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PAPER

A Case Study of Princess Sumaya University for Technology (PSUT) Engineering Students' Perceptions of Utilizing Simulation Software via Online Learning

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ABSTRACT

The primary goal of this research has been to examine the perceptions related to the use of simulation software in the context of e-learning at Engineering PSUT in Jordan, which is acknowledged as one of the leading private universities in the country. The present study and a descriptive study utilized a 25-item survey given to 270 students. The research findings indicate that, according to the students' subjective viewpoint, the effectiveness of simulation software in the context of online learning was observed to be significantly high. This observation is supported by an average score of 3.89 and a standard deviation of 0.959, indicating a relatively consistent perception among the participants. The study's results indicate that there were no significant variations observed in terms of academic year, computer skills, student GPA or gender parameters. The research findings underscore the importance of incorporating simulation software in higher educational institutions to improve the teaching and learning experience.

KEYWORDS

COVID-19 pandemic, electronic exams, higher education, perspective, undergraduate students, engineering students

1 INTRODUCTION

Globalization is a complex phenomenon that has attracted significant attention from scholars and policymakers alike. Accompanied by ongoing and rapid changes in various aspects of our daily lives, it has led to a fundamental shift in focus towards the international community. In contemporary times, humanity resides within a period marked by significant scientific progress and a dominant culture of openness. This era has successfully overcome various obstacles and challenges, leading to improved interpersonal connectivity and the ability to communicate across vast

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geographical distances. The widespread influence of the technological and scientific revolution is easily seen and felt in all aspects of modern life. The phenomenon of edification is a prominent example of this category of influential factors. The vicible manifestation of this phenomenon is evident in educational curricula, pedagogical methodologies, and evaluative protocols. A compelling demonstration of this phenomenon can be observed in the process of converting the enlightening concept into its contemporary manifestation as interactive education [1]. It relies on the utilization of interactive computer applications. According to the findings of [2], it has been observed to serve as a complementary tool for enhancing traditional pedagogical methods. The user's request for a citation is a valuable reminder of the importance of substantiating claims with credible sources. In the field of social science, [3] has emphasized that the emergence of new technology and software has enhanced the capabilities of simulation as a highly sophisticated tool that accurately reflects real-life situations. The sudden emergence of COVID-19 has had a profound impact on nations across various dimensions, and this is widely acknowledged. The recent pandemic has significantly impacted the construction industry. However, due to the significant impact of the pandemic, many countries have reevaluated and adopted modern educational approaches. This has been done to ensure the uninterrupted provision of education and training, thereby enhancing individuals' ability to adapt to the evolving circumstances brought about by the pandemic [4]. Recent research conducted by universities, colleges, and institutions has resulted in a consensus regarding the optimal approach to education. This consensus suggests a shift from traditional classroom-based instruction to online learning, supplemented by the integration of diverse pedagogical methodologies [5, 6]. Online learning is a form of educational instruction that uses technology to facilitate knowledge acquisition. It involves delivering educational content exclusively through digital platforms, enabling learners and educators to engage in the learning experience without needing physical presence at the same time and place [7–9]. "Online learning" encompasses a form of educational instruction conducted remotely, without the need for physical proximity between the teacher and the learner. In response to the increasing prevalence of online indoctrination, governments worldwide have launched funding initiatives to enhance the quality of online education [10]. This can be contrasted by articulating that online learning can be seen as a tangible manifestation of the constructivist theory of cognition. The theory facilitated a paradigm shift from a preceptor-centered approach characterized by authoritative dictation to a learner-centered approach, empowering students with a greater sense of agency and ownership in their educational pursuits. The emergence of online learning can be attributed to the constructivist theory of cognition. The user's text consists of a numerical range, specifically [11–15]. This range suggests a potential interval or continuum within the social sciences. Based on the research findings presented in [16], it is evident that the outcomes observed in technical laboratory domains underscore the importance of integrating theoretical knowledge with practical skills in a manner that is contextually aligned with the respective discipline. When it comes to acquiring practical skills, the focus is on engaging in activities that allow students to explore and analyze experimental methodologies, conduct visual examinations, and develop diverse communication proficiencies. This is complemented by integrating consistent laboratory protocols and utilizing appropriate equipment [17, 18]. The prevalence of online learning has significantly increased in various educational settings [19, 20], primarily due to the rapid advancement of digital technology during the early years of the 21st century. Integrated instructional methodologies are used to facilitate education and knowledge acquisition in on-site academic programs. Web-based activities have become a crucial element in distance education courses, being widely used and integrated within these courses. The approach referred to as coalescent learning, as outlined in [21], involves using web-based e-learning tools before a practical class. This approach serves the purpose of testing hypotheses, making forecasts, evaluating the results obtained, and subsequently analyzing the submitted forecasts after the session is completed. As a result, individuals engaged in distance learning miss out on tactile engagement and the chance to fully grasp the immersive atmosphere [22–26]. Henceforth, educational institutions must thoroughly review their current methods for conducting laboratory-based practical experiments and technical training courses for their students. This evaluation should also consider the future implementation of these practices after the COVID-19 pandemic, with a focus on attaining desired learning outcomes, especially given the current circumstances related to COVID-19. Furthermore, educational institutions must thoroughly examine the strategies they will employ during the post-COVID-19 era. The transition to online learning during the global COVID-19 pandemic presents challenges for students and educators in laboratory and technical disciplines. The increasing use of simulation applications in education can be attributed to the dedicated efforts of programmers and engineers. These innovative tools have been developed to improve the teaching methods used by instructors in technical courses by making it easier to convey essential concepts to students. As indicated by the scholarly citation [27–29], engineering as an academic discipline encompasses a variety of software simulation tools. However, it is worth noting that only a limited subset of these systems have been empirically validated to meet the rigorous academic prerequisites and benchmarks. Al-Balqa Applied University (BAU), a well-known educational institution in Jordan, is responsive to the emerging changes in its environment. The Colleges of Engineering have conducted extensive research on effectively disseminating hands-on technical subjects and electrical laboratories, such as Circuits courses, while ensuring a superior and enlightening educational experience. In response to the prevailing circumstances surrounding the COVID-19 pandemic, engineering institutions have developed a new approach to imparting practical engineering knowledge to students. This involves using online learning platforms to deliver courses that emphasize the application of engineering principles in real-world scenarios. Notably, the integration of simulation software has proven to be instrumental in facilitating the acquisition of practical skills, especially in circuits. The curriculum of these courses encompassed the pedagogy of establishing accurate connections within electric circuits, assessing the operational efficacy of interconnected circuits, comprehending the dynamic nature of electrical energy, and applying the theoretical constructs in practical scenarios encountered in the real world.

Princess Sumaya University for Technology (PSUT) provides a comprehensive educational experience through its School of Engineering, with a specific focus on the field of electrical engineering. This prestigious institution provides its students with a diverse range of software tools, enabling them to acquire knowledge and skills in constructing and simulating circuits and systems. These resources are meticulously designed to cover the different aspects of electrical engineering, ensuring a comprehensive approach to learning and development. Indeed, it is noteworthy that a significant proportion of courses in various engineering disciplines require students to gain proficiency in simulation tools and complete at least one term project as a mandatory part of the curriculum. Utilizing the software tool LTSpice is of great importance in analyzing electrical circuits, especially those of an electronic nature. This tool is extensively used in Electronics I and II courses, as well as in advanced electronics engineering courses. Using LT Spice makes it easier for students to build electronic circuits by providing access to a wide range of generic and industry-specific electronic components. This comprehensive collection includes diodes, transistors, and other essential circuit components. The circuits can be assessed by subjecting them to diverse loading conditions and considering important industrial constraints, such as temperature, to achieve results that accurately reflect the circuit's operational performance. The primary objective of this research is to explore the viewpoints of engineering students enrolled at PSUT, specifically focusing on their assessments of the usefulness of the LT Spice software used in their academic study of electronics courses within the university's curriculum. LT Spice is widely recognized as a prominent software application in the academic engineering domain because of its exceptional ability to accurately simulate the behavior of various components and construct intricate circuit diagrams. LTSpice is a sophisticated modeling tool developed meticulously and refined by the renowned semiconductor manufacturer Analog Devices [30]. LTSpice is a widely used software tool that simulates diverse electrical and electronic circuits. Its main purpose is to analyze and investigate the performance and characteristics of different circuit configurations used in power engineering, computer engineering, communications, and electronics, and it is widely used by many scholars in these specific fields. Numerous scholarly studies in the existing literature have utilized LTspice as their primary tool for simulation purposes [31–33]. The study referenced in [31] utilizes LTSpice as a tool for designing FPGA-based circuits. These circuits are significant in computer engineering programs as they enable the construction and evaluation of digital circuits.

Conversely, reference [32] uses LTSpice to effectively simulate and model circuits within the analog domain. The use of power applications is widely acknowledged in the field of LTSpice [33–35]. These references focus on the implementation and evaluation of power electronics circuits, such as buck-boost converters and power parameter correction circuits, using software. For the PSUT Electronics 1 cohort assignment, each student was required to build and simulate a basic common-emitter amplifier circuit similar to the example shown in Figure 1. Furthermore, it is noteworthy that the students were provided with specific design specifications that they were required to meet.

The amplifier circuit required a precise minimum amplification gain, which prompted students to engage in the design process to achieve this gain. This objective is typically achieved through the execution of DC and AC circuit analyses, where the selection of resistor values, such as R1, R2, RC, and RE, is crucial. The magnitudes of these resistors are crucial for achieving proper transistor biasing within the active region while also ensuring that the specifications for amplification are adequately met. The use of LTSpice in educational settings not only promotes the development of critical thinking skills among students by encouraging them to evaluate various design options but also facilitates the understanding of the significance of resistance values in circuit operation. This, in turn, enables students to comprehend the resulting effects on amplification and the proper biasing of transistor circuits. In this context, the curriculum provides students with foundational knowledge, equipping them with the initial skills necessary to excel as proficient designers of electronic circuits. Furthermore, it serves as a springboard for their future professional paths, enhancing their readiness to engage with complex circuitry and advanced systems as they move beyond their academic journey.

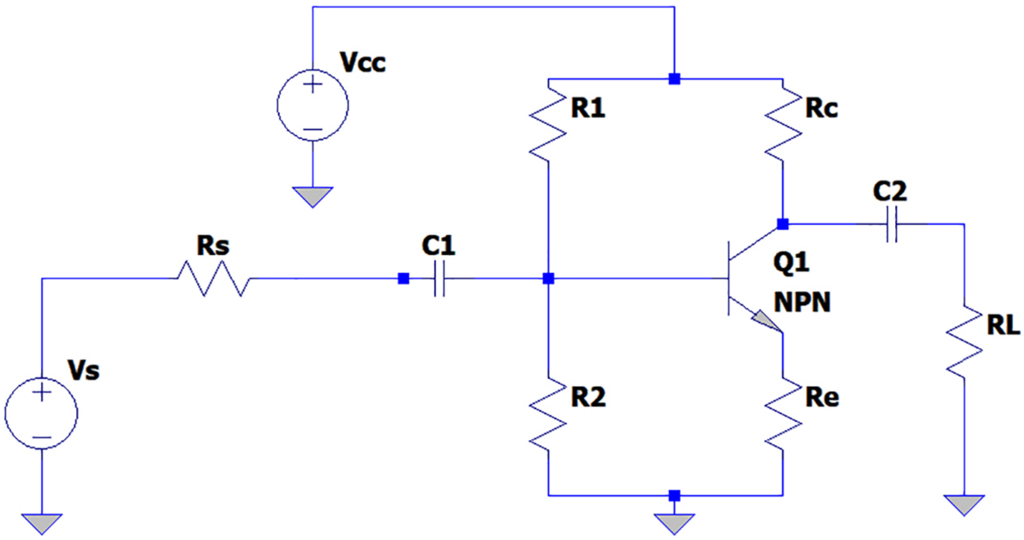

Fig. 1. Diagrammatic representation of a basic amplifier circuit utilizing LTSPice

1.1 Study's questions

This study aims to address the following questions:

RQ1: To what extent does the Engineering College at PSUT in Jordan use simulation software to learn online?
RQ2: Do students' perceptions of the effectiveness of using simulation software in online learning differ depending on their gender, academic year, computer skills, and student GPA at PSUT in Jordan's Engineering College?

1.2 Research significance

- This study examines students' perspectives on the effectiveness of simulation software in online learning at the Engineering College in PSUT, located in Jordan.
- One can understand the importance of using software in education by gaining a deeper understanding of students' perceptions.
- The use of the software application has the potential to improve engineering students' understanding of engineering subjects.

2 METHODOLOGY

2.1 Research's approach

As per Shields, Patricia, and Rangarajan's (2013) research, the current study utilized a descriptive methodology. This approach involves collecting quantifiable data to offer a comprehensive description of the participants, conditions, or phenomena under investigation. Subsequently, statistical analysis was used to analyze the gathered data. As a prerequisite for participating in the research project, the students were asked to carefully complete a comprehensive questionnaire.

2.2 Research participants

The research sample consisted of 270 individuals, specifically students, who were selected from the PSUT population in Jordan. These participants were selected based on their enrollment in the second semester of the 2021–2022 academic year. The distribution of participants across various demographic categories is presented in Table 1 and visually depicted in Figure 2.

Table 1. Research participant's demographics

Study Parameters	Levels of Parameters	Frequency (f)	Percent%
Genders	F	130	$(4815) \times 10^{-2}$
	M	140	$(5185) \times 10^{-2}$
	Total	**270**	**(10000)** $\times 10^{-2}$
Skills in Computer	Excellent	84	$(3088) \times 10^{-2}$
	Good	69	$(2537) \times 10^{-2}$
	Mod	58	$(2132) \times 10^{-2}$
	Poor	61	$(2243) \times 10^{-2}$
	Total	**270**	**(10000)** $\times 10^{-2}$
Academic year	1st	60	$(2206) \times 10^{-2}$
	2nd	55	$(2022) \times 10^{-2}$
	3rd	70	$(2574) \times 10^{-2}$
	4th	45	$(1654) \times 10^{-2}$
	5th	42	$(1544) \times 10^{-2}$
	Total	**272**	**(10000)** $\times 10^{-2}$

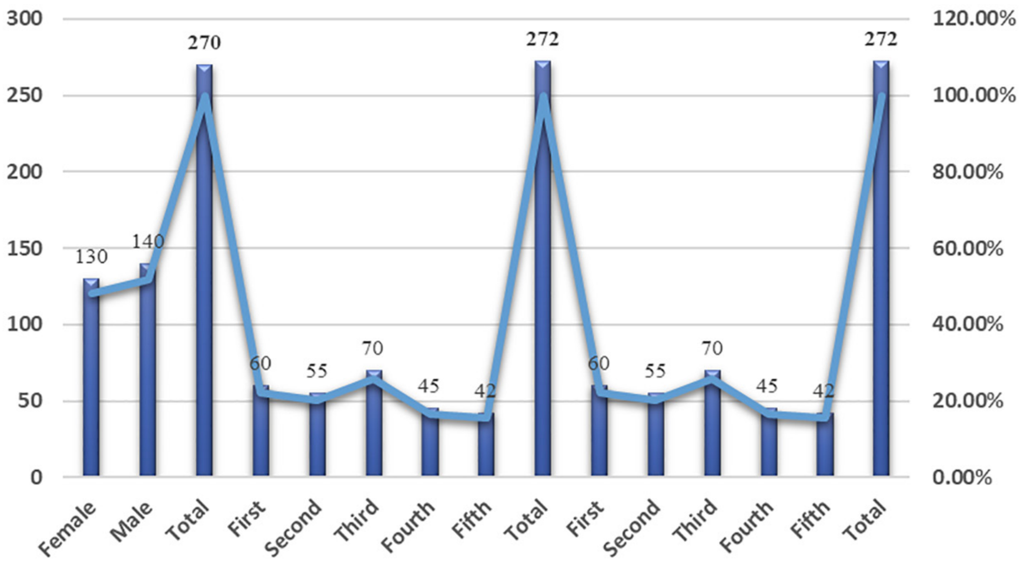

Fig. 2. Research participant's demographics

2.3 Research instruments

In the second semester of 2021–2022, a group of student participants completed a survey that was specifically designed to align with the research goals. The survey consists of two distinct sections. The first section contains the student's general information, while the following section includes 25 survey items ($n = 25$) aligned with the research objectives.

To assess the relevance of the survey responses about the achievement of research objectives as well as the quantity and inclusiveness of the items, a panel of ten respected faculty members from Jordanian universities with significant expertise in the field of education was asked to provide their expert opinions on the items. The feedback and ideas of educational experts were taken into account, leading to improvements and eliminations. As a result of this alteration, the survey comprised 25 components, effectively achieving the study's objective. The internal consistency coefficient of the study tool was assessed using Cronbach's α. The coefficient (0.804) was computed using the specified methodology in an initial study involving 35 participants who were not included in the main sample.

2.4 Measurements of data analysis

Researchers evaluate data using a five-dimension Likert scale, as Table 2 illustrates. Scale data may be evaluated using both scale and interval choices.

Table 2. The assessment of scale data using score intervals and scale choices

Depiction	Scores	Intervals
Very high (VH)	5	$(421 - 500) \times 10^{-2}$
High (H)	4	$(341 - 420) \times 10^{-2}$
Moderate (Mod)	3	$(261 - 340) \times 10^{-2}$
Low (L)	2	$(181 - 260) \times 10^{-2}$
Very low (VL)	1	$(100 - 180) \times 10^{-2}$

2.5 Analyzing the data statistically

The SPSS software utilizes various techniques, including calculating percentages, averages, and standard deviations, performing one-way analysis of variance (ANOVA), and conducting Scheffe tests. Additionally, independent t-tests were also used as part of the analysis. Percentage averages, standard deviations, one-way ANOVAs, Scheffe tests, and independent t-tests were calculated using SPSS software.

3 RESULTS AND DISCUSSION

3.1 Research findings related to question 1

Within Table 5, the researchers have calculated the average scores and standard deviation (STD) of the responses provided by the participants. These responses addressed the initial research question, which centered on the students' willingness to accept electronic exams during the widespread COVID-19 pandemic. The data presented in the table provides a comprehensive overview of the statistical measures derived from the participants' perspectives.

Table 3. Detailed information on the answers provided by the students

No. of Questions	Paragraphs	Average	SD	Depiction
1	Engaging in the utilization of simulation software to study engineering topics catalyses the enhancement of one's skills.	3.96	0.956	H
2	The utilization of simulation software is a valuable tool for engineering students, as it aids in the resolution and administration of intricate engineering dilemmas.	4.17	0.781	H
3	Using simulation software drives the individual's engagement in the educational journey.	4.00	0.890	H
4	The utilization of simulation software has proven to be advantageous in comprehending the concepts presented in engineering lectures.	3.77	1.164	H
5	Software for simulation could assist in improving the understanding and interpretation of engineering investigations.	4.00	0.906	H
6	Owing to the Simulation program, I felt more confident.	3.50	1.240	H
7	I learn more about engineering practical courses when I use simulation software.	3.92	0.917	H
8	Simulation software shields students from dangerous engineering research.	4.09	0.992	H
9	Simulation software facilitates more effective communication between teachers and students.	3.73	1.083	H
10	My comprehension and academic achievement will improve with further practice using simulation software.	3.99	0.985	H
11	In the end, simulation software offers superior feedback compared to conventional techniques.	3.88	1.082	H
12	Simulation tools have to be included in engineering curricula and courses.	4.18	0.780	H
13	Simulation software increases students' faith in real-world experiments.	4.06	0.805	H
14	Engineering experiments are beneficial when supplemented, not when substituted, by simulation.	4.11	0.877	H
15	The utilization of software for simulation facilitates learning in practical engineering courses.	4.02	0.924	H
16	Simulation software may produce a realistic, secure, and repeatable learning environment.	4.26	0.830	VH
17	Simulation software diminished the instructor's position.	3.69	1.034	H

(Continued)

Table 3. Detailed information on the answers provided by the students *(Continued)*

No. of Questions	Paragraphs	Average	SD	Depiction
18	Students had the opportunity to participate more actively in their education thanks to simulation software.	3.98	0.751	H
19	When the engineering curriculum includes simulation software, the teacher will have to put in less work.	3.83	1.086	H
20	Simulation software has enhanced students' comprehension of engineering subjects.	3.79	0.838	H
21	Utilizing simulation software, engineering students have enhanced their critical thinking abilities.	3.94	0.871	H
22	Simulation software is necessary for learning engineering concepts.	3.36	1.347	Mod
23	Utilizing simulation software makes learning more pleasant, self-assured, and engaging for me.	3.64	0.841	H
24	For the most part, simulation software can compensate for the lack of real engineering experiments.	3.57	1.035	H
25	The simulation program is adaptable in terms of both time and place.	3.81	0.954	H
Total		**3.89**	**0.959**	**H**

The data presented in Table 3 shows that the average responses for all items (1–25) resulted in an average score of 3.89, with a standard deviation of 1.22. The results indicate that students at Princess University for Technology in Jordan generally have a positive perception of using simulation programs in the context of online learning. This finding potentially suggests that students have a strong inclination to use software applications. The findings presented in Table 3 demonstrate a clear pattern in the students' responses. Specifically, the question about the potential of simulation software to facilitate highly realistic, safe, and reproducible learning experiences (Q-16) received the highest average rating of 4.26, indicating a strong consensus among the participants. Similarly, the question of integrating simulation tools in engineering curricula and courses (Q-12) received the second-highest average rating of 4.18, indicating a significant level of agreement among the respondents. The study found that using simulation software has the potential to significantly benefit engineering students by enhancing their ability to effectively address and handle complex engineering problems. This aspect, referred to as Q-2, achieved a significant ranking, securing the third position. The average magnitude of Q-2 was calculated to be 3.70, indicating a relatively high level of agreement among the participants. Furthermore, it is noteworthy that Q-14, which emphasizes the value of simulating engineering experiments as a valuable complement rather than a replacement, ranked fourth in acceptance of electronic exams. This finding is significant because it indicates a high level of agreement among participants, with an average magnitude of 4.11. Furthermore, it is evident from the students' feedback on Q-8 that they believe students are protected from hazardous engineering experiments through the use of simulation software. This query received a relatively high ranking, being placed fifth out of all the questions. The average score for this question was 4.09, indicating a high level of agreement among the respondents. In a similar vein, it is worth noting that a significant level of importance was observed for Q-13, 15, 3, 5, 10, 18, 1, 21, 7, 11, 19, 25, 20, 4, 9, 17, 23, 24, and 6, as evidenced by their respective average magnitudes of 4.06, 4.02, 4.00, 4.00, 3.99, 3.98, 3.96, 3.94, 3.92, 3.88, 3.83, 3.81, 3.79, 3.77, 3.73, 3.69, 3.64, 3.57, and 3.50. Similarly, Qs-22 (related to the need for simulation software for learning engineering topics) received a moderate degree of agreement, as indicated by the average magnitude of 3.36, which is comparatively lower than other average magnitudes.

3.2 Findings from question 2

- **Students' gender varying**

Utilizing the data presented in Table 4 and Figure 2, a T-test was employed to determine the presence of statistically significant differences in average responses between genders.

Table 4. Gender-specific student responses: SDs and averages

Gender	N	Average	SD	Average Difference	T. Magnitude	df	Sig.
Female	92	3.91	0.500	0.02538	0.334	0.334	0.369
Male	178	3.88	0.633				

Note: Statistical significance at (p less than 0.05).

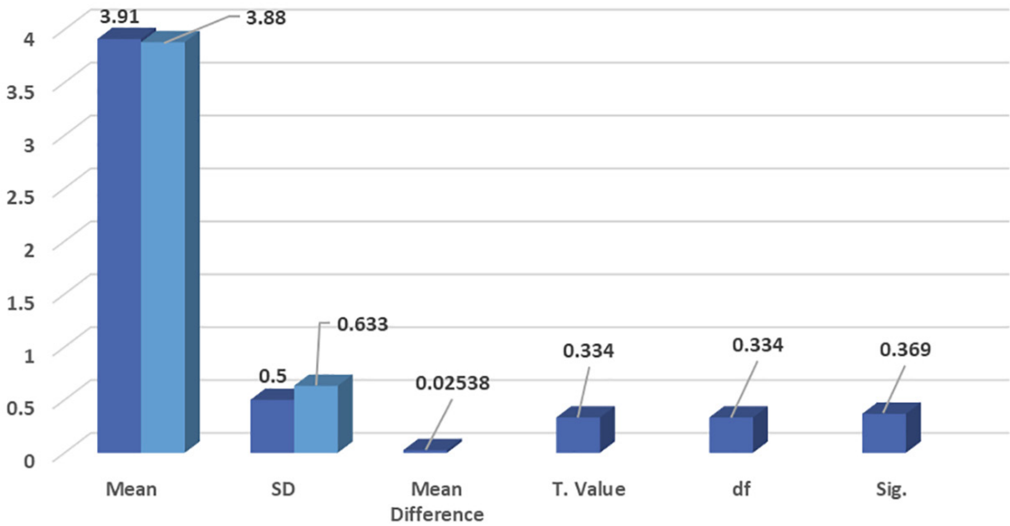

Fig. 3. Gender-specific student responses: SDs and averages

According to the data presented in Table 4 and Figure 2, our analysis reveals that the calculated t magnitude of 0.334 falls below the critical t magnitude from the table, indicating that there is no statistically significant difference between the average magnitudes of females and males. The significance level of 0.369 exceeds the required statistical significance level of 0.05.

- **Skills parameter in computer**

Utilizing the data presented in Table 5 and Figure 4, a one-way ANOVA was performed to determine the statistical significance of differences in the average responses related to computer skills.

Table 5. College parameter across students: One-way ANOVA test

		Sum of Squares	df	Average Square	F	Sig. (Tailed)
College parameter	Between Sets	0.213	3	0.071	0.202	0.895
	Within Sets	93.501	266	0.352		
	Total	93.714	269			

Note: Statistical significance at (p less than 0.05).

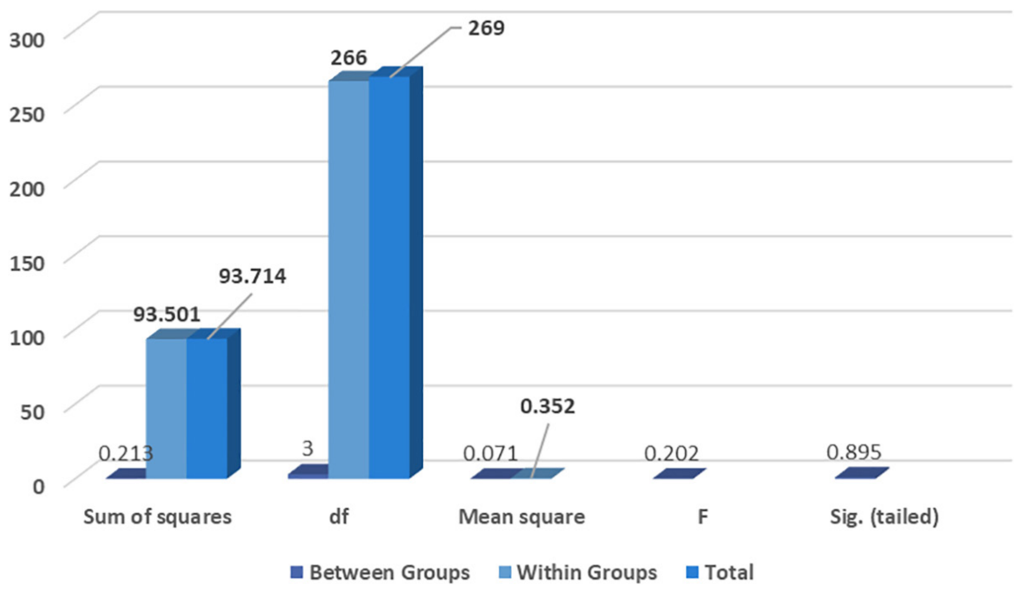

Fig. 4. College parameter across students: One-way ANOVA test

According to the empirical data presented in Table 5 and Figure 3, it is evident that the p-magnitude associated with the parameter "computer skills" is 0.895. This magnitude exceeds the established statistical significance threshold, which is typically set at 0.05. Consequently, these results indicate that there have not been statistically significant disparities in students' perspectives regarding their level of computer skills.

- **Academic year parameters**

Utilizing the data presented in Table 6 and Figure 5, a one-way ANOVA has been conducted to determine the statistical significance of the differences in the average responses across various academic years.

Table 6. College parameters across students using a one-way ANOVA testing

		Sum of Squares	df	Average Square	F	Sig. (Tailed)
College parameter	Between Sets	2.639	4	.660	1.920	0.107
	Within Sets	91.075	265	.344		
	Total	93.714	269			

Note: Statistical significance at (p less than 0.05).

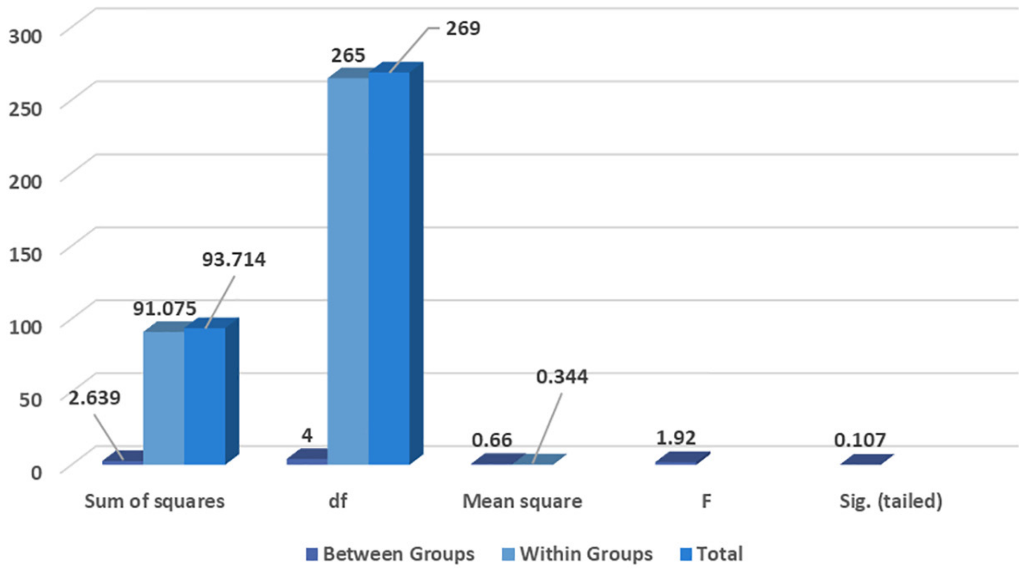

Fig. 5. College parameters across students using a one-way ANOVA testing

According to the results presented in Figure 4 and Table 6, the p-magnitude associated with the parameter of academic year was determined to be 0.107. This magnitude exceeds the usual statistical significance threshold, which is typically set at 0.05. Consequently, these findings indicate that there are no discernible and statistically significant variations in students' perspectives when considering their academic year.

3.3 Discussion

The findings of the initial investigation into the effectiveness of simulation software in online learning within the Engineering College at PSUT in Jordan. According to the students' subjective viewpoint, the simulation software was perceived to be highly effective in online learning, owing to an average score of 3.89 and a standard deviation of 0.959. The findings suggest that a significant number of students participating in the research show positive emotions, contentment, and openness to integrating electronic programs into their educational experience, especially in engineering subjects, at PSUT in Jordan. The findings presented in Table 3 illuminate the students' perceptions and attitudes toward using simulation software in online learning within the Engineering College at PSUT in Jordan. The majority of the students expressed positive views about the effectiveness of using simulation software in their learning experiences. It is worth noting that all survey items received high ratings, indicating strong agreement with the benefits of using simulation software. However, it is important to highlight that Item Qs-22, which concerns the need for simulation software in learning engineering topics, received a moderate rating. This suggests that there is room for improvement in emphasizing the importance of simulation software in engineering education. The average magnitude of 3.36 for this item further supports this observation, indicating a relatively lower level of agreement compared to other items on the questionnaire. The findings suggest that engineering students at PSUT in Jordan may experience higher satisfaction when simulation software is integrated into online learning within the Engineering College. The potential causes of this phenomenon can be attributed to factors related to the characteristics of simulation software. These factors include the software's ability to replicate real-world settings, such as an e-learning computer lab or a 3-D virtual modeling class simulation. Simulations usually involve participants taking on specific roles based on real-life scenarios. The participants' interactions can then be carefully considered through a structured process of reflection, allowing them to recognize and appreciate the positive educational outcomes that have arisen. Simulated learning environments provide learners with predefined parameters, including resources and time constraints, to engage in problem-solving or respond to events within a controlled setting. In addition to improving overall security, simulations also serve as a means of continuous knowledge acquisition. Learning simulations demonstrate superior cost-efficiency compared to offline simulations and traditional training methods. The findings of this study are consistent with the conclusions drawn from previous research conducted by various scholars [36–40]. The studies' findings revealed that students showed a significant interest in and openness to using simulation programs in the context of online education at tertiary institutions. The results also supported the students' preference for integrating simulation programs into their learning experience.

The second research inquiry aimed to investigate the perceived variations in the effective utilization of simulation software in online learning within the Engineering College at PSUT in Jordan, as reported by students. This investigation aimed to explore potential differences based on academic year, computer skills, student GPA, and gender. The results obtained from the data analysis, specifically presented in Tables 4, 5, and 6, as well as Figures 2, 3, and 4, indicate no discernible variation observed with the academic year, computer skills, student GPA, and gender parameters.

4 CONCLUSION

Education in Jordan is considered a crucial aspect of Jordanian culture and society, playing a decisive role in positioning Jordan among Arab countries in terms of the quality and efficiency of graduates in the Arab world. The purpose of this study is to examine students' perceptions of using simulation software in the context of e-learning at PSUT in Jordan, which is considered one of the nation's leading private universities. This will improve their comprehension of engineering concepts. As a result of the research findings, higher education institutions should consider integrating simulation software to improve teaching and learning.

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