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Impact of the Homework Implementation Method (MITCA) on student involvement: digital versus paper-based intervention

Fátima María Díaz-Freire[1,*], Tania Vieites[2], Susana Rodríguez[1], Antonio Valle[1] & Carolina Rodríguez-Llorente[1]

[1] *Universidade de A Coruña, A Coruña (Spain)*
[2] *Universidad Complutense de Madrid, Madrid (Spain)*

Keywords

Homework
Primary education
Intervention
Educational technology
Student involvement

Abstract

Homework outcomes depend not only on homework quantity but also on implementation quality. This quasi-experimental pretest-posttest study compared two versions of the MITCA homework method –digital (MITCAdigital) and paper (MITCApaper)– with a control condition in 1,170 students (50.1% girls; M_{age} = 10.7 years, SD = 0.7) from 5th and 6th grade in 20 schools across Galicia, Spain. Over 12 weeks, participants completed Spanish, Galician, and math homework following the MITCA method conditions. Pretest and posttest measures were collected for cognitive involvement (deep and surface approaches), behavioral involvement (amount of homework, time spent, and time management), and affective-motivational involvement (perceived usefulness, interest, attitude, and anxiety). Compared to the control group, both MITCA conditions showed more favorable behavioral patterns (e.g., task completion and homework time). MITCAdigital was associated with higher perceived usefulness and reduced anxiety, while MITCApaper fostered a more positive attitude toward homework. Regarding cognitive involvement, MITCAdigital was linked to greater use of deep learning approaches. These findings support the relevance of a well-structured homework design. Although both versions promoted student involvement, the digital format stood out for its impact on cognitive and emotional involvement. Combining both formats may optimize students' overall involvement in homework.

Impacto del Método de Implementación de Tareas para Casa (MITCA) en la implicación del alumnado: intervención digital frente a en papel

Palabras clave

Tareas escolares
Enseñanza primaria
Intervención
Tecnología educativa
Participación de los estudiantes

Resumen

La implicación del alumnado en las tareas escolares depende no solo de la cantidad de tareas, sino también de la calidad de su implementación. Esta investigación compara los efectos de la versión digital (MITCAdigital) y en papel (MITCApapel) del método MITCA en la implicación con las tareas escolares. El estudio cuasi-experimental pretest–postest, con un grupo control y dos experimentales, incluyó a 1,170 estudiantes de 5º y 6º de Educación Primaria (50.1% chicas; M_{edad} = 10.7 años; DE = 0.7) de 20 centros de Galicia, España. Durante 12 semanas, los participantes completaron las tareas de lengua castellana, gallego y matemáticas bajo las condiciones del método MITCA. Se recogieron medidas pretest y postest de implicación cognitiva (enfoques profundo y superficial), conductual (cantidad de tareas, tiempo dedicado y aprovechamiento del tiempo) y afectivo-motivacional (utilidad percibida, interés, actitud y ansiedad). Frente al control, ambos grupos MITCA mostraron patrones conductuales más favorables. MITCAdigital se asoció con una mayor utilidad percibida y una reducción de la ansiedad, mientras que el grupo MITCApapel mostró una actitud más positiva hacia las tareas. MITCAdigital también se vinculó con un mayor uso de enfoques de aprendizaje profundo. Los resultados respaldan la importancia de un diseño estructurado de tareas escolares. Aunque ambas versiones favorecen la implicación del alumnado, el formato digital destaca por su impacto en la implicación cognitiva y emocional. La combinación de ambos formatos podría optimizar el compromiso con las tareas escolares.

* *Corresponding author:* Fátima María Díaz Freire. Calle Alcalde Suárez Ferrín 1, 8ºH A Coruña 15011, Spain. fatima.diaz@udc.es
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Homework is a widely used pedagogical practice in educational systems worldwide, aimed at extending learning beyond the classroom and consolidating the content addressed in school lessons (Tam & Chan, 2011). However, its effectiveness does not lie solely in the number of tasks assigned, but rather in the degree of student involvement (Trautwein, 2007). In this regard, student involvement in homework has been conceptualized from a three-dimensional perspective –cognitive, behavioral, and affective-motivational (Valle et al., 2015). Research has shown that forms of involvement with homework, such as attributing value to the tasks and putting effort into completing them, are key predictors of students' academic performance (e.g., Xu, 2020a).

Large-scale studies and international analyses reveal that homework can contribute to students' performance, yet the effect sizes are modest and strongly dependent on how homework is assigned and supported (e.g., Fernández-Alonso et al., 2017). These studies highlight that simply increasing homework time may amplify differences between students rather than reducing them. For this reason, more recent research shifts attention from the amount of homework prescribed to the quality of its design, with evidence showing that well-designed and differentiated homework is positively related to students' performance (Feiss et al., 2025).

The rise of educational technology, particularly following the COVID-19 pandemic, led to an increasing implementation of digital homework, noted for its potential to enhance student involvement (Magalhães et al., 2020). Unlike traditional formats, digital homework offers immediate feedback, access to interactive resources, and greater opportunities for personalization (Chen et al., 2023). Recent studies highlight that when students perceive these tasks as useful for their learning, their involvement and interest increase (Wiggins & Van der Hoff, 2021). Nevertheless, their effectiveness largely depends on the quality of instructional design, students' self-regulation abilities, and their capacity to manage distractions in digital environments (Wang et al., 2023; Xu, 2020b). In this context, it is important to examine how each dimension of student involvement in homework manifests itself, considering both traditional and digital methods.

Cognitive involvement refers to the level of mental processing students apply while completing homework, which is linked to deep and surface learning approaches (Regueiro, 2018). Students who adopt a deep approach tend to integrate content, connect it to prior knowledge, and reflect on its utility, thus fostering meaningful learning (Valle et al., 2015). This dimension is particularly relevant in digital contexts, where interactive tasks with immediate feedback and multimodal content can promote deeper processing (Chen et al., 2023). However, information overload or poor digital design may lead to surface strategies focused on task completion without thoughtful reflection (Xu, 2020b).

Behavioral involvement refers to observable aspects of student conduct, such as time spent, persistence, and task completion (Regueiro, 2018). In digital contexts, these behaviors may change because homework is performed in environments that are more flexible but also more fragmented: tasks can be accessed anytime and anywhere, yet students often work amid competing notifications and entertainment options, which can interrupt sustained involvement (Pérez-Juárez et al., 2023). Research on online learning suggests that technology-rich settings can support behavioral involvement when they incorporate clear task sequences, progress indicators, and timely feedback that encourage persistence and completion; however, when design is weak or demands are unclear, students' effort and continuity tend to decline (Oinas et al., 2025; Sui et al., 2024). Thus, compared with paper-based homework –which often occurs in more stable routines–, digital homework may either strengthen behavioral involvement through structured guidance and feedback or undermine it through distraction and discontinuity, making it essential to examine how students' time investment and task completion evolve across formats.

Finally, affective-motivational involvement encompasses students' emotions, attitudes, and beliefs toward homework (Regueiro, 2018). Intrinsic value –the enjoyment or interest in the task– and perceived usefulness are key elements influencing motivation (Wigfield & Eccles, 2020). In this sense, digital homework offers advantages such as higher personalization and gamified features that may enhance interest and enjoyment (Chen et al., 2023). However, it can also generate frustration when the interface is unintuitive or when students lack basic digital skills (Xu et al., 2018). Moreover, negative emotions such as anxiety or boredom remain frequent in both formats, especially when homework is experienced as excessive or disconnected from meaningful learning goals (Hong et al., 2021).

Recent research shows that what matters for students' learning is not simply how much homework they receive, but the combination of time spent, effort, time management, and perceived task quality (Rodríguez et al., 2025; Xu, 2025a). Person-centered studies indicate that profiles combining moderate homework load with good time management and clear purposes are more strongly related to motivation, emotions, and achievement than high-load profiles (Rodríguez et al., 2025; Valle et al., 2019). From a well-being perspective, qualitative and survey studies with children, parents, and teachers report that repetitive and overloaded homework is associated with frustration, stress, and sleep problems, whereas varied and meaningful tasks support more positive emotions (Negru & Sava, 2023). At the same time, research on teachers' emotions and homework quality conceptualizes homework as both a cognitive and emotional resource: perceived embedding of homework in teaching predicts performance partly via lower anger during homework (Feiss et al., 2025), and teachers' enthusiasm and value beliefs about homework are linked to their willingness to design more engaging tasks (Feiss et al., 2023). Consistent with self-regulation learning (SRL) frameworks, homework is increasingly described as a "classic" context in which teacher-led SRL instruction and high-quality homework involvement foster students' homework management strategies, persistence, and achievement (Avcı et al., 2025; Xu, 2025a, 2025b).

These discussions intersect with a broader international debate about the role of digital technologies in homework.

On one hand, technology-enhanced environments and online homework systems can support monitoring, feedback, and engagement when they are well designed (Magalhães et al., 2020; Sui et al., 2024). On the other hand, large-scale studies describe e-learning as a "double-edged sword," where digital distractions, unequal access, and mixed emotional experiences can undermine potential benefits, particularly for more vulnerable students (Oinas et al., 2025; Pérez-Juárez et al., 2023). Within this landscape, SRL-oriented homework methods such as MITCA offer a promising alternative by explicitly structuring homework around preparation, execution, and reflection, and by emphasizing meaningful, varied, and evaluable tasks (Valle & Rodríguez, 2020; Vieites et al., 2023; Vieites et al., 2024). A recent quasi-experimental study showed that the digital version of MITCA strengthened behavioral self-regulation, particularly time management and task planning, whereas the paper format was especially effective for organizing the physical study environment (Díaz-Freire et al., 2025). However, it remains unclear whether these format-specific SRL benefits translate into different patterns of cognitive, behavioral, and affective-motivational involvement in homework when MITCAdigital, MITCApaper, and conventional homework prescriptions are compared in primary education.

The present study

Since homework offers a strategic opportunity to promote students' learning and self-regulation, it is essential to focus not only on its assignment but also on how it is designed and implemented. In this context, the Homework Implementation Method (MITCA, Valle & Rodríguez, 2020), grounded in self-regulated learning, structures homework as a learning episode with three phases: preparation, execution, and final reflection. It incorporates five pedagogical conditions for designing tasks that are varied, specific, meaningful, planned weekly, and systematically evaluated. While the paper-based version has yielded positive outcomes on students' behavioral and emotional involvement (Vieites et al., 2023; Vieites et al., 2024), the ongoing integration of technology in education calls for exploring its potential in digital environments.

The main objective is to examine the effects of the digital MITCA method compared to its paper-based version and to conventional homework prescriptions, in the three dimensions of student homework involvement: cognitive, behavioral, and affective-motivational. Specifically, it is expected that students using MITCA in digital format will show better involvement in homework overall. Additionally, the study will explore potential differences between both MITCA formats (digital versus paper) regarding student involvement in homework.

Method

The study employed a quasi-experimental pretest-posttest design with three conditions (control, MITCApaper, and MITCAdigital). The intervention lasted 12 weeks (one academic term). Classrooms constituted the unit of assignment; school administrators allocated classes to conditions considering scheduling constraints and the availability of digital devices, aiming to maintain comparability across groups by grade level and school context. Outcomes were assessed at two time points (pretest and posttest).

Participants

The study involved 59 teachers (5th grade: $n = 30$; 6th grade: $n = 29$) and 1,170 students (50.1% girls; $M_{age} = 10.7$, $SD = 0.7$) from 20 primary schools in the Autonomous Community of Galicia (Spain). Group sizes were as follows: control (19 teachers; 431 students), MITCApaper (24 teachers; 533 students), and MITCAdigital (16 teachers; 206 students). All participating schools were located in urban settings; the sample comprised 13 public schools and 7 publicly subsidized (charter) schools. According to the Spanish National Institute of Statistics (2022), the socio-economic status of the areas where these schools were located ranged from medium to high.

Instruments

Homework cognitive involvement was assessed with the *Inventory of Study Processes* (IPE, Rosário et al., 2006). This questionnaire measures students' deep and surface learning approaches. The surface learning approach was evaluated through a set of four items ($\alpha_{Pre} = .73/\alpha_{Post} = .78$; e.g., "I usually do my homework, but I rarely pay attention to how I'm doing it"). In contrast, the deep learning approach consisted of six items ($\alpha_{Pre} = .77/\alpha_{Post} = .6$; e.g., "Doing homework is a great opportunity to check how well I've mastered the subject matter").

Homework behavioral involvement was assessed using the *Homework Survey* (EDE, Núñez et al., 2015). It was evaluated through three different measures: the amount of homework completed by students was obtained through responses to two items ($\alpha_{Pre} = .79/\alpha_{Post} = .83$; e.g., "Of the homework given by teachers, how much do you usually complete?"); the time spent on homework was assessed with three items ($\alpha_{Pre} = .7/\alpha_{Post} = .79$; e.g., "On average, how much time do you usually spend per day on homework?"); and effective management of homework time was measured using three items (e.g., $\alpha_{Pre} = .61/\ \alpha_{Post} = .7$; "When I start doing homework, I concentrate and don't think about anything else until I finish").

Homework affective-motivational involvement was also assessed with five subscales from the EDE: homework perceived usefulness (two items; $\alpha_{Pre} = .95/\alpha_{Post} = .96$; e.g., "Doing homework is very common because teachers believe it is useful for learning the subjects"); domain orientation towards homework (seven items; $\alpha_{Pre} = .8/\alpha_{Post} = .84$ e.g., "I enjoy doing homework because it helps me learn more"); interest in homework (three items; $\alpha_{Pre} = .75/\alpha_{Post} = .77$; e.g., "I believe doing homework at home increases my interest in the subjects"); attitude toward homework (three items; $\alpha_{Pre} = .73/\alpha_{Post} = .75$; e.g., "I'm in a good mood while doing homework"); and homework-related anxiety (four items; $\alpha_{Pre} = .76/\alpha_{Post} = .77$; e.g., "I get so nervous when doing homework that I forget the things I've learned").

Item-level descriptive statistics were computed at pretest and posttest (means, standard deviations, skewness, and kurtosis) for all items assessing cognitive, behavioral, and affective-motivational involvement with homework. These results are reported in Tables A1-A3 (see Appendices) and were used to screen for potential floor/ceiling effects and distributional anomalies prior to computing scale scores and conducting the main analyses.

Unless otherwise indicated, items used 5-point response formats. Attitudinal/affective homework items and the *Study Process Inventory* used 1 = *Totally false* to 5 = *Totally true*, whereas the *School Engagement Scale* used 1 = *Never* to 5 = *Always*. For behavioral homework indicators (EDE), options were item-specific: completion 1 = *None* to 5 = *All*, time spent 1 = *< 30 min* to 5 *> 2h*, and time management/efficiency 1 = *I waste it completely* to 5 = *I use it completely*; other EDE items used 5-point frequency/usefulness options as shown in the questionnaire.

Procedure

Both MITCApaper and MITCAdigital were designed following the five essential pedagogical conditions: (1) assigning not only review tasks but also pre-topic, organization, and production tasks (Varied); (2) describing tasks in terms of the mental work involved and the content addressed (Specific); (3) clearly communicating the purpose, interest, and usefulness of the task (Worthwhile); (4) establishing a weekly planning structure in which students select their time slots (Planned); and (5) evaluating tasks weekly, either individually or collectively, with constructive feedback (Evaluated).

The study began with formal written contact addressed to the school principals, outlining the goals, structure, and ethical considerations of the study. Once approval was granted by the school administration, informative meetings were held with the participating teachers. During these sessions, the intervention plan was explained in detail, and written informed consent was requested from the families of all the students involved.

Teachers assigned to the experimental conditions received initial training to ensure they understood the guidelines and core principles required to implement the MITCA method in both paper and digital formats for homework prescriptions. Training was equivalent across the two experimental groups regarding the MITCA-based homework prescription procedure. The main distinction concerned teacher selection for the MITCAdigital condition: preference was given to teachers who already used Moodle (or a comparable LMS) in their regular practice and were familiar with the platform. In addition to instruction on the MITCA method, the digital group also received guidance on embedding the MITCA digital template within each school's virtual learning environment.

For the experiment group working with the paper version, all experimental-group teachers attended an initial 60-minute seminar followed by a 30-minute question-and-answer session. The seminar reviewed the five MITCA conditions step by step and provided practical examples illustrating how to adapt textbook activities into MITCA-aligned prescriptions. In the subsequent academic year, the digital cohort completed an analogous session with the same structure and duration, supplemented by approximately 15 additional minutes focused on integrating the MITCA digital template into the school's Moodle/LMS.

In both experimental conditions, training was reinforced through a follow-up seminar conducted six weeks after implementation began, which aimed to evaluate alignment with teachers' instructional routines and to address emerging questions. In addition, a weekly online follow-up mechanism was established to support consistent application of the MITCA principles in homework prescriptions and corrections.

Teachers in the control group continued their usual homework assignment practices throughout the 12-week study period, without any MITCA-related modifications.

Throughout the 12 weeks, teachers in both experimental groups incorporated the five MITCA conditions into their weekly homework prescriptions (paper or digital). Implementation was monitored each week using the MITCA template, which was accessible both to teachers and the research team. During the initial training, teachers were offered two feedback formats: (a) individual feedback, provided either in person or through an online platform, highlighting strengths and weaknesses of students' work and suggesting improvements (e.g., effort, dedication, and quality), or (b) group feedback, in which corrections were provided in detail for each assigned task. Ongoing fidelity was supported through weekly contact with teachers to resolve issues and to collect perceptions regarding the method's fit with classroom practice.

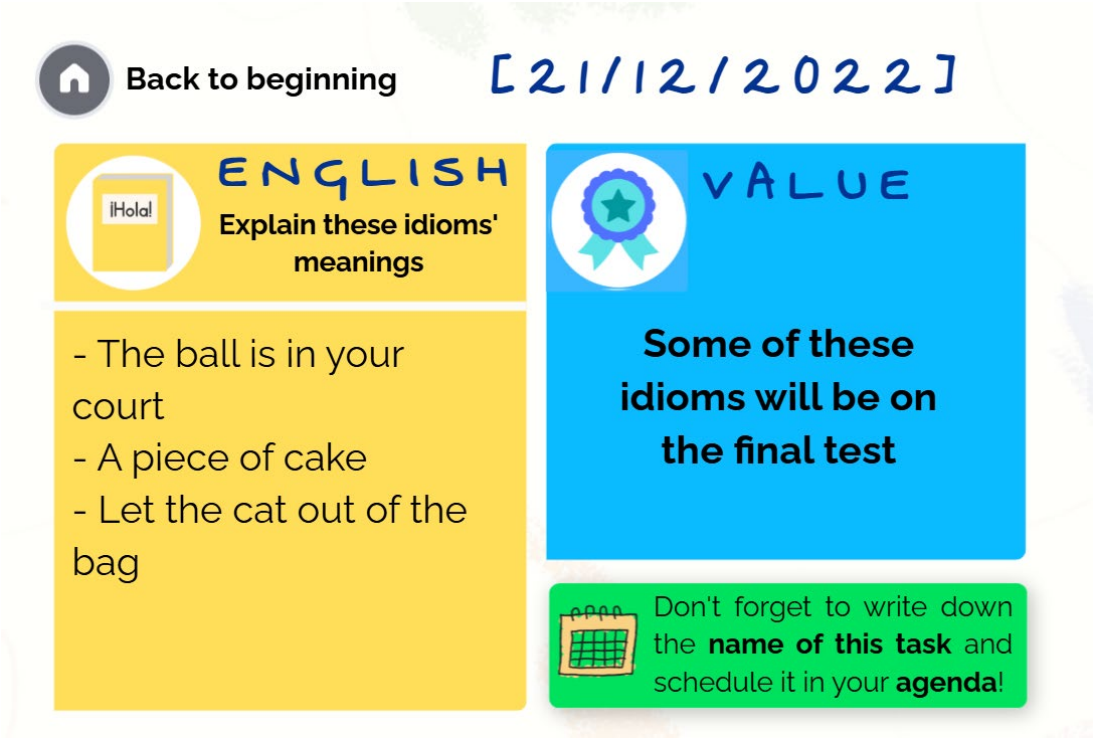
Fidelity was assessed weekly through review of the MITCA template and researcher check-ins, verifying that all five conditions were included and documenting which feedback format was used. As homework prescriptions were issued weekly, teachers sent their assigned tasks to the research team each week via email; in the MITCAdigital condition, prescriptions were additionally reviewed directly within the online template (alongside email-based contact). Any deviations from the protocol were discussed with the teacher during the subsequent weekly check-in.

Finally, it is worth mentioning that the MITCAdigital condition, a template was created using Genially, an interactive online platform commonly used in Spanish educational settings. The template was divided into three visually distinct sections: task definition (yellow), value explanation (blue), and time planning (green). Teachers with prior experience using Moodle were prioritized for this group and were additionally trained on how to integrate and update the Genially template within the virtual campus (Figure 1).

The data for the MITCApaper condition were collected during the 2021-2022 academic year, and for MITCAdigital during 2022-2023. School conditions remained consistent throughout the years, including the curriculum, homework policy, timetable, grading procedures, and academic calendar. MITCA training, materials, and the prescription rubric were implemented in the same way across cohorts, and the pre-/post-assessment periods and intervention duration were equivalent. The only operational difference concerned device access in the digital condi-

Figure 1

Screenshot of the MITCA digital template on Genially



tion; to minimize potential confounding, classes were matched within the same grade and school.

Pretest and posttest measures were administered to all groups during regular school hours by trained research assistants. Data was collected during regular school hours, with prior authorization from the school administration and the consent from the families. To protect participant privacy, all responses were anonymized through alphanumeric coding and used solely for research purposes. Access to the data was restricted to the research team.

All procedures were aligned with current ethical standards and applicable personal data-protection frameworks, notably Organic Law 3/2018 and Regulation (EU) 2016/679 (GDPR). Privacy was preserved by pseudonymizing records via unique participant codes, limiting dataset access to authorized members of the research team, and conducting analyses and reporting at the aggregate level. Because the sample included minors, heightened protections were applied to ensure respect for participants' rights, dignity, and well-being. Informed consent was obtained from legal guardians, and participating schools and families were provided with comprehensive information about the study aims and procedures. The project was carried out under principles of research integrity, with truthful and accurate data collection and record-keeping and without plagiarism, fabrication, falsification, or manipulation.

Data analysis

The data from the three student groups were analyzed to detect outliers, missing values, and non-normal distributions. Descriptive statistics of the study variables (central tendency, dispersion, and distribution) were performed to ensure their normal distribution and to assess the initial levels of student homework involvement before the intervention. To test the between-group hypotheses, several multiple analysis of variance (MANOVA) were performed using as dependent variables each of the components of cognitive, behavioral, and affective-motivational homework involvement described. Subsequently, analysis of covariance (ANCOVA) was used to control baseline effects on posttest scores, and paired Student's *t*-tests were conducted to compare pretest and posttest differences within each group. Time (pretest vs. posttest) was used as the within-subjects factor and group (Control, MITCApaper, MITCAdigital) as the between-subjects factor for each of the dependent variables. For the interpretation of the effect sizes, the criterion established by Cohen (1988) was used, according to which, an effect is small when $d = 0.2$, medium when $d = 0.5$ and large when $d = 0.8$. All data was analyzed with SPSS version 28.

Results

Preliminary analyses

Table 1 shows the descriptive statistics for the pretest and posttest measurements of the study variables for the control group, MITCApaper, and MITCAdigital conditions. All variables were normally distributed.

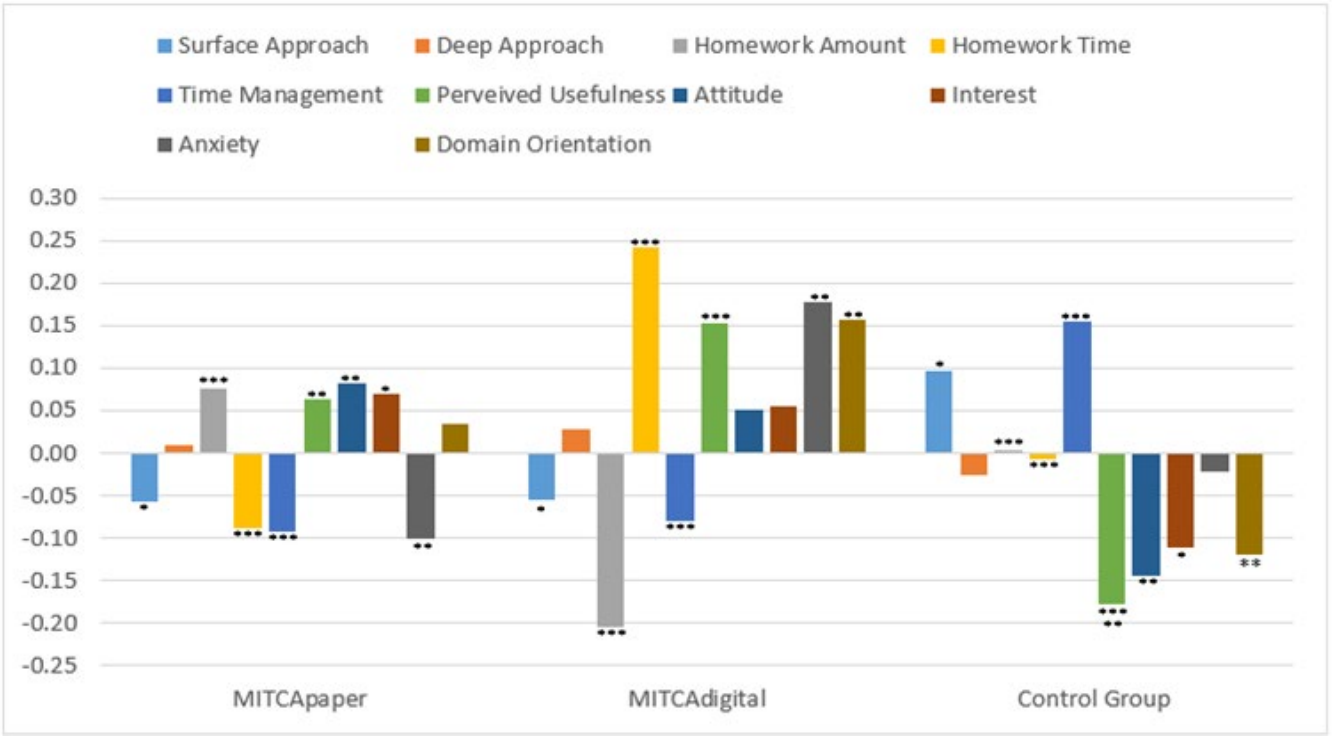
Table 1

Descriptive statistics of the pretest and posttest measures of the criterion variable

M		Pretest			Posttest			
		SD	Skewness	Kurtosis	*M*	*SD*	Skewness	Kurtosis
Cognitive Involvement	*Deep Approach*							
	Control Group	-0.03	1.03	-0.16	-0.24	-0.1	1.01	-0.31	-0.07
	$MITCA_{paper}$	0.01	0.98	-0.42	0.11	0.02	1.00	-0.33	-0.04
	$MITCA_{digital}$	0.03	0.99	-0.95	1.51	0.15	0.97	-0.55	-0.14
	Surface Approach							
	Control Group	0.1	1.03	0.41	-0.35	0.11	1.03	0.37	-0.66
	$MITCA_{paper}$	-0.06	0.98	0.59	-0.12	-0.07	0.99	0.63	0.02
	$MITCA_{digital}$	-0.06	0.97	0.54	-0.03	-0.04	0.96	0.60	0.11
Behavioral Involvement	*Homework Amount*							
	Control Group	0.01	0.96	-1.59	2.45	-0.08	1.1	-1.59	2.77
	$MITCA_{paper}$	0.08	0.97	-1.89	3.86	0.10	0.91	-1.82	3.75
	$MITCA_{digital}$	-0.21	1.12	-1.39	1.56	-0.09	0.98	-1.52	2.64
	Homework Time							
	Control Group	-0.01	1.01	0.43	-0.21	-0.09	1.02	0.45	-0.34
	$MITCA_{paper}$	-0.09	0.97	0.65	0.45	0.07	1	0.4	-0.25
	$MITCA_{digital}$	0.24	1.02	0.3	-0.18	0.01	0.95	0.36	-0.51
	Time Management							
	Control Group	0.16	1.03	-0.38	-0.43	0.05	1.02	-0.49	-0.14
	$MITCA_{paper}$	-0.1	0.96	-0.24	0.11	-0.04	0.97	-0.52	0.45
	$MITCA_{digital}$	-0.8	1.01	-0.34	0.08	0.01	1.03	-0.51	-0.00
Affective-motivational Involvement	*Domain Orientation*							
	Control Group	-0.11	1.04	-0.93	-0.91	-0.17	1.04	-0.64	-0.12
	$MITCA_{paper}$	0.28	0.99	-1.03	1.18	0.05	0.95	-0.89	0.57
	$MITCA_{digital}$	0.15	0.92	-1.08	1.29	0.21	0.99	-1	0.39
	Interest							
	Control Group	-0.09	1.05	-0.27	-0.71	-0.11	1.01	-0.25	-0.86
	$MITCA_{paper}$	0.06	1.00	-0.33	-0.64	0.02	0.98	-0.35	-0.59
	$MITCA_{digital}$	0.05	.9	-0.2	-0.53	0.18	1.01	-0.52	-0.70
	Anxiety							
	Control Group	-0.02	1	1.24	0.90	0.04	1.04	1.23	0.9
	$MITCA_{paper}$	-0.06	.96	1.27	1.22	-0.03	0.95	1.28	1.32
	$MITCA_{digital}$	0.18	1.08	1.14	0.87	0.01	1.04	1.36	1.42
	Attitude							
	Control Group	-0.12	1.04	0.34	-0.63	-0.13	0.97	0.39	-0.50
	$MITCA_{paper}$	0.08	0.96	0.11	-0.32	0.06	1.02	0.21	-.07
	$MITCA_{digital}$	0.05	1.	0.08	-0.54	1.3	0.97	0.14	-.05
	Usefulness							
	Control Group	-0.18	1.06	-0.7	0.04	-0.21	1.09	-0.77	-0.07
	$MITCA_{paper}$	0.08	0.94	-0.63	-0.23	0.09	0.95	-0.96	0.84
	$MITCA_{digital}$	0.15	0.98	-0.97	0.89	0.24	0.82	-0.84	1.05

Figure 2

Between-group pretest differences in homework involvement



Note. Asterisks indicate comparisons between groups in which each condition differs significantly. Bars with the same number of asterisks represent groups that differ from each other. When a condition differs from both remaining conditions, its bar displays two levels of asterisks (one for each significant comparison).

***$p < .001$, **$p < .01$, *$p < .05$.

Between-group differences in homework involvement

Pretest Comparisons

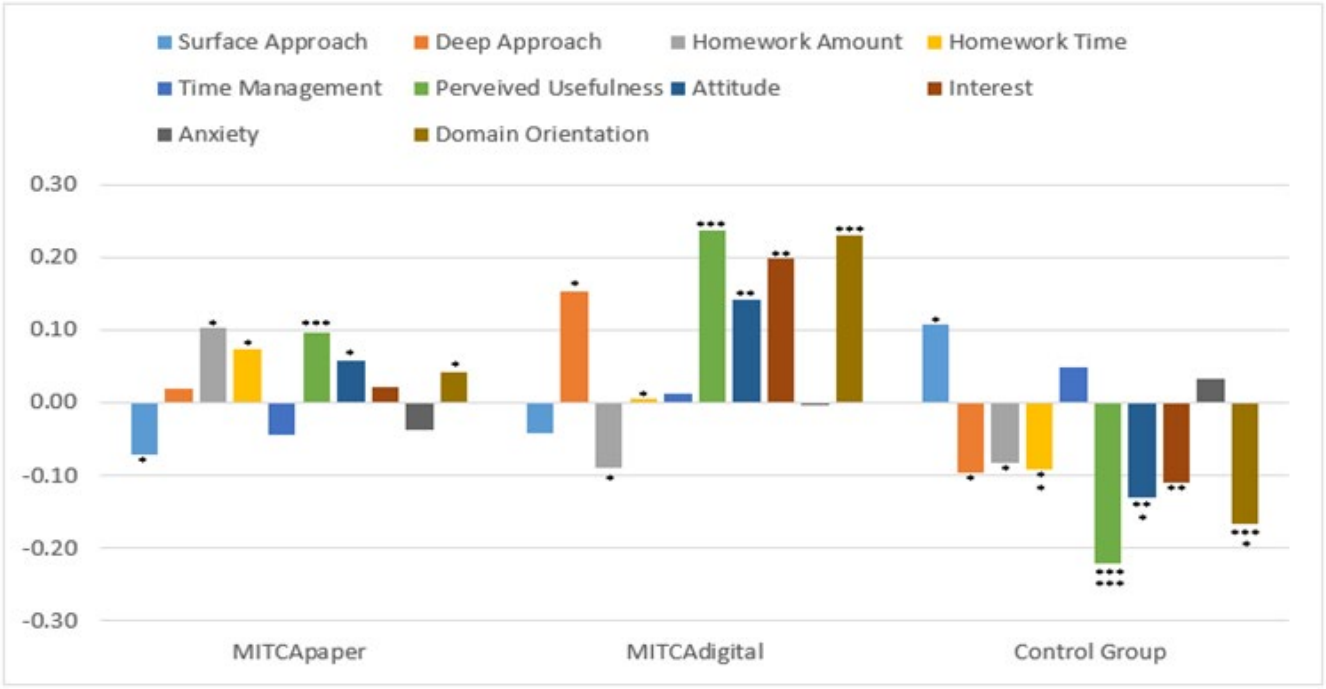
The data obtained from the multivariate analysis indicates that there were small differences between the three groups in the pretest homework involvement scores between the three conditions. Regarding homework cognitive involvement, significant differences were found for surface approach (MITCApaper vs MITCAdigital; $F_{(2,1120}$ = 3.09, $p < .05$; $d = 0.14$). There were also some differences in homework behavioral involvement (Wilks Lambda = .96; $F_{(6,2296)}$ = 7.41; $p < .001$; $d = 0.28$). Specifically, significant differences on homework amount ($F_{(2,1152)}$ = 5.95; $p < .001$; $d = 0.201$), time spent ($F_{(2,1150)}$ = 8.17; $p < .001$; $d = 0.24$), and time management ($F_{(2,1150)}$ = 8; $p < .001$; $d = 0.24$) were observed between the three conditions. Finally, there were some significant differences on affective-motivational involvement (Wilks Lambda = .96; $F_{(10,2046)}$ = 4.16; $p < .001$; $d = 0.27$), particularly in homework perceived usefulness ($F_{(2,1030)}$ = 9.35; $p < .001$; $d = 0.27$), attitude ($F_{(2,1152)}$ = 5.7; $p < .01$; $d = 0.21$), anxiety ($F_{(2,1142)}$ = 5.65; $p < .01$; $d = 0.21$), interest ($F_{(2,1142)}$ = 3.69; $p < .05$; $d = 0.17$), and domain orientation ($F_{(2,1103)}$ = 5.48; $p < .01$; $d = 0.21$). All effect sizes were overall small. Figure 2 shows the significant differences between groups from the multiple comparisons results.

Posttest Comparisons

The results derived from the multivariate analysis for the posttest measures indicate that there are statistically significant differences between the three groups in cognitive (Wilks Lambda = .98; $F_{(4,2098)}$ = 3.85; $p < .01$; $d = 0.17$), behavioral (Wilks Lambda = .984; $F_{(6,2140)}$ = 2.93; $p < .01$; $d = 0.18$), and affective-motivational involvement (Wilks Lambda = .96; $F_{(10,\ 1994)}$ = 4.23; $p < .001$; $d = 0.29$). The analysis of intergroup effects shows that differences are obtained for both the deep approach ($F_{(2,1050)}$ = 4.05; $p < .05$; $d = 0.18$) and the surface approach ($F_{(2,1050)}$ = 3.65; $p < .05$; $d = 0.17$) in the cognitive dimension; for the amount of homework completed ($F_{(2,1075)}$ = 4.79; $p < .01$; $d = 0.19$) and time spent ($F_{(2,1075)}$ = 3.03; $p < .05$; $d = 0.18$) in the behavioral dimension; and for perceived usefulness ($F_{(2,1075)}$ = 16.6; $p < .001$; $d = 0.36$), domain orientation ($F_{(2,1075)}$ = 10.53; $p < .001$; $d = 0.29$), interest ($F_{(2,1075)}$ = 5.94; $p < .01$; $d = 0.22$), and attitude ($F_{(2,1075)}$ = 5.57; $p < .01$; $d = 0.21$) in the affective-motivational dimension. All effect sizes ranged from moderate to small. Figure 3 presents the significant differences between groups from the multiple comparisons results.

Figure 3

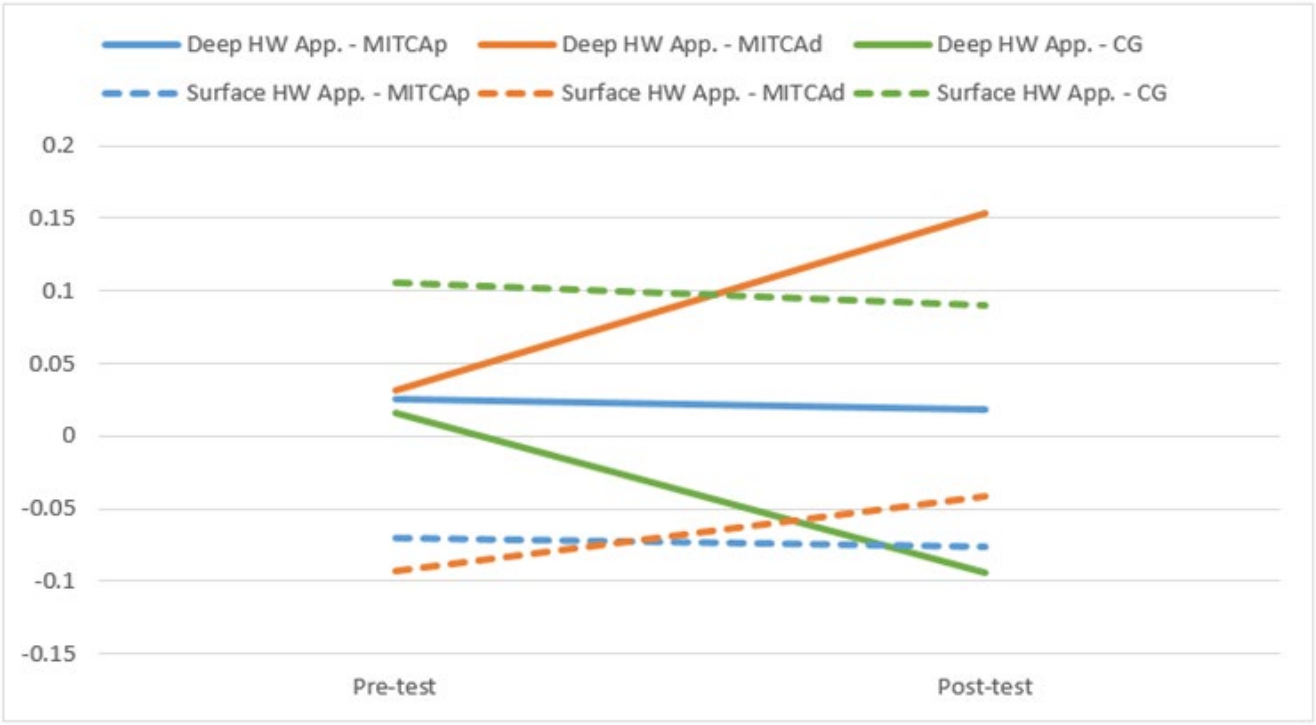
Between-group posttest differences in homework involvement



Note. See Figure 2.

Figure 4

Within-group differences in homework cognitive involvement



Note. HW = homework; MITCAp = MITCApaper; MITCAd = MITCAdigital; CG = Control group.

Within-group changes in homework involvement

Homework cognitive involvement

ANCOVA analysis further confirmed a significant effect of the intervention on deep approach scores ($F_{(2,1008)} = 4.84$, $p < .01$, $d = 0.2$), whereas no significant effect was observed for surface approach ($F_{(2,1008)} = .959$, $p = .384$, $d = 0.09$). Pretest scores explained a considerable proportion of variance in both deep (21.9%) and surface (20.3%) learning approaches, indicating the influence of prior cognitive strategies.

Within-group comparisons revealed that while no significant differences between the pretest and posttests were found in the MITCA groups (MITCAdigital: $t_{(184)} = -1.452$; $p = .148$; $d = 0.13$; MITCApaper: $t_{(451)} = .151$; $p = .88$; $d = 0.01$), the control group experienced a significant decline in the deep learning approach over the 12-week period ($t_{(374)} = 2.046$; $p < .05$; $d = 0.13$) (Figure 4). On the other hand, no significant changes were found in surface approach within any group, although the MITCApaper group maintained slightly lower levels post-intervention.

Homework behavioral involvement

The ANCOVA conducted for behavioral engagement found a statistically significant intervention effect on time spent ($F_{(2, 1056)} = 8.498$, $p < .001$, $d = 0.25$) and homework amount ($F_{(2, 1060)} = 3.47$, $p < .05$, $d = 0.17$), but not on time management ($F_{(2, 1056)} = 0.305$, $p = .737$, $d = 0.06$) (Figure 5). While significant, the effect sizes were small, suggesting that a large portion of variance was explained by pre-intervention levels (24.2% for time spent, 22.3% for homework amount, and 18.5% for time management).

Paired-sample *t*-tests showed no significant change in time use for the control group ($t_{(390)} = 1.593$; $p = .112$), but significant reductions were observed in both MITCApaper ($t_{(486)} = -3.684$; $p < .001$; $d = 0.17$) and MITCAdigital ($t_{(181)} = -3.41$; $p < .001$; $d = 0.25$). Notably, both experimental groups converged toward similar average time use post-intervention.

For task completion, the control group exhibited a small but significant reduction ($t_{(390)} = 1.92$; $p < .05$; $d = 0.1$), while no significant change was found for MITCApaper ($t_{(486)} = -0.389$; $p = .697$; $d = 0.02$) or MITCAdigital ($t_{(181)} = -1.134$; $p = .258$; $d = 0.08$), indicating that MITCA may help sustain task completion levels over time.

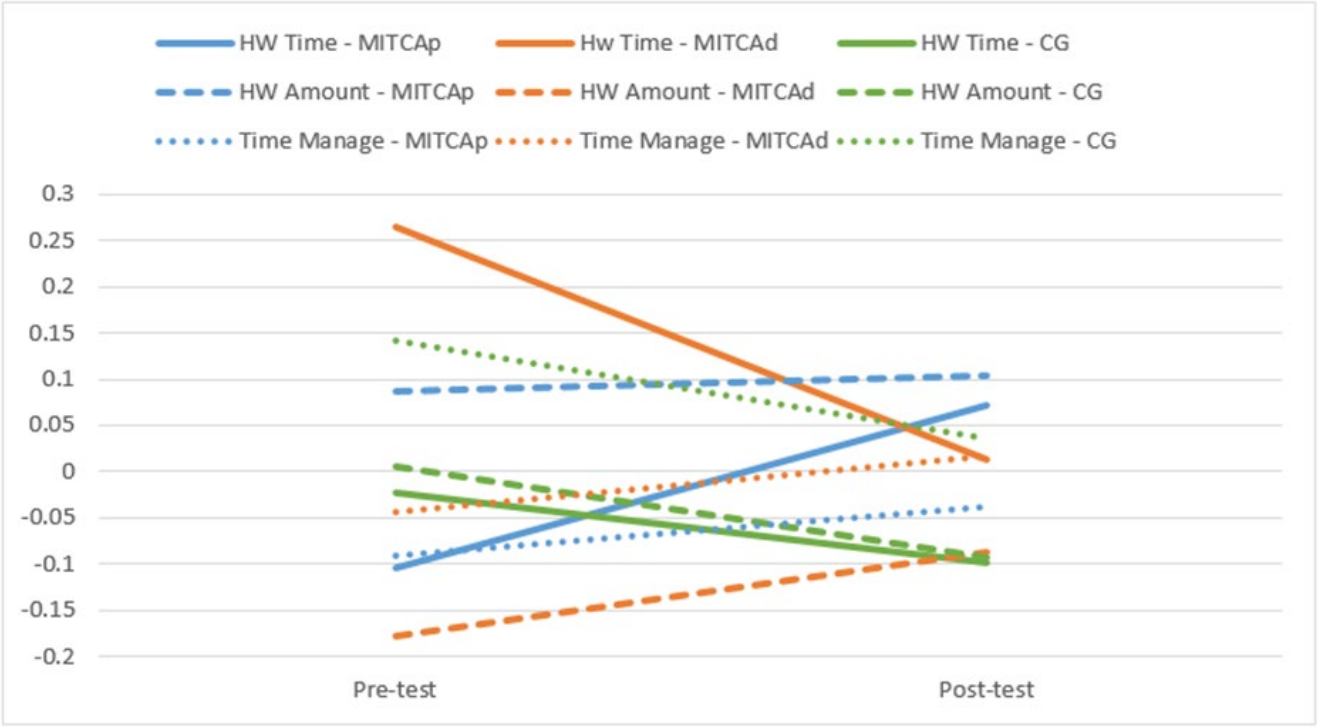
Regarding time management, only the control group showed a significant decline ($t_{(390)} = 2.025$; $p < .05$; $d = 0.1$), whereas both MITCA groups maintained stable levels (MITCApaper: $t_{(486)} = 1.076$; $p = .282$; $d = 0.05$; MITCAdigital: $t_{(181)} = -0.746$; $p = .457$; $d = 0.05$).

Homework affective-motivational involvement

The intervention had a statistically significant effect on perceived usefulness ($F_{(2, 1056)} = 5.565$, $p < .01$, $d = 0.2$), interest ($F_{(2,1056)} = 3.990$, $p < .05$, $d = .01$), and domain orienta-

Figure 5

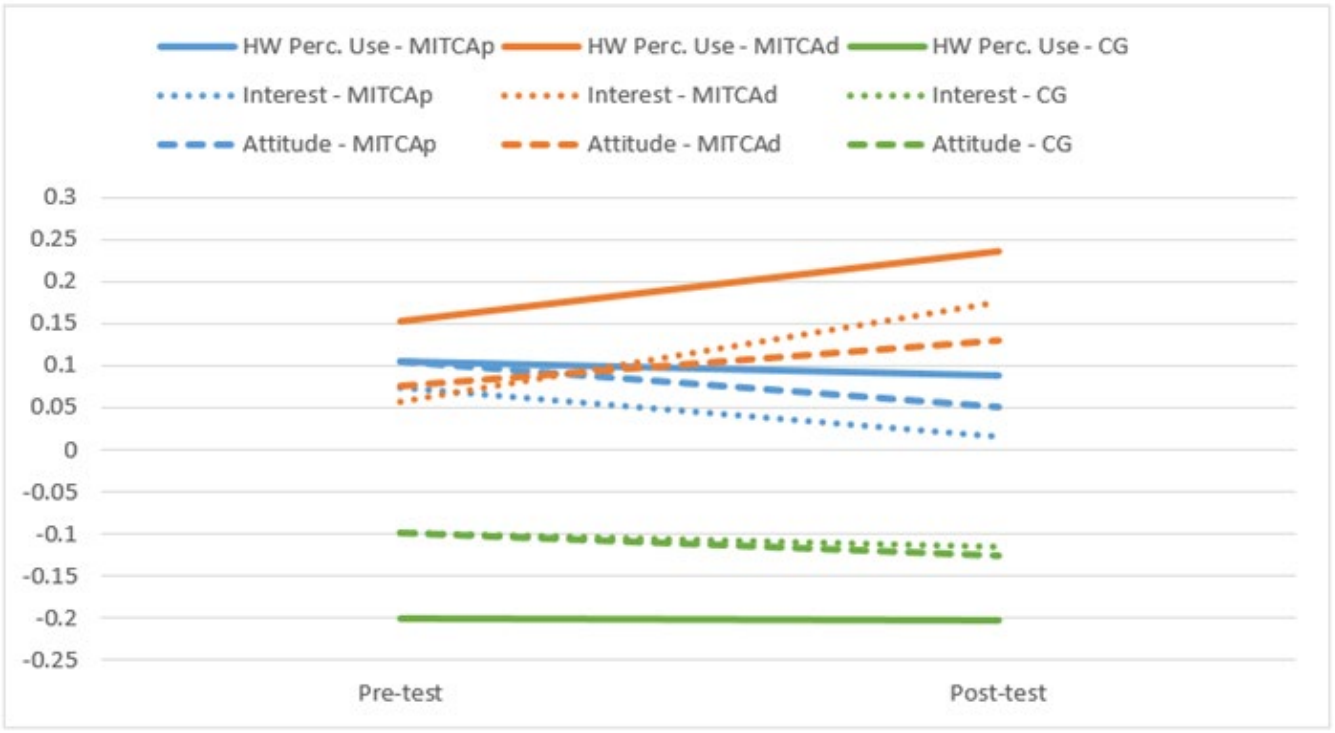
Intragroup differences on homework behavioral involvement



Note. See Figure 4.

Figure 6

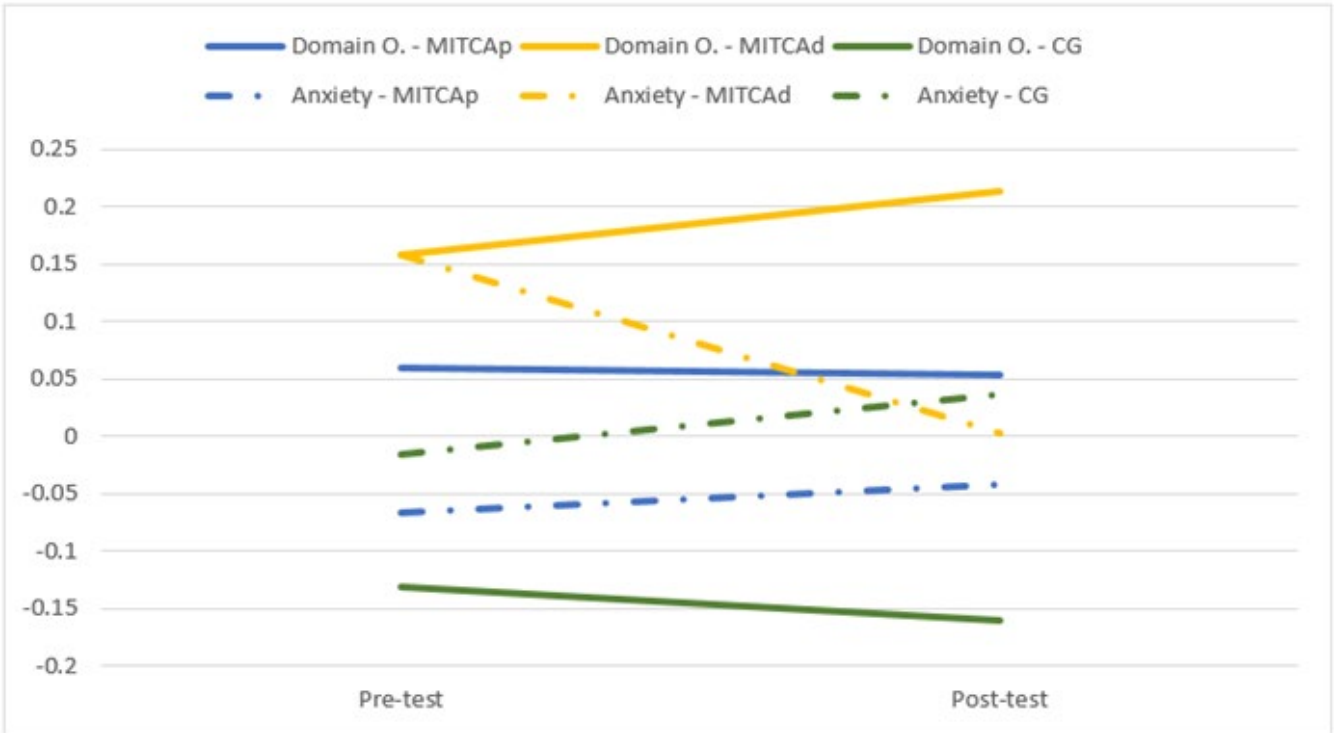
Within-group differences in homework perceived usefulness, interest, and attitude



Note. See Figure 4.

Figure 7

Within-group differences on homework domain orientation and anxiety



Note. See Figure 4.

tion ($F_{(2,993)}$7= 3.892, $p < .05$, $d = 0.18$). However, effect sizes were small. No significant effects were observed for attitude toward homework ($F_{(2,1060)} = 2.38$, $p = .093$, $d = 0.13$) or anxiety ($F_{(2,1049)} = 1.26$, $p = .28$, $d = 0.09$).

Finally, intragroup analyses revealed that none of the three groups showed significant changes in perceived usefulness, interest, attitude, or domain orientation from pretest to posttest. However, the MITCAdigital group did report a small but statistically significant decrease in homework-related anxiety ($t_{(181)} = 1.88$, $p < .05$, $d = 0.14$) (Figures 6 and 7).

Discussion

This study examined the differences in the effect of three types of homework prescription strategies (conventional homework, MITCApaper, and MITCAdigital) on students' involvement. The findings point to a differentiated effect of each condition on homework involvement.

Only a significant improvement in the deep approach of the MITCAdigital group was observed for *cognitive involvement*. This suggests that the digital format may enhance this dimension to a greater extent. This difference can be explained by the interactivity and visual appeal of the digital environment. Like game-based learning methodologies, digital formats encourage active learning and student participation (Hui & Mahmud, 2023), which are key elements for deep cognitive involvement. The design of MITCAdigital is based on the principles of the TPACK model (Mishra & Koehler, 2006), which integrates technological, pedagogical, and content knowledge to create meaningful learning experiences. This approach supports not only content understanding but also enjoyment and reflection, contributing to autonomous and contextualized learning (Zhou et al., 2023). Although MITCApaper did not promote a significant increase in deep approach, it did slow down the decline observed in the control group. This effect can be interpreted through the ICAP framework (Chi & Wylie, 2014), which classifies involvement levels into passive, active, constructive, and interactive. While constructive and interactive modes are the most effective for learning, even less interactive interventions –such as MITCApaper– can be effective if well-structured. Despite being a short intervention, the results suggest that the format and design of the tool have a notable influence on cognitive engagement (Anthonysamy et al., 2020; Heilporn et al., 2021). Although the method is not directly aimed at promoting deep approach, its structure seems to support self-regulatory strategies that do (Vieites et al., 2024).

As for *homework behavioral involvement*, the digital version of MITCA did not lead to an overall increase in time management or total time spent. Instead, the pattern suggests a calibration effect: students in the MITCAdigital condition started from comparatively high homework-time levels and reduced the time they invested after the intervention, whereas students in the MITCApaper condition –who initially spent less time– showed an increase. As a result, both groups converged toward similar, more balanced levels of homework time. Importantly, this adjustment did not translate into disengagement. Both MITCA groups maintained –or slightly improved– their homework time during the study period, whereas the control group showed a decline. A similar pattern emerged for task completion: while the control group showed a significant decline after the intervention, both MITCA conditions maintained or increased task completion, suggesting that MITCA may help stabilize students' behavioral engagement over time by aligning time investment with homework demands –an important finding given that this form of involvement typically declines in school settings (Skinner & Pritzer, 2012).

Lastly, both MITCA groups show higher posttest levels of affective-motivational involvement compared to the control group. Although no significant differences between the pretest and posttest were found, there is a positive trend in interest, perceived usefulness, positive attitude, and domain orientation, especially in the MITCAdigital group. The specification of task value in MITCA seems to play a key role in this improvement (Wigfield & Eccles, 2020). Additionally, MITCAdigital seems more effective at stimulating student interest. Interactive platforms enhance motivation, improve flow experience, and can offer greater personalization, which in turn fosters involvement (Sung et al., 2016). Moreover, the novelty of using a digital environment may increase curiosity and initial commitment (Keller, 2010). As for homework-related anxiety, a significant reduction is confirmed in this group. This improvement may be due to both increased interest and the user-friendly design of the interface (Balaskas et al., 2022).

Limitations and practical implications

From an educational standpoint, these results highlight the importance of implementing meaningful, student-centered homework practices. Although some differences emerged between the digital and paper-based versions, the observed benefits are largely attributed to the instructional design of the MITCA method. By fostering autonomy, clarity, and motivation, MITCA demonstrates how a well-structured homework approach regardless of its format can effectively support student learning and well-being.

Despite its contributions, several limitations must be considered when interpreting the study findings. First, the allocation of classrooms to each condition was not randomized. Participation depended on the teacher's availability, and recruitment occurred through snowball sampling. Furthermore, the MITCApaper and MITCAdigital conditions belong to different academic cohorts. Although they were similar in educational stage and regional context, year-specific variations –e.g., differences in school climate, changes in teaching staff, or broader shifts related to the progressive integration of digital tools following the pandemic–may have influenced student involvement in ways not directly related to the intervention.

Another limitation stems from the exclusive reliance on self-reported measures to assess homework involvement. Although the instruments used have strong psychometric properties, the absence of objective behavioral indicators –e.g., digital log data from Moodle or analysis of the quality or com-

pleteness of submitted tasks– restricts the accuracy with which actual student behaviors can be evaluated. Finally, although the study indicates that the digital format is associated with improvements in certain components of involvement, further work is needed to clarify the theoretical mechanisms underlying these differences. While MITCAdigital is presented as an adaptation of the paper-based version, the findings suggest that digital features may introduce additional learning processes –e.g., enhanced interactivity, multimodal presentation, guided planning structures– (Noetel et al., 2022).

Future research would benefit from integrating longitudinal designs, multimethod assessment strategies, and randomized assignments when possible. Additionally, incorporating the perspectives of other educational stakeholders –such as families– and integrating qualitative methodologies could offer a more comprehensive understanding of students' homework involvement.

Conclusion

The findings of this study indicate that homework outcomes depend on implementation quality. Both MITCA versions helped sustain students' homework involvement. MITCAdigital showed the clearest advantages for cognitive and emotional components. On the other hand, MITCApaper did not yield comparable gains but appeared to attenuate the decline observed in the control condition and was associated with a more positive homework attitude.

These results contribute to the homework debate by suggesting that the central issue is not whether homework is inherently beneficial or harmful, but how it is designed and implemented. MITCA operationalizes a shift toward quality and structure by making tasks clearer, more purposeful, and easier to plan and review features likely to support motivation and self-regulation. At the same time, the differentiated patterns between formats underscore that delivery mode may shape which components of involvement are most affected, with digital delivery potentially amplifying deeper involvement and reducing anxiety, while paper-based delivery may support attitudes differently.

Author contributions

Conceptualization: F. M. D. F., S. R., A. V.
Methodology: F. M. D. F., T. V., S. R., A.V., C. R. L.
Data collection: F. M. D. F., C. R. L., V. T.
Formal analysis: S. R., A. V.
Supervision: S. R., A. V.
Writing – original draft: F. M. D. F., C. R. L., V. T.
Writing – review & editing: F. M. D. F., V. T., R. S., C. R. L.

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Declaration of interests

The authors declare that there is no conflict of interest.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

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Appendix

Table A1

Item-level descriptive statistics for homework cognitive involvement

	M Pre/Post	*SD* Pre/Post	Skewness Pre/Post	Kurtosis Pre/Post
1. I do my homework with interest because it helps me better understand what the teacher explains in class each day.	3.76/3.65	1.20/1.26	-0.73/-0.63	-0.35/-0.61
2. When I do my homework, I don't stop to think about different ways of doing it or anything else—I just do it the way the teacher said it should be done.	3.75/3.48	1.19/1.29	-0.68/-0.48	-0.41/-0.78
3. For me, doing homework is really boring; I mostly do it out of obligation.	2.66/2.72	1.39/1.4	0.39/0.35	-1.06/-1.1
4. While doing my homework, I think about how I'm doing it to check if I'm applying what the teacher taught in class—and if not, I try to see how I can do it better.	3.86/3.75	1.14/1.17	-0.87/-0.71	0.11/-0.28
5. Doing homework is a great opportunity to check how well I've mastered the subject matter.	4.13/3.93	1.04/1.12	-1.14/-0.91	0.72/0.93
6. To do my homework, I use my notebook or textbook, look at how similar exercises were done, and do it the same way.	3.15/3.29	1.33/1.31	-0.19/-0.27	-1.02/-0.96
7. I don't care if I learn while doing homework—the only thing I care about is finishing as quickly as possible.	2.06/2.18	1.25/1.26	1.02/0.89	0.17/-0.25
8. Before I start my homework, I usually think about whether I've understood what was covered in class, and if I haven't, I review the lesson first.	3.33/3.33	1.27/1.3	-0.33/-0.29	-0.86/-0.94
9. I enjoy doing homework because I usually finish with a good feeling of competence and feel proud of myself.	3.20/3.09	1.34/1.33	-0.22/-0.12	-1.06/-1.07
10. I usually do my homework, but I rarely pay attention to how I'm doing it.	2.26/2.28	1.23/1.2	0.68/0.69	-0.53/-0.43
11. To be honest, I have to admit I do homework because otherwise I'll get punished (by parents or teachers).	2.45/2.40	1.48/1.43	0.58/0.63	-1.09/-0.95
12. When I do my homework, I think about the different ways to approach it, whether I understand what I'm doing, and if I know how to apply it to other similar tasks that weren't directly covered in class (e.g., other problems, another text commentary, etc.).	3.15/3.18	1.23/1.25	-0.16/-0.19	-0.8/-0.79

Note. *M* = Mean; *SD* = Standard deviation.

Table A2

Item-level descriptive statistics for homework behavioral involvement

	M Pre/Post	*SD* Pre/Post	Skewness Pre/ Post	Kurtosis Pre/ Post
1. Of the homework assigned by your teachers, how much do you usually complete?	4.52/4.57	0.79/0.74	-1.81/-1.99	3.00/4.09
2. In general, how much time do you usually spend doing homework (exercises, assignments, studying, etc.) each day from Monday to Friday?	2.63/2.7	1.07/1.12	0.44/0.35	-0.38/-0.6
3. In general, how much time do you usually spend doing homework (exercises, assignments, studying, etc.) during the weekend?	2.48/2.56	1.17/1.12	0.64/0.51	-0.33/-0.42
4. When it's time to do homework, I find an excuse to put it off.	1.74/1.83	0.90/0.95	1.20/1.18	1.21/1.24
5. When I start doing homework, I concentrate and don't think about anything else until I finish.	3.59/3.66	1.13/1.11	-0.53/-0.62	-0.45/-0.22
6. My opinion about homework is that…	3.88/3.79	1.02/1.08	-0.89/-0.88	0.46/0.32
7. Some students do their homework and others don't. How much homework do you usually do?	4.51/4.53	0.80/0.79	-1.86/-1.90	3.15/3.39
8. On average, how much time do you usually spend per day on homework?	2.23/2.38	0.98/1.04	0.67/0.57	0.18/-0.21
9. Students usually do homework at home, but a lot of the time they spend on it is wasted because they get distracted by their phone, computer, or other thoughts... How do you use the time you dedicate to homework?	3.82/3.84	0.9/0.9	-0.74/-0.84	0.85/1.08
10. Doing homework is very common because teachers believe it is useful for learning the subjects. How useful do you think homework is?	3.87/3.82	0.99/1.08	-0.84/-0.96	0.44/0.5

Note. *M* = Mean; *SD* = Standard deviation.

Table A3

Item-level descriptive statistics for homework affective-motivational involvement

	M Pre/Post	*DT* Pre/Post	Skewness Pre/ Post	Kurtosis Pre/ Post
1. Doing homework allows me to see if I understand what is explained in class and, if I have doubts, to ask the teacher the next day.	4.28/4.25	0.98/1.03	-1.41/-1.30	1.63/1.2
2. I enjoy doing homework that helps me learn more.	3.52/3.15	1.28/1.29	-0.29/-0.24	-0.89/-0.92
3. Doing homework helps me understand what is being covered in class.	4.31/4.20	0.96/1.02	-1.51/-1.25	1.94/0.95
4. Doing homework helps me learn how to plan my time.	3.51/3.5	1.22/1.25	-0.51/-0.53	-0.63/-0.63
5. Doing homework helps me become more responsible.	4.08/3.96	1.10/1.15	-1.2/-1.05	0.77/0.35
6. Doing homework helps me develop good discipline.	3.96/3.84	1.06/1.16	-0.97/-0.82	0.5/-0.11
7. Doing homework helps me prepare for the next day's lesson.	3.82/3.75	1.16/1.19	-0.78/-0.73	-0.19/-0.29
8. I generally think homework is very interesting.	3.03/2.97	1.24/1.27	-0.17/-0.14	-0.82/-0.96
9. In general, I hate homework. (REC)	2.58/2.64	1.35/1.39	0.42/0.38	-0.92/-1.07
10. I believe doing homework at home increases my interest in the subjects.	3.14/3.17	1.29/1.33	-0.19/-0.23	-0.98/-1.03
11. I get so nervous when doing homework that I forget the things I've learned.	1.91/1.9	1.2/1.19	1.17/1.21	0.31/0.44
12. Just thinking about doing homework makes me nervous.	1.84/1.82	1.22/1.21	1.36/1.4	0.74/0.85
13. When I start doing homework, I think about how badly I must be doing it.	1.96/1.96	1.23/1.24	1.11/1.09	0.19/0.11
14. While doing homework, I feel worried and upset.	1.71/1.72	1.11/1.12	1.54/1.54	1.46/1.48
15. I feel more motivated to do homework than to do other things.	2.43/2.33	1.18/1.17	0.37/0.54	-0.67/-0.47
16. It's harder for me to concentrate when I do homework than when I do any other activity outside of class.	3.15/3.09	1.36/1.34	-0.11/-0.08	-1.15/-1.11
17. I'm in a good mood while I'm doing homework.	3.17/3.16	1.22/1.24	-0.26/-0.2	-0.71/-0.82
18. Of all the tasks I do outside of class, I think homework is one of my favorites.	2.23/2.21	1.16/1.24	0.60/0.69	-0.54/-0.57

Note. *M* = Mean; *SD* = Standard deviation.