Technology Fusion in Assessment: Test Anxiety and Academic Achievement in Tertiary Institutions

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Abstract

The fusion of computer technologies has had a remarkable impact on contemporary culture, as computers have a substantial impact on practically all aspects of learning; nonetheless, some students have claimed that they still feel uncomfortable when using computers. Test anxiety related to computer–assisted assessment (CAA) is a main factor that is expected to influence students' academic achievement. Learning math in the digital environment could be a challenging process for students which could increase anxiety levels among them. The current quantitative research study pursues to measure students' levels of anxiety that result from learning and assessment with computers and discover whether anxiety level is associated with students' academic achievement in tertiary institutions. Descriptive analysis and Correlation Coefficient are the employed statistical techniques to achieve the study objectives. Findings demonstrated that more than 90% of the sample identified with low anxiety levels and there is a noteworthy negative correlation between anxiety levels and students' academic achievement in math. The findings have implications for practice in the higher education sector in instructional design and university counselling services.

Keywords: Fusion assessment; Math learning; Computer-assisted Assessment; Anxiety; Academic Achievement

1. Introduction

The fusion of education technology has meaningfully transformed the structure of teaching and assessment in various educational settings. The numerous tools of education technology have leveraged students' learning experience. [11] suggested the enhancement of the practicum program when it is integrated with a professional outlook of the fusion of technology, which enhances students' critical thinking ability. As higher education students demonstrated medium to high levels of readiness toward computer-based learning [1], studying the factors related to computer-assisted assessment should be an objective of educators and researchers. Assessment is a fundamental method that is applied to determine academic performance among students. Computer-assisted assessment (CAA) is a term that refers to embracing computers in assessment processes, including test delivery, answers' capture, and grading by either computer or human indicator [19]. Computer-assisted assessment systems create enough challenges and stress for users which could cause some emotional states among students. Anxiety is one of the emotional states that can unfavourably influence students' efficiency, learning outcome, and subjective well-being and welfare regardless of the student's gender [22, 33, 39]. Psychological research studies showed that anxiety is the natural response of the human body when it undergoes stressful situations [28]. Many decades ago, [14] found that test anxiety scores relate negatively to students' academic accomplishment. The association between test anxiety scores and academic performance was examined by the research study of [37], their findings demonstrated a substantial negative correlation between these two variables. Moreover, test anxiety was found to be a responsible factor for students' underachievement and low academic performance. It was discovered that social anxiety significantly connected negatively and explicitly with academic achievement [5]. Previously published research studies that discussed learning mathematics revealed that learning mathematics inside the physical classroom is a challenge for many college students [4]. Teaching mathematics virtually is

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accompanied by implementing an e-system for solving problems and writing equations and mathematical formulas. Thus, using computers in learning and assessment of mathematics could stress students as it requires them to develop e-skills to meet the challenges of learning and computer-assisted assessment.

[17] studied the challenges faced during learning mathematics remotely in higher education during the pandemic of COVID – 19. The outcomes discovered that although there are many online platforms integrated to facilitate math education, there are some hindrances such as the students' limited basic skills of using some online learning tools. Moreover, limitations were found in writing mathematical equations and symbols [17]. According to [20], sufficient digital literacy skills are associated with efficacious participation and completion of online learning. It is essential for students to release anxiety to succeed. Moreover, [25] indicated that anxiety among higher education students is related to poor academic achievement, heavy workload, incompetence, inadequate teacher-student interaction, lack of proper occupational readiness, and financial problems, among other factors. Thus, investigating the anxiety levels because of learning mathematics and being assessed by computers is a crucial objective that helps educators predict students' academic achievement.
The current research study aims to measure the students' e-skill, and levels of anxiety related to using computers when learning mathematics and implementing computer-assisted assessment among higher education students. Moreover, the study intends to discover the association between anxiety and students' academic achievement. For this study, computer anxiety refers to anxiety that is caused by using portable electronic devices in learning mathematics such as tablet PCs or any other portable technology. Computer-assisted assessment refers to attending the assessment on computers. The academic achievement here is measured by students' Grade Point Average (GPA) in an introductory math course.

The effect of anxiety has been discussed deeply from many perspectives such as examining the gender-based differences in academic achievement in relation to perceived general self-efficacy and test anxiety. [31, 23] studied the influence of anxiety, age, gender, and depression on students' academic success within a teenage group. Their results revealed an association between these variables and academic achievement. Nevertheless, investigating the effect of computer anxiety on mathematics achievement within higher education settings is a crucial objective that needs further research and study. The impact of computer anxiety and math learning and achievement has been investigated in different educational settings ([40, 39], however, the topic is less researched in higher education settings which necessities a deep understanding of the relationship between computer anxiety and students' achievement in a math course in the tertiary institutions. The current research findings are anticipated to advantage the higher education division in terms of offering online math academic programs and training sessions.

2. Related Work

2.1 Computer-based Anxiety

Digital skills are essential in modern economies since they allow people to access and share information, increase social interactions, automate different activities, ease education and training, and enhance productivity. The computer is a powerful technology that facilitates information management and improves productivity in addition to its efficiency for education and work. [15] demonstrated that the teaching and learning process relies heavily on computers for all subject areas and at all educational levels. It is predicted that excessive use of computers may create some challenges. Currently, the prevalent usage of computer technology enables access to much more information than ever before. As technology advances, people find themselves in a position to address the need to educate themselves in order to meet the demands of the digital age, however, not every individual shows the same level of interest in improving their digital literacy. Those who show resistance to coping with the shift to digital tech could encounter fear and anxiety that impact their life and work performance. Low-computer efficacy is common among undergraduate students and its results affect their academic performance [20]. Computer anxiety may prompt the student to avoid using computers, which poses a serious barrier to learning. This may compromise the student's academic achievement and productivity [9].

Many decades ago, computer anxiety has been documented in literature reviews in many research studies such as [6, 10, 30]. [10] suggested that computer anxiety or avoiding using computers is one of the factors that push students to seek counseling. The concept of computer anxiety was developed more than 3 decades ago [38, 29] and since then, it has been defined and analyzed by many researchers. [30] described computer anxiety as an individual's feeling of fear and dread when using computer technology. Computer anxiety refers to the human feelings of anxiety when utilizing a computer; it is an emotional response. Computer anxiety comprises individuals' negative attitudes regarding computers that cause subjective opinions and feelings related to computers which differ from one's expressive response related to utilizing computers [40]. One explanation of computer anxiety suggests that it refers to a sensation that comes with the increasing use of computers or portable

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electronic devices on a daily basis. Anxiety is caused by exposure to technology such as gadgets, computers, and laptops referred to as computer anxiety [8]. As explained by [44], the concept of computer anxiety can be termed as the dread of imminent interaction with a computer that may be unequal to the genuine risk [44]. Massive technology penetration into daily life activities motivates people to continue using it, but on the other hand, there are some developed fears and anxiety about its usage. The global transition to e-learning in 2020 obliged students to increase their technology usage which increased their anxiety levels among students [44]. Technology anxiety could minimize students' motivation to learn and educate and influence their performance negatively. [8] revealed the most prevalent symptoms of computer anxiety include dizziness and unreal feelings, such as heart pounding, breath shortness, and sweating. In addition to developing "technophobia" the uncomfortable feeling while interacting with technology. Although the triggers of computer anxiety are not well identified, [8] suggested that the factors behind computer anxiety include a repressed feeling that is developed since the first interaction experience with technology, or it could be associated with users' gender differences and age. Furthermore, it was revealed that users with high computer literacy develop positive behavior towards technology but those with limited computer literacy experience anxiety when they interact with computers in an attempt to avoid failure and receive unsatisfied judgment from their peers. Additionally, people getting anxious about using computers prefer not to announce it to avoid being embarrassed [44]. Researchers' early investigation focused on e-learning and its qualities, and it was observed that computer anxiety is a substantial contributor to learning development [13]. People with elevated computer anxiety are expected to develop greater anxious moods if they keep on continual exposure to computers. Moreover, they are expected to struggle and maybe resist using portable electronic devices and lose the learning benefits because of the anxiety [13]. On the other hand, it was found that Engineering students show a high self–efficacy, and e-learning system which could minimize computer anxiety [32].

2.2 Math Anxiety

Studying math could be an annoying issue for many students which could cause an anxious state. Math anxiety refers to early as suffering from panic emotions and weakness when being involved in a math problem [42], which could result in psychological and functional symptoms [7]. Studying the relationship between anxiety and achievement in mathematics is an attractive topic for research and study. Prior research work suggested the existence of a high correlation between learning mathematics and students' attitudes to learning math and math anxiety. It was shown that a notable negative consequence of math anxiety on mathematics achievement e.g., [34, 45, 7]. Math anxiety was suggested to diminish students' math performance. The association between anxiety and math accomplishment was examined by [47] by analyzing previously conducted studies within a large sample size. The outcomes revealed a strong negative link between anxiety and performance in mathematics. A recent study by [21] and a group of researchers proposed that instructor misconduct increases students' math anxiety which impacts their math performance. The significant work of [46] assessed the impact of implicit and explicit math anxiety on students in math courses. The results showed that measuring math anxiety implicitly and explicitly is an effective predictor of math achievement. A few decades ago, there was a contradiction among researchers regarding math anxiety, for instance, [27], (1986) assumed the existence of interrelations between students' math skills and computer anxiety. Research findings discovered that high math technical ability among students minimizes math anxiety caused by computers. However, other researchers argued that math ability does not affect computer math anxiety [12]. Additionally, there was no solid association between students' math anxiety and computer math anxiety [43].

2.3 Anxiety and Students' Success in Higher Education

Occasional anxiety is part and parcel of humans' lives. However, persistent feelings of anxiety result in a mental health condition referred to as anxiety. Anxiety is a state of fear and trepidation that is experienced by many people. Anxiety can be perceived as a feeling of disquiet or a feeling of panic about facing some uncomfortable situations [28]. [28] connected anxiety with the feeling of the first day in a job. Psychological studies described anxiety as a natural response of the human body when facing a stressful situation [28]. Anxiety is the most prevalent mental condition that may interfere with individual performance and relationships and impede one from living a fulfilling life [2]. One may experience a sudden feeling of intense worry due to certain stimuli or may have general anxiety marked by nervousness due to a sense of anticipating impending threats related to certain activities. This may interfere with one's daily life and predispose an individual to depression and other mental health issues. Anxiety is a common phenomenon among undergraduate students and may remain high for a long time, which is expected to affect their interpersonal relationships, social skills, and personal well-being. Moreover, anxiety and burnout are also implicated in poor academic performance.

Anxiety is a common problem among college and university students [3]. Researchers found in higher education, the pressure of studies increases stress levels among students, and they pass through anxiety situations. Higher education students are coping with anxiety differently, however, anxiousness among students may affect their

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academic performance. Several factors can contribute to the anxiety level among students. The prominent factors are studying a new language, a difficult curriculum, difficulty in solving exams, financial pressure, and a sudden increase in responsibilities [8]. [18] examined the connection between math anxiety, perfectionism, and student's academic performance within a group of undergraduates who are enrolled in an advanced math course. Findings indicated that perfectionist students are the ones who have anxiety that is associated with studying math as this type of anxiety pushes students to avoid mistakes.

2.4 Research Questions

Achieving the objectives of this research paper is led by the subsequent research inquiries.

1. What is the e-skills level of college students when engaged in computer-assisted assessment?
2. What are the students' anxiety levels when engaged in computer-assisted assessment?
3. What is the association between anxiety levels and students' academic achievement in mathematics courses?

3. Mathematical equations, subsections, tables, and figures

3.1 Study Population and *Sample*

The population of college students in the United Arab Emirates (UAE) was chosen to achieve the study aim. More than 500 higher education students have been reached; however, 361 valid responses have been received. The 361 sample comprises (n=216 (59.8%) females; and n=145 (40.2%) males) registered in various colleges and universities in the UAE and have taken or are currently registered in online math courses. The sample's descriptive demonstrated that participants' ages vary between 18 and 45 with an average of 35, with (*median* = 22, *mode* = 21, and *SD* = 0.481). Students' education levels varied from undergraduate freshmen (first year) to graduate students as displayed in Table 1. A random sample from different majors such as Business Administration, Law, and Education, Computer Information Technology, Engineering, and Medical Sciences. A diverse sample voluntarily contributed to the study as shown in Table 2.

Table 1: descriptive of sample's educational level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Undergraduate Freshman (first year)	131	36.3	36.3	36.3
	Undergraduate Sophomore (second year)	151	41.8	41.8	78.1
	Undergraduate Junior (third year)	42	11.6	11.6	89.8
	Undergraduate Senior (fourth year)	24	6.6	6.6	96.4
	Graduate student	13	3.6	3.6	100.0
	Total	361	100.0	100.0	

N=361.

Table 2: distribution of participants' nationality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Algerian	2	.6	.6	.6
	American	3	.8	.8	1.4
	Bahraini	3	.8	.8	2.2
	Canadian	7	1.9	1.9	4.2
	Egypt	43	11.9	11.9	16.1
	Indian	10	2.8	2.8	18.8
	Irani	5	1.4	1.4	20.2
	Iraqi	17	4.7	4.7	24.9

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	Jordanian	22	6.1	6.1	31.0
	Lebanese	6	1.7	1.7	32.7
	Pakistani	4	1.1	1.1	33.8
	Palestinian	14	3.9	3.9	37.7
	Russian	5	1.4	1.4	39.1
	Saudi	12	3.3	3.3	42.4
	Serbian	2	.6	.6	42.9
	Somali	1	.3	.3	43.2
	Sudanese	13	3.6	3.6	46.8
	Syrian	27	7.5	7.5	54.3
	Turkey	3	.8	.8	55.1
	UAE	144	39.9	39.9	95.0
	Yemen	18	5.0	5.0	100.0
	Total	361	100.0	100.0	

N= 361

3.2 Tools

This empirical research study embraces the Computer Anxiety Rating Scale (CARS) [16] to achieve its purpose and answer the proposed research questions. The CARS was structured to contain 19 items designed to measure computer anxiety among users. CARS is designed on a 5-point Likert scale to signify respondents' answers. The Likert scale of CARS begins with 1 indicating *strongly disagree* and ends with 5 signifying *strongly agree*. As stated by [41], the 19 items of CARS entail 9 items (2, 4, 5, 6, 7, 9,10, 17, and 19) that were worded negatively and mandate reverse scoring, "5" suggesting *strongly disagree to* "1" suggesting *strongly agree*. The total scores of CARS (*N* = 19 items) are expected to range between 19 and 95, with higher scores suggesting worsening anxiety levels in relation to utilizing computers for learning. According to [41], the respondents' total scores of CARS were categorized into three distinctive groups: (a) lower scores refer to "No anxiety", (b) medium scores refer to "Low Anxiety", and (c) "Moderate/High Anxiety" is indicated by the higher range of scores. The total score of CARS is calculated by adding up the scores of the 19 items then finding the range of the scores (subtract the lowest value from the highest value; 95 minus 19 = 76) and then dividing 76 by 3 equals 25; so the lower range of scores which indicates "No Anxiety" equals 19–44, medium-range, which refers to "Low Anxiety" becomes 45–69, and the higher range, the indicators of "Moderate/High Anxiety" becomes 70–95. In addition to the 19 items of CARS, the demographic questions were added to include the required demographic data of the sample. The computer skills (e-learning skills) were measured by a 7-point Likert Scale, a short questionnaire consisting of 4 questions designed to assess the respondents' computer experience in learning math.

3.3 Reliability and Validity

As examining the instrument validity is an essential goal, the validity of CARS was verified by [16] Heinssen et al., (1987). Statistical analysis of CARS reported a high internal consistency as confirmed by the value of *Cronbach's alpha* α = 0.87 [16]. To confirm the reliability of the CARS and measure the internal consistency of the 19 items, *Cronbach's alpha* α was found to equal 0.70, as suggested by [35], attaining α value that starts from 0.7, which implies a satisfying level of reliability. The face validity was assessed by a panel of specialists in measurement and assessment; the CARS was approved as a valid instrument that can measure students' anxiety levels when learning math depending on a computer or any portable device. For the e-learning skills questionnaire, the internal consistency was evaluated and revealed α = 0.841 for the items, and the face validity was assessed by an expert panel of measurement.

3.4 Data Collection

The task of data collection was set out early in the spring 2023 and remained for 8 weeks until reaching a satisfying sample size. The Computer Anxiety Rate Scale (CARS) was constructed on the survey administration software *Google Forms*. Study objectives and the method for responding to the questions were included and clearly explained, in addition to the informed consent. The researchers reached many students who met the criteria for this study which is registering undergraduate introductory online math courses. In a *Micro Soft Teams (MST)* meeting room, students who accepted the invitation attended the meeting and submitted their responses to the survey. The survey link was published on the *MST* with the presence of the researchers to answer students' concerns. All gathered data were uploaded to SPSS version 24.0 for statistical analysis and inference.

1. Data Analysis and Research Outcomes

The process of data analysis started with data cleaning and screening to prevent errors and address any inconsistency in the data set. Answering ***RQ 1*** demonstrates students' e-learning skills which were measured here by an ***e-learning skills*** questionnaire, descriptive analysis showed a high level of e-learning skills in math learning

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(*M*= 5.898, *SD*= 1.018). To answer ***RQ 2,*** *CARS* total scores were categorized into three different groups: (a) lower scores mean "No anxiety", (b) medium scores indicate "Low Anxiety", and (c) high scores refer to "Moderate/High Anxiety". The calculations of the total score of CARS showed the different levels of anxiety (See Table 3)

Table 3: the distribution of the sample's anxiety levels

Anxiety Category	Groups	Frequency	Percent
No anxiety	19-44	33	9%
Low Anxiety	45-69	326	90%
Moderate/High Anxiety	70-95	2	1%
	Total	361	100%

RQ 3 discussed the correlation between anxiety levels and students' academic achievement denoted by their GPA. Students' GPA was computed and found (*M* = 3.14, *SD* = 0.775). The outcome suggests the existence of a negative moderate correlation between anxiety levels and students' GPA (See Table 4).

Table 4: the correlation between anxiety level and student's math achievement

		AnxietyLevel	MathGPA
AnxietyLevel	Pearson Correlation	1	-.516**
	Sig. (2-tailed)		.000
	N	361	361
**. Correlation is significant at the 0.01 level (2-tailed).			

To establish a description of the correlation between anxiety level and achievement in math, *a Correlation Coefficient* and *Simple Linear Regression* were performed. ***Pearson's r*** demonstrated a medium negative correlation between the two variables, the higher the anxiety level the less the math achievement of the students. The findings showed that anxiety can predict students' math achievement, $R^2 = 0.27$, so 27 % of the total variance in students' math achievement in math is accounted for by their anxiety level because of using computers when learning math, F (1, 359) = = 130.528, $p < .001$ is statistically significant indicating the existence of a linear correlation between anxiety level and math achievement. The following is the significant regression model.

$Y' = \beta_0 + \beta * X$

Math Achievement = 6.229 - .057****Anxiety Level***

Thus, for each 1-unit decrease in ***anxiety level***, students' achievement in math increases by 0.057 units.

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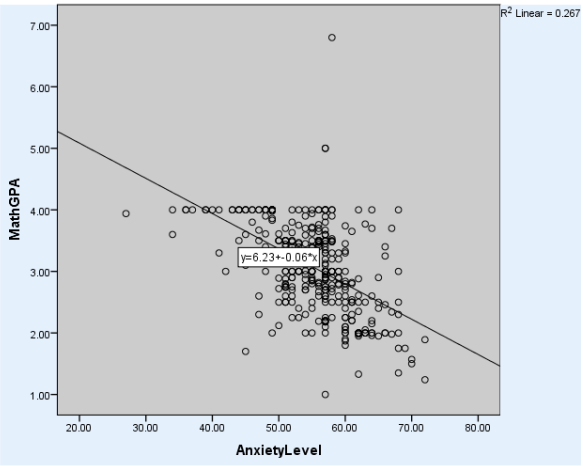

Figure 1: the correlation between anxiety level and math GPA

2. Discussion

This research paper discusses computer anxiety while learning and assessment of online math courses within a higher education student group in the UAE. A sample of 361 voluntarily contributed to the study and were surveyed to measure their computer (portable devices) anxiety levels while learning math. The findings showed that higher education students have high e-learning skills that enable them to use portable devices comfortably when learning math which minimizes computer anxiety levels among students. This result agrees with the findings of [24] who measured students' e-skills by exploring students' confidence and ability to utilize online learning platforms and discovered that students' confidence level to study online can predict their satisfaction with online learning and assessment, which suggests enough e-skills. Moreover, the results demonstrated that most participants identified with low anxiety levels which could be explained as students' e –skills establishing confidence about using e-learning and making them resilient enough to release different stressors and anxiety factors. One explanation suggests that low anxiety levels could reflect the quality of students' received services pertaining to counseling and guidance or well-training offered to students to master the online exam techniques. This finding of low anxiety levels is expected because it is supported by the results of [36] who revealed that 91% of UAE nationals showed high satisfaction levels with their life, which could minimize anxiety generally and computer anxiety particularly. Furthermore, this finding is consistent with (Libo, 2012) [26] who stated that happiness levels among people in the UAE range from 79% for residents and 83% for Emirates which indicates high subjective well-being. The findings of the negative correlation between anxiety levels and students' academic success are expected, for anxious students because learning math on computers is anticipated to show low performance. This outcome is consistent with [25] Lattie et al., (2019) who revealed that anxiety levels of higher education students are connected to weak academic achievement, which could be explained as students with low anxiety levels can succeed and attain adequate GPAs and anxious students need to release their anxiety to succeed and achieve better when learning math using computer or portal devices.

6. Conclusion

The study was conducted in a tertiary institution in the UAE where math courses are offered online whereas students are mandated to use computers or any portable device to learn and assess math knowledge and skills. The study outcomes demonstrated that higher education students possess high technical ability and e – skills which enable them to smoothly achieve math courses and adhere to its requirements. One of the greatest findings is the low anxiety level that is commonly found among college students in the UAE when using computers in online learning, which could indicate students' resilience and sufficient e-technical skills. The students' anxiety was found negatively correlated to their academic achievement, so students' achievement would increase when they keep high e-skills and felt less anxious. Study limitations are found in implementing the correlation as it is not causation.

6.1 Practical Recommendations

The outcome of this research study suggests some recommendations for implications in higher education settings. The practical implication can be in the College Counselling Centers via offering counseling sessions to help students maintain their low anxiety levels and enhance their subjective well–being for better academic

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achievement. In the instructional design, higher education professors are recommended to examine students' e-skill and anxiety levels when teaching math depending on portable devices to ensure students' readiness for online math learning.

6.2 Potential Research: As this research paper focuses on examining the association between anxiety levels and studying math online (denoted by academic achievement) and the findings suggest low anxiety levels among students, further research could focus on the role of e-skills in academic achievement. Moreover, studying factors related to the low level of anxiety.

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