

# Exploring and Strengthening Energy Concepts through Computer Simulation in Educational Institutions

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**ABSTRACT:** In a world increasingly dependent on energy, understanding its fundamental concepts becomes paramount. As we navigate complex global challenges related to sustainability and innovation, educating the younger generation about energy is crucial. Computer simulation learning has emerged as a pivotal tool in optimizing teaching methodologies, particularly when it comes to comprehending and mastering energy-related concepts. This innovative approach provides an immersive experience, allowing students to practically and interactively explore the intricate principles of energy. Focused on the industrial technology associated with energy, this study delves into the application of computer simulation to enhance the understanding of adolescents aged 13 to 16. A sample of students, spanning three classes, underwent electrical circuit manipulation tests utilizing simulation software. Analysis of the results, employing Pearson's correlation coefficient, revealed a significant enhancement in the comprehension of energy concepts through simulation-based learning. By enabling students to visualize and experiment with various energy-related scenarios.

**Keywords:** Energy Concepts, computer simulation, E-learning, Energy education.

## 1 Introduction

In today's digital age, where technological innovation and sustainable development are at the forefront of global challenges, understanding energy-related concepts is more crucial than ever [1, 2]. Colleges and educational institutions play a vital role in preparing future citizens and professionals to tackle the complex energy challenges of the 21<sup>st</sup> century [3, 4].

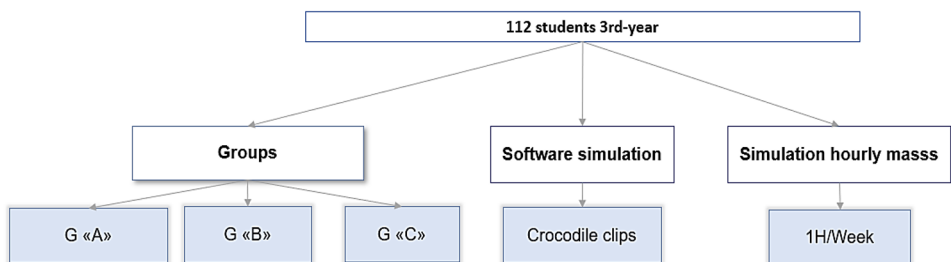
In the context of energy education, learning through simulation has emerged as a transformative approach [5]. Using computer-based tools to simulate electrical circuits provides students with invaluable insights into the functioning of batteries, The practice of using less energy by implementing various strategies and technologies [6] and applying the concepts of kinetic and potential energy to electrical circuits, demonstrating how energy can be stored and released [7]. Exploring how sensors and controllers can be utilized to automate and optimize energy systems [8-10]. allowing them to grasp complex concepts tangibly and interactively. Through simulation software like Crocodile Clips, students can visualize, experiment, and assemble electrical circuits, enhancing their understanding of battery operations. Moreover, this method aids in memorizing symbols associated with various energy components, reinforcing their knowledge of energy systems [11-13]. In this article, we delve into the fundamental importance of learning energy-related concepts in colleges, The objective of this study is to rigorously investigate the impact of interactive simulations on academic performance [14]. We seek to answer crucial questions, including whether there exists a correlative relationship between energy educational computer simulations and student outcomes [15]. The results findings of our research confirm the presence of a robust correlation between these two variables [16].

## 2 Methodology

### 2.1 Participants

The present research was carried out by conducting 4 tests of 3 groups 3rd-year at a public school in the city of Sidi Slimane, which lasted for 4 months to 112 students to measure the results of the integration of computer simulation into the learning process. We applied four tests to students in each group, the groups were taught using simulation activities with crocodile clip simulation software for one hour every week for each class. simulating electronic circuits with software like Crocodile Clips offers a versatile and effective way to learn, experiment, and design electronic circuits. It provides a safe, accessible, and interactive platform for users to develop their electronic knowledge and skills while also facilitating collaboration and real-world applications.

We organized the students into pairs, with each pair sharing a computer. (The computer room has a total of 18 computers) a video projector, linked to the teacher's computer, was employed concurrently to assist and direct students in building their understanding while also addressing any technical inquiries they had the data gathered underwent analysis through IBM SPSS.



**Fig. 1.** Description of the methodology

## 2.2 Work tool: Crocodile clip

In this research, we worked with Crocodile Clips software to conduct in-depth simulations on several aspects of energy concepts. such as the exploration of different types of electrical sources, the study of battery operation, the examination of the energy storage principle during charging and discharging phases, and the analysis of the use of sensors such as the LDR sensor.

## 3 Results

### 3.1 Socio-demographic characteristics

Table 1 provides a comprehensive overview of participant demographics within the study, delineating the distribution across three distinct groups. Notably, the data reveals a gender distribution of 59 participants (52.7%) identified as girls and 53 participants (47.3%) as boys, shedding light on the gender composition within the research cohort.

**Table 1:** Socio-demographic characteristics

	Frequency	Percentage	Valid percentage	Cumulative percentage
<b>Male</b>	53	47,3	47,3	47,3
<b>Female</b>	59	52,7	52,7	100,0
<b>Total</b>	112	100,0	100,0	

### 3.2 The descriptive statistics of the student's outcomes

The results presented in Table 2 demonstrate a notable trend in the student's performance as they engage in simulations before each test, showing a consistent improvement in mean scores and a reduction in standard deviation. For the first test without any simulation, the mean score was 13, indicating a significant dispersion of performance among students, as reflected by the standard deviation of 3.130. In the second test, where students completed a single simulation before answering, the mean increased to 14, suggesting a typical improvement. However, the standard deviation of 2.601 indicates some variability in individual performances. The third test, following two simulations, saw a further increase in the mean to 16, indicating a general improvement over the second test. The standard deviation decreased slightly to 2.124, suggesting a reduction in variability and increased consistency in performance.

The last test, after three simulations, displayed a substantial mean improvement to 18, showcasing the positive impact of repeated simulations on student performance. The small standard deviation of 1.755 indicates that individual results are closely clustered around the mean, highlighting a consistent and less variable performance. In summary, the results indicate that active learning through simulations positively

influenced students' understanding and mastery of electronic circuits, resulting in improved mean scores and enhanced consistency in performance.

**Table 2:** The statistical parameters of the sample

	TEST 1	TEST 2	TEST 3	TEST 4
<b>Moy</b>	12,278	14,191	15,939	17,438
<b>Max</b>	19	20	20	20
<b>Min</b>	6	10	12	13
<b>Mean</b>	13	14	16	18
<b>Mod</b>	11	15	16	18
<b>Standard Deviation</b>	3,130	2,601	2,124	1,755
<b>Var. Cof</b>	0,254	0,183	0,133	0,100

## 4 Discussion

In Table 3 we explore the correlation of the linear relationship, with two variables; score test 1 and score test 4, and it is abundantly evident from Table 4, which meticulously examines the intricate relationship between the utilization of computer simulations and academic achievement, that a remarkable correlation exists. The statistical measure of this association, as quantified by Pearson's correlation coefficient ( $r$ ), is an impressive 0.933. This substantial correlation coefficient value unequivocally attests to the presence of a robust and positive link between the proclivity for using simulation-based computers and the resulting academic performance of students.

**Table 3:** the Pearson correlation coefficient

Descriptive statistics			
	Mean	std. deviation	N
<b>S. Test 1</b>	12,28	3,130	115
<b>S. Test 4</b>	17,44	1,755	114

**Table 4:** The statistical Pearson correlation coefficient

Correlation			
		S.Test 1	S.Test 4
<b>S. Test1</b>	The Pearson Correlation	1	,933**
	Sig. (bilatérale)		<,001
	N	115	114
<b>S. Test4</b>	The Pearson Correlation	,933**	1
	Sig. (bilateral)	<,001	
	N	114	114

The substantial Pearson's correlation coefficient of 0.933 reflects the extent to which addiction to computer simulations is intertwined with academic success. This statistic, falling within the range of -1 to +1, where +1 represents a perfect positive correlation, and -1 signifies a perfect negative correlation, strongly supports the notion that the more students engage with computer simulations, the higher their academic

achievements tend to be. In this context, an r-value of 0.933 signifies that nearly 93.3% of the variation in academic achievement can be attributed to the use of simulation-based computers.

The implications of such a robust correlation are profound and multifaceted. Firstly, it underscores the vital role that computer simulations play in modern education. Students who engage with these educational tools appear to reap substantial benefits in terms of their academic performance [17-19]. Such simulations can offer immersive and interactive learning experiences, enabling students to grasp complex concepts and principles more effectively. Moreover, this correlation underscores the importance of incorporating technology into the educational curriculum. As society becomes increasingly reliant on technology, ensuring that students are adept at using computer simulations can better prepare them for the demands of the modern workforce. It is no longer sufficient for students to be passive recipients of information; they must actively engage with technology to thrive in the digital age.

## 5 Conclusion

In conclusion, the findings of this research highlight a significant correlation between learning energy concepts through simulation and a marked improvement in students' results as well as their level of understanding. The use of simulations has proven to be an effective pedagogical tool, providing students with an immersive approach that surpasses traditional teaching methods. The results indicate that integrating simulations into the educational process allows students not only to grasp concepts more deeply but also to apply them practically [20]. This approach has led to a tangible enhancement in academic performance, with a positive correlation between students' engagement in simulation experiences and their increased understanding of energy-related subjects. The observed correlation extends beyond assessment results, also influencing the students' level of learning. Simulations offer a dynamic platform where students can experiment, make decisions, and interactively solve problems, thus fostering a deeper and more enduring assimilation of knowledge [21, 22].

The data collected in this study support the notion that integrating simulations into the teaching of energy concepts significantly contributes to the improvement of academic outcomes and the elevation of students' learning levels [23, 24]. This positive correlation strengthens the case for the continued adoption of simulation-based learning methods in the educational domain [25].

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