Research Article

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The Impact of Information and Communication Technologies (ICT)-Based Education on the Mathematics Academic Enthusiasm

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Abstract

The main objective of this study is to investigate the impact of Information and Communication Technologies (ICT)-based education on the academic enthusiasm of eleventh-grade female students in mathematics. The study was conducted in a secondary school in the United Arab Emirates during the first semester of 2020-2021, using a quasi-experimental methodology. A school with the necessary facilities for ICT-based education was chosen, and two classes were randomly assigned as control and experimental groups. The study utilized the Mathematics Academic Enthusiasm (MAE) questionnaire, which included three subscales: cognitive, behavioural, and emotional. The study's findings revealed that the ICT-based education method had a more significant impact on students' MAE for the cognitive and behavioural subscales in comparison to traditional education methods. However, there was no significant impact observed on the emotional subscale. The study recommends further examination of students' enthusiasm for other new educational methods and investigating the impact of ICT on other variables such as mathematical achievement, motivation, and beliefs towards mathematics.

Keywords: *Mathematics Academic Enthusiasm (MAE), Information & Communication Technologies (ICT), (ICT)-Based Education, Traditional Education*

1. Introduction

Several studies have demonstrated the benefits of Information and Communication Technologies (ICT) in education, including research conducted by Mardiyah et al. (2021), Ahmad et al. (2020), Alonso et al. (2019), Bin-Hady et al. (2020), and Fernandes et al. (2018). The advantages of ICT are derived from the online training it offers students through mobile devices (Ahmad et al., 2020; Bin-Hady & Al-Tamimi, 2021). Additionally, it is a valuable resource that can be integrated into teaching and learning (Espinosa et al., 2020) and plays an essential role in everyday life (Li, 2014; Bin-Hady et al., 2020). Furthermore, it enhances mathematics education by providing the classroom with the necessary elements for virtual learning modes (Alonso et al., 2019; Fernandes et al., 2018; Kricorian et al., 2020; Subagja et al., 2022). ICT is a combination of multimedia, software, and delivery systems that provide resources such as libraries and websites, enabling teachers and students to browse, read online, and download resources anytime and anywhere.

Furthermore, the increasing (ICT) development plays a vital role in coming up with the educational system requirements. Thus, (ICT) tries to help solve the hanging educational problems by providing support and tools for visualizing the learning process (Fannakhosrow et al., 2022; Tashtoush et al., 2020 b). In mathematics, (ICT) provides many prospects for promising practice in various aspects. However, the success of such applicability lies on several issues, including teachers' attitudes and skills towards the role that (ICT) plays in mathematics. Still, teachers' attitudes to the space that (ICT) provides for students learning is a crucial issue in the success of (ICT) in math (Alonso et al., 2019).

Mathematics education has been the focus of numerous studies exploring the role of ICT (Akbarjono et al., 2022; Alonso et al., 2019; Dalby, 2019; Fannakhosrow et al., 2022; Mikropoulos, 2018). These studies have highlighted the positive impact of ICT on the learning process. The integration of ICT in mathematics education promotes collaboration among learners and facilitates mathematical tasks (Dalby, 2019). Moreover, it has been shown to positively affect students' learning and academic outcomes (Alemayehu & Natarajan, 2018; Mikropoulos, 2018).

Effective teaching and learning are preserved by focusing on cognitive tasks and activities and focusing on students' emotions, feelings, and enthusiasm or humanising students. So, whenever students' feelings are considered, learning becomes motivational and leads to the student's success. (ICT) can be motivational and enthusiastic sources for learning which ensure students' participation in classroom activities (Alemayehu & Natarajan, 2018; Fannakhosrow et al., 2022; Tashtoush et al., 2023 c). Furthermore, academic enthusiasm promotes students' learning by minimizing the educational risk of negative behaviours. Students become committed to achieving their goals and are involved in in-class assignments.

Fannakhosrow et al. (2022) defined academic enthusiasm as combining the energy and efficiency that a student needs to do a task effectively. As a stimulus, academic enthusiasm to students in obtaining the task also manages good relationships between students and teachers, motivates students to participate in school tasks actively, and consolidates the school culture (Fannakhosrow et al., 2022).

Agyei and Voogt (2010) explored the feasibility of including (ICT) in teaching mathematics in Ghana senior secondary schools. The study obtained both questionnaires and interviews to gather data from mat teachers. Findings showed that in Ghana, high school math teachers did not use (ICT) in their classrooms due to some challenges, including teachers' unawareness to merge such technology into classroom practice.

Kikha and Hoveida (2013) studied the effect of (ICT) on slow secondary school learners. The study showed the positive impact of (ICT) on students' innovation and success. Likely, Brian et al. (2014) investigated the correlations between academic achievement, motivation, and self-efficacy. The study concluded that (ICT) affects academic motivation and self-efficacy toward school.

Chao (2015) gauged the impact of (ICT) on teacher training. It also explored the use of such teachers (ICT) in their teaching practice, which helps make the class more interesting and active no

matter the limited infrastructure of the teaching environment. The study reported that teachers lack the essential skills for employing (ICT) in their teaching practice as well as the fogy policy for teacher training and improving the infrastructure.

Alonso et al. (2019) probed the correlation between (ICT) sustainable objectives and effective teaching practice in Spanish. The study investigated 27 research papers as data research. Results revealed that effective teaching has an association with the use of ICT. Virtual learning is also reported as a sign of a good teaching experience.

Likely, Alemayehu and Natarajan (2018) scrutinized the differences between the students of Jimma University's use and non-use of (ICT). The study recruited (184) participants randomly assigned. The study revealed that the great majority of students were sufficiently competent in using (ICT) with good searching skills. The research recommended the use of (ICT) to a high extent among teachers and students.

Fannakhosrow et al. (2022) explored the impact of conventional and (ICT) instruction on Iran's nine-grade students' motivation for English learning. The study obtained experimental design. Findings showed that teaching using (ICT) has a strong impact on student's academic motivation than traditional teaching. Furthermore, Akbarjono et al. (2022) examined English use among students during the Covid-19 pandemic. The study also explored teachers' motivation for their students to use English. The study reported that the students continued to use English more enthusiastically due to the videos used to present the content. Likely, Mireles et al. (2022) investigated the use of (ICTs) in the classroom to improve the teacher training profession. The study explored 90 different schools in Garza. Results showed that (ICTs) are perceived as an essential resource for teacher training. Furthermore, communication between students and teachers usually occurs via email. Moreover, the teachers exhibit their consent to the importance of using (ICTs) in the learning process.

Akbarjono et al. (2022) stated that mathematics is among the compulsory high and primary education courses. The Ministry of Education pays significant attention to ensuring quality education in Mathematics. Thus, Mathematics shapes many aspects of the student's personality. Similarly, Sadovsky (2007) called on teachers to encourage students about the practical importance of mathematics in their daily lives. Hence, such can be achieved by considering the appropriate techniques and methods for teaching Mathematics, ensuring the development of learners' intellectualities.

ICTs provide many solutions to social life. It can develop the educational system by using the many resources to make learning accessible and reachable for students. Therefore, to make math classes more accessible and attractive, teachers should apply (ICT) technologies in their teaching. Educational games and videos can change the boredom of traditional classes and make them more attractive (Alimi et al., 2020; Tashtoush et al., 2023 a; Oduma et al., 2014; Tashtoush et al., 2023 c).

A changeable society with constant development in technologies and sciences embraces us. Every person in this revolutionized society is connected with others with technological instruments like cell phones and laptops. Such communication tools have become indispensable to our culture and educational system (Al-Ansi et al., 2021; Alemayehu & Natarajan, 2018). Hence, realising the importance of indulging such (ICTs) in our mathematics class is essential to improve the learning situation and make it more dynamic. Math students can use (ICTs) to design graphs, calculate formulas, and solve math equations. One example of technology is using a calculator to make complex numbers easily and in part for a second time. Furthermore, math students can use tools like algebra systems, spreadsheets, or graphical calculators to perform and test such (ICT) methods. Likely, graph plotters can be used to solve math equations instead of algebra (Mireles et al., 2022; Tashtoush et al., 2023 b).

Tashtoush et al. (2022) confirmed that students could make use of the calculator with many statistical properties to do some statistical analysis of math equations. Likely, a geomantic equation can be understood, solved, or even proved by drawing an image with the dynamic geometry package application. Besides, students' capabilities in using math applications will be developed as a result of

the continuous practice of using (ICT) to solve, prove, and understand math problems. Nevertheless, Mikropoulos et al. (2018) affirmed the efficiency of (ICT) tools; students can use such an opportunity to learn the technical tools efficiently.

Advantageously, (ICT) can be utilized in various areas of mathematics. However, due to its benefits, the followings are of great importance. ICT can be used to solve problems, apply mathematics, equation, sequences, graph, geomatics, position value, rounding, shapes, transformation coordination, construction, probability, handling data, and statistical application. Some software mathematics is presented (Fannakhosrow et al., 2022; Bonitasya et al., 2021; Kayha & Hoveyda, 2013).

Maxima, a computer-based application with various POSIX principles like BSD, OS X, Linux, and UNIX, is software for solving algebra equations. But the plot is applied to draw figures. SymPy is intended format symbols. It provides all features of algebra through a computer system. Python keeps all the math codes simple but also understandable and accessible. Likely, GeoGebra is software that teachers and mathematics students can beneficially apply. As a robust, Geogebra can help beginners understand math properly in solving linear programming problems, complex numbers, algebra, calculus, and vectors (Akbarjono et al., 2022).

Even some of this software has become accessible through mobile. Math Aid app is launched to provide math learners with a self-learning environment. Math students can use such software for the most frequent math equations in the secondary school curriculum. Math Aid offers learners both mathematical concepts through the theoretical side of the application. It also concretely demonstrates the studies unit with pertinent hints and solutions. They will help them to answer the math tasks.

Still, Math Aid provides teachers with the prosperity of observing students in class or on individual students. It also constructs the learning tasks for an interactive purpose and for self-instructions. Math aid contains calculation steps, animations, and demonstrations that help visualize mathematics. This software is accessible through mobile, laptop, and stables that operate on Android and iOS systems (Mikropoulos, 2018).

In UAE, the authorities are accustomed to providing high levels of well-being to the students. The field of education has experienced tremendous benefits from the technological advancements that have emerged in recent years. Education professionals have shown great interest in keeping up with these developments, incorporating ICT tools to enhance learning. In line with this trend, the UAE Ministry of Education has introduced various educational platforms such as Madrassa, Matvik, McGraw Hill, Nahla, and Nahil. These platforms offer students exciting opportunities to engage with educational content and acquire knowledge while having fun. Furthermore, these resources can benefit math teachers seeking to enhance their teaching methods. In addition, these educational platforms have created a fun and joyful atmosphere for students to learn using modern techniques that foster creativity, self-confidence, and academic enthusiasm. By providing interactive and engaging content, students can develop their critical thinking skills and gain a deeper understanding of the subject matter. As a result, students are motivated to take an active role in their learning journey, leading to better academic outcomes and overall success.

So, the main question for this study is: What is the impact of (ICT)-based education on the mathematics academic enthusiasm of eleventh-grade students? The major importance of this study is to determine how student mathematics academic enthusiasm (MAE) for students in the eleventh-grade female students in secondary school in the United Arab Emirates is affected by ICT-based instruction

2. Materials and Methods

The research methodology used was a quasi-experimental pre-and post-test design with two experimental and control groups. The statistical population consisted of female eleventh-grade students in secondary schools in the United Arab Emirates during the academic year 2020-2021. The

available sampling method was used due to the need for appropriate facilities and technical infrastructure in the school and basic skills among eleventh-grade students. The Modern School in Abu Dhabi was selected as the research site, with all (ICT) multimedia available. The students were randomly selected and divided into two groups: an experimental group consisting of 31 female students who were taught using (ICT)-based education and a control group comprised of 30 female students who were taught using the traditional method. A pre-test of (MAE) was administered to both groups before the treatment began.

The lessons were designed to span 15 class sessions, each lasting 45 minutes. The educational materials were self-paced, utilizing text, video, teacher narration, examples, exercises, and gamification elements. The content was shared with the experimental group via the Electronic Learning Management System (Moodle) two days prior to the scheduled class, while the control group received no intervention. At the end of the semester, a post-test was administered to both groups.

To measure the (MAE) of the participants, the authors used a survey scale based on the research scale developed by Frederick, Bloomenfeld, and Paris. The questionnaire used in the study consisted of 15 questions with three subscales: behavioural, emotional, and cognitive. A 5-point Likert scale was used with a minimum score of 15 and a maximum of 75. The data for this quantitative research was collected from 61 valid questionnaires and entered, coded, and analyzed using the SPSS software.

Academic experts approved the validity of the questionnaire. The reliability of the (MAE) questionnaire using Cronbach's Alpha coefficient was (0.89, 0.92, 0.91, and 0.91) for behavioural, cognitive, emotional, and overall scales, respectively. These values are acceptable for applying this study (Odeh, 2014).

3. Results

Descriptive statistics for the (MAE) related to the two study groups, which are shown in Table (1), show that in the variable (MAE), the mean score of post-tests of the experimental group was more advanced than the control group.

Table 1. Mean and SD of (MAE) for two study groups

Group	Application	Statistic	Academic Enthusiasm Subscales			
			Cognitive	Behavioural	Behavioural	Overall
Control	Pre-test	Mean	8.21	17.32	10.62	59.52
		SD	1.65	2.72	2.09	5.65
	Post-test	Mean	8.62	17.39	10.43	60.95
		SD	1.68	2.75	2.11	5.43
Experimental	Pre-test	Mean	8.92	17.83	10.92	58.62
		SD	1.77	2.82	2.12	5.68
	Post-test	Mean	13.65	22.69	15.32	66.48
		SD	2.36	3.85	2.92	5.68

Table 1 shows that the students' MAE scores were relatively similar between the control and experimental groups in the pre-application phase. However, significant improvements were observed in the MAE scores of the experimental group in the post-application phase, with higher scores in all subscales (cognitive, behavioural, and emotional) as well as the overall test score. The treatment group showed more substantial improvement than the control group, with significantly higher mean scores for the experimental group (13.65, 22.69, 15.32, and 66.48, respectively) than the control group (8.92, 17.83, 10.92, and 58.68, respectively).

To determine the statistical significance of the observed differences in the MAE scores between the experimental and control groups, a multiple variance analysis (MANCOVA) was conducted.

Additionally, effect sizes were calculated for the MAE scale as a whole and its three subscales: cognitive, behavioral, and emotional. Table 2 presents the mean scores of the MAE scale for both groups following the treatment. The findings suggest that using ICT-based education had a significantly more substantial impact on students' academic enthusiasm than the traditional approach.

Table (2): MANCOVA results for the (MAE) scale at the post-test

Source	Skill	SS	d.f.	MS	F	Sig.	η^2	Effect size
Accompanying	Cognitive	169.32	1	169.32	27.89	0.000	0.503	
	Behavioural	148.65	1	148.65	26.97	0.005	0.417	
	Emotional	118.04	1	118.04	29.88	0.005	0.550	
	Overall	406.12	1	406.12	43.76	0.027	0.574	
Post- Test	Cognitive	125.32	1	125.32	16.79	0.002*	0.273	Large
	Behavioural	72.95	1	72.95	9.77	0.009*	0.206	Large
	Emotional	68.71	1	68.71	9.8	0.057	0.263	Large
	Overall	175.25	1	175.25	12.74	0.000*	0.315	Large
Error	Cognitive	352.62	58	6.07				
	Behavioural	319.98	58	5.51				
	Emotional	229.25	58	3.95				
	Overall	724.55	58	12.49				
Total	Cognitive	557.25	60	9.28				
	Behavioural	448.12	60	7.46				
	Emotional	421.03	60	7.01				
	Overall	825.22	60	13.75				
* Significance level ($\alpha = 0.05$)								

The effect size (Eta-square, $\eta 2$) in Table (2) indicates the magnitude of the impact of the (ICT)-based education on the students' (MAE) scores. A value of $\eta 2$ greater than 0.14 is considered a large effect size. In this case, the effect size was more significant than 0.14 for all three subscales and the scale, indicating that the (ICT)-based education has a large positive impact on students' academic enthusiasm in the cognitive, behavioural, and emotional domains. This suggests that (ICT)-based education can be a practical approach to improve student's academic motivation and engagement in mathematics.

4. Discussion

This demonstrates the extent to which students benefit from using (ICT)-based education, which can be attributed to the excellent use of (ICT) technology to create educational material that simulates students in a computerized way. This approach fosters enthusiasm for learning Mathematics by tailoring the material and content to students' interests, needs, and tendencies while being suitable for this age group. The educational material was presented in colourful forms, with sound (ICT), graphics, simulation models, and reinforcements that captivate students' attention. This creates a positive interaction between (ICT) technology and the student, increasing their (MAE) for learning Mathematics. These findings were confirmed by studies conducted by (Fannakhosrow et al. 2022; Rasheed & Tashtoush, 2021; Andersen, 2020; Tashtoush et al., 2020; Alemayehu et al., 2018; Chao et al., 2015; Tashtoush et al., 2022 a; Ikawati et al., 2022; Bashpour et al., 2013; Tashtoush et al., 2022 b; Tashtoush et al., 2020 b; Widiawati et al., 2022).

The previous result can be explained that the use of the (ICT)-based education for learning mathematics had a good impact on increasing cognitive skills for the students', such as: ability to learn, analyze information, speed audio and visual processing, activate memory, assessment, and make an appropriate decision regarding the learning process, and the opportunity it provides for

interaction with the educational process, and makes students the focus of the educational process, and the feedback it gives at the end of each training, and its multiple advantages in presenting the educational material, and use of influences in its various forms, such as: sounds, images, movements, and colors, all of which attract students and increase their academic enthusiasm for learning mathematics, and make of the educational material more enjoyable and enthusiastic and less burdensome to study it with a high degree of perfection, The use of the (ICT)-based education to learn mathematics, deviating from the traditional method, and avoiding routine and imitation, allowed the student to be active, exploit his senses, and provide an atmosphere for participation, interaction and excitement of the reasons, all of which led to an increase in (MAE) through their cognitive skills towards learning Mathematics.

Furthermore, using ICT-based education provides students with colourful forms, simulations, sounds, images, and animations that spark their academic enthusiasm and equip them with practical skills that enhance their behavioural capabilities. In addition to its academic benefits, the ICT environment can also affect the psychological state of individuals. By leveraging technology, the experimental group was able to cultivate valuable skills that contributed to an increase in their MAE scores, leading to a more positive and confident attitude towards learning. It allows them to adapt to different educational situations. It helps them learn how to change their traditional thinking patterns and deal with academic problems positively with logical and scientific thinking. The educational environment offered by ICT-based education is characterized by its effectiveness in modifying behaviour, developing communication skills, promoting self-development, time management, patience, and decision-making. The interactive nature of this environment, including dialogue and discussion forums, facilitates the exchange of experiences and knowledge among the experimental group. This interaction also enables the exploration of the behavior of others, leading to the development of critical behavioural skills such as creativity, leadership, motivation, and learning. As a result, the experimental group acquired practical skills that will serve them both academically and personally.

For the final subscale; emotional skill, the students have made significant progress in the academic enthusiasm, and this result can be attributed to the effect of using the traditional method of education, and its advantages that cannot be neglected if it is well planned in proportion to the educational goals, and this result is logical and reasonable; Because students, regardless of their educational levels, whatever their (MAE) for learning mathematics, they must benefit from explaining the new educational material to them in the traditional way, but the benefit varies from one student to another; Because of their individual differences, although there are some negatives in them, but there are positives that distinguish them; such as; the face-to-face meeting of the teacher and the students; It is the most powerful means of communication and information transfer, where image, sound and movement combine with feelings and sensations, thus affecting the message and the entire educational situation and being affected by it.

5. Conclusions

The primary goal of this study is to determine how student mathematics academic enthusiasm (MAE) for students in the eleventh grade is affected by ICT-based instruction. In the first semester of 2020–2021, eleventh-grade female students from a secondary school in the United Arab Emirates are included in the sample. The quasi-experimental approach is used in this investigation. Two classes from this school were chosen randomly as the control and experimental groups because it has the facilities needed to conduct (ICT)-based instruction. The (MAE) questionnaire, which has three subscales: cognitive, behavioural, and emotional, served as the study instrument. The study's findings indicated that the ICT-based education technique had a greater impact than traditional education for the cognitive and behavioural subscales of the student's MAE. However, there is no effect on the emotional subscale. The study suggested assessing students' excitement for utilizing other novel instructional strategies and studying the impact of ICT on different factors like mathematical

achievement, motives, and beliefs.

6. Recommendations

The study recommended some suggestions: Organizing training courses and workshops to develop the teachers to using (ICT)-based education and to familiarize them with the importance of (ICT) as the main focus in teaching and learning mathematics, and conducting more studies and research that examine the use of communication and information technology, to include different study stages, and other variables. Examine students' enthusiasm for using other new educational methods. Investigate the impact of (ICT) on other variables in the future, such as mathematical achievement, motivations, and beliefs towards mathematics.

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