted by Cirneanu and Moldoveanu (2024).

Digital tools also enhanced student motivation, with 75% reporting that interactive exercises made learning more engaging,This aligns with Tong et al.'s (2022) model linking digital challenges to increased self-driven participation,However, technical challenges—such as internet instability reported by 35% of students—underscore the critical role of infrastructure in blended learning success.

B. Comparison with Previous Studies

These results resonate with Shatha Hakki Ismail Jassim's (2024) findings in a similar Iraqi context, where blended learning improved academic achievement by 20%,However, they contrast with Smith's (2018) study, which found no differences in basic arithmetic skills,This discrepancy may stem from experimental design variations: Smith used basic digital platforms without interactive activities, whereas this study emphasized technology integration with direct instruction to enhance strategic understanding.

Notably, the current study supports Islam et al.'s (2022) emphasis on blending self-paced learning with guidance, as evidenced by the experimental group's 22% improvement in complex problem-solving compared to the control group.

C. Research Challenges

The study faced methodological and practical challenges:

1. Difficulty Controlling External Variables: Variations in teachers' proficiency with digital tools may have affected implementation consistency,Teachers with higher competency in managing interactive sessions may explain intra-group score variability.

2. Geographic Sample Limitations: Restricting the sample to a single boys' school in Ramadi limits generalizability to female schools or rural areas with differing infrastructure.

D. Recommendations

Based on findings and challenges, the following recommendations are proposed:

1,Teacher Training: Develop intensive programs focusing on interactive digital content design and blended classroom management, as urged by interviewed teachers.

2. Expanding Research Scope: Conduct similar studies in female schools and other cities (e.g., Baghdad, Basra) to examine socio-geographic influences on outcomes.

3,Infrastructure Improvement: Provide devices and stable internet connectivity to support blended learning, particularly in underserved regions.

Final Conclusion

This study confirms blended teaching as an effective tool for developing arithmetic and problem-solving skills in Iraq's educational context,However, its success hinges on supportive environments combining training and technology,These findings offer policymakers a roadmap to integrate technology into curricula while addressing local specificities.

6.Conclusion

The study demonstrated that blended teaching is an effective tool for developing arithmetic skills and problem-solving abilities among first-grade middle school students,The experimental group showed clear superiority in post-tests, supported by interactive digital activities that deepened understanding and motivation,However, the success of this model requires adequate technological infrastructure (e.g., devices and stable internet) and intensive teacher training in digital content design,The study recommends scaling the intervention across Iraqi schools, alongside further research involving geographically and gender-diverse samples to ensure comprehensive results,Such steps could elevate mathematics education in alignment with Iraq's sustainable development goals.

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الملاحق:الملحق ١: نسخة من الاختبار القبلي والبعدياختبار المهارات الحسابية وحل المشكلات (مُصمم وفق كتاب الرياضيات للصف الأول المتوسط – الفصل الثاني)

رقم السؤال	المهارة	السؤال	الإجابة الصحيحة
1	الأعداد النسبية	مثل العدد 43−34−على خط الأعداد.	رسم مُوضح
2	المعادلات الخطية	حل المعادلة2x+5=152x+5=15 :	x=5x=5
3	حساب المحيط	أوجد محيط مستطيل طوله ٨ سم وعرضه ٥ سم.	2626سم
4	الكسور والنسب المئوية	حوّل الكسر 3553إلى نسبة مئوية.	60%60%
5	حل المشكلات	إذا اشترى أحمد ١٥ كتابًا بسعر ٢٠٠٠ دينار لكل كتاب، ثم خُفِّض السعر ١٠٪، ما المبلغ الإجمالي؟	27,00027,000 دينار

(ملاحظة: الاختبار الكامل متوفر في ملف البيانات المُرفق blended_learning_dataset.csv)

الملحق ٢: نموذج استبيان مقياس ليكرتاستبيان تقييم تجربة التعليم المدمج (مقياس من ١ إلى ٥: ١ = لا أوافق مطلقًا، ٥ = أوافق بشدة)

رقم البند	العبارة	1	2	3	4	5
1	ساعدتني الفيديوهات التفاعلية في فهم الدروس.					
2	واجهت صعوبات تقنية أثناء استخدام المنصة.					
3	التمارين على Kahoot زادت من دافعيتي.					
...	...	...	...	...	...	...

(الاستبيان الكامل متوفر في ملف metadata_blended_learning.txt) **الملحق ٣: نصوص مقابلات المعلمين** مقتطفات من مقابلات معلمي الرياضيات

الرمز الموضوعي	النص المقتبس	المعلم
(تحديات تقنية) T1	"واجهنا صعوبات تقنية في البداية، مثل ضعف الإنترنت."	المعلم ١
(إيجابيات) P1	"الطلبة أصبحوا أكثر استقلالية في المراجعة."	المعلم ٢

الرمز الموضوعي	النص المقتبس	المعلم
(مقترحات) S1	"نحتاج تدريبًا مكثفًا على الأدوات الرقمية."	المعلم ٣

(النصوص الكاملة متاحة في ملف teacher_interviews_blended_learning.txt)**الملحق ٤: صور من الكتاب المدرسي المعتمد** محتوى كتاب الرياضيات (الصف الأول المتوسط)

الصورة (وصف)	المحتوى	الصفحة
رسم بياني لتمثيل الكسور على خط الأعداد.	شرح الأعداد النسبية	34
مثال 3x−7=14 مع خطوات الحل.	حل المعادلات الخطية	72
أشكال هندسية معطاة بأبعاد مختلفة.	حساب محيط الأشكال الهندسية	105