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Assessing the impact of laptop integration on students' self-confidence and self-efficacy in technology use: the case of middle school students in Abu Dhabi

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This study examines the quantitative effects of a laptop introduction program in Abu Dhabi's middle schools on students' self-confidence and self-efficacy in using technology. The quantitative phase involved 198 students, with data collected pre- and post-intervention through a survey questionnaire. The study employed a control and intervention group design, allowing for comparative analysis. Using statistical models, the study explored the impact of facilitating conditions, social influence, experience, socio-economic status, and gender on students' self-confidence and self-efficacy. Results indicated a significant positive relationship between gender and self-confidence, with male students reporting higher self-confidence in technology use. Facilitating conditions, such as access to various technological devices, were also positively associated with self-confidence, while prior experience emerged as the sole significant predictor of self-efficacy. By situating the study in the under-researched context of Abu Dhabi, this research addresses the gap in evidence from Middle Eastern education systems and highlights how contextual factors shape the outcomes of technology integration. The findings contribute to international debates on digital inclusion by showing that successful laptop integration depends not only on access to devices but also on students' prior experience and home resources, offering practical insights for policymakers and educators seeking to foster equitable digital learning environments.

KEYWORDS

laptop integration, self-confidence, self-efficacy, technology in education, middle school students, quantitative analysis

Introduction

The integration of technology in education has become a global priority, with the potential to enhance learning experiences, improve digital literacy, and prepare students for a technology-driven world (Higgins et al., 2012; Livingstone, 2012; OECD, 2015; Warschauer and Matuchniak, 2010). Digital tools, such as laptops, tablets, and online platforms, have been adopted in classrooms worldwide, reflecting a shift from traditional teaching methods to more interactive, student-centered approaches. However, despite the rapid expansion of educational technology, questions remain about its effectiveness in fostering key student outcomes, including self-confidence and self-efficacy with technology (Crompton et al., 2017; Tondeur et al., 2017; Leonard et al., 2016). This study addresses these questions by examining the impact of a laptop integration program in middle school classrooms in Abu Dhabi, aiming to understand how such interventions influence students' attitudes toward technology use.

Self-confidence and self-efficacy are critical components of digital literacy, determining how students perceive their abilities to engage with and master new technological tools (Bandura, 1997). Recent confirmatory and validation studies further affirm that self-efficacy represents students' belief in their capacity to perform tasks effectively across diverse domains, influencing their persistence, resilience, and performance outcomes (Kolil et al., 2023; Nair et al., 2025). Recent cross-national research has reinforced the centrality of self-confidence in digital learning, demonstrating that it significantly predicts the development of digital skills among university students (Rosales-Márquez et al., 2025). This finding supports the view that belief in one's capabilities is not only motivational but also instrumental in navigating and mastering digital environments. Both constructs are essential for ensuring that students can navigate the digital landscape confidently and competently, which is particularly important as digital skills become increasingly necessary in academic, professional, and personal contexts (Ertmer et al., 2012; Schunk and DiBenedetto, 2020; Scherer et al., 2019). Previous studies have shown that access to technology can enhance self-confidence and self-efficacy, yet the evidence is mixed, with some research suggesting that merely providing digital devices is not sufficient (Zheng et al., 2016; Player-Koro et al., 2018). There is a need for deeper exploration of the conditions under which technological integration can lead to positive outcomes, particularly in different cultural and educational contexts.

The context of this study is Abu Dhabi, where the Ministry of Education has been actively promoting the integration of technology in schools as part of a broader strategy to modernize education and improve digital competencies among students. However, the introduction of laptops in classrooms is not without challenges. Research suggests that the success of such programs depends on multiple factors, including teacher readiness, availability of resources, and student engagement (Hew and Brush, 2007). In Abu Dhabi, the phased approach to implementing technology has created an opportunity to study its effects in a real-world setting, where logistical and contextual factors play a significant role in shaping outcomes (Conway and Amberson, 2011).

This study employs a quasi-experimental design to evaluate the impact of a laptop introduction program on students' self-confidence and self-efficacy with technology. By comparing treatment and control groups, the study seeks to determine whether students who have direct access to laptops in the classroom exhibit higher levels of self-confidence and self-efficacy compared to those who do not. Furthermore, this research examines how other factors, such as prior experience with ICT, gender, socioeconomic status, and facilitating conditions, interact with the intervention to influence students' attitudes toward technology use. Understanding these dynamics can help educators and policymakers make informed decisions about how to implement technology in a way that maximizes benefits for students.

The findings of this study contribute to the ongoing debate about the role of technology in education by providing empirical evidence on the effects of laptop integration in a middle school setting. By highlighting the importance of both in-school interventions and external resources, this research offers practical insights into how technology programs can be designed to support students' digital skills development. Additionally, this study extends existing theories, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), by exploring how external facilitating conditions and prior experience with ICT play a role in shaping technology-related attitudes.

In summary, this research aims to address the following key questions:

1. Does the introduction of laptops in middle school classrooms improve students' self-confidence and self-efficacy with technology?
2. What are the effects of factors such as gender, prior ICT experience, socioeconomic status, and facilitating conditions on students' attitudes toward technology?

By answering these questions, this study seeks to advance our understanding of how technology can be effectively integrated into educational settings, particularly in contexts like Abu Dhabi, where digital transformation is a strategic priority.

Education and technology in the UAE

Education in the UAE is free and compulsory for all citizens through primary and secondary school, reflecting the country's early commitment to public education and the elimination of illiteracy (Alhebsi et al., 2015). This commitment is integral to UAE Vision 2021, which emphasizes the creation of a first-rate education system and aims to elevate educational standards to international levels. The establishment of the Abu Dhabi Education Council (ADEC), later renamed the Department of Education and Knowledge (ADEK), underscored the focus on enhancing educational quality and competitiveness in Abu Dhabi. Since 2018, operational oversight of public schools in the emirate has been managed by the UAE Ministry of Education, ensuring consistent standards across the country. These efforts have positioned the UAE as a leader in educational reform, with a focus on expanding access and improving the quality of education.

The integration of technology has become a key component of the UAE's educational strategy, especially accelerated by the challenges of the COVID-19 pandemic (Bawa'aneh, 2021). Initiatives such as the Smart Learning program have driven significant investments in digital infrastructure, including issuing nearly 66,000 laptops to students in Abu Dhabi's public schools. This initiative aimed to promote digital literacy and enhance modern, student-centered learning. Platforms like Alef, which support mobile learning, were introduced to transform traditional teaching approaches and foster independent learning among students. However, while infrastructure improvements have been notable, challenges remain. Ensuring that students can fully benefit from technology integration depends not only on access to devices but also on how effectively these tools are used for learning. Quantitative data collected from students can help assess the impact of these initiatives, identifying key factors that influence students‘ self-confidence and self-efficacy with technology, which are crucial for the UAE’s broader vision of educational excellence.

Literature review

Conceptual framework

The conceptual framework guiding this research is anchored in three well-established theories: the Technology Acceptance Model (TAM) (Davis, 1989), the Theory of Technical Capital (Yardi, 2010), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh and Bala, 2008) (see Figure 1). These theories provide a comprehensive basis for examining how students engage with technology, what factors facilitate or hinder their digital literacy, and how educational environments can better support the effective use of digital tools.

The Technology Acceptance Model (TAM) is instrumental in understanding the perceived ease of use and perceived usefulness of technology, which predicts the acceptance and adoption of digital tools. In the context of this study, TAM is used to explore how students‘ attitudes toward technology influence their self-confidence and self-efficacy, especially in environments where new tools like the Alef platform are being integrated (Davis, 1989). This model provides insight into how students’ perceptions shape their engagement with technology, informing strategies for enhancing digital literacy.

The Theory of Technical Capital, articulated by Yardi (2010), emphasizes the development of technical skills and competencies through accessible resources and targeted interventions. This theory underscores the importance of providing the necessary infrastructure, training, and support systems to build students‘ confidence and competence in using technology. In this study, the theory is applied to understand how facilitating conditions, such as reliable infrastructure and teacher support, impact students’ self-efficacy. It highlights the need for inclusive and supportive educational environments that allow students to develop essential digital skills irrespective of their socio-economic background or prior experience with technology.

The Unified Theory of Acceptance and Use of Technology (UTAUT) offers a broader perspective by considering how organizational support, managerial interventions, and external influences shape technology adoption. This framework is crucial for understanding the role of school policies, teacher engagement, and parental support in influencing students’ digital confidence and self-efficacy (Venkatesh and Bala, 2008). By focusing on external factors, UTAUT helps identify barriers and facilitators to effective technology use, offering insights into how educational institutions can optimize their technology integration strategies for better educational outcomes.

The implementation of mobile learning (m-learning) tools, such as laptops in classroom settings, has been promoted as a key strategy to increase student engagement and improve learning outcomes. Initiatives like the UAE’s Smart Learning program have made significant investments in digital infrastructure, providing tens of thousands of laptops to students across Abu Dhabi’s public schools (Bawa’aneh, 2021; Al-Qirim and Al-Hammadi, 2019). Recent research demonstrates that students’ digital literacy and positive attitudes toward technology significantly influence their self-efficacy, which, in turn, predicts enhanced engagement across social, behavioral, cognitive, emotional, and collaborative dimensions in online learning environments (Getenet et al., 2024). However, challenges persist, including the need for ongoing teacher training and comprehensive support systems to ensure that technology is utilized effectively. Previous studies have indicated that m-learning can enhance self-confidence and self-efficacy, yet the effectiveness of these programs is often contingent upon addressing broader issues related to digital access, infrastructure, and the pedagogical integration of technology (Joseph, 2013; MacCallum and Jeffrey, 2014). The literature suggests that for educational technology to realize its full potential, there must be a concerted effort to address these foundational elements.

Based on these theoretical foundations, this study identifies five key variables from literature to be integrated into the conceptual model (see Figure 2): experience, social influences, facilitating conditions, socio-economic status, and gender. These variables help in examining the complex dynamics that influence students‘ digital literacy. For instance, prior experience with technology can enhance self-confidence, while facilitating conditions—such as robust infrastructure and teacher support—can improve self-efficacy. Gender and socio-economic status are critical factors that may constrain or promote students’ ability to engage with technology, underscoring the need for inclusive practices that address these disparities.

In summary, the conceptual framework of this study, grounded in established theories, emphasizes a holistic approach to technology integration in education. It focuses on how factors such as infrastructure, training, and supportive environments can mediate the effects of gender and SES, thereby fostering self-confidence and self-efficacy in technology use. By understanding these relationships, this study aims to provide insights that will help policymakers and educators develop effective strategies for integrating digital tools in classrooms, ensuring equitable access and meaningful engagement for all students.

The integration of technology in education has become a global priority, widely regarded as a means to enhance learning experiences, improve digital literacy, and prepare students for a technology-driven world (Ertmer et al., 2012). However, while there is consensus on the potential benefits of educational technology, the empirical evidence remains mixed. Several studies suggest that simply providing access to digital devices is insufficient to guarantee positive outcomes; instead, the success of technology

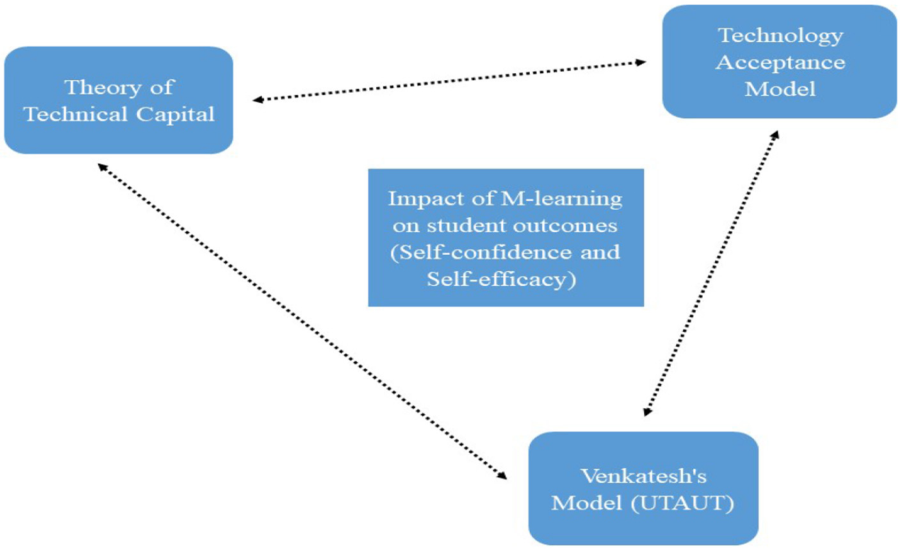

FIGURE 1
Conceptual framework underpinning the research presented here.

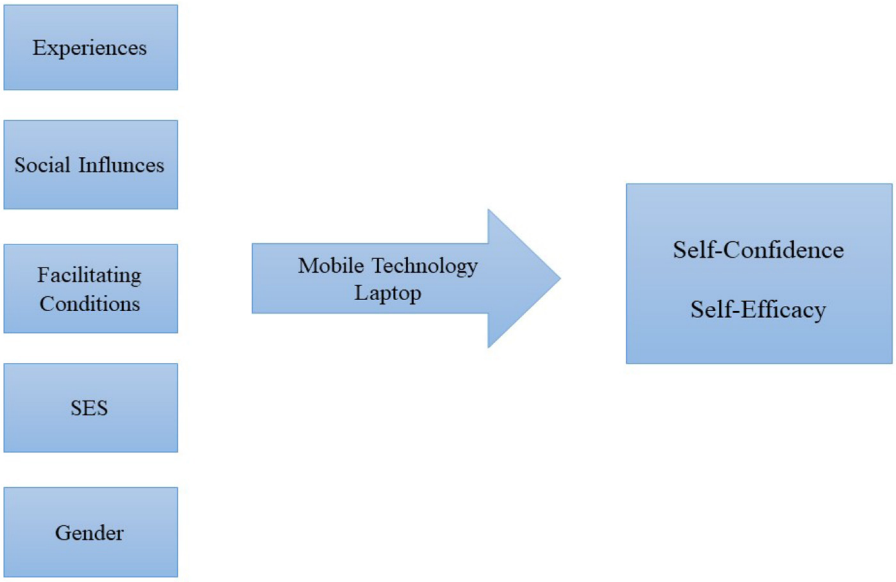

FIGURE 2
Framework illustrating factors influencing digital self-confidence and self-efficacy.

integration hinges on contextual factors, including the quality of support systems, robust infrastructure, and the readiness of both students and educators (Zheng et al., 2016; Player-Koro et al., 2018). Key outcomes such as self-confidence and self-efficacy have emerged as critical components of digital literacy, influencing students' perceived abilities to engage with and master new technological tools (Bandura, 1997). These constructs are essential in ensuring that students navigate the digital landscape confidently and competently, especially as digital skills become increasingly necessary in academic, professional, and personal contexts (Schunk and DiBenedetto, 2020; Scherer et al., 2019).

Gender and technology adoption

A substantial body of quantitative research has explored the role of gender in the adoption of new technologies, revealing significant patterns and disparities. Studies have often highlighted that gender differences can influence how and when individuals adopt technology, challenging the assumption that technology use is inherently gender-neutral (Orser and Riding, 2018). For example, large-scale reports by organizations like the United Nations and the OECD have demonstrated that males tend to adopt new technologies at a faster rate than females, with global statistics showing persistent inequalities in access and usage. The OECD (2018b) found that around 327 million fewer women than men have access to smartphones and mobile internet worldwide, and men are four times more likely than women to work as ICT specialists. Such findings underscore the broader context of gender disparities, suggesting that gender influences not only access to technology but also the pace of its adoption (Volman and van Eck, 2001).

Empirical studies have consistently shown differences in technology adoption rates between males and females. For instance, research by Li et al. (2008) found that males tend to move through the stages of technology adoption more rapidly than females, particularly in the context of e-commerce. Similarly, quantitative analyses of gender-specific behavior patterns revealed that male students reported higher confidence levels and were quicker to adopt new digital tools compared to their female counterparts. This has implications beyond the business environment, suggesting that similar patterns might be observed in educational settings where technology adoption is increasingly encouraged.

In the educational context, Zhou and Xu (2007) conducted a study that identified gender differences in how male and female teachers adopt technology. Their findings indicated that male teachers were generally more confident in using technology and preferred to rely on their own experimentation, whereas female teachers were more likely to seek external support and learn from their colleagues. These results suggest that gender-based preferences could shape the strategies employed by educators to integrate digital tools in classrooms, potentially influencing students' exposure to and adoption of technology.

The evidence on whether these gender differences are diminishing is mixed. Davison and Argyriou (2016), in their study on university students' use of mobile technology, reported no significant differences in the overall adoption of mobile devices between male and female students, though they did identify subtle gender-based preferences in how the technology was used. This suggests that while the gender gap in technology adoption may be narrowing, it has not completely disappeared, and specific nuances still exist.

In the context of the Middle East, research indicates that gender disparities in technology adoption persist, though with regional differences. For example, Moussa and Seraphim (2017) conducted a study with 190 female students in the UAE, highlighting how technology adoption can help identify and address existing power imbalances in society. Their findings suggest that technology may play a role in empowering women, but barriers related to socio-cultural norms still exist, affecting the rate of adoption. Similarly, Mohammed (2021) posited that technology could help close the gender gap in education by providing greater access to information, though this potential is tempered by existing structural inequalities.

Previous research provides robust evidence that gender differences continue to play a significant role in technology adoption, with variations across different contexts and environments. Understanding these differences is crucial for developing targeted interventions that promote equitable access to and use of technology. In the context of this study, examining how gender influences students' self-confidence and self-efficacy with technology can offer valuable insights into how educational technology programs can be tailored to address and possibly reduce these disparities.

Socio-economic status and technology adoption

Socio-economic status (SES) is a critical determinant in the adoption and use of technology, reflecting a broader issue known as the "digital divide," which highlights persistent inequalities in access, usage, and benefits of digital technologies across different social groups (Hilbert, 2015). While technology holds the potential to bridge educational and economic gaps, it often reinforces existing disparities. Wessels (2013) argues that technology, deeply embedded in social and economic processes, is experienced unevenly across SES groups, suggesting that rather than acting as a leveling force, it may perpetuate inequalities. Segev (2010) expands on this by identifying the global, social, and democratic dimensions of the digital divide, illustrating how socio-economic barriers persist even within technologically advanced nations. For example, Xanthidis et al. (2020) highlight that although the UAE is a leading adopter of digital technologies, disparities based on SES continue to shape how these advancements are experienced, particularly in education. Simply providing access is insufficient; socio-economic conditions influence how technology is used and integrated into daily life. Students from lower SES backgrounds face barriers such as limited access to devices, inadequate connectivity, and lower digital literacy, hindering their ability to engage with educational technology.

Addressing these disparities requires not just technological solutions but also comprehensive policies aimed at reducing broader socio-economic inequalities. This study acknowledges the importance of SES by exploring its impact on students' self-confidence and self-efficacy with technology, aiming to inform policies that ensure equitable access and effective integration of digital tools in education.

Methodology

Sample

This study used a purposive sampling technique to select schools and classes to investigate the impact of laptop introduction on students' self-confidence and self-efficacy in technology use. Due to the Ministry of Education (MOE) Abu Dhabi's phased approach to implementing technology, fully randomized school selection was not feasible. Instead, this study grouped schools pre-designated by the MOE for laptop integration separately from those not scheduled to receive technology in the midterm. Purposive sampling is often appropriate when specific characteristics, such as prior exposure to

TABLE 1 The sample size for test and control group based on gender.

Group	School gender	Student survey sample
Test	Boys	59
	Girls	50
Control	Boys	46
	Girls	43
Total		198*

*Sample size based on the number of students per group.

an intervention, are essential for achieving the study's objectives (Patton, 2014).

A two-stage sampling procedure was employed. First, four public middle schools in Abu Dhabi with similar characteristics—such as size, location, and student capacity—were selected to enhance comparability (Creswell and Clark, 2017). Second, one male and one female school were randomly assigned to the treatment group (receiving laptops), while the remaining two were assigned to the control group. Within each school, two 8th-grade classes were chosen, capturing a broad range of academic performance levels to ensure adequate representation and variability within the sample. This sampling approach ensured that each group contained enough students (at least 30) to allow for reliable statistical analysis (Babbie, 2020) (see Table 1).

While the control/intervention design strengthens the study's ability to draw comparisons between groups, the limited sample size (four schools) constrains the generalizability of findings to all schools in Abu Dhabi. No formal statistical power analysis was conducted prior to data collection, as school selection was determined by the MOE's phased implementation plan. While this limits our ability to make claims about statistical power, the sample size ($n = 198$) met the conventional threshold of at least 30 students per group for meaningful statistical comparison (Babbie, 2020). Thus, while the findings should be interpreted with caution, they provide valuable exploratory insights into the early effects of laptop integration in Abu Dhabi's middle schools. Nevertheless, this approach provides valuable insights into the initial effects of laptop implementation on student attitudes toward technology. Although randomization was not feasible due to the MOE's phased implementation, potential selection bias was mitigated by matching treatment and control schools on key characteristics such as size, location, and student capacity. This matching approach enhanced comparability across groups and served as a bias control measure to strengthen the validity of the findings. Although formal statistical baseline equivalence checks were not feasible due to the small number of schools, our use of pre– and post–test difference scores helped to account for potential baseline variation between groups.

Data collection

The quantitative data collection was conducted in two phases, each involving survey administration. In the first phase, prior to the introduction of laptops, a paper-based survey was distributed to all participant groups. School administrators and class head teachers were consulted, and teachers guided students through the survey, addressing any misunderstandings and using both Arabic and English for clarity. This approach ensured a comprehensive response, despite the potential limitations of paper surveys, such as incomplete responses (Kiesler and Sproull, 1986). In the second phase, following the intervention, surveys were administered online via Teams to the test groups. Teachers ensured data consistency by confirming that the same students from the first phase completed the surveys, using student ID numbers for verification.

Measures

The study is composed of two dependent variables and four independent variables. The two dependent variables are self-confidence and self-efficacy. Self-confidence is composed of eight questions. These questions revolve around the level of comfort a student feels in using digital devices and the extent of independence that he or she feels in using these devices or solving problems that this student or his or her affiliates may experience.

Self-efficacy is composed of seven questions that revolve around the level of ease that a student may experience in dealing with digital issues or tasks. These tasks include searching, changing settings, uploading, installing, editing and judging the trustworthiness of websites.

The four independent variables are experience, social influence, facilitating conditions and socioeconomic status. The first variable is the Experience variable is composed of nine items that correspond to the frequency of using ICT for activities outside school. The Experience variable measures students' use of ICT for various activities outside of school, encompassing nine items. Participants responded to the question: "How often do you use ICT for the following activities outside of school?" The items included activities such as searching the Internet for information on places to go or activities to do, reading online reviews of products, reading stories online, and using websites or videos to learn how to do something. Other activities covered include playing games, listening to downloaded music, watching downloaded TV shows or movies, and downloading new apps on mobile devices. Responses were recorded on a five-point scale ranging from "Never" (0) to "Every day" (4), where higher scores indicate more frequent use of ICT for these activities. This variable reflects students' familiarity with using digital technology for non-school-related activities.

The second variable is the social influence variable is composed of four items and is related to people that have helped the student achieve certain ICT activities. This variable is referred to in other studies as social influence and is the extent that a person will be encouraged to devote an effort in response to a social stimulus (Venkatesh and Davis, 2000; Venkatesh et al., 2003). The aim of including this variable is to what extent that students can undertake digital activities without relying on others. It aims to examine whether introducing technology has helped students gain more independence in collecting knowledge or doing educational-related activities. Moreover, it also aims to understand the level of skill development that students have experienced in doing tasks by themselves.

The facilitating conditions variable is composed of four items related to the devices available at students' houses. The Facilitating Conditions variable assesses the availability of digital devices for students to use at home, based on four items. Participants were asked: "Are any of these devices available for you to use at home?" The items included a desktop computer, laptop, iPad/tablet, and smartphone. Responses were recorded as "Yes" (1) or "No" (0), indicating whether each device was accessible to the student at home. This variable provides insight into the technological resources available to students outside of school, which may influence their familiarity and comfort with using digital devices. The availability condition refers to existing facilitating conditions, such as infrastructure, in which a person believes they play a role in promoting support for using innovation (Venkatesh et al., 2003). In this study, one main indicator was considered in the survey to examine the affordability of this condition in students' settings: ICT devices at home. A positive correlation between facilitating conditions and the use of ICT in learning is plausible and evident. Empirically, Venkatesh et al. (2003) emphasize that the presence of adequate technical infrastructure motivates learners and instructors to use ICT devices more often in the learning setting.

The Socioeconomic Status (SES) variable is composed of six items that provide insights into the socioeconomic background of the students. It includes questions about the educational level of both parents (father and mother), as well as their occupations. Additional indicators of socioeconomic status are assessed through questions on the number of maids employed in the household and the number of books available at home. Collectively, these items offer a comprehensive view of the students' socioeconomic environment, which may influence their access to educational resources and learning experiences.

Gender is a binary variable where 1 represents male students and 0 represents female students.

Analytical strategy

This study employs a quasi-experimental design to investigate the effects of introducing laptops in middle school classrooms on students' attitudes toward technology. Quasi-experimental designs, like true experimental designs, aim to establish causal relationships between an independent and dependent variable. However, unlike true experiments, quasi-experiments lack random assignment, which can reduce internal validity (Kim and Steiner, 2016). In a quasi-experimental design, participants are assigned to treatment and control groups based on non-random criteria, such as existing classes or program enrollment, which is often necessary in educational settings due to logistical or ethical constraints (Cook and Campbell, 1979).

Furthermore, quasi-experimental designs typically offer less control over the intervention, as researchers may not fully dictate how and when the treatment occurs (Johnson and Christensen, 2024). In this study, for example, the assignment of students to the laptop intervention group and control group followed a non-random process due to practical limitations in the school setting. While this approach limits the ability to make definitive causal claims, it allows for a realistic exploration of the intervention's potential effects in an authentic educational environment.

We acknowledge that students were nested within schools, which may introduce cluster effects. However, given the small number of schools ($n = 4$), multilevel modeling was not feasible. To mitigate this limitation, we included key covariates (gender, SES, prior experience, and facilitating conditions) and analyzed pre–post difference scores, which help reduce bias from pre-existing differences. We interpret the findings as indicative rather than definitive evidence of causal effects.

To analyze the effects of the laptop introduction on students' attitudes, regression analyses were conducted for two outcome variables: self-efficacy (SE) and self-confidence (SC). First, pre-test and post-test scores for each outcome variable were collected from both the treatment and control groups. The change in scores was calculated by subtracting the pre-test scores from the post-test scores, yielding a difference score that reflects the impact of the intervention. These difference scores were then used as the dependent variables in the regression models. Each regression included key predictors such as treatment coded as 1, facilitating conditions, gender, experience, and socio-economic status, allowing for a comprehensive examination of how these factors influenced changes in students' self-efficacy and self-confidence.

General equations:

$$Y_i\ (SC/SE) = \beta_0 + \beta_1\ (Treatment) + \beta_2\ (SES) + \beta_3\ (Gender) + \beta_4\ (Experience) + \beta_5\ (Social\ Influence) + \beta_6\ (Facilitating\ Conditions)$$

$$Y_i\ (SC/SE) = \beta_0 + \beta_1\ (T) + \beta_2\ (SES) + \beta_3\ (G) + \beta_4\ (E) + \beta_5\ (SI) + \beta_6\ (FC)$$

Models:

$$Model1: Y_i\ (SC/SE) = \beta_0 + \beta_1\ (T)$$

$$Model2: Y_i\ (SC/SE) = \beta_0 + \beta_1\ (T) + \beta_2\ (SES) + \beta_3\ (G)$$

$$Model3: Y_i\ (SC/SE) = \beta_0 + \beta_1\ (T) + \beta_2\ (SES) + \beta_3\ (G) + \beta_4\ (E)$$

$$Model4: Y_i\ (SC/SE) = \beta_0 + \beta_1\ (T) + \beta_2\ (SES) + \beta_3\ (G) + \beta_4\ (E) + \beta_5\ (SI)$$

$$Model5: Y_i\ (SC/SE) = \beta_0 + \beta_1\ (T) + \beta_2\ (SES) + \beta_3\ (G) + \beta_4\ (E) + \beta_5\ (SI) + \beta_6\ (FC)$$

Results

The results of this study are presented in two parts: correlation analysis and regression analysis. First, the correlation analysis explores the relationships between key variables, including self-confidence, self-efficacy, treatment, experience, social influence, facilitating conditions, socioeconomic status (SES), and gender. This analysis provides an initial understanding of the associations among these factors, setting the stage for a more detailed examination. Following the correlation analysis, regression models were employed to assess the effects of the laptop intervention and other predictor variables on students‘ self-confidence and self-efficacy with technology. These models allow for a more nuanced exploration of how various factors contribute to students' attitudes toward digital devices, controlling for other influences.

The correlation analysis (Tables 2, 3) reveals several significant relationships between the dependent variables (self-confidence and self-efficacy) and the independent variables, including experience, treatment, social influence, facilitating conditions, socioeconomic status (SES), and gender.

For self-confidence (Table 2), there was a positive correlation with experience ($r = 0.186$, $p < 0.01$) indicating that students who frequently use ICT outside of school tend to have higher self-confidence in using digital devices. Additionally, treatment was positively correlated with self-confidence ($r = 0.209$, $p < 0.01$), suggesting that students in the laptop intervention group reported greater self-confidence compared to those in the control group. A positive correlation was also observed between facilitating conditions and self-confidence ($r = 0.148$, $p < 0.05$), meaning that the availability of digital devices at home was associated with higher self-confidence. No significant correlations were found between self-confidence and social influence or SES. Although gender showed a weak positive correlation with self-confidence ($r = 0.104$), it was not statistically significant, suggesting no strong evidence of gender differences in self-confidence.

For self-efficacy (Table 3), the results indicated a positive correlation with experience ($r = 0.226$, $p < 0.01$), showing that frequent ICT use outside of school was linked to greater self-efficacy in using digital devices. Treatment was also positively correlated with self-efficacy ($r = 0.205$, $p < 0.01$), suggesting that students in the treatment group had higher self-efficacy than those in the control group. Additionally, social influence was positively correlated with self-efficacy ($r = 0.164$, $p < 0.05$), indicating that positive perceptions of social support for technology use were associated with greater self-efficacy. Gender had a weak negative correlation with self-efficacy ($r = -0.061$), though it was not statistically significant, indicating no strong gender differences in self-efficacy. Facilitating conditions and SES were not significantly correlated with self-efficacy.

Across both sets of results, experience consistently showed a significant positive relationship with both self-confidence and self-efficacy, emphasizing the role of frequent ICT use in developing students‘ comfort and perceived competence with digital devices. Additionally, the treatment variable was positively associated with both outcomes, suggesting that the laptop intervention may have had a beneficial impact on students' attitudes toward technology.

It is noteworthy that gender was negatively correlated with experience ($r = -0.267$, $p < 0.01$), indicating that male students were less likely to report frequent ICT use outside of school compared to female students. Moreover, SES was positively correlated with the treatment variable ($r = 0.231$, $p < 0.01$), suggesting that students from higher socioeconomic backgrounds were more likely to be in the treatment group.

Given the significant correlations identified between key independent variables (such as experience and treatment) and the outcomes of self-confidence and self-efficacy, we proceeded with regression analyses to further investigate the strength and direction of these relationships, while controlling for other factors.

The regression results presented in Table 4 show that Model 5, which includes all key predictors, reveals several significant relationships with self-confidence in technology use. The treatment variable ($\beta = 0.220$, $p < 0.05$) was a significant positive predictor, indicating that students who participated in the laptop intervention reported higher self-confidence compared to those in the control group. This suggests that the introduction of laptops had a positive impact on students' comfort and competence with digital devices.

Gender ($\beta = 0.190$, $p < 0.05$) was also a significant predictor, with male students exhibiting higher self-confidence in technology use than female students, reflecting possible gender differences in digital engagement. Additionally, facilitating conditions ($\beta = 0.170$, $p < 0.05$) were positively associated with self-confidence, suggesting that access to digital devices at home enhances students' confidence in using technology.

Although experience and social influence were included in the model, they did not emerge as significant predictors in Model 5, despite experience showing significance in earlier models (Model 3 and Model 4). This change indicates that the effects of these variables may be mitigated when other factors, such as facilitating conditions and gender, are considered.

Overall, the findings suggest that the laptop intervention (treatment), gender, and facilitating conditions play significant roles in shaping students' self-confidence with technology, emphasizing the importance of both in-school programs and out-of-school resources in fostering digital competence.

The regression results in Table 5 show that Model 5, which includes all key predictors, reveals significant relationships with self-efficacy in technology use. Treatment ($\beta = 0.198$, $p < 0.05$) was a significant positive predictor, indicating that students in the laptop intervention group reported higher self-efficacy compared to those in the control group, suggesting that the introduction of laptops positively influenced students' belief in their ability to use digital devices.

Experience ($\beta = 0.222$, $p < 0.05$) was also a significant predictor, showing that students who frequently use ICT outside of school reported greater self-efficacy, emphasizing the role of prior experience in building confidence with technology.

Other variables, including SES, gender, social influence, and facilitating conditions, were not statistically significant in Model 5. Although social influence had some effect in earlier models, its impact was not robust when all factors were included, suggesting that experience and treatment are more consistent predictors of self-efficacy. Overall, the results highlight that both the laptop intervention (treatment) and experience with technology are key factors in enhancing students' self-efficacy, underscoring the importance of providing direct access to technology in the classroom and fostering prior ICT experience.

Discussion

The findings of this study provide important insights into the effects of laptop integration on students‘ self-confidence and self-efficacy with technology in middle school classrooms in Abu Dhabi. The results showed that

TABLE 2 Correlations among dependent (self-confidence) and independent variables.

	Self confidence	Experience	Treatment	Social influence	Facilitating conditions	SES	Gender
Self confidence	1						
Experience	0.186**	1					
Treatment	0.209**	0.088	1				
Social Influence	0.019	0.017	0.048	1			
Facilitating Conditions	0.148*	0.135	−0.132	−0.041	1		
SES	−0.031	−0.14	0.231**	0.026	−0.158	1	
Gender	0.104	−0.267**	0.024	−0.041	−0.09	0.207*	1

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

TABLE 3 Correlations among dependent (self−efficacy) and independent variables.

	Self−efficacy	Experience	Treatment	Social influence	Facilitating conditions	SES	Gender
Self-efficacy	1						
Experience	0.226**	1					
Treatment	0.205**	0.088	1				
Social influence	0.164*	0.017	0.048	1			
Facilitating conditions	−0.009	0.135	−0.132	−0.041	1		
SES	−0.004	−0.14	0.231**	0.026	−0.158	1	
Gender	−0.061	−0.267**	0.024	−0.041	−0.09	−0.207*	1

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

TABLE 4 Factors predicting self−confidence with technology.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Treatment	0.209**	0.248**	0.207*	0.205*	0.220*
SES		−0.057	−0.016	−0.016	0.007
Gender		0.138	0.174	0.178	0.19*
Experience			0.165*	0.166*	0.15
Social Influence				0.065	0.069
Facilitating Conditions					0.17*
Intercept	−0.334*	−0.766**	−0.727**	−0.742**	−0.758**
R−square	0.039	0.051	0.068	0.065	0.087
N	198	198	198	198	198

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

students in the treatment group, who had access to laptops, exhibited significantly higher levels of self-confidence and self-efficacy compared to those in the control group. This aligns with previous research, which has suggested that access to technology can enhance students' comfort and ability to engage with digital tools (Zheng et al., 2016; Ertmer et al., 2012). However, our findings also indicate that simply providing digital devices is not sufficient; the effectiveness of technology integration is influenced by several other factors, including prior experience with ICT, gender, socio-economic status (SES), and facilitating conditions.

In terms of self-confidence and self-efficacy with technology, the positive association between laptop access and both self-confidence and self-efficacy suggests that hands-on experience with technology in an educational setting can empower students by building their digital skills. This supports the Technology Acceptance Model (TAM), which emphasizes perceived ease of use and usefulness as critical determinants of technology adoption (Davis, 1989). Students who regularly used laptops were more comfortable and confident in navigating digital platforms, which may contribute to improved digital literacy and readiness for future technological demands. However, the study's mixed results

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TABLE 5 Factors predicting self–efficacy with technology.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Treatment	0.205**	0.262**	0.21*	0.199*	0.198*
SES		−0.062	−0.009	−0.008	−0.009
Gender		0.006	0.056	0.073	0.072
Experience			0.217*	0.222*	0.222*
Social Influence				0.16	0.16
Facilitating Conditions					0.918
Intercept	−0.311*	−0.48	−0.432	−0.46	−0.459
R–square	0.037	0.044	0.079	0.098	0.091
N	198	198	198	198	198

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

concerning socio-economic factors highlight persistent challenges. Students from lower SES backgrounds did not experience the same level of benefit from laptop integration, likely due to fewer opportunities for reinforcement of these skills outside of school. This finding is consistent with the digital divide literature, which argues that technology can sometimes exacerbate existing inequalities (Wessels, 2013; Hilbert, 2015).

In terms of influence of gender and socio-economic status, gender differences were observed in the study, with male students reporting higher self-confidence levels compared to female students. This echoes earlier research that has identified gender-based discrepancies in technology adoption, where males often report greater confidence and ease of use with digital devices (Li et al., 2008; Orser and Riding, 2018). However, this finding also underlines the need for more targeted interventions to promote equitable digital competence across genders, especially in educational contexts. The absence of significant differences in self-efficacy between genders suggests that when both groups have equal exposure to technology, the gap may narrow, pointing to the potential of school-based initiatives to address gender disparities.

Socio-economic status (SES) did not play a significant role in shaping technology-related attitudes in this study. This lack of difference might be attributed to the relatively high SES background of students across Abu Dhabi, where educational and technological resources are more uniformly accessible. Unlike contexts where SES disparities lead to unequal access and engagement with digital tools, the consistent availability of resources in Abu Dhabi's education system may have contributed to the absence of SES-related differences in self-confidence and self-efficacy. These findings suggest that, in environments where resources are equitably distributed, other factors, such as educational support and individual experience, may play a more prominent role in influencing students' attitudes toward technology use.

In terms of role of facilitating conditions and social influence, the study highlighted the importance of facilitating conditions, such as teacher support and reliable infrastructure, in enhancing students' digital confidence. This is in line with the Theory of Technical Capital (Yardi, 2010), which suggests that building technical skills requires accessible resources and supportive environments. Schools that provided adequate training and consistent access to laptops saw better outcomes, underscoring that the success of technology integration is not just about access, but also about how these tools are implemented and supported. Moreover, social influence, including encouragement from teachers and peers, appeared to play a secondary but significant role in shaping students' attitudes toward technology, consistent with findings from UTAUT (Venkatesh and Bala, 2008). More recent work further underscores the role of digital self-efficacy in promoting engagement across emotional, social, and cognitive dimensions, particularly through its influence on students' sense of social presence in online environments (Wu, 2023).

Conclusion

This study contributes to the ongoing discourse on digital education by offering empirical evidence on the effects of laptop programs in middle schools. It highlights not only the potential of such programs to enhance students' self-confidence and self-efficacy but also the critical role of contextual enablers—robust infrastructure, sustained teacher training, and socio-economic support mechanisms. In doing so, the study advances our understanding of digital education as a multifaceted process that requires alignment between technological provisions and pedagogical, institutional, and socio-cultural readiness. It contributes to the broader field by underscoring that digital transformation in education is not merely a technical endeavor but a deeply systemic and relational one.

Implications for policy and practice

The findings underscore the importance of comprehensive and context-sensitive strategies for technology integration in education. Policymakers should invest not only in digital infrastructure but also in continuous professional development programs that equip teachers to integrate digital tools effectively into pedagogy. Furthermore, to bridge digital divides, initiatives should include support for students' home access to technology and community-based digital literacy programs. Specific attention must be given to addressing gender-based disparities by designing interventions that empower female students to build digital skills and confidence.

Future research could build on these findings by examining how digital technology affects broader student outcomes, including collaborative learning, creativity, and critical thinking. Mixed-method or longitudinal designs would be particularly valuable in capturing the evolution of digital engagement over time and linking early gains in confidence to long-term academic or career trajectories. Comparative studies across countries, income levels, and school types can also provide insights into which implementation strategies are scalable and equitable. Additionally, research on the role of school leadership and teacher agency in sustaining digital transformation would offer a promising line of inquiry.

In conclusion, this study demonstrates that effective technology integration in education requires a holistic and equity-oriented approach. Providing devices alone is insufficient; success depends on the surrounding ecosystem—teacher support, socio-economic inclusion, and pedagogical vision. By addressing these contextual factors and designing with equity in mind, education systems can better leverage technology to foster inclusive, future-ready learning environments.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study received ethical approval from the Abu Dhabi Department of Education and Knowledge (ADEK) Institutional Review Board. All procedures were conducted in accordance with ADEK's ethical guidelines for educational research involving human participants. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

HA: Conceptualization, Validation, Data curation, Writing – review & editing, Investigation, Formal analysis, Writing – original draft, Funding acquisition, Methodology, Resources, Visualization. AS-H: Project administration, Resources, Supervision, Validation, Investigation, Conceptualization, Writing – review & editing. NE: Validation, Resources, Visualization, Writing – review & editing, Investigation, Software, Formal analysis.

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The author(s) declare that Gen AI was used in the creation of this manuscript. The author(s) verify and take full responsibility for the use of generative AI in the preparation of this manuscript. Generative AI (ChatGPT-4o, OpenAI) was used solely to check grammar, enhance clarity, and improve the readability of the text. All content, analysis, and interpretations are the original work of the author(s).

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