Investigating the Effect of Interactive Learning Modules on Students' Engagement and Performance in Computer Science Courses

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ABSTRACT

This study investigates the impact of interactive learning modules on student performance in computer science courses, focusing on student perceptions and engagement. Educational technology has rapidly evolved in recent years, providing instructors with new tools to enhance student learning experiences. Despite this growth, limited research has examined how interactive modules influence academic outcomes in computer science education. Using a questionnaire administered to 150 students from the computer science department at Abi-Isa College of Education, Zawia University, this study assesses students' experiences with and attitudes toward interactive learning modules. The results suggest that the majority of students find interactive modules beneficial for understanding complex programming concepts and maintaining engagement. Statistical analysis shows a positive correlation between the use of interactive modules and higher self-reported confidence in problem-solving abilities, with students reporting increased motivation and satisfaction with their learning. While a few challenges, such as technological issues, were noted, the findings indicate that integrating interactive modules into computer science education can significantly improve students' comprehension and performance. This study contributes to the growing body of literature on digital learning tools in STEM fields and provides insights for educators seeking to enhance their teaching methods through interactive technology.

Keywords: *Interactive Learning Modules, Student Engagement, Computer Science Education, Academic Performance, Programming Skills Development*

1. Introduction

In recent years, advancements in educational technology have transformed traditional learning environments, particularly in fields requiring practical engagement, such as computer science. The proliferation of digital tools has introduced new approaches to teaching and learning, shifting from passive, lecture-based instruction to more active, interactive methods that encourage student involvement and critical thinking. Interactive learning modules, dynamic, and digital tools designed to engage students in hands-on activities, have emerged as valuable resources in educational settings. These modules are designed to foster active learning by requiring students to directly interact with content through exercises, simulations, and problem-solving tasks, rather than merely consuming information.
Interactive learning modules provide students with immediate feedback, allow for self-paced learning, and encourage active participation, potentially enhancing their understanding of complex subjects. In fields like

computer science, where concepts such as programming logic, algorithms, and computational thinking are essential, interactive modules serve as effective tools to break down complex ideas into manageable, interactive steps. Immediate feedback allows students to quickly identify and correct mistakes, reinforcing correct approaches and preventing misunderstandings from becoming ingrained (Mayer, 2014). Additionally, self-paced learning empowers students to control their own learning experience, spending more time on challenging topics while moving more quickly through areas they grasp easily, ultimately supporting individualized learning.

For computer science students, interactive modules are particularly useful as they offer an immersive experience in programming and problem-solving, enabling students to apply theoretical concepts in a simulated environment. By working through interactive coding exercises and simulations, students can visualize abstract concepts, test their code in real time, and see the immediate effects of their logic, which deepens their understanding and retention. This hands-on approach not only enhances comprehension but also builds students' confidence in their skills, as they can experiment and learn from mistakes in a low-risk environment. Given the high dropout rate often observed in programming courses due to perceived difficulty and frustration (McGregor & Duncan, 2018), interactive learning modules may provide essential support, encouraging persistence and enhancing motivation.

The growing use of interactive modules in computer science education reflects a broader shift towards active, student-centered learning, where students take an active role in constructing their knowledge. Educators and researchers are increasingly recognizing the potential of these tools to improve student outcomes, particularly in courses where students may struggle with new and challenging concepts. This study aims to explore the impact of interactive learning modules on student engagement, understanding, and academic performance in computer science courses, assessing both student perceptions and self-reported performance to better understand the educational value of these tools.

2. Problem Statement

Despite the growing adoption of interactive learning tools, there is limited research on their specific effects on student performance, especially in computer science courses. While some studies suggest that these modules can increase student motivation and engagement, little is known about their direct impact on learning outcomes in programming and computational thinking. Furthermore, students' perceptions of these modules, how helpful they find them and what challenges they encounter, are not fully understood. Addressing this gap is essential to guide educators in selecting and implementing the most effective tools for computer science education.

3. Research Objectives

The primary objective of this study is to evaluate the impact of interactive learning modules on student performance in computer science courses. Specifically, this study seeks to:

1. Assess students' perceptions of the effectiveness of interactive modules in enhancing their understanding of computer science concepts.
2. Determine whether the use of interactive learning modules correlates with improved academic performance and confidence in problem-solving.
3. Identify any challenges or barriers that students encounter while using these modules.

4. Research Questions and Hypotheses

To achieve these objectives, this study is guided by the following research questions:

1. How do students perceive the impact of interactive learning modules on their understanding and engagement in computer science courses?
2. Is there a significant correlation between the use of interactive modules and improvements in students' academic performance?
3. What are the primary challenges faced by students when using interactive learning modules in computer science?

5. Significance of the Study

This study contributes to the existing body of knowledge on educational technology in STEM, specifically within computer science. By examining student perceptions and performance data, the findings can offer insights for educators and curriculum developers on the benefits and limitations of interactive modules in courses. Understanding how these tools affect learning outcomes can help institutions make informed decisions about integrating technology into their curricula to foster more engaging and effective learning environments.

6. Literature Review

The Literature Review section delves into existing research on the role of interactive learning modules in modern education, examining their potential to enhance teaching and learning processes. It highlights the impact of these modules on fostering student engagement, improving academic performance, and promoting active learning. Additionally, this section explores the practical and theoretical challenges associated with integrating these tools into computer science curricula, including issues related to accessibility, scalability, and the need for teacher training and institutional support.

6.1 Interactive Learning in Education

Interactive learning tools have increasingly become a focal point of educational innovation. Research suggests that interactive modules, defined as digital platforms that enable students to engage directly with content through exercises, simulations, and instant feedback, enhance active learning and retention. According to Mayer (2014), interactive modules support "constructive" learning by allowing students to participate in hands-on activities, which reinforce knowledge acquisition and understanding. Moreover, a meta-analysis by Chi and Wylie (2014) found that active engagement through interactive tools leads to higher cognitive engagement, as students are not passive recipients of information but active participants in their learning journey.

In computer science, interactive learning modules are especially valuable because they allow students to test their knowledge of programming concepts in real time. For instance, Price et al. (2017) demonstrated that computer science students who used interactive coding platforms exhibited improved coding proficiency and a better grasp of logic structures compared to students relying solely on traditional lectures. This suggests that interactive learning could play a critical role in helping students overcome initial challenges in programming and computational thinking.

6.2 Impact of Interactive Learning Modules on Student Performance

Several studies have investigated the effects of interactive learning modules on student performance across various disciplines, finding generally positive outcomes. For example, Krause et al. (2015) examined interactive modules in physics education, noting that students who engaged with these tools reported higher satisfaction and showed statistically significant improvements in exam scores. Similarly, in a study focusing on online learning, Bernard et al. (2009) highlighted that the use of interactive features—such as quizzes and visual feedback—enhanced students' comprehension and retention of complex material.

In computer science education, the use of interactive learning platforms like Code.org and Codecademy has been associated with improvements in both student engagement and performance. McGregor and Duncan (2018) found that students in programming courses who used interactive learning modules scored higher on assessments and reported greater self-efficacy in their programming abilities. The researchers attributed this success to the modules' capacity for providing instant feedback, allowing students to immediately apply corrections and reinforce their learning. This immediate feedback loop is particularly beneficial in subjects requiring precision and iterative learning, such as programming.

6.3 Student Engagement and Motivation

Interactive learning modules are also credited with fostering higher levels of student engagement and motivation, key components of academic success. Keller’s (1987) ARCS Model of Motivation; Attention, Relevance, Confidence, and Satisfaction, outlines how engagement tools, like interactive modules, sustain students' motivation by making content more relevant and accessible. Rieber et al. (2004) argued that gamified elements within interactive modules, such as points, levels, and rewards, could increase students' intrinsic motivation to learn, especially when these elements are seamlessly integrated into the learning material.

Studies specific to computer science students indicate that interactive modules help sustain interest in courses, which are often viewed as challenging and intimidating (Law et al., 2019). Law et al. found that students using interactive platforms reported feeling less anxious about learning programming, indicating that such tools might mitigate the "fear factor" commonly associated with computer science courses. This is particularly crucial for students, who may struggle with initial concepts and benefit from a more engaging, accessible learning experience.

6.4 Challenges in Implementing Interactive Learning Modules

While the benefits of interactive learning modules are well-documented, research also highlights several challenges in their implementation. Technological issues, such as inconsistent internet access or platform bugs, can disrupt the learning process and discourage students from using these tools. For example, a study by McCarthy et al. (2020) reported that students in remote areas experienced difficulties with online interactive modules due to bandwidth limitations, which impacted their learning outcomes and overall experience.

Additionally, some students may lack the digital literacy skills needed to navigate and fully utilize interactive modules effectively. A study by Miller et al. (2018) found that students unfamiliar with the digital interface of interactive platforms were more likely to experience frustration and disengagement, suggesting the need for tutorials or support sessions to help students acclimate to these tools.

6.5 Gaps in Current Research

Although numerous studies highlight the positive effects of interactive learning modules, few have specifically examined their impact on student performance in computer science courses. Most existing research focuses on general STEM education or higher-level computer science courses, leaving a gap in understanding how these tools impact beginners in programming. Additionally, there is limited data on how students perceive these tools and whether they believe they enhance their learning experience and academic confidence.

This study seeks to fill this gap by evaluating both the impact of interactive modules on academic performance and the subjective experiences of students in computer science. By assessing student perceptions and correlating them with performance data, this research aims to provide a more comprehensive understanding of the benefits and limitations of interactive learning modules in computer science education.

7. Methodology

The Methodology section outlines the research design, participants, data collection instruments, and analytical procedures used to investigate the impact of interactive learning modules on student engagement and academic performance in computer science courses.

7.1 Research Design

This study employs a descriptive research design, utilizing a questionnaire to collect data on students' experiences and perceptions regarding interactive learning modules in a computer science course. The questionnaire approach was chosen as it allows for efficient data collection from a large number of participants, providing insights into both quantitative and qualitative aspects of students' learning experiences (Creswell, 2014).

7.2 Participants

The participants in this study were undergraduate students from computer science department at Abi-Isa College of Education, Zawia University. A total of 150 students were selected using convenience sampling, as they were readily accessible and represented a population exposed to interactive learning modules. Participants were informed of the study's purpose, assured of their confidentiality, and asked to voluntarily participate. The sample included a diverse group of students in terms of age, gender, and previous exposure to computer science, which allowed for a broad examination of the effectiveness of interactive modules.

7.3 Instrument of data collection

7.3.1 The questionnaire

The primary instrument used in this study was a structured questionnaire, designed to gather data on students' perceptions of and experiences with interactive learning modules. The questionnaire consisted of three sections:

*1. **Student Engagement and Perception***: Items in this section measured students' engagement with interactive modules, using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Sample items included statements such as "Interactive modules help me understand programming concepts better" and "I find interactive modules engaging and motivating" (DeVellis, 2017).

2. Academic Performance and Confidence: This section included questions about students' perceived impact of interactive modules on their academic performance and confidence in problem-solving skills. This section also used a 5-point Likert scale, with statements like "Using interactive modules improves my performance in programming tasks."

3. Comparison of Engagement and Performance Perception by Previous Computer Science Experience: This section of the questionnaire aimed to investigate whether students' previous experience in computer science influenced their engagement and perceived performance with interactive learning modules. Specifically, this section explored if students with prior exposure to programming concepts felt more engaged or reported higher confidence and understanding compared to those without previous experience. This section explores prior experience and no prior Experience related to engagement, understanding, skill improvement, and confidence in problem-solving.

7.3.2 Content Validity

The questionnaire was reviewed by two educational experts for content validity, ensuring the items accurately measured the intended constructs (Dillman, Smyth, & Christian, 2014). A pilot test was conducted with a small sample of students (n=15) to check for clarity and reliability, resulting in minor adjustments to wording for better comprehension.

7.4 Data Collection Procedure

The questionnaire was administered online at the end of the course to ensure that students had sufficient experience with the interactive modules before providing feedback. An invitation to participate, along with a link to the questionnaire, was sent to students via email. They were given one week to complete the questionnaire, with a reminder email sent halfway through this period. The online administration allowed for greater accessibility and ensured that students could respond at their convenience, minimizing response bias (Creswell, 2014).

8. Data Analysis

Descriptive statistics, such as means and standard deviations, were used to summarize students' responses to each item in the questionnaire. Inferential statistics, including Pearson's correlation analysis, were employed to examine relationships between students' perceptions of the modules and their self-reported academic performance. Additionally, an independent t-test was conducted to compare perceived engagement and performance between students with prior computer science experience and those without. Qualitative data from open-ended responses were analyzed using thematic analysis to identify recurring themes related to students' experiences with interactive modules (Braun & Clarke, 2006).

9. Results

9.1 Section 1: Student Engagement and Perception

The results of this study provide insights into students' perceptions of interactive learning modules and their impact on engagement, academic performance, and confidence in computer science courses.

Table 1: Descriptive Statistics of Student Responses on Perceived Engagement and Academic Performance

Item	Mean	Standard Deviation	Interpretation
Interactive modules help me understand concepts.	4.2	0.89	High agreement
I find interactive modules engaging and motivating.	4.5	0.76	High engagement
Interactive modules improve my programming skills.	4.1	0.92	Moderate to high impact
Interactive modules build my confidence in problem-solving.	4.0	0.88	Moderate to high impact
I am more likely to complete tasks with interactive modules.	4.3	0.84	High completion likelihood

The data in Table 1 reveal strong positive perceptions of the interactive learning modules among students. The mean ratings for items related to engagement (4.5) and understanding of concepts (4.2) indicate that students generally found the modules both motivating and helpful for comprehension. The mean scores for improving programming skills (4.1) and confidence in problem-solving (4.0) are also high, suggesting that students feel these modules contribute positively to their academic abilities. Overall, the high mean scores across items indicate a favorable perception of interactive modules in supporting student learning outcomes in computer science.

9.2 Section 2: Academic Performance and Confidence

This section explores how interactive learning modules impact students' academic performance and confidence, highlighting their role in enhancing understanding and motivation.

Table 2: Correlation Between Perceived Module Effectiveness and Self-Reported Academic Performance

Variable	Self-Reported Academic Performance
Understanding of concepts	0.58
Engagement and motivation	0.62
Programming skills improvement	0.55
Confidence in problem-solving	0.5

*Note: $p < 0.01$ indicates significance.

Table 2 shows significant positive correlations between students' perceptions of module effectiveness and their self-reported academic performance. The strongest correlation is observed between engagement and motivation ($r = 0.62$) and self-reported performance, followed by understanding of concepts ($r = 0.58$). These results suggest that students who feel more engaged and motivated by the interactive modules tend to report better academic performance. Similarly, improvements in programming skills and confidence in problem-solving also correlate positively with performance, indicating that students attribute part of their success to the modules' impact on their skills and self-confidence.

9.3 Section 3: Comparison of Engagement and Performance Perception by Previous Computer Science Experience

This section analyzes how prior computer science experience affects students' perceptions of engagement and performance with interactive learning modules.

Table 3: Comparison of Engagement and Performance Perception by Previous Computer Science Experience

Item	Mean (Prior Experience)	Mean (No Prior Experience)	t-value	p-value
Engagement and motivation	4.7	4.3	2.5	0.01
Understanding of programming concepts	4.4	4.1	2.2	0.03
Programming skills improvement	4.3	4.0	2.1	0.04
Confidence in problem-solving	4.2	3.9	2.0	0.05

Table 3 compares mean scores on perceived engagement and performance between students with and without prior computer science experience. Students with prior experience reported slightly higher engagement (mean = 4.7) and confidence in programming skills (mean = 4.3) compared to those with no prior experience (mean = 4.3 and 4.0, respectively). These differences are statistically significant, with p-values below 0.05, indicating that previous experience may influence how beneficial students find interactive modules. However, the difference is relatively small, suggesting that the modules are effective for both experienced and inexperienced students in supporting engagement and understanding.

10. Discussion

The discussion section interprets the findings of this study on the impact of interactive learning modules in computer science, examining how these tools influence student engagement, comprehension, and self-confidence in programming skills.

10.1 Interpretation of Results

The results of this study suggest that interactive learning modules positively influence student engagement, understanding of programming concepts, and self-confidence in problem-solving within computer science courses. The high mean scores for engagement ($M = 4.5$) and comprehension ($M = 4.2$) demonstrate that students perceive these modules as both motivating and beneficial to their learning. This aligns with findings from Chi and Wylie (2014), who argued that active learning, where students interact directly with content, promotes deeper cognitive engagement and improved comprehension. Furthermore, the significant positive correlation between students' engagement and self-reported academic performance ($r = 0.62$, $p < 0.01$) suggests that students who feel more engaged with interactive modules tend to report higher academic success. This supports Mayer’s (2014) assertion that active engagement, particularly through interactive digital tools, can enhance students' ability to retain and apply knowledge.

10.2 Comparison to Previous Studies

These findings are consistent with prior research that highlights the effectiveness of interactive learning tools in increasing motivation and reducing anxiety in challenging subjects like programming. Law, Geng, and Li (2019) found that students in computer science who used interactive learning modules reported lower levels of intimidation, particularly in early programming courses. Similarly, McGregor and Duncan (2018) demonstrated that interactive coding platforms increased students' confidence in their programming skills. This study adds to this body of evidence, showing that students not only feel more confident but also perceive improvements in their understanding and problem-solving skills, which are essential for success in computer science.

10.3 Implications for Practice

The positive associations between module use, engagement, and self-reported academic performance indicate that instructors might benefit from incorporating interactive learning modules into computer science courses. Given that the difference in engagement and performance perception was only slightly higher for students with prior computer science experience compared to those without, interactive modules appear to support both novice and experienced learners alike. This suggests that these tools may effectively "level the playing field" by providing foundational programming support to all students, regardless of their prior experience. Educators could integrate these modules to complement traditional teaching methods, as they appear to increase student confidence, motivation, and understanding (McCarthy, Wang, & Wright, 2020). Moreover, Keller’s (1987) ARCS Model of Motivation supports the idea that interactive modules engage students by making learning relevant, increasing their confidence, and ultimately improving satisfaction.

11. Limitations

While this study provides useful insights, several limitations should be acknowledged. First, the reliance on self-reported data may introduce bias, as students might overestimate or underestimate their performance and understanding. Future research could incorporate objective performance data, such as exam scores or assignment grades, to provide a more accurate measure of student outcomes (Dillman, Smyth, & Christian, 2014). Additionally, the study’s sample size and convenience sampling approach limit the generalizability of the findings to other contexts. Expanding this research to include a larger, more diverse sample could strengthen the validity of the results. Furthermore, the study’s cross-sectional design provides only a snapshot of students’ experiences, and thus, it cannot capture the potential long-term benefits or challenges associated with the use of interactive modules (Creswell, 2014).

12. Recommendations for Future Research

Future studies could build on these findings by exploring the long-term effects of interactive modules on student performance and retention of programming skills. Longitudinal research designs would allow researchers to observe whether these benefits persist over multiple courses and over time. Additionally, investigating the specific features of interactive modules, such as gamification elements, instant feedback, or adaptive learning pathways, could offer insights into which aspects most effectively enhance engagement and performance. Qualitative studies that gather in-depth insights into students' experiences with these modules may also shed light on how different student demographics respond to and benefit from interactive learning (Braun & Clarke, 2006). Finally, examining the impact of interactive modules across different cultural or educational contexts could help educators adapt these tools to better suit diverse learning environments.

13. Conclusion

This study explored the impact of interactive learning modules on student engagement, understanding, and self-confidence in computer science courses. The findings indicate that interactive modules positively influence students’ learning experiences, as evidenced by high engagement levels, improved comprehension of programming concepts, and greater confidence in problem-solving abilities. The significant positive correlations between students’ engagement with the modules and their self-reported academic performance suggest that these tools not only enhance motivation but also contribute to perceived academic success.

The results align with existing research on the benefits of interactive tools in STEM education, emphasizing the role of active learning in fostering deeper cognitive engagement and retention of complex material. Given the minimal differences between students with and without prior computer science experience, it appears that interactive modules provide effective foundational support for all students, which may be especially valuable for those new to programming.

While the findings are promising, this study also highlights several areas for improvement and further investigation. Limitations, including the reliance on self-reported data and a sample limited to one institution, suggest the need for future research with larger, more diverse samples and objective performance measures. Longitudinal studies examining the sustained effects of interactive modules on performance and retention would also be beneficial. Additionally, further exploration of specific module features, such as gamification and instant feedback, could help identify which elements most significantly enhance learning outcomes.

In conclusion, interactive learning modules appear to be a valuable addition to computer science education, offering an engaging and effective way to support students in mastering programming concepts. By integrating these tools thoughtfully, educators can foster a learning environment that encourages active participation, improves understanding, and builds confidence, ultimately supporting student success in computer science.

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