Blended Learning through the "Digital Classes-Morocco" Platform: Effects on Achievement and Retention in Mathematics

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***Abstract*—This study explored the impact of blended learning through the platform Digital Classes-Morocco (DCM) on students' math achievement and knowledge retention. A quasi-experimental research design was employed to investigate the influence of blended learning on students' academic achievement and knowledge retention of third-grade middle school students about the module on the Thales theorem. The study involved 80 participants, divided into an experimental group and a control group containing 40 participants. The data collection tools included three tests to assess mathematical achievement: a pretest, a posttest, and a retention test. The pretest and posttest contained 20 multiple-choice questions, with the posttest questions reused in the retention test. Three experts validated these tools. The control group underwent conventional face-to-face instruction, while the experimental group engaged in blended instruction through the DCM platform. Thus, the pretests, posttests, and retention tests assessing mathematics achievement scores were conducted for both groups. Analysis of Covariance (ANCOVA) revealed a statistically significant difference, with the experimental group outperforming the control group in both achievement and retention scores. Thus, students who engaged in blended learning through the DCM platform scored higher in academic achievement and knowledge retention than those who underwent conventional face-to-face instruction. According to the findings, it is recommended that strategies for blended learning be incorporated into mathematics instruction and that the curriculum be reviewed to include strategies that help students improve their educational outcomes, enhance their understanding and knowledge retention, and apply them in solving new problems.**

***Keywords*—effect, blended learning, Digital Classes-Morocco (DCM), mathematics, Thales' theorem, achievement, retention**

I. Introduction

In mathematics education, the effectiveness of modern teaching methods that utilize technological tools remains a significant focus for educators [1, 2]. Various contemporary teaching approaches can be applied in mathematics instruction at the middle and secondary levels, each with unique advantages and limitations [3]. Among these methods are blended learning [4, 5], cooperative learning [6], game-based learning [7], learning through virtual and augmented reality [8, 9], project-based learning [10], adaptive learning [11], and interactive learning [12], among others. Among these teaching methods, blended learning has garnered significant attention in educational research. It is viewed as an innovative and practical approach to improving students' achievement in mathematics, enhancing their retention of mathematical concepts and rules, and fostering positive attitudes toward the subject [13–16].

Blended learning is an instructional method that combines conventional education in class with digital technology, such as the internet and educational platforms. This method provides greater flexibility for students to access content, improves interaction and engagement within the classroom, enhances self-directed learning, and helps tailor education to meet the needs of each student. This approach positively impacts students' performance in mathematics and their retention of mathematical concepts and rules [17–20].

Efthymiou [21] highlights several benefits of blended learning in education. First, it enhances students' understanding of concepts by combining traditional teaching methods with digital educational resources. Second, it allows students to learn according to their individual needs, contributing to improved achievement of educational goals. Third, blended learning encourages interaction between students and teachers, fostering better communication and teamwork skills. Finally, it promotes independence in learning by enabling students to access educational content anytime and anywhere. This flexibility encourages them to take responsibility for their academic progress, leading to improved performance levels and better retention of mathematical concepts [22, 23]. Blended learning, based on the principles of social constructivism, is an effective means of promoting deep understanding and long-term retention of knowledge [24]. This approach coincides with contemporary instructional approaches focusing on active participation, developing skills of the 21st century, and adopting learner-centered teaching methodologies [25]. Blended learning creates a flexible learning environment in which students can continuously access digital educational resources and engage with both teachers and peers. This enhances the effectiveness of learning and increases opportunities for communication and collaboration, in contrast to traditional methods that rely solely on direct instruction [26, 27].

In Morocco, studies on the education system, especially

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regarding the changes brought about by the COVID-19 pandemic, such as the shift to online education, have highlighted the need to diversify modern learning methods and strategies [28–32].

Mathematics often presents significant challenges for students, who frequently need help retaining basic mathematical knowledge [33]. This difficulty hampers their ability to continue learning mathematics, negatively impacts their academic performance, and diminishes their enthusiasm for the subject [34]. Retention indicates students' ability to retain and utilize the math concepts learned in prior lessons for an extended time [35]. While tackling challenges related to underachievement in mathematics is crucial, it is equally important to focus on students' retention of these concepts as a significant variable [36]. The incapability to retain basic mathematical knowledge can hinder students' comprehension of the subject matter and create difficulties with topics of greater complexity that build on foundational concepts [37]. Therefore, it is crucial to explore teaching methods that enhance students' performance in mathematics and promote sustainable retention of fundamental mathematical concepts.

According to the International Trends in Mathematics and Science Study (TIMSS) report (2023), Moroccan students ranked second to last among 47 participating countries, scoring only 378 points in mathematics [38]. This low performance underscores the urgent need to improve students' mastery of fundamental mathematics skills [39]. To address this issue, teachers must adopt effective teaching methods that enhance students' understanding of mathematical concepts, which fosters better academic achievement and long-term retention of essential mathematical knowledge [40]. Among the innovative and effective teaching approaches, this study particularly emphasizes blended learning.

A recent study by Riccomini *et al*. [41] revealed that most middle and secondary students experience significant academic underperformance and difficulties understanding and retaining mathematical concepts. The researchers identified that teachers' use of traditional teaching techniques is among the primary factors contributing to this underperformance and these difficulties [42]. The findings of Attard and Holmes's [43] study align with previous research by Lo and Hew [44] and Lessani *et al*. [45], which confirmed that the adoption of traditional teaching techniques is a significant factor limiting the effectiveness of mathematics education.

In Moroccan schools, the mathematics teaching method often relies on a deductive approach, where teachers mainly focus on transferring knowledge rather than encouraging students to construct their concepts and actively participate in the learning process [46]. Occasionally, teachers implement problem-solving methods that require students to utilize their knowledge to deepen their understanding. However, many students struggle to recall the prior knowledge and skills necessary for solving these problems. This difficulty can lead to low levels of interaction and participation, hindering their ability to build knowledge [47]. Additionally, many teachers' instructional methods lack modern technology and interactive activities that promote critical thinking and enhance student motivation [48].

Students often perceive mathematics as abstract due to its unique language, distinctive symbols, and inherent complexity, which makes it challenging to learn the subject [49, 50]. These characteristics set mathematics apart from other disciplines but often lead learners to view it as a challenging subject meant solely for gifted students [51]. Luttenberger *et al*. [52] noted that students who struggle to understand and retain mathematical concepts, along with experiencing math-related anxiety, tend to avoid the subject, which reduces their competence in mathematics and limits their opportunities to pursue prestigious career paths. The abstract nature of mathematics is considered a crucial element in understanding how to mitigate this abstract aspect in its teaching [53].

Despite many students' difficulty learning mathematics, teachers adopting diverse teaching methods that cater to each student's needs, particularly student-centred strategies based on interactive activities, can facilitate mathematics learning without causing stress [54, 55]. These approaches also help improve students' attitudes toward mathematics and positively alter their perceptions of its difficulties [56].

The use of appropriate instructional materials, the implementation of student-centred teaching strategies such as transitioning from concrete to symbolic representation and abstract concepts, and the incorporation of blended learning methods are effective solutions for improving student achievement and enhancing their retention of mathematical concepts and rules [57].

The blended learning strategy is an educational strategy that offers students a personalized learning experience by combining conventional instruction with digital learning. This approach enables students to interact with academic content through online platforms in addition to participating in classroom activities [58–60]. Comprehending the potential of blended learning to improve academic performance and enhance students' retention of mathematical concepts is promising for addressing current educational challenges.

As blended learning gains recognition as a valuable pedagogical method, its implications for teaching mathematics must be examined comprehensively. This study builds upon the existing literature to explore the potential of a blended approach to improve students' achievement and retention of mathematical knowledge. Specifically, this study examines the blended learning approach using the digital educational platform "Digital Classes-Morocco (DCM)" to improve the academic attainment and retention of the mathematical knowledge of third-grade middle school students. It concentrates on the instructional unit related to Thales' Theorem within the Geometry curriculum and compares the potency of the blended learning method to traditional teaching approaches. This study especially attempts to answer the following Research Questions (RQ).

RQ1: What are students' mathematics achievement scores when taught Thales' Theorem using the method of blended learning on the DCM platform compared to those taught using conventional methods?

RQ2: What are students' mathematical knowledge retention scores when taught Thales' Theorem using the method of blended learning on the DCM platform compared to those taught using conventional methods?

The study at hand aimed at assessing the validity of the following two hypotheses:

H1: There is no statistically significant difference between the average achievement scores of students taught Thales' Theorem through blended learning on the DCM platform and those taught using conventional methods.

H2: There is no statistically significant difference between the average mathematical knowledge retention scores of students taught Thales' Theorem through blended learning on the DCM platform and those taught using conventional methods.

This study's importance lies in providing empirical insights to direct instructors and developers of educational programs, enabling them to make educated decisions about blending learning through the DCM platform to enhance students' academic achievement and mathematical knowledge retention. The research aims to investigate how a blended learning method with the DCM platform impacts student learning and mathematical knowledge retention. This insight may lead to developing innovative teaching methods that better cater to the needs of 21st-century learners. Ultimately, the results of the present inquiry could improve classroom mathematics instruction in Morocco and different educational environments worldwide by utilizing blended learning approaches to enhance retention in mathematics and achieve better learning outcomes.

II. Literature Review

Numerous studies have reviewed the potency of blended learning methods in teaching mathematics, emphasizing their positive effects on academic performance, reducing achievement gaps among students, and enhancing students' abilities to retain mathematical concepts and rules. This literature review examines studies that research the influence of blended learning on learning mathematics, focusing on recent research findings that confirm its effectiveness in improving academic achievement and developing skills for retaining key mathematical concepts and rules.

A. Blended Learning and Mathematics Achievement

Many studies have researched the positive implications of blended learning on mathematics achievement. For example, Tong *et al*. [61] investigated the effectiveness of the Flex model of blended learning in teaching the topic of coordinates in the plane within the mathematics curriculum by enhancing students' academic achievement, self-study skills, and learning attitudes. The study found that blended learning improved students' achievement in the experiment group compared to the control group. Furthermore, observations and the findings from the student opinion poll revealed that blended learning enhanced student interactions with instructors and elevated their academic performance, self-study skills, and attitudes toward learning. These findings align with the research findings of studies conducted by Asrizal *et al*. [62], Tashtoush *et al*. [63], Budhyani *et al*. [64], Kobicheva and Baranova [65], and Rahman *et al*. [66]. Similarly, Şentürk [67] conducted a study examining the influence of the approach to blended learning on the academic achievement and 21st-century abilities of pre-service teachers engaging in the "Principles and Methods of Teaching" course. The study displayed a significant difference between the two groups, with the experimental group surpassing the control group in both academic success and 21st-century abilities. Moreover, Samritin *et al*. [68] performed a study to determine the effect of the blended learning model on mathematics learning achievement. This research used a meta-analysis methodology, examining 20 effect sizes derived from 18 primary papers indexed in Scopus that fulfilled the inclusion criteria. The study's findings demonstrated that using the blended learning model affects math achievement compared to conventional education.

Furthermore, Islam *et al*. [69] conducted a study that examined the differences in performance and motivation between students utilizing the direct learning method and those utilizing the blended learning method. The results revealed a substantial difference in performance and motivation for students who utilized the blended learning method compared to those who used the direct learning method. Similarly, Alsalhi *et al*. [70] conducted a study to investigate the influence of blended learning on the mathematical achievement of high school students. The results displayed significant differences in achievement test performance among the groups, with the experimental group utilizing blended learning outperforming the control group that relied on traditional teaching methods. Similarly, Indrapangastuti *et al*. [71] conducted a research study to explore the potency of the approach to blended learning in teaching mathematics to improve students' achievement in mathematical concepts at State Senior High School 1 Sewon, Yogyakarta, Indonesia. The results indicated that blended learning was significantly more potent than the traditional model in enhancing students' achievement in mathematical concepts. The findings of this research are also consistent with those of Ceylan and Kesici [72], Kundu *et al*. [73], Ulfa and Puspaningtyas [74], Firdaus *et al*. [75], and Nkanyani *et al*. [76]. Research reveals that blended learning substantially improves student performance in mathematics and overcomes achievement inequalities among students. This instructional approach promotes inclusive and effective learning environments in mathematics, leading to equitable outcomes for all students.

B. Blended Learning and Knowledge Retention

Research indicates that blended learning substantially improves the retention of mathematical concepts. Multiple studies across various educational contexts confirm that blended learning improves students' ability to retain and apply mathematical information effectively. For example, Alali *et al*. [77] investigated the potency of using blended learning to teach mathematics in high schools in Jordan. They evaluated its effectiveness in enhancing students' understanding, engagement, and retention of mathematical concepts. The findings revealed that students in the experimental group achieved significantly higher academic performance and demonstrated enhanced retention of mathematical concepts relative to their counterparts in the control group. Similarly, Ibrahim [78] conducted a study to assess the impact of blended learning on the academic achievement and knowledge retention of secondary school physics students in Lokoja, Kogi State, Nigeria. The results indicated that students who were taught physics through blended learning experienced a significant improvement in their academic performance and knowledge retention compared to those who were taught using conventional methods. Likewise, Edem and Anari [79] conducted a study to examine the effect of a blended learning strategy on students' achievement and retention in chemistry. The results showed a statistically significant difference in the mean retention scores between students who studied chemical reactions using the blended learning strategy and those who studied it using the expository method.

Furthermore, Obi *et al*. [80] researched the impact of combining the lecture method with geometric models, compared to using the lecture method alone, on students' achievement and retention of mathematics knowledge in Delta State. The results showed a substantial difference in average achievement and knowledge retention scores between students taught using the combination of the lecture method and geometric models and those taught using the lecture method only. Additionally, Paul and Richard [81] found that high school students taught using the station-rotation model demonstrated higher levels of knowledge retention than those instructed through the conventional teaching method. This study's research results are also consistent with those of Tumba1 *et al*. [82], Mahto and Kumar [83], and Hughes [84].

Research shows that blended learning improves student achievement in mathematics, significantly boosts the retention of mathematical concepts, and helps close achievement gaps among learners. This educational approach creates inclusive and effective learning environments in mathematics, promoting equitable outcomes for all students.

III. Methodology

A. Research Design

EG:	**O1**	**X1**	**O2**	**O3**
CG:	**O1**	**X0**	**O2**	**O3**

EG: Experimental group
CG: Control group
O1: Mathematics Achievement Test (Pre-MAT)
O2: Mathematics Achievement Test (Post-MAT)
O3: Mathematics Achievement Test (Retention-MAT)
X1: Blended learning using the Digital Classes-Morocco (DCM) platform
X0: traditional face-to-face instruction

Fig. 1. The study's research design.

A quasi-experimental design was used, including a pretest (pre-MAT), posttest (post-MAT), and retention test (retention-MAT) for a Control Group (CG) and an Experimental Group (EG). The present study aims to assess the influence of blended learning methods on the achievement and knowledge retention of third-year middle school students in mathematics. The quasi-experimental design is selected because it allows for comparing groups with some control over variables, even though random assignment is not feasible. The study's CG received traditional face-to-face instruction, while the EG received blended learning using the DCM platform. The lesson tested from the geometry module focused on Thales' Theorem, a fundamental module in mathematics within the educational program. The textbook "Al Moufid in Mathematics" is intended for third-year middle school students under the Moroccan educational curriculum for the 2023–2024 academic year. In the present study, the instructional approach was the independent variable (traditional face-to-face instruction, Blended learning using the DCM platform). In contrast, the dependent variables, represented by the Math Achievement Test, were given to both groups during the pretest, posttest, and retention tests. Fig. 1 presents the design of the research study.

B. Participants

The study involved 80 third-grade students from Omar Ibn Al Khattab Middle School in Sidi Slimane, Morocco. These students shared similar socioeconomic backgrounds, mostly from low to middle-income families. The school offered eight third-year classes, and two of these, both taught by the same teacher, were randomly selected for the study. One of the classes was assigned as the EG, while the other served as the CG. The EG consisted of 40 students, including 19 girls and 21 boys, while the CG had 40 students, made up of 18 girls and 22 boys. Students in both groups were between the ages of 14 and 15. Omar Ibn Al Khattab Middle School was chosen as the study site for its dual role in this research. It was selected because it represented one of the institutions piloting digital classrooms for scientific subjects during the 2023–2024 academic year, and its staff supported the field study.

C. Instruments

To address the two research questions, we administered three Mathematics Achievement Tests (MATs): a pretest (pre-MAT), a posttest (post-MAT), and a knowledge retention test (retention-MAT). For the knowledge retention test (retention-MAT), the same questions used in the posttest (post-MAT) were modified. These modifications included changing the order of the questions, rearranging the answer choices for each question, and adjusting the labelling of figures in the post-MAT questions.

Although the specific questions on the pre-MAT and post-MAT tests differed, the measured core concepts remained consistent. To evaluate student achievement at this educational stage, we created 26 multiple-choice questions for both the pre-MAT and post-MAT, which were aligned with the content of the Moroccan mathematics curriculum for the third year of middle school. The test items were designed by the proportional distribution for each skill level, as specified by the ministry's guidelines on continuous assessment in secondary mathematics (50% for the first skill level: direct application of knowledge, 30% for the second skill level: recall and application of implicit knowledge, and 20% for the third skill level: recall, application, and synthesis of knowledge in unfamiliar situations). Before administering these tests to the participants, an exploratory study was conducted with 40 students in early November 2023 for the pretest (pre-MAT) and early December of the same year for the posttest (post-MAT). Three experts in tool development ensured that the tests were technically valid. In comparison, three mathematics content experts verified the face validity and content of both the pre-MAT and post-MAT. A specifications table was created to ensure the accuracy of the content strands and the effectiveness of the MATs in assessing mathematical skills. This table is available for reference in Table 1.

According to Munir *et al*. [85], only items with a discriminating index value greater than 0.20 and a difficulty index value between 0.30 and 0.70 were included in the final versions of the pretest and posttest. This decision was made after a thorough item analysis following the exploratory research. The final version of the pre-and post-MATs consisted of 20 questions, measuring three primary mathematical skill levels: direct application of knowledge (45%), recall and application of implicit knowledge (35%), and recall application and synthesis of knowledge in unfamiliar contexts (20%). The pretest's and posttest's Cronbach's alpha reliability values were 0.90 and 0.83, respectively. Appendix (Tables A1 and A2) contains the specifics of the mathematics pre- and post-MAT questions. The control and experimental groups were given the pre-MAT before the intervention, and the post-MAT and retention-MAT tests were given after the intervention. When the test results were analyzed, a '1' was given for accurate answers, while a '0' was given for inaccurate or blank replies. Based on these points, each student's overall score was then determined.

Table 1. Skill levels with the weighting for each level in the test

Skill level		Number of items	weighting (%)
First level	Direct application of knowledge	13	50.00
Second level	Recall and application of implicit knowledge	8	30.77
Third level	Recall, application, and synthesis of knowledge in unfamiliar situations	5	19.23
	Total	26	100.00

D. Procedure of Study

Participants in this research study were selected following approval from the Parents and Guardians Association of the relevant institution. One classroom of three-grade students of an Omar Ibn Al Khattab middle school was designated as the experimental group, which received blended learning through the DCM platform. In contrast, another classroom was defined as the control group, which received traditional face-to-face instruction. The mathematics teacher at the selected school was employed in this research study after undergoing intensive one-week training on using a blended learning method to teach mathematical concepts and utilizing the DCM educational platform. The teacher was provided with lesson plans and notes as guides for both the experimental and control groups. The lesson plans and notes for the experimental group were designed following the blended learning method, whereas those for the control group followed the traditional method. The mathematical concept taught to third-year middle school students was geometry (Thales' theorem). Table 2 below compares the instructional activities executed in both of these groups. Before beginning the lesson on Thales' Theorem, both groups underwent a pre-test (pre-MAT) to verify their equivalence in mathematical concepts. During the intervention period, and before initiating the mathematics lessons that included Thales' theorem, the teacher allocated a one-hour training session to instruct the experimental group of students on accessing the DCM platform and utilizing its content, including preparatory activities and interactive exercises. Fig. 2 represents the interface of the DCM educational platform for the unit on Thales' theorem. It includes icons representing links to interactive activities, practical exercises, and summaries for this unit. The experimental and control groups underwent a 4-week intervention, with sessions conducted five times weekly, totalling 20 hours of instruction. The posttest (post-MAT) was conducted in the fifth week. its results were recorded and used to provide data on students' performance in both the experimental and control groups. The posttest (post-MAT) items were reorganized before being administered in the delayed posttest (retention-MAT) to give them a new appearance and prevent students from recognizing them. This delayed posttest (retention-MAT) was conducted five weeks after the initial posttest. Subsequently, retention data for both groups were collected based on these findings of the delayed posttest. Fig. 3 presents a visual overview of the experimental procedures implemented in the study.

Table 2. Overview of the educational activities implemented in the experimental and control groups

Experimental Group (1 hour per lesson, 5 lessons per week)	**Control Group (1 hour per lesson, 5 lessons per week)**
➢ *In-class activities:* *Orientation (5 min):* Provide a comprehensive overview of the learning objectives, focusing on the importance of Thales' Theorem and its practical applications. The guidance includes explaining the planned activities before, during, and after the class session. *The Blended Learning Method (5 min):* The lesson is delivered through three main learning stations: direct interaction with the teacher (face-to-face), discussions within small groups, and learning through interactive resources on the Digital Classes-Morocco (DCM) platform. Practical examples support each station to enhance understanding and the application of concepts. *Face-to-face instruction (5 min):* The teacher delivers a face-to-face educational session on Thales' Theorem, incorporating interactive discussions and a teacher-guided explanation. *Small group discussions (15 min):* Students are grouped into small teams of five based on their discussion and interaction needs. They participate in collaborative discussions focused on study topics related to Thales' Theorem. *Learning via the DCM platform: (20 min):* Students access the DCM educational platform to utilize additional resources and complete their assigned tasks. This includes participating in interactive activities and exploring Thales' Theorem through simulation tools. Following this, they engage in applied and guided exercises, progress to practice exercises, and work on activities designed to deepen their understanding of the concepts. *The interaction between the student and the teacher (5 min):* Through the forum dedicated to Thales' Theorem for student-related comments and clarifications, the teacher actively engages with student feedback, providing necessary explanations and addressing raised queries. Additionally, the teacher offers detailed feedback on tasks submitted via the DCM educational platform, providing targeted guidance to enhance students' ability to apply Thales' Theorem. *Interaction between students and their peers (5 min):* Students interact through the DCM learning platform in collaborative discussions within small groups, exchanging ideas, discussing challenges, and working together to deepen their understanding of the concepts. The DCM platform also includes a peer review mechanism that allows students to assess the tasks submitted by their peers and provide constructive feedback, enhancing collective learning and encouraging knowledge exchange with peers.	➢ *In-class activities:* *Traditional teaching (10 min):* Explaining Thales' Theorem using traditional instructional methods, supported by educational activities derived from the textbook. *Application of Thales' theorem (25 min):* The *teacher* demonstrates the application of Thales' Theorem through practical examples and exercises. Students actively engage by asking questions and participating in discussions. *Class assignments (25 min):* Students *receive* tasks to complete during class, which they submit for assessment by the teacher.

➢ *After-class activities:* *Interactive discussions and feedback on the DCM platform (60 min):* Through the forum dedicated to Thales' theorem, students engage in discussions and interactions to exchange ideas and knowledge. They also provide feedback on the educational resources available on the DCM platform, complete supplementary tasks, and participate in self-directed learning through the platform. *Evaluations and tasks (30 min):* Assessments and in-depth exercises are completed to deepen students' understanding of knowledge gained from interactive discussions and supplementary resources on the DCM platform. Furthermore, students are assigned tasks that require them to apply Thales' Theorem to real-life situations.	➢ *After-class activities:* *Completion of homework (90 min):* Students independently complete their homework exercises related to Thales's theorem from the textbook.

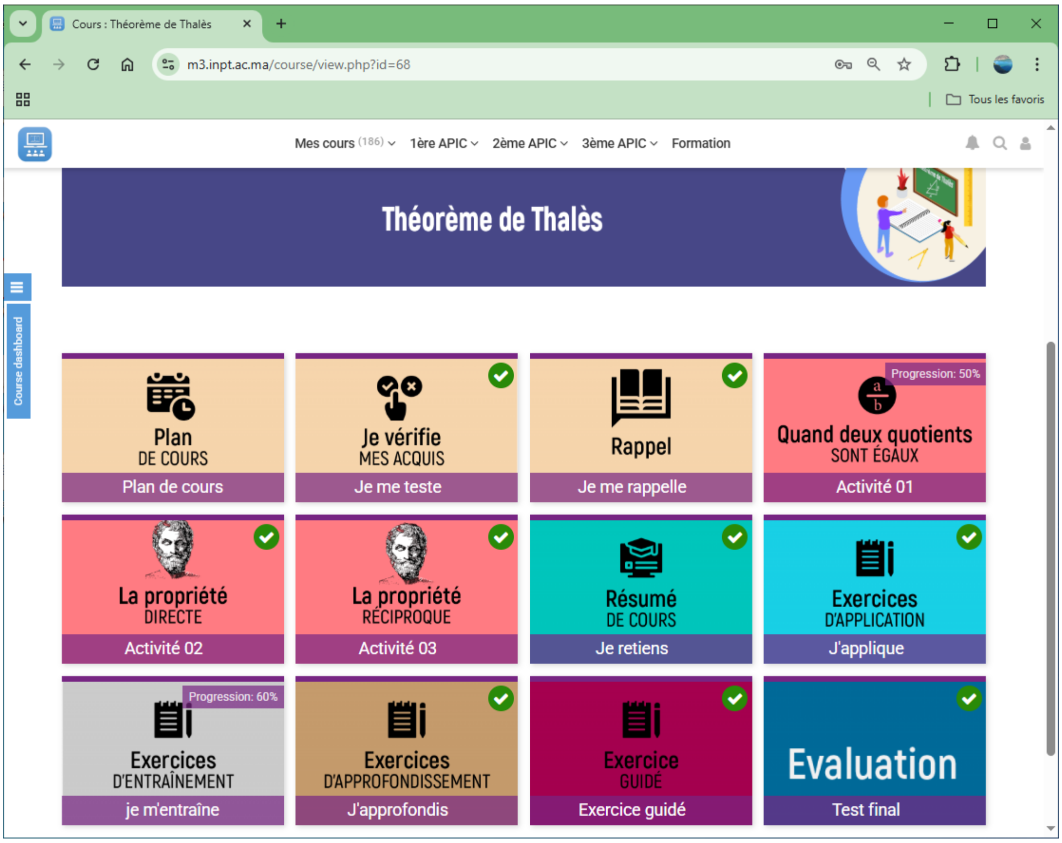


Fig. 2. Interface of the DCM educational platform for the unit on Thales' theorem.

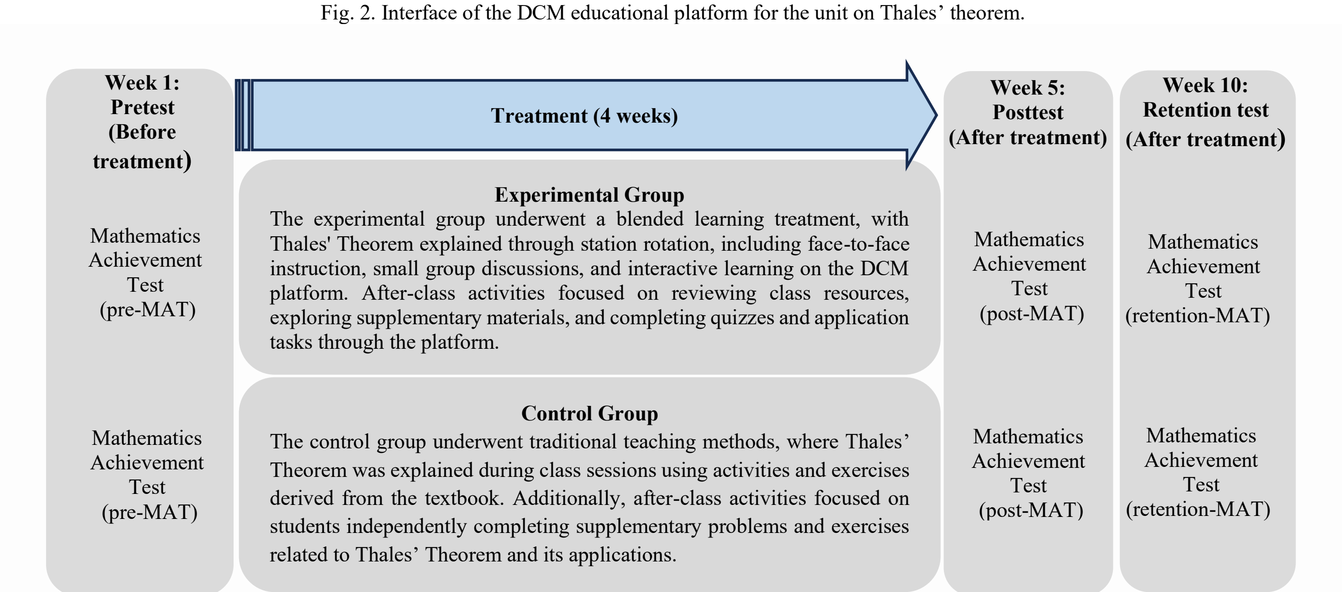


Fig. 3. A visual overview of the experimental procedures implemented in the study.

E. Analysis of Data

The data collected from the pre-MAT, post-MAT, and retention-MAT assessments were analyzed using SPSS version 26. To address the research questions, we calculated the mean and standard deviation. Analysis of Covariance (ANCOVA) was employed to test the hypotheses, with the significance level established at 0.05. This quasi-experimental study employed ANCOVA to control for initial group differences by utilizing covariates, which allows for a more accurate evaluation of the treatment's influence and enhanced statistical power. The decision-making criteria were established as follows: the null hypothesis was rejected when the p-value was ≤ 0.05, and it was not rejected when the p-value exceeded 0.05.

IV. Findings

The study's findings were organized and displayed according to the formulated questions of research and hypothesis.

A. Results Related to the First Research Question and Hypothesis

RQ1. What are students' mathematics achievement scores when taught Thales' Theorem using the method of blended learning on the DCM platform compared to those taught using conventional methods?

The answer to the first research question is provided in Table 3.

Table 3 presents students' mean pre-MAT and post-MAT scores in both the experimental and control groups. The experimental group had a pre-MAT mean score of 9.17 (SD = 2.70) and a post-MAT mean score of 13.31 (SD = 2.51), resulting in a difference of 4.14 in mean achievement scores among the two assessment tests. In contrast, the control group had a pre-MAT mean score of 9.06 (SD = 2.71) and a post-MAT mean score of 10.10 (SD = 2.78), yielding a difference of 1.04 among the two assessment tests. Analysis shows that students in the experimental group obtained higher average achievement scores than their peers in the control group.

Table 3. The mean achievement scores of students in both the experimental and control groups for the pre-MAT and post-MAT

Group	N	pre-MAT		post-MAT		Mean Difference
		Mean	SD	Mean	SD	
EG (Blended learning)	40	9.17	2.70	13.31	2.51	4.14
CG (Traditional teaching)	40	9.06	2.71	10.10	2.78	1.04

N: Number of participants; SD: Standard deviation.

H1: There is no statistically significant difference between the average achievement scores of students taught Thales' Theorem through blended learning on the DCM platform and those taught using conventional methods.

To test this hypothesis, we conducted an ANCOVA on the post-MAT scores, using pre-MAT scores as the covariate. This analysis sought to account for initial differences and accurately assess the teaching method's influence on the results. The results obtained from this analysis are displayed in Table 4.

Table 4. Results of the ANCOVA for the post-MAT scores with pre-MAT as the covariate

Source	Sum of Squares	df	Mean Square	F	Sig.	η^2
Corrected Model	231.274[a]	2	115.637	17.006	0.000	0.306
Intercept	609.382	1	609.382	89.620	0.000	0.538
pre-MAT	24.871	1	24.871	3.658	0.060	0.045
Groups	203.311	1	203.311	29.900	0.000	0.280
Error	523.573	77	6.800	-	-	-
Total	11,717.750	80	-	-	-	-
Corrected Total	754.847	79	-	-	-	-

[a] R Squared = 0.306 (Adjusted R Squared = 0.288); df: Degrees of freedom; F: F-test; Sig.: Significant; η^2: Partial eta squared.

Table 4 presents the results obtained from an ANCOVA analysis. It shows the difference in achievement scores between students in the experimental group, who underwent blended learning through the DCM educational platform, and the control group, who used traditional textbook-based teaching. The analyses reveal a significant main effect for the treatment groups ($F(1, 77) = 29.900$, $p = 0.000$). Since the p-value (0.000) is below the pre-established significance threshold ($p \leq 0.05$), the hypothesis of null, which posits no statistically significant difference, is discarded. This difference is attributed to the teaching method used. Based on these findings, the experimental group, which used blended learning through the DCM platform to study Thales' theorem, outperformed the control group, which relied on traditional learning. Moreover, according to Cohen's [86] effect size evaluation, the results indicate a large effect size, as evidenced by a partial eta-squared value of 0.280. This suggests that the use of blended learning methods through the DCM platform resulted in a significant improvement of 28.00% in students' achievement scores. The effect size underscores the practical significance of the differences in academic achievement scores, showing that students who participated in blended learning outperformed those taught using traditional methods.

B. Results Related to the Second Research Question and Hypothesis

RQ2. What are students' mathematical knowledge retention scores when taught Thales' Theorem using the method of blended learning on the DCM platform compared to those taught using conventional methods?

The answer to the second research question is given in Table 5.

Table 5. The mean achievement scores of students in both the experimental and control groups for the post-MAT and retention-MAT

Group	N	post-MAT		retention-MAT		Mean Difference
		Mean	SD	Mean	SD	
EG (Blended learning)	40	13.31	2.51	13.16	2.30	0.15
CG (Traditional teaching)	40	10.10	2.78	9.22	2.74	0.88

Table 5 presents students' mean post-MAT and retention-MAT scores in the experimental and control groups. For the experimental group, students achieved a mean score of 13.31 in the post-MAT (SD = 2.51) and a mean score of 13.16 in the retention-MAT (SD = 2.30), resulting in a difference of 0.15 among the two assessment tests. In the control group, students recorded a mean of 10.10 in the post-MAT (SD = 2.78) and a mean of 9.22 in the retention-MAT (SD = 2.74), resulting in a difference of 0.88 among the two assessment tests. The results indicate that students in the experimental group showed superior knowledge retention compared to those in the control group, as the difference between the two assessment scores was smaller in the experimental group.

H2: There is no statistically significant difference between the average mathematical knowledge retention scores of students taught Thales' Theorem through blended learning on the DCM platform and those taught using conventional methods.

To test this hypothesis, we conducted an ANCOVA on the retention-MAT scores, using post-MAT scores as the covariate. This analysis sought to account for initial differences and accurately assess the teaching method's influence on the results. The results obtained from this analysis are displayed in Table 6.

Table 6. Results of the ANCOVA for the retention-MAT scores with post-MAT as the covariate

Source	Sum of squares	df	Mean Square	F	Sig.	η^2
Corrected Model	386.755[a]	2	193.378	35.077	0.000	0.477
Intercept	177.109	1	177.109	32.126	0.000	0.294
post-MAT	76.677	1	76.677	13.909	0.000	0.153
Groups	108.801	1	108.801	19.736	0.000	0.204
Error	424.491	77	5.513	-	-	-
Total	10,835.250	80	-	-	-	-
Corrected Total	811.247	79	-	-	-	-

[a] R Squared = 0.477 (Adjusted R Squared = 0.463).

Table 6 presents the results of the ANCOVA analysis, which examines the differences in knowledge retention scores between students in the experimental group, who received instructions in mathematics employing blended learning methods via the DCM platform, and those in the control group, who received traditional textbook-based instruction. The analyses reveal a significant main effect for the treatment groups ($F(1, 77) = 19.736$, $p = 0.000$). Since the p-value (0.000) is below the pre-established significance threshold ($p \leq 0.05$), the hypothesis of null, which posits no statistically significant difference, is discarded. This difference is attributed to the instructional method used. Based on this, there is a substantial difference in knowledge retention scores among students who received mathematics teaching employing blended learning via the DCM platform for studying Thales' Theorem compared to students in the control group who received traditional textbook-based instruction. These differences favored the experimental group. According to Cohen's [86] effect size evaluation, the results show a large effect size, indicated by the partial eta-squared value of 0.204. This suggests that applying the blended learning methods through the DCM platform contributed to a notable difference of 20.4% in students' knowledge retention scores. The effect size emphasizes the practical importance of the differences in retention scores, demonstrating that students who participated in blended learning showed better knowledge retention than those taught using traditional methods.

V. Discussions

This study examined how teaching Thales' theorem to third-grade middle school students utilizing blended learning methods through the DCM platform affected their achievement and knowledge retention of mathematical concepts. The study's results indicated that using the DCM platform within the blended learning approach significantly positively affected students' mathematics achievement compared to traditional teaching methods. When testing the first hypothesis, statistical analyses indicated a significant difference in achievement scores between students taught through blended learning and those instructed using traditional methods, showing that utilizing blended learning was more beneficial for students. This indicates the efficacy of blended learning methods in enhancing mathematics achievement among students. The positive outcomes of blended learning can be interpreted in light of the interactive features inherent in this educational model, which contributes to developing creative thinking and self-regulated learning skills through a balanced integration of traditional instructional methods and modern digital technologies [87]. The DCM platform exemplifies this integration by offering diverse interactive content, including digital activities, simulations, instructional videos, and short quizzes, that enables students to actively and effectively explore mathematical concepts. This shift promotes transforming the student's role from a passive recipient to an active participant, thereby fostering deep conceptual understanding and the ability to apply knowledge across various educational contexts [88]. The platform also offers broad opportunities to adopt diverse learning strategies that cater to individual differences, including self-directed learning through a flexible environment that allows students to set personal goals, manage their time, and monitor their progress using interactive assessment tools. This process enhances student autonomy and nurtures essential life skills [89]. Additionally, the platform supports active learning by integrating interactive tasks that stimulate continuous engagement with the learning material [90]. It further reinforces project-based learning through tools like GeoGebra, fostering creativity and innovation in learning mathematical concepts. These tools allow learners to explore concepts creatively, encouraging them to design and share interactive activities [91]. For example, when learning Thales' Theorem, learners can build interactive geometric models and visually test the relationships between sides. This enables them to discover the theorem independently, propose practical applications, and design projects highlighting its uses, thus developing their critical and creative thinking skills. Complementing these strategies, small-group discussions function as a pedagogical scaffold that facilitates the exchange of ideas and supports collaborative knowledge construction, promoting critical thinking, problem-solving, and cooperative skills. Through such constructive interaction, students reconstruct their knowledge in light of new insights, enhancing their analytical and logical reasoning capabilities [92]. Within this context, the teacher plays a central role in cultivating a learning environment conducive to dialogue, guiding students in effectively using the platform's resources, and providing ongoing support to ensure the achievement of educational objectives [93]. Consequently, integrating the platform's interactive functions and the pedagogical role of the teacher contributes to creating a flexible learning environment that promotes higher-order thinking and prepares learners to face future learning challenges effectively. Thus, blended learning supported by the DCM platform emerges as a significant contributor to enhancing students' academic performance in mathematics. The results of this study support existing research showing improved mathematics achievement among students at various educational levels when employing blended learning methods. For instance, the survey by Fazal and Bryant [94] found that sixth-grade students taught using the stations of rotation model within the blended learning framework achieved higher scores on the Measures of Progress in Academics test than students instructed in a face-to-face setting. Additionally, Ojaleye and Awofala's study [95] showed that secondary school students achieved better results in algebra when utilizing blended learning and problem-solving curricula than those taught employing the conventional lecture style. Furthermore, Gongden's [96] study found substantial differences in chemistry achievement assessments among high school students in Jos, Nigeria. Students who employed rotational blended learning outperformed those who relied on conventional instruction through lectures. Additionally, Olatunde-Aiyedun and Adams [97] found notable differences in science academic achievement at the high school level, with students engaged in blended learning achieving higher outcomes than those relying on conventional teaching methods. These studies, which were carried out across different contexts, show a notable improvement in math achievement among students when blended learning methods are employed compared to conventional methods. In general, our study adds to the expanding body of evidence highlighting the role of blended learning methods in improving math achievement among school students. This research provided important insights for legislators and educators aiming to develop and enhance strategies for teaching mathematics by offering data that supports the potency of integrating technological tools with conventional methods to improve educational outcomes.

The results exhibited that implementing blended learning methods via the DCM platform helped improve students' knowledge retention of mathematical concepts compared with the conventional method based on direct instruction and using textbooks. When testing the second hypothesis, significant differences were found in knowledge retention scores for mathematics concepts between students who studied Thales' Theorem using blended learning through the DCM platform and those who received traditional instruction. The results favored the experimental group, indicating the effectiveness of the blended learning approach in enhancing students' ability to retain mathematical concepts. Improving students' retention of mathematical concepts can be explained through the instructional method that uses blended learning via the DCM platform. This platform provides a learning environment rich in interactive activities and diverse exercises, enhancing students' engagement with the content and effectively reinforcing the concepts. The platform also offers a flexible environment that encourages self-directed learning. Students can explore the content at a pace suited to them and identify points that need further reinforcement. Additionally, the platform's prompt feedback allows students to correct their errors and boost their comprehension of the concepts. Collaborative discussions in small groups, both inside and outside the classroom, also facilitated a more profound understanding of the concepts. These factors work together to enhance the retention of mathematical knowledge. These studies' findings correspond with the current scientific literature, indicating that blended learning significantly boosts students' retention of mathematical knowledge compared to more conventional methods. For instance, a research study by Egara and Mosimege [98] revealed that students in high schools in Nigeria who received mathematics instruction via a blended learning method experienced substantial improvements in maths achievement and knowledge retention compared to their peers taught using conventional methods. Likewise, Tukur and Hauwa [99] found that high school students with a blended learning method grounded in constructivist principles showed substantial increases in math success and knowledge retention compared to students who taught using conventional education. In addition, Suleiman *et al.* [100] found that computer-aided blended teaching substantially improved secondary-level students' retention of chemistry concepts when applied in a collaborative educational setting compared to individual learning or lecture-based methods. Likewise, the study by Onyenma and Olele [101] demonstrated that blended learning significantly improved the retention of physics concepts among Federal Colleges in Nigeria compared to students taught using conventional methods. The multiple studies reviewed agree that a blended learning method substantially enhances students' capacity for knowledge retention of scientific concepts. These studies support that combining conventional educational methods with modern learning technologies helps enhance knowledge retention. Our research results support previous studies, affirming that blended instruction enhances knowledge retention in scientific fields, particularly in mathematics topics such as geometry.

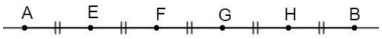
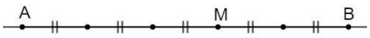
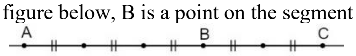
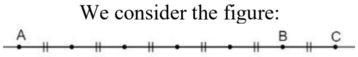
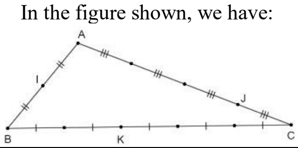
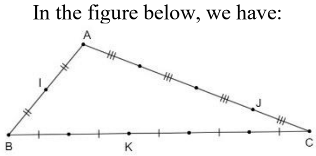
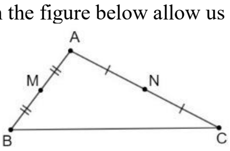
VI. Conclusion

This research study evaluated the influence of a blended instructional method through the DCM platform on math achievement and knowledge retention among third-grade middle school students related to Thales' theorem. The study results showed that the blended instructional method using the DCM platform significantly enhances students' math achievement and improves their ability to retain knowledge compared to conventional teaching methods. The results indicated that students who studied Thales' theorem using the blended learning method demonstrated notable improvements in their math achievement scores and knowledge retention compared to those taught through conventional methods. Building on these findings, it is clear that integrating blended learning methods into the educational process is an effective strategy for enhancing students' academic performance and strengthening their capacity to retain concepts. This approach also contributes to fostering a motivational and engaging learning environment, which promotes active interaction and participation of students with the educational content. In light of these findings, it is recommended that the Ministry responsible for education invest in enhancing the technological infrastructure of educational institutions by providing high-speed internet and portable or tablet computers. Additionally, it is advised that flexible curricula that combine traditional and online learning methods should be developed. Furthermore, teachers should be trained to implement blended educational methods and employ diverse instructional strategies consistent with this teaching model. Blended educational environments should foster interaction and active participation through interactive content, discussions, and collaborative projects. Personalized learning pathways should allow students to progress at their own pace and offer additional support for those facing challenges with digital components. Finally, it is recommended that a continuous assessment system be set up to measure the potency of blended learning, using the results to implement ongoing improvements that align with students' needs.

This study has some limitations that should be taken into consideration. Although the outcomes indicate the potency of blended learning in enhancing academic achievement and knowledge retention among students in mathematics, it is essential to consider the influence of this teaching method's novelty on the sustainability of its results over the long term. Therefore, subsequent studies should focus on the sustainability of these effects over more extended periods. Moreover, selecting a relatively small sample (80 students) from establishments with specific features may affect the generalizability of the results, necessitating the use of larger and more diverse samples in future studies. Additionally, the study did not account for differences in the competencies of mathematics instructors, such as teaching methods, expertise, and their levels of commitment to implementing the blended learning model, all of which might have affected students' achievement and retention of concepts. Therefore, subsequent studies must address these factors more precisely to clarify the teacher's role in influencing student outcomes in a blended learning environment. Lastly, the research scope can be broadened to investigate the impact of blended learning on various topics and educational levels, thereby enhancing the understanding of this approach across diverse educational contexts.

APPENDIX

Table A1. Mathematics achievement test (pre-MAT) (for each question, check the correct answer)

No	Questions	Answers		
1	We have: $\frac{x}{5}=\frac{2}{3}$ Therefore...	$x=\frac{2}{3\times 5}$ ☐	$x=\frac{5\times 3}{2}$ ☐	$x=\frac{5\times 2}{3}$ ☐
2	We have: $\frac{4}{9}=\frac{y}{2}$ Therefore...	$y=\frac{9\times 2}{4}$ ☐	$y=\frac{2\times 4}{9}$ ☐	$y=\frac{9}{2\times 4}$ ☐
3	We have: $\frac{6}{z}=\frac{4}{5}$ Therefore …	$z=\frac{10}{3}$ ☐	$z=\frac{24}{5}$ ☐	z = 7.5 ☐
4	 If M is a point on [AB] and if $\frac{AM}{AH}=\frac{1}{2}$, Then …	M = E ☐	M = G ☐	M = F ☐
5	We have:  Therefore …	$\frac{AM}{AB}=\frac{2}{3}$ ☐	$\frac{AM}{AB}=\frac{2}{5}$ ☐	$\frac{AM}{AB}=\frac{3}{2}$ ☐
6	In the figure below, B is a point on the segment [AC].  We can write:	$\frac{AB}{AC}=\frac{3}{2}$ ☐	$\frac{AB}{AC}=\frac{2}{5}$ ☐	$\frac{AB}{AC}=\frac{3}{5}$ ☐
7	We consider the figure:  We have…	$\frac{AB}{AC}=\frac{1}{6}$ ☐	$\frac{AB}{AC}=\frac{5}{6}$ ☐	$\frac{AB}{AC}=\frac{6}{5}$ ☐
8	In the figure shown, we have: 	$\frac{AI}{AB}=\frac{1}{2}$ ☐	$\frac{AB}{AI}=\frac{1}{2}$ ☐	$\frac{BI}{BA}=2$ ☐
9	In the figure below, we have: 	$\frac{CK}{CB}=\frac{5}{3}$ ☐	$\frac{BK}{CB}=\frac{1}{2}$ ☐	$\frac{BK}{BC}=\frac{2}{5}$ ☐
10	The codings in the figure below allow us to assert that: 	BC = 2 × MN ☐	BN = CM ☐	(MN)∥(BC) ☐

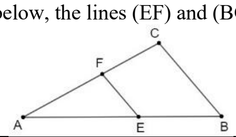
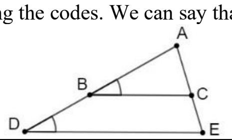
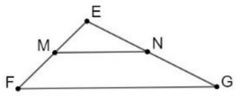
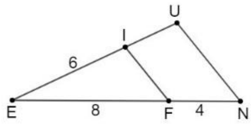
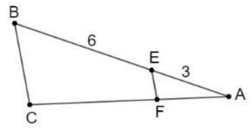
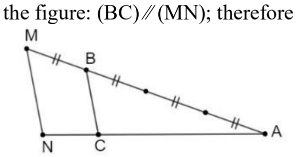
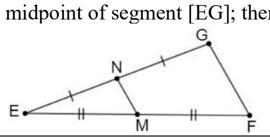
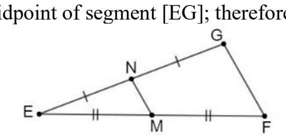
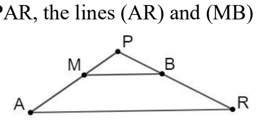
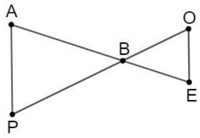
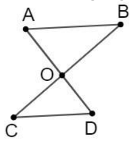
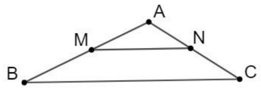
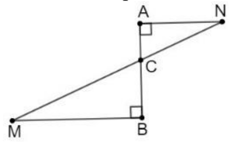
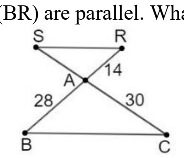
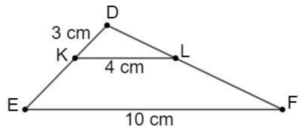
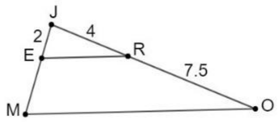
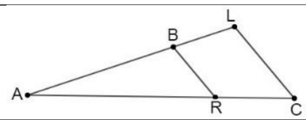
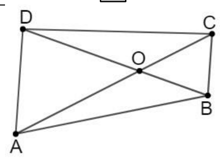
11	In the figure below, the lines (EF) and (BC) are parallel. 	$\frac{AF}{AC}=\frac{AE}{AB}=\frac{EF}{BC}$ ☐	$\frac{AF}{AE}=\frac{AC}{AB}=\frac{EF}{BC}$ ☐	$\frac{AF}{FC}=\frac{AE}{EB}=\frac{EF}{BC}$ ☐
12	Using the codes. We can say that... 	Point B is the midpoint of segment [AD] ☐	(BC)⫽(DE) ☐	(AB)⫽(DC) ☐
13	We have: $2AB - 3AC = 0$, therefore…	$\frac{AB}{AC}=\frac{2}{3}$ ☐	$\frac{AC}{AB}=5$ ☐	$\frac{AC}{AB}=\frac{2}{3}$ ☐
14	We have: $\frac{EF}{EG}=\frac{5}{3}$ Therefore: …	$5EF = 3EG$ ☐	$3EF = 5EG$ ☐	$EG=\frac{5}{3}EF$ ☐
15	In triangle EFG, we have: M ∈ [EF] and N ∈ [EG] and (MN)⫽(FG); therefore … 	$\frac{EM}{EF}=\frac{FG}{MN}$ ☐	$\frac{EM}{EF}=\frac{EG}{EN}$ ☐	$\frac{EM}{EF}=\frac{MN}{FG}$ ☐
16	In triangle ENU, (FI)⫽(NU), I ∈ [EU] and F ∈ [EN]; therefore … 	$\frac{8}{12}=\frac{6}{EU}$ ☐	$\frac{8}{4}=\frac{6}{EU}$ ☐	$\frac{12}{8}=\frac{EU}{6}$ ☐
17	In triangle ABC, (EF)⫽(BC) and EF = 2; therefore … 	$BC = 3$ ☐	$BC=\frac{3}{2}$ ☐	$BC=\frac{2}{3}$ ☐
18	In the figure: (BC)⫽(MN); therefore … 	$\frac{AC}{AN}=\frac{4}{3}$ ☐	$\frac{AC}{AN}=\frac{3}{4}$ ☐	$\frac{AC}{AN}=\frac{1}{4}$ ☐
19	In triangle EFG, we have: M is the midpoint of segment [EF] and N is the midpoint of segment [EG]; therefore... 	(MN) is a median of triangle EFG ☐	(MN)⫽(FG) ☐	(MN) and (FG) are intersecting lines ☐
20	In triangle EFG, M is the midpoint of segment [EF] and N is the midpoint of segment [EG]; therefore, ... 	$\frac{MN}{FG}=\frac{1}{2}$ ☐	$EN = 2EG$ ☐	$\frac{EF}{EM}=\frac{1}{2}$ ☐

Table A2. Mathematics achievement test (post-MAT) (for each question, check the correct answer)

No	Questions	Answers		
1	If $\frac{5}{AB}=\frac{2}{3}$ Then …	$AB=\frac{6}{3}$ ☐	$AB=\frac{10}{3}$ ☐	$AB=\frac{15}{2}$ ☐
2	What is the purpose of Thales' theorem?	To calculate lengths ☐	To demonstrate that lines are parallel ☐	To calculate angles ☐
3	What is the purpose of the converse of the Thales theorem?	To calculate angles ☐	To demonstrate that lines are parallel ☐	To calculate lengths ☐
4	In triangle PAR, the lines (AR) and (MB) are parallel.  According to the Thales theorem, we have:	$\frac{AM}{AP}=\frac{RB}{RP}=\frac{MB}{AR}$ ☐	$\frac{PM}{AP}=\frac{PB}{PR}=\frac{MB}{AR}$ ☐	$\frac{PM}{PA}=\frac{PR}{PB}=\frac{MB}{AR}$ ☐

5	In the figure, points A, B, and E and P, B, and O are collinear. The lines (AP) and (OE) are parallel.  According to the Thales theorem, we have:	$\frac{BE}{BA}=\frac{BO}{BP}=\frac{AP}{OE}$ ☐	$\frac{BE}{BA}=\frac{PB}{BO}=\frac{OE}{AP}$ ☐	$\frac{BE}{BA}=\frac{BO}{BP}=\frac{OE}{AP}$ ☐
6	Let the following figure be:  Given that (AB) is parallel to (CD), which of these equalities is true:	$\frac{OB}{OC}=\frac{OA}{AB}$ ☐	$\frac{OB}{OC}=\frac{OA}{OD}$ ☐	$\frac{AB}{CD}=\frac{OC}{OB}$ ☐
7	Let the following figure be:  Given that (MN) is parallel to (BC), which of these equalities is true:	$\frac{AM}{AB}=\frac{AC}{AN}$ ☐	$\frac{AM}{AB}=\frac{BC}{MN}$ ☐	$\frac{AM}{AB}=\frac{AN}{AC}$ ☐
8	What equal ratios can we express based on this figure? 	$\frac{AC}{AB}=\frac{NC}{NM}=\frac{AM}{BM}$ ☐	$\frac{CA}{CB}=\frac{CN}{CM}=\frac{AN}{MB}$ ☐	$\frac{CA}{AB}=\frac{CM}{CN}=\frac{NA}{MB}$ ☐
9	The lines (SR) and (BR) are parallel. What is the value of AS? 	$AS=14$ ☐	$AS=15$ ☐	$AS=60$ ☐
10	In triangle EFD, the lines (KL) and (EF) are parallel. Therefore, we have: 	$DE=7$cm ☐	$DE=7.5$cm ☐	$DE=8$cm ☐
11	Are the lines (ER) and (MO) parallel? 	Yes ☐	No ☐	It cannot be determined ☐
	For questions 12 to 16, please refer to the figure on the right. Points A, B, and L are collinear, as are points A, R, and C.			
12	We assume that (BR) is parallel to (LC). According to Thales' theorem, we have:	$\frac{AB}{BL}=\frac{AR}{RC}=\frac{BR}{LC}$ ☐	$\frac{AB}{AL}=\frac{AR}{AC}=\frac{BR}{LC}$ ☐	$\frac{LC}{BR}=\frac{AL}{AB}=\frac{AR}{AC}$ ☐
13	If (BR) // (LC), AB = 5, AL = 8, and BR = 3 Then:	$LC=\frac{8}{15}$ ☐	$LC=\frac{15}{8}$ ☐	$LC=\frac{24}{5}$ ☐
14	If (BR) // (LC), AR = 8, RC = 6 and AL = 9 Then:	$AB=5$ ☐	$AB=\frac{36}{7}$ ☐	$AB=\frac{63}{4}$ ☐
15	If (BR) // (LC), AR = 6, AC = 9, and AB = 4 Then:	$BL=2$ ☐	$BL=1$ ☐	$BL=3$ ☐
16	If AR = 6, AC = 9, AB = 4, and AL = 6 Then:	The lines (BR) and (LC) are parallel ☐	The lines (BR) and (LC) are not parallel. ☐	$RC=4$ ☐
	For questions 17 to 20, please refer to the figure on the right. Points A, O, and C, as well as D, O, and B, are collinear.			

17	We assume that (AD) is parallel to (BC). According to the Thales theorem:	$\frac{AO}{AC}=\frac{DO}{DB}=\frac{AD}{BC}$ ☐	$\frac{OA}{OC}=\frac{OB}{OD}=\frac{AD}{BC}$ ☐	$\frac{OA}{OC}=\frac{OD}{OB}=\frac{AD}{BC}$ ☐
18	If (AD) // (BC), AO = 4,5 cm, OC = 3 cm and BC = 2 cm. Then:	AD = 2 cm ☐	AD = 3 cm ☐	AD = 3,33 cm ☐
19	If (AD) // (BC), AD = 7 cm, BC = 4 cm, and OD = 5 cm Then:	$OB=\frac{35}{4}cm$ ☐	$OB=\frac{20}{7}cm$ ☐	$OB=\frac{28}{5}cm$ ☐
20	If AO = 6,5 cm, OC = 4 cm, DO = 3 cm, and OB = 4,5 cm. Then:	The lines (AD) and (BC) are parallel ☐	The lines (AD) and (BC) are not parallel ☐	The lines (AB) and (DC) are not parallel ☐

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

AE and MR designed and conducted the research study and wrote the original manuscript; AS and MG analyzed the data and contributed to writing the manuscript; RT, RE, and HL designed the research study, developed the methodology, and revised the manuscript; all authors had approved the final version.

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