The Effectiveness of Computer-Based Educational Games on Academic Engagement and Procrastination among First-Year Secondary School Students

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Abstract

Introduction: The present study aimed to investigate the effectiveness of computer-based educational games on academic engagement and procrastination among first-year secondary school students in Marvdasht.

Research Methodology: This research utilized a quasi-experimental design, consisting of pre-tests and post-tests with both experimental and control groups. The statistical population included all secondary school students in this city. Using a cluster sampling method, four classes were selected as samples, and questionnaires were administered to 80 students. Among these individuals, 40 were randomly assigned to the experimental group and 40 to the control group. The experimental group received training through computer-based educational games, while the control group did not benefit from such training. The measurement tools used in this research included the Friedel and Paris (2005) Academic Engagement Questionnaire and the Suvari (2011) Academic Procrastination Questionnaire. For data analysis, descriptive statistics (mean and standard deviation) and multivariate analysis of variance (MANOVA) were employed.

Findings: The results indicated that computer-based educational games had a significant impact on both procrastination and academic engagement among students. These games notably affected various dimensions of student procrastination, with the greatest impact observed in procrastination due to physical and mental fatigue. Furthermore, educational games significantly influenced the dimensions of students' academic engagement, particularly in the area of cognitive engagement.

Conclusion: According to the results of the research and studies conducted in connection with the present study, computer games can be considered one of the important and influential factors on academic procrastination and academic engagement. Because subsidized games have the power to engage students' minds and provide a platform for motivation, progress, and academic success in students. In addition, computer games have the potential to develop critical thinking, reasoning, analysis, and creativity.

Key Words: Computer-Based Educational Games, Academic Engagement, Procrastination.

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Introduction

For years, the teaching of school subjects has continued through the conventional method of teacher-centered lectures. This method is perceived as merely fulfilling an obligation - both by teachers and students - and as the most common educational approach, it places all students, despite their individual differences, in the same learning conditions. In this type of education, the primary activity is carried out by the teacher, who delivers content to the students, with a "good student" being someone who can accurately recount the information provided. Consequently, class time is predominantly spent on teacher-centered lectures, while students attend merely as listeners and observers. There is little time for intellectual exchange and discussion of academic topics, and instead of employing active teaching methods that enhance students' thinking and reasoning abilities, the focus is placed on information retention and memory strengthening. As a result, students often adopt a passive role in the classroom, whereas more effective and lasting learning occurs when they actively participate in the learning process.

Active teaching methods encourage students to engage in activities that prompt them to utilize their own ideas and thoughts. One such method of active learning is the use of games. Games, aside from being entertaining, have educational and developmental qualities and, in some cases, are more impactful for learning than traditional reading materials. Children, while playing - especially educational games - acquire new mental concepts and gain more skills. Through these experiences, they achieve valuable insights and learn the material willingly and without pressure. Thus, many educators believe that teaching subjects should occur concurrently with play, and formal school hours should be transformed into periods of creative and educational games.

The advancements in technology and electronic games have increasingly expanded this medium among students. Today, computer-based educational games have reached a point where their audiences engage fully in gameplay. One way to actively involve students in the teaching-learning process is through the use of computer-based educational games. Some of these games and activities can enhance children's learning more effectively than any textbook. There are several reasons for utilizing games in education, such as: 1) motivating students; 2) aligning with different learning styles; and 3) promoting active learning during gameplay, where children, as active participants, make decisions and solve problems (Wolf, 2011).

Teachers and researchers have repeatedly concluded that one of the advantages of computer-based educational games is the creation of a positive emotional state, which fosters motivation and engagement in the learning process, improving participation and success (Pintrich & Schunk, 2002). Two significant variables affected by computer-based educational games are procrastination and academic engagement. Academic procrastination refers to the disregard for responsibilities and the postponement of tasks. Balkis and Duru defined procrastination as the failure to perform responsibilities and duties on time, where an individual avoids fulfilling their obligations. They also noted that academic procrastination is one of the most common issues at educational

levels, reflecting students' tendency to delay tasks, which can negatively impact their performance (Balkis & Duru, 2006). Furthermore, procrastination can lead to several problems, such as decreased quality of work, rushed tasks, stress, and frustration.

The other variable is academic engagement, which refers to the amount of energy a student invests in their academic activities and its associated effectiveness. Students with higher academic engagement exhibit greater attention and focus on learning topics, adhere to school rules, and perform better on assessments. Academic engagement includes three dimensions: absorption, vigor, and dedication, with the absorption dimension indicating concentration and immersion in academic activities (Schaufeli, 2006).

Achieving progress and economic development in any country is contingent upon advancements in education and learning. Therefore, teaching and learning methods hold special significance in all countries and represent a national goal in most developed nations. In this context, computer-based educational games have been gradually recognized as active and suitable tools for education, entering academic and research fields and generating numerous studies. One major change introduced by the incorporation of computer games into education is evident in the essence of learning. Researchers have found that new learning tools have shifted from "memorization" and "information repetition" to "the ability to find, assess, and appropriately utilize information."

They believe that computer-based educational games can be effective in learning advanced 21st-century skills, including analytical thinking, problem-solving abilities, independent thinking, collaboration, communication, and using digital tools for information gathering. Educational games designed based on specific educational frameworks aimed at achieving learning outcomes are referred to as educational games. The use of such games in education has various advantages, including increased attention, concentration, imagination, creativity, motivation, and student performance. These games also assist in generating new ideas and thinking. However, it is essential to note that some studies have also reported negative impacts associated with the use of these games, including physical harm, diminished capacity for emotional relationships, and decreased academic performance (Zaki, 2014).

Among the critical factors affected by computer-based educational games are procrastination and academic engagement. Understanding human behaviors is challenging due to their complexity, and one of the concerns of psychologists and researchers is discovering the causes and origins of these behaviors. Procrastination is one such complex behavior, referring to the habit of delaying tasks, faced by many individuals. Researchers believe that this trait may stem from human inherent tendencies. Initially, procrastination may begin with the intent to enhance life enjoyment; however, in many cases, it results in stress, confusion, and repeated failures. It is important to acknowledge that procrastination is not always problematic, but it can often hinder progress and lead to detrimental, irreversible consequences by preventing goal attainment. Some researchers have characterized procrastination as a behavioral problem, where the aim of intervention is to decrease procrastination time and increase

study or activity time. Others regard it as a cognitive issue underpinning incorrect beliefs about the conditions and outcomes of tasks. Additionally, some researchers emphasize the motivational aspect of procrastination, suggesting that this behavior arises not from disinterest but from individuals' desire to engage in alternative activities. Ultimately, procrastination can become habitual and lead to decreased individual performance (Kazemi et al., 2010).

The other variable under investigation in this research is academic engagement, whose significance cannot be overstated. Academic engagement refers to behaviors related to learning and progress, emphasizing the quality of effort students expend in purposeful educational activities (Rostgar, 2009). Engagement is more than just a fleeting emotional state; it can be a stable cognitive condition focused on a specific subject. Academic engagement comprises three components: behavioral engagement, which includes learning activities, effort, attention, positive interaction, and presence; emotional engagement, which relates to positive attitudes and feelings of belonging to the learning environment; and cognitive engagement, which includes flexibility in problem-solving, a willingness to work hard, a positive response to failure, and the use of self-regulated learning strategies (Abbasi, 2015).

Given that numerous studies have addressed the variables in this research, the following highlights key findings from both domestic and international research. Serkan et al. (2009), in their study titled "The Impact of Computer Games on Students' Attitudes Toward Mathematics Courses and Computer Games," showed that computer games significantly influence students' attitudes towards mathematics courses. Furthermore, a significant correlation existed between students' attitudes toward mathematics courses and their attitudes toward computer games. Consequently, students evaluated their overall attitude towards both areas - mathematics and computer games - positively. Klein and Fritsch (2011) concluded that educational games have a significant impact on four motivational components: attention, relevance, trust, and satisfaction. Their findings indicate that educational games facilitate students' learning and can enhance their active participation in the classroom.

Similarly, Feng Li et al. (2013), in a study titled "The Impact of Game-Based Learning on Students' Learning Performance in Science," analyzed 18 fifth-grade classes in an elementary school in northern Taiwan, finding that students had a positive attitude towards using educational card games in their science learning, with the effectiveness of these games confirmed in improving their knowledge in transportation and energy. Deasy et al. (2013) studied the impact of computer games on high school students' performance in Los Santos, Laguna, Philippines, concluding that social factors and family conditions, such as income, gender, peer group, and education level, positively influence students' decisions to play games. Results indicated significant effects of study time and other factors, such as the student's prior knowledge level, on academic performance, with 60% of students' daily expenses allocated to video games.

In a study by Chernoff et al. (2016), it was shown that engagement in gameplay positively affected learning, although no connection was found between immersion in the game and learning. Game challenges significantly

enhanced learning, while gameplay skills did not directly influence learning but impacted it through increased engagement. Liang Yi-Cheng and Chi Chang (2016), in their research titled "Examining the Impact of Gender on Motivation and Success of Students in Digital Game Learning," revealed that gender has no significant effect on academic progress, but there are differences in motivation to learn, with female students showing significantly higher motivation in a digital game than male students. Furthermore, Perez et al. (2018) concluded that game-based learning is an innovative method capable of harnessing the educational potential of games, particularly serious games, to improve learning processes. Their study revealed significant differences in children's mathematical, natural, and verbal learning levels before and after participating in computer games.

Amini Far et al. (2012), in their research titled "The Impact of Computer Games on Students' Motivation and Mathematical Progress," found that teaching through computer-based educational games positively influences students' mathematical achievement, motivational progress, and attitudes towards mathematics, although no significant effect on avoidance motivation was observed. In another study conducted by Maleki and Moradi (2015), titled "The Impact of Computer-Based Educational Games on the Academic Motivation of Students with Learning Disabilities in Mathematics," it was determined that learning through computer games caused a significant difference in the academic motivation of the experimental group compared to the control group. Utilization of these games in concepts of addition, subtraction, multiplication, and division increased these students' academic motivation. Based on the results, it was suggested that modern educational technologies, particularly computer games, be employed in teaching mathematical concepts. Moradi and Norouzi (2016) found in their research titled "Comparing the Effectiveness of Teaching through Computer-Based Educational Games and Traditional Methods on Critical Thinking and Creativity Skills of Gifted Students," that after adjusting the pre-test scores, a significant difference was found between the experimental and control groups. The findings indicated that using computer-based educational games was more effective than traditional methods for enhancing students' critical thinking and creativity skills. Further, the univariate analysis of covariance revealed that the average post-test scores of the experimental group were higher than those of the control group, and this improvement was particularly evident in creativity components.

In a study by Bigdeli et al. (2017) titled "The Effectiveness of Mathematical Problem-Solving Training Through Games on Intrinsic Motivation in Students with Mathematical Learning Disabilities," it was emphasized that game-based education positively affected intrinsic motivation in solving mathematical problems for these students and could be utilized as an effective intervention method to foster motivation in this area. In research conducted by Gojar (2018) titled "The Impact of Web-Based Multiplayer Educational Games on Learning and Motivation of Students," results indicated positive effects of web-based multiplayer educational games on students' learning and motivation (interest,

relevance, satisfaction, and expectation) in third-grade students. These games can create a fun and engaging environment to establish connections between learners, making them effective tools in the learning process. Furthermore, Alborzi (2019) found in a study titled "The Relationship Between the Amount of Use of Computer Games and Academic Procrastination: The Mediating Role of Goal Orientation in Elementary School Students," that a significant negative relationship exists between academic procrastination and mastery-approach goal orientation and the amount of use of computer games. Additionally, the mastery-avoid goal orientation was identified as a significant positive predictor of academic procrastination. Results showed no significant differences in goal orientation variables (performance-approach, mastery-approach, performance-avoid, mastery-avoid) and the amount of use of computer games between male and female students.

Therefore, this research addresses the variables of computer-based educational games, academic engagement, and procrastination, examining the various theories related to each of these variables. The aim of this investigation is to provide an appropriate tool for assessing hypotheses and enable the study and comparison of these variables for readers. Computer-based educational games have gradually gained a special place in academic and research fields as active and effective platforms in the learning process. The introduction of these games into education, particularly, has profoundly affected learning methods, shifting the focus from "memorization" and "repetition" to "the ability to find, gauge, and appropriately utilize information." These tools can enhance various skills, including higher-order thinking, complex problem-solving, independent thought, and collaboration. Academic procrastination, another variable explored in this chapter, refers to students' inclination to postpone academic tasks. This phenomenon can negatively impact academic performance by leading to task avoidance and neglecting exam preparation. Ultimately, academic engagement reflects the energy and attention that students devote to their academic work, comprising three dimensions: absorption, vigor, and dedication. Students with high levels of engagement demonstrate greater focus on learning and adhere to school rules.

A review of domestic and international research highlights the scarcity of studies investigating these three variables simultaneously. Consequently, this research is conducted to fill this gap and enrich the relevant literature on this topic. New learning environments have consistently been a primary concern for researchers. In education, one of the most influential factors in learning is the environment in which the learning process occurs. Computer games, recognized as active and suitable spaces for learning, have gradually gained attention and entered academic and research disciplines, leading to numerous studies. Given the need for transformation in education, employing innovative teaching methods is essential. New educational technologies can play a significant role in facilitating this transformation. The rapid advancement of digital and multimedia media represents a significant development in these technologies. Digital media encompass various types, among which computer-based educational games are considered one of the most interactive forms of cognitive

engagement. Play, as a natural aspect of human life, has been covered by various theories that illustrate its role in facilitating the growth process. For instance, according to Vygotsky's theory, play can elevate a child's abilities to a higher level of potential development. In Piaget's cognitive development theory, interaction with the environment, primarily through play during childhood, plays a fundamental role in an individual's life (Azari, 2011).

Play not only serves as an entertainment medium but also has educational and developmental aspects. In some instances, a child's engagement with play may even be more valuable than reading books. Through gameplay, particularly educational games, children can grasp new cognitive concepts and acquire additional skills. Games provide children with the opportunity to gain valuable experiences and learn materials positively and enthusiastically, without pressure. For this reason, some educators and stakeholders in education believe that every lesson topic should be taught alongside play, and formal teaching hours should transform into hours of creative and educational games. This process fosters alignment and adaptation in a child's mind and the formation of new schemata. Moreover, procrastination and academic engagement, as two essential factors related to computer games, are significant (Steel, 2007).

Some specialists recognize procrastination as a cognitive issue, asserting that this phenomenon arises from individuals' cognitive errors regarding the conditions and outcomes of their activities. Conversely, other experts perceive procrastination as a motivational issue, suggesting that those who experience this phenomenon tend to be more interested in activities unrelated to their assignments. In educational contexts focused on learning objectives, if an individual possesses intrinsic interest and motivation towards the subject matter, this can facilitate learning, allowing the learner to master the lesson topic. Thus, interest, joy, and eagerness to learn can lead to deeper and more effective study. Topics studied superficially and without engagement are more susceptible to procrastination because, in such situations, tasks become burdensome, and the learner cannot find pleasure in learning. Consequently, students experiencing procrastination encounter unpleasant emotions throughout this shallow form of learning (Urpen, 1998). Academic engagement, another crucial variable for learning, is considered a key factor. This variable refers to the energy expended by a learner for their tasks and the effectiveness derived from their efforts. Students with high academic engagement typically demonstrate greater focus and attention on learning issues, adhere more closely to school rules, and avoid inappropriate behaviors. Academic engagement encompasses three components: behavioral engagement involving learning activities, attention, positive interactions, and participation; emotional engagement related to positive attitudes and feelings of belonging to the educational environment; and cognitive engagement, which includes the flexibility in problem-solving, a willingness to work hard, a positive response to failure, and the use of self-regulated learning strategies (Niamy, 2011).

Considering that the results of this research could contribute to enhancing engagement and reducing procrastination among students, computer games present effective tools that offer tangible, engaging, and enjoyable learning

experiences. New technologies facilitate and expedite the learning process, decreasing learning time. Nonetheless, traditional teaching methods have struggled to adequately meet the needs of students, especially those facing learning difficulties. The quality of education among students is a crucial issue that warrants attention. Computer games, recognized as active and credible educational platforms, have gradually entered academic fields, allowing for numerous studies. These games can enhance hand-eye coordination and reinforce spatial visualization skills. Children who engage with these games can develop better learning strategies across various situations. Therefore, the time spent by children in engaging with computer games can play a substantial role in improving their performance. Given these considerations, the primary research question is: Do computer-based educational games have a significant impact on students' procrastination and academic engagement?

Methodology

The current research utilized a quasi-experimental design with pre-tests and post-tests involving both experimental and control groups. In this study, subjects were divided into control and experimental groups, where both groups were assessed through pre-tests and post-tests. The statistical population for this research consisted of all first-year secondary school students in the city of Marvdasht. The researcher implemented a cluster sampling method to select four classes. Consequently, 80 students responded to the questionnaires, with 40 being randomly selected as the experimental group and 40 as the control group. The experimental group received training through computer-based educational games, while the control group did not benefit from such training. Additionally, in this section, for the purpose of gathering information regarding the theoretical foundations and literature of the research, library resources, articles, relevant books, and reputable websites were utilized, and three questionnaires were individually distributed among participants to collect the desired information.

A) Academic Engagement Questionnaire

The construct of academic engagement in school refers to behaviors related to learning and progress, emphasizing the quality of effort students expend in purposeful educational activities in a way that directly contributes to achieving desired outcomes (Rostgar, 2009). The scores for this construct were obtained through a questionnaire developed by Friedel and Paris (2005), which includes 15 items and measures three sub-scales: behavioral, emotional, and cognitive engagement among students. The behavioral engagement sub-scale includes items 1 to 4, the emotional engagement sub-scale includes items 5 to 10, and the cognitive engagement sub-scale includes items 11 to 15. To assess the content validity of the questionnaire, the perspectives and opinions of specialists, university professors, and experts were solicited, and necessary revisions were made based on various interviews to ensure that the questionnaire accurately measures the intended construct. Friedel et al. (2005) reported a reliability coefficient of 0.86 for this scale.

B) Academic Procrastination Questionnaire

In recent years, academic procrastination has been recognized as a detrimental habit and behavioral issue faced by many adults in their daily activities, especially concerning tasks that need to be completed within a certain timeframe. This type of procrastination equates to neglect and delays in fulfilling academic duties. Milgram et al. (1998) determined that delays in academic tasks are considered academic procrastination. The scores for academic procrastination among subjects were derived from a 12-item questionnaire designed by Suvari (2011). This questionnaire was created due to the lack of suitable tools in the field of psychology within the country and consists of 12 questions regarding various indicators of academic procrastination. Initial revisions of this questionnaire were made following a preliminary study involving 50 students. The questionnaire was structured so that respondents chose from one of five options (never, rarely, sometimes, often, always). The components and corresponding questions for each component are as follows: 1) Intentional procrastination (questions 1 to 5), 2) Procrastination due to physical-mental fatigue (questions 6 to 9), and 3) Procrastination due to lack of planning (questions 10 to 12). Experts' opinions were sought to ensure content validity, and necessary adjustments were made to verify that the questionnaire accurately assessed the intended construct. Suvari (2011) reported a reliability coefficient of 0.92 for this scale.

Educational Games

Educational games refer to the use of computer-based technology to provide a joyful and entertaining method for educating learners (Hurst & McDonough, 2002). In this research, the educational games refer to the sessions of educational games conducted for the experimental group over eight sessions, each lasting an hour and a half, occurring twice a week.

1. **Session One:** Introducing students to the history and objectives of computer-based educational games.
2. **Session Two:** Familiarizing students with various types of educational games and the Arya Book software for math lessons, motivating students through the teacher's guidance. The Flash software for creating educational games by students is also introduced.
3. **Session Three:** Teaching the 9th-grade math curriculum by the teacher using the Arya software.
4. **Session Four:** Teaching reasoning and proof (conceptual understanding) using Arya's educational software and Flash software.
5. **Session Five:** Teaching visual perception and understanding the intersections of altitudes, medians, and angle bisectors using Arya software and GeoGebra, along with available computer games.
6. **Session Six:** Teaching problem-solving in geometry and proving theorems with Arya's educational software and GeoGebra.
7. **Session Seven:** Teaching similar shapes using Storyline educational software and games, where students identify similar shapes through gaming and photography.

8. **Session Eight:** Conducting an exam on geometry using Arya, Flash, and Storyline educational software, concluding the assessment.

In the execution phase of this research, after completing necessary communications and coordinating with the education department's security about the importance and goals of the research and its implementation process, their cooperation was secured. Subsequently, the questionnaires were distributed to the students, and information to facilitate their completion was provided. After the questionnaires were completed, the data were transferred to a computer using SPSS for analysis. Data analysis was conducted in two sections: descriptive statistics and inferential statistics. In the descriptive statistics section, frequency distribution tables, means, and standard deviations were employed to describe the data, while multivariate analysis of variance was used in the inferential statistics section. Regarding ethical considerations, efforts were made to ensure respondents answered the questionnaires willingly and with awareness of the research objectives. To uphold ethical principles, anonymity of the questionnaire, respecting the sources cited, and safeguarding participants' intellectual rights were particularly emphasized. Additionally, in analyzing and interpreting the results, the researcher committed to ethical, scientific, and honest reporting of the findings.

Research Findings

Descriptive Analysis of Procrastination Scores and Their Dimensions

Table 1- Mean and Standard Deviation of Procrastination Scores

Variable	Group	Measure	N	Mean	Standard Deviation
Procrastination	Experiment	Pre-test	40	39.90	4.6
		Post-test	40	25.18	5.9
	Control	Pre-test	40	39.55	3.8
		Post-test	40	40.03	4.8
Intentional Procrastination	Experiment	Pre-test	40	15.55	2.5
		Post-test	40	11.05	2.8
	Control	Pre-test	40	15.97	2.0
		Post-test	40	15.60	2.5
Procrastination due to Physical - Psychological Fatigue	Experiment	Pre-test	40	14.07	2.7
		Post-test	40	7.20	3.1
	Control	Pre-test	40	13.55	1.8
		Post-test	40	14.12	2.7
Procrastination due to Lack of Planning	Experiment	Pre-test	40	10.27	1.4
		Post-test	40	6.92	2.05
	Control	Pre-test	40	10.02	1.6
		Post-test	40	10.30	1.4
Academic Engagement	Experiment	Pre-test	40	42.45	6.08
		Post-test	40	58.48	4.9
	Control	Pre-test	40	41.73	5.8
		Post-test	40	43.63	6.1
Behavioral Engagement	Experiment	Pre-test	40	11.08	2.5
		Post-test	40	14.70	2.2

	Control	Pre-test	40	11.13	2.9
		Post-test	40	11.35	2.5
Emotional Engagement	Experiment	Pre-test	40	16.45	2.8
		Post-test	40	23.20	3.4
	Control	Pre-test	40	16.15	3.3
		Post-test	40	16.73	3.3
Cognitive Engagement	Experiment	Pre-test	40	14.93	3.3
		Post-test	40	20.58	1.7
	Control	Pre-test	40	14.45	2.7
		Post-test	40	15.55	3.2

As noted in **Table 1**, the post-test mean procrastination scores for the experimental group (25.18) were lower than those for the control group (40.03). The post-test mean scores for the component of intentional procrastination were also lower in the experimental group (11.05) compared to the control group (15.60). Additionally, the post-test mean scores for physical-psychological fatigue procrastination were lower in the experimental group (7.20) than in the control group (14.12). Moreover, the post-test mean scores for procrastination due to lack of planning in the experimental group (6.92) were lower than in the control group (10.30).

Further, **Table 1** shows that the post-test mean scores for academic engagement in the experimental group (58.48) were higher than in the control group (43.63). The post-test mean scores for behavioral engagement in the experimental group (14.70) also surpassed those of the control group (11.35). Likewise, the post-test mean scores for emotional engagement were higher in the experimental group (23.20) compared to the control group (16.73), and the cognitive engagement post-test means in the experimental group (20.58) were greater than those in the control group (15.55).

Hypothesis: The Impact of Computer-Based Educational Games on Students' Procrastination and Academic Engagement

A) Examining the Impact of Computer-Based Educational Games on Procrastination

Assessing Assumptions of Covariance Analysis:

1. **Normality of Scores:**

Table 2- Evaluating the Normality of the Overall Procrastination Variable

Variable	Kolmogorov-Smirnov Test	N	Statistic	Significance Level
Procrastination Pre-Test		40	1.11	1.0
Procrastination Post-Test		40	1.13	1.0

The results from the above table indicate that the significance levels in the tests are greater than 0.05. The null hypothesis in the Kolmogorov-Smirnov test states that the data follow a specified distribution (in this case, normal). The alternative hypothesis posits that the data do not follow the specified distribution (normal). Given the significance level and failure to reject the null hypothesis, the distribution of data can be considered normal.

2. **Homogeneity of Variance:**
   The subjects must exhibit homogeneous variances. Levene's test evaluates this assumption.

Table 3- Homogeneity of Overall Procrastination Scores (Levene's Test)

Variable	F-value	df1	df2	Significance Level (p)
Procrastination Pre-Test	4.46	1	78	0.03
Procrastination Post-Test	0.89	1	78	0.30

As observed from the above table, the F value for the pre-test procrastination variable is significant ($p < 0.05$). Therefore, we conclude that there is a significant difference in the variance of scores between the experimental and control groups in the pre-test, and this assumption has not been satisfied.

3. **Third Assumption: Assessing the Homogeneity of Regression Slopes**

Table 4- Testing Interaction between Groups and Pre-Test Following Total Procrastination

Variable	Source of Change	Sum of Squares	df	Mean Square	F-statistic	Significance Level
Procrastination	Interaction Effect Pre-Test & Group	4402.938	2	2201.469	73.6	0.0001

According to the table above, the F value for the interaction between pre-test and group equals 73.6, which is significant ($p < 0.01$). Therefore, it can be concluded that the homogeneity of regression slopes assumption has not been met. Given the non-fulfillment of all three assumptions, the statistical analysis of the impact of computer-based educational games on students' procrastination cannot utilize the "covariance analysis" method. Instead, a one-way ANOVA will be conducted on the post-test scores minus pre-test scores (net scores) (Table 5).

Table 5- Testing Procrastination Component Scores by Experimental and Control Groups

Group	N	Mean Differences	Standard Deviation
Experiment	40	14.72	7.8
Control	40	-0.47	6.1

Table 6- One-Way ANOVA for Procrastination Scores by Experimental and Control Groups

p	F-value	Mean Squares	df	Sum of Squares	Source of Changes
0.0001	2.92	4620.8	1	4620.8	Between Groups
		50.76	78	3905.95	Within Groups
		8526.79	79		Total

Based on **Table 6**, the F-statistic (2.92) is significant at the level of 0.0001 ($p < 0.01$), indicating a significant difference in procrastination scores among students in the experimental group compared to those in the control group. The

mean differences in **Table 4** lead to the conclusion that computer-based educational games have a significant impact on students' procrastination levels.

B) Examining the Impact of Computer-Based Educational Games on Academic Engagement

Assessing Assumptions of Covariance Analysis:

1. **Normality of Scores:**

Table 7- Evaluating the Normality of the Overall Academic Engagement Variable

Variable	Kolmogorov-Smirnov Test	N	Statistic	Significance Level
Academic Engagement Pre-Test		40	0.686	0.7
Academic Engagement Post-Test		40	1.01	0.2

The results from the above table indicate that the significance levels are less than 0.05. The null hypothesis states that the data follow a specified distribution (here, normal). The opposite hypothesis states that the data do not follow the specified distribution (normal). Given the significance level and failure to confirm the null hypothesis, the distribution of data is considered non-normal.

2. **Homogeneity of Variance:**

Table 8- Homogeneity of Academic Engagement Scores (Levene's Test)

Variable	F-value	df1	df2	Significance Level (p)
Academic Engagement Pre-Test	0.415	1	78	0.5
Academic Engagement Post-Test	3.88	1	78	0.052

As observed from the table above, the F-values for academic engagement pre-test and post-test have significance levels above 0.05, indicating that there is no significant difference in variance between the experimental and control groups, thus satisfying this assumption.

Third Assumption: Assessing Homogeneity of Regression Slopes

Table 9- Examining Interaction Between Group and Pre-Test for Overall Academic Engagement

Variable	Source of Variation	Sum of Squares	df	Mean Square	F-value	Significance Level
Academic Engagement	Interaction Effect Pre-Test & Group	4532.056	2	2266.028	1.76	0.0001

From the above table, we observe that the F-value for the interaction between pre-test and group is 1.76, which is significant ($p < 0.01$). Therefore, we can conclude that the assumption of homogeneity of regression slopes has not been met. Given the violation of these three assumptions, we cannot use the "covariance analysis" method for the statistical analysis of the impact of computer-based educational games on students' academic engagement. Instead, we will utilize a one-way ANOVA on the difference scores from post-test to pre-test (net scores) as shown in **Table 10**.

Table 10- Examining Differences in Academic Engagement Component Scores by Experimental and Control Groups

Group	N	Mean Differences	Standard Deviation
Experiment	40	-16.02	6.3
Control	40	-1.9	7.5

Table 11- One-Way ANOVA for Academic Engagement Scores by Experimental and Control Groups

p	F-value	Mean Squares	df	Sum of Squares	Source of Variation
0.0001	81.8	3990.312	1	3990.312	Between Groups
		48.777	78	3804.575	Within Groups
		7794.888	79		Total

According to **Table 11**, the F-statistic (81.8) is significant at the level of 0.0001 ($p < 0.01$), which means that there is a significant difference in academic engagement scores between the students in the experimental group compared to those in the control group. The differences in means shown in **Table 10** allow us to conclude that computer-based educational games have a significant impact on the academic engagement levels of students.

Specific Hypothesis 1: Computer-based educational games have a significant impact on dimensions of students' procrastination.

To test this hypothesis, we will initially use covariance analysis while checking the assumptions (Tables 12, 13, and 14).

1. **Examining Homogeneity of Variances**

Table 12- Testing Equality of Variances for Procrastination Dimensions (Levene's Test)

Dimensions	Condition	F-value	df1	df2	Significance Level (p)
Intentional Procrastination	Pre-test	4.05	1	78	0.04
	Post-test	0.21	1	78	0.60
Procrastination Due to Physical-Psychological Fatigue	Pre-test	4.57	1	78	0.03
	Post-test	0.019	1	78	0.80
Procrastination Due to Lack of Planning	Pre-test	0.195	1	78	0.60
	Post-test	4.3	1	78	0.04

As noted in **Table 12**, the F-values for all variables exceed the significance level of 0.05; thus, the homogeneity of variances assumption is not met for all variables.

2. **Assessing Homogeneity of Regression Slopes**

Table 13- Examining Interaction Between Group and Pre-Test for Procrastination Dimensions

Dimensions	Source of Variation	Sum of Squares	df	Mean Square	F-value	Significance Level
Intentional Procrastination	Interaction Effect Pre-Test & Group	405.483	2	202.741	26.8	0.0001
Procrastination Due to Physical-	Interaction Effect Pre-Test & Group	957.941	2	478.97	53.6	0.0001

Psychological Fatigue						
Procrastination Due to Lack of Planning	Interaction Effect Pre-Test & Group	220.126	2	110.063	33.5	0.0001

According to **Table 13**, the F-values for the interaction between pre-test and group are significant for all dimensions ($p < 0.01$), indicating that the assumption of homogeneity of regression slopes is violated for all dimensions. Given the violations of these two assumptions, we cannot utilize "covariance analysis" for the statistical analysis of Specific Hypothesis 1 and must instead employ the "multivariate analysis of variance" method.

Table 14- Examining Differences in Post-Test Scores for Procrastination Dimensions by Experimental and Control Groups

Dimensions	Group	N	Mean Differences	Standard Deviation
Intentional Procrastination	Experiment	40	11.05	2.8
	Control	40	15.60	2.5
Procrastination Due to Physical-Psychological Fatigue	Experiment	40	7.20	1.3
	Control	40	14.12	2.2
Procrastination Due to Lack of Planning	Experiment	40	6.92	2.05
	Control	40	10.30	1.4

Table 15- Multivariate Analysis of Variance (MANOVA) for Procrastination Dimensions in Two Groups

Index	F-value	df	Significance Level	Eta Squared	Statistical Power
Wilks' Lambda	49.5	3	0.0001	0.66	1.00

The results from the multivariate analysis in the above table indicate that the differences between the two groups concerning the three-dimensional centroid are significant ($p < 0.05$). Therefore, Specific Hypothesis 1 is confirmed. The effectiveness of computer-based educational games on the dimensions of students' procrastination is 0.66, meaning that 66% of the differences can be attributed to group membership. Accordingly, we will further analyze each variable separately. The power value of 1.00 indicates an adequate sample size.

Table 16- Results of Covariance Analysis for Procrastination Dimensions in Both Experimental and Control Groups

Source of Variation	Index	Sum of Squares	df	Mean Square	F-value	Significance Level	Eta Squared	Statistical Power
Group	Intentional Procrastination	414.05	1	414.05	3.56	0.0001	0.42	1.00

	Procrastination Due to Physical-Psychological Fatigue	959.113	1	959.113	108.99	0.0001	0.58	1.00
	Procrastination Due to Lack of Planning	227.813	1	227.813	72.4	0.0001	0.48	1.00

Table 16 shows that there are significant differences between mean procrastination scores across both groups ($p < 0.0001$). This indicates the effectiveness of computer-based educational games on students' procrastination dimensions. The effect sizes for each dimension can be observed, with the greatest impact observed in procrastination due to physical-psychological fatigue (0.58).

Hypothesis 2:

Computer-based educational games significantly influence dimensions of students' academic engagement.

To test this hypothesis, we will initially use covariance analysis, checking the necessary assumptions (Tables 17 and 18).

1. **Examining Homogeneity of Variances**

Table 17- Testing Equality of Variances for Academic Engagement Dimensions (Levene's Test)

Dimensions	Condition	F-value	df1	df2	Significance Level (p)
Behavioral Engagement	Pre-test	0.88	1	78	0.3
	Post-test	0.072	1	78	0.7
Emotional Engagement	Pre-test	0.683	1	78	0.4
	Post-test	0.074	1	78	0.7
Cognitive Engagement	Pre-test	0.684	1	78	0.4
	Post-test	9.6	1	78	0.003

As noted in **Table 17**, the F-value for the post-test cognitive engagement dimension is significant ($p < 0.05$), thus violating the homogeneity assumption.

2. **Assessing Homogeneity of Regression Slopes**

Table 18- Examining Interaction Between Group and Pre-Test for Academic Engagement Dimensions

Dimensions	Source of Variation	Sum of Squares	df	Mean Square	F-value	Significance Level
Behavioral Engagement	Interaction Effect Pre-Test & Group	223.665	2	111.833	18.7	0.0001
Emotional Engagement	Interaction Effect Pre-Test & Group	862.338	2	431.169	38.4	0.0001
Cognitive Engagement	Interaction Effect Pre-Test & Group	500.459	2	250.229	35.7	0.0001

From **Table 18**, we see that the F-values for the interaction between pre-test and group are significant for all dimensions ($p < 0.01$), confirming that the homogeneity of regression slopes assumption is not met for any of the dimensions. Given the violations of these two assumptions, we cannot use

"covariance analysis" for the statistical analysis of Specific Hypothesis 2. Instead, a multivariate analysis of variance must be used.

Table 19- Examining Differences in Post-Test Scores for Academic Engagement Dimensions by Experimental and Control Groups

Dimensions	Group	N	Mean Differences	Standard Deviation
Behavioral Engagement	Experiment	40	14.70	2.2
	Control	40	11.35	2.5
Emotional Engagement	Experiment	40	23.20	3.4
	Control	40	16.73	3.3
Cognitive Engagement	Experiment	40	20.58	1.7
	Control	40	15.55	3.2

Table 20- Multivariate Analysis Results for Academic Engagement Dimensions in Two Groups

Index	F-value	df	Significance Level	Eta Squared	Statistical Power
Wilks' Lambda	0.350	3	0.0001	0.65	1.00

The multivariate analysis results in **Table 20** show significant differences between the two groups regarding the three-dimensional centroid ($p < 0.05$). Thus, Specific Hypothesis 1 is confirmed. The effectiveness of computer-based educational games on students' academic engagement dimensions is 0.65, indicating that 65% of the differences are attributed to group membership. We will subsequently analyze each variable separately. A power of 1.00 indicates sufficient sample size.

Table 21- Results of Covariance Analysis for Academic Engagement Dimensions in Both Experimental and Control Groups

Source of Variation	Index	Sum of Squares	df	Mean Square	F-value	Significance Level	Eta Squared	Statistical Power
Group	Behavioral Engagement	224.450	1	224.450	1.38	0.0001	0.32	1.00
	Emotional Engagement	838.513	1	838.513	6.73	0.0001	0.48	1.00
	Cognitive Engagement	505.013	1	505.013	8.73	0.0001	0.49	1.00

Table 21 indicates that there are significant differences in mean scores of academic engagement dimensions between the two groups ($p < 0.0001$). This demonstrates the effectiveness of computer-based educational games on dimensions of academic engagement among students, with the highest impact observed in cognitive engagement (0.49).

Discussion and conclusion

Hypothesis1: Computer-based educational games have a significant impact on students' procrastination and academic engagement.

A: The analysis of the impact of computer-based educational games on procrastination indicates that the procrastination scores of students in the experimental group significantly differ from those in the control group. This suggests that computer-based educational games have a meaningful effect on students' levels of procrastination.

B: Additionally, the examination of the impact of these games on academic engagement also reveals a significant difference in academic engagement scores between the experimental and control groups, clearly demonstrating the positive effect of computer-based educational games on students' academic engagement. These findings align with the research of Klein and Friedrichs (2011), Liang Yi Chang and Chi Chang (2016), and Goujar (2018). Due to easy access to the internet, computer-based educational games provide a suitable opportunity to achieve educational goals. Considering the importance and benefits of these games, as well as the diverse abilities of students, their use in teaching subject concepts can enhance students' engagement and reduce academic procrastination, ultimately improving learning outcomes. Educational games possess various features that contribute to increasing academic engagement and facilitating effective learning, such as immediate feedback, interaction with peers, student engagement, and adaptability to different learning styles. Researchers believe that such games can positively influence learning advanced 21st-century skills, including critical thinking, complex problem-solving, independence, and collaboration.

Educational games designed with specific educational objectives offer numerous advantages, including increased attention, focus, creativity, and motivation among students. While playing, children learn new concepts spontaneously and willingly, fostering valuable experiences and facilitating learning. For this reason, some educators argue that teaching academic content should be accompanied by play, and formal educational hours should be converted into creative and educational playtime. One of the effective methods for engaging students in the teaching-learning process is through the use of these games, as some of these activities can enhance children's learning more than textbooks. There are multiple reasons for utilizing games in education, including encouraging students, matching with various individual learning styles, and promoting active learning. Educational games also create a positive emotional state that enhances enthusiasm for learning and improves participation, ultimately leading to a reduction in academic procrastination. These games provide information timely and suitable to the user’s ability, reinforcing problem-solving skills. Overall, computer-based educational games enhance students' learning by promoting attention and focus on reading and writing skills, thereby facilitating active participation in class, which ultimately leads to increased academic engagement and reduced procrastination.

Hypothesis 2: Computer-based educational games have a significant impact on dimensions of students' procrastination.

The research results show that there is a significant difference between the mean procrastination scores in the two groups ($p < 0.001$), indicating the effectiveness of computer-based educational games on various dimensions of

students' procrastination. The greatest impact of these games was observed in procrastination due to physical-psychological fatigue (0.58). In explaining these findings regarding intentional procrastination, it can be said that students tend to prefer non-essential tasks over academic assignments that affect their future life and career. This behavior causes them to spend less time on academic tasks. Consequently, students who score high on procrastination tend to have lower classroom attendance and often postpone studying for exams until the last minute, leading to wasted time and delays in completing their responsibilities. Computer games significantly enhance learners' knowledge and awareness while boosting multitasking abilities. These games, with features such as competition, complexity, testability, observability, flexibility, and content richness, have a significant impact on creativity, learning advancement, character and behavior development, talent cultivation, concentration and precision, intelligence improvement, global perspectives expansion, artistic appreciation enhancement, complex concept teaching, and increasing children's motivation and enthusiasm, thereby reducing intentional procrastination. Concerning academic procrastination due to physical fatigue, it can be noted that mental and physical fatigue impact work efficiency and cause disruptions in cognitive performance and focus.

Games create a virtual environment where learning necessitates overcoming various stages. Instead of dictating content, these games teach problem-solving methods. In essence, educational games leverage motivational features and learning principles such as immediacy and reinforcement to mitigate student fatigue. The relationship between procrastination due to lack of planning can also be elucidated; this type of procrastination is primarily related to the lack of planning for completing assignments and arises from the specific traits of procrastinating students. They may mistakenly believe they should dedicate all their time to assignments. Delay in decision-making is one of the notable features of these individuals. Chronic procrastination in decision-making can lead to chronic procrastination in task completion, as these individuals struggle to determine which activities to prioritize and when to perform them.

Non-procrastinators may also occasionally exhibit delaying behavior; however, this behavior among procrastinators can deeply affect their positive thinking and lead to various delay-related behaviors. If procrastinators feel that success is unattainable and failure is inevitable, they may succumb to feelings of despair and anxiety. Researchers believe that computer games can enhance advanced 21st-century skills such as critical thinking, complex problem-solving, independent thought, collaboration, and effective communication. Moreover, these games provide enjoyable moments and offer near-real experiences that facilitate quicker and more sustainable learning. Well-designed educational games focus on thinking and planning rather than merely memorizing content. Students facing challenges in understanding printed materials often achieve a better comprehension with the aid of games and typically build their confidence through role-playing.

Hypothesis 3: Computer-based educational games have a significant impact on dimensions of students' academic engagement.

The study's results revealed significant differences in academic engagement means between the two groups, clearly demonstrating the effectiveness of computer-based educational games on students' academic engagement dimensions. The greatest impact of these games was observed in cognitive engagement. Based on these results, computer-based educational games significantly influence the dimensions of students' academic engagement. The first dimension of engagement, behavioral engagement, relates to learning activities, attention and focus, positive behaviors, and presence in the learning environment. Additionally, emotional engagement has a direct relationship with positive attitudes and a sense of belonging to the educational setting. Cognitive engagement refers to adaptability in problem-solving, a strong work ethic, a positive response to failure, and a self-regulated approach to learning. In essence, educational computer games can enhance enthusiasm, effort, and task completion by incorporating motivational characteristics and learning principles such as immediacy and reinforcement. This enables students to tackle learning challenges with enthusiasm and diligence. These games facilitate active and thoughtful learning, fostering competition among students by providing effective feedback. Accordingly, educational games create opportunities for students to grasp new concepts and acquire remarkable skills. While playing, they absorb information enthusiastically without feeling pressured. Consequently, many educators believe that every type of academic content should be taught alongside games, and formal teaching hours should be transformed into sessions of creative and educational play.

This approach promotes adaptability and forms new mental schemas in students' minds. The structure of computer-based educational games is designed with high flexibility, often placing users in diverse scenarios due to their nonlinear organization. These games significantly impact creativity, learning, and personal development through features like competition, complexity, testability, observability, and self-motivated engagement. They also contribute to enhancing concentration and precision, increasing intelligence, broadening worldview perspectives, developing artistic appreciation, teaching complex concepts, and honing math and reading skills. Designers of these games provide various exciting and engaging learning opportunities within an appealing and structured format, allowing learners to feel a sense of ownership and participation in the learning process by selecting different options. This approach enhances the quality of task completion and learning challenges with increased enthusiasm and engagement.

This research explores the impact of computer-based educational games on students' academic engagement and reduction of procrastination, yielding positive results in this area. Based on these findings, it is recommended that educational games occupy a suitable position in teachers' lesson plans, and educators should be encouraged to produce and introduce new educational games to enhance student engagement. Establishing computer labs in schools with designated times for using educational games and conducting preparation workshops for teachers are also suggested. Further recommendations include using visual and auditory exercise methods, such as educational games, across

all subjects and educational levels to prevent procrastination and improve understanding of academic concepts. Future studies should emphasize investigating the impact of educational games on student burnout, utilizing diverse tools such as interviews and observations. There is also a suggestion to extend research to larger samples. Limitations of this study include its execution among middle school students in Marvdasht County and the potential influence of intervening variables, such as age and gender, on results. Another mentioned limitation is the absence of interviews and observations for data collection, which could enrich the research findings.

Conclusion:

According to the results of the research and studies conducted in connection with the present study, computer games can be considered one of the important and influential factors on academic procrastination and academic engagement. Because subsidized games have the power to engage students' minds and provide a platform for motivation, progress, and academic success in students. In addition, computer games have the potential to develop critical thinking, reasoning, analysis, and creativity.

Following the principles of research ethics

Informed consent forms were completed by all subjects in the present study.

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Conflicts of interest

According to the authors, the present article does not have any conflict of interest.

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