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Combining Arduino Programming with Collaborative Learning Its Effect on Motivation and Academic Performance Among Students

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***Abstract**: The study explores the impact of integrating Arduino programming with collaborative learning on students' motivation and academic performance. By combining these pedagogical approaches, the research aims to investigate how they influence students' engagement, enthusiasm, and achievement. The investigation revealed that Arduino programming and collaborative learning have a substantial impact on both students' motivation (1.1) and their academic performance (1.2). The integration of these methodologies positively influences students' engagement and understanding, leading to improved performance.*

Keywords: Arduino Programming, Collaborative Learning, Motivation, Academic Performance, Students.

Introduction

In numerous countries, science and technology curricula now encompass the incorporation of computational thinking (CT) and programming languages, with the aim of enhancing students' CT skills. Proficiency in programming languages has been shown to facilitate improved CT abilities. Furthermore, the application of situated learning, where students engage with real-world scenarios, enables them to construct knowledge and refine their problem-solving competencies. This investigation, therefore, scrutinized the repercussions of infusing Arduino-based learning and a situated learning approach into a programming course. The research delved into the impact of this integration on students' trigonometric computational skills, their motivation to learn, and their overall course satisfaction.

Concurrently, based on prior definitions, research findings, and the evolving field of social robotics, it is conceivable that robotics can perform multifaceted tasks and employ various communication techniques when interacting with humans. The future envisions social robots operating in diverse settings, including workplaces, educational institutions, businesses, and households. The advancement of signal processing techniques within computer systems, such as sound, image, and natural language processing, has elevated social robotics to a pivotal domain of exploration.

In the domain of education, collaborative learning practices have been strongly associated with several significant student outcomes, supported by extensive empirical evidence. Academic motivation remains a well-studied subject within the educational domain. Despite the breadth of research in this area, there remains a scarcity of investigations that specifically scrutinize potential links between collaborative learning and shifts in students' academic motivation. This gap in the literature is particularly notable considering the increasing emphasis placed by educators on implementing active and collaborative learning methodologies in academic settings, which have been demonstrated to enhance learning engagement and, as a consequence, academic motivation.

This research is designed to evaluate the impact of Arduino programming and collaborative learning on the motivation and academic performance of computer engineering and senior high school (STEM) students at the National University Bulacan during the academic year 2022-2023.

In addressing the challenges associated with teaching programming, especially to novices, a range of visualization tools have been employed, including platforms like Code.org, Scratch, Small Basic, Alice, and Lego Mindstorm. These tools are primarily designed to enhance the understanding of programming concepts and demystify the intricacies of the programming process. Moreover, they empower students to create narratives and games, which prove valuable in teaching programming. The integration of robotic kits and design exercises has been a prevalent approach in programming education.

Engaging in robotics design studies has demonstrated a noticeable increase in students' motivation to learn, rendering the learning process more effective. This is primarily attributed to the active involvement of students in creating meaningful and innovative robotic designs (Lin, Liu & Huang, 2012; Liu, Lin & Chang, 2010; Liu, Lin, Feng & Hou, 2014). Robotics design represents an enjoyable, educational, and artistic activity that not only enhances coding and design skills but also fosters advanced problem-solving abilities (Gerecke & Wagner, 2007). In the realm of programming education using robots, readily available kits like Lego Mindstorms and MBot, equipped with sensors, motors, and programmable microcontrollers, play a pivotal role. These kits serve as valuable educational tools for students, including those in K-12 levels, as they delve into subjects within the domains of Science, Technology, Engineering, and Mathematics (STEM) while offering flexibility through easy assembly (Benitti, 2012).

The main concern of the study was to assessed Arduino programming and collaborative learning its effect on computer engineering and senior high school students' (STEM) learning motivation, and academic performance This would seek to answer the following questions:

What is the impact of Arduino programming and collaborative learning in
Students' motivation;
academic performance?
What is the result of the pre-test before using Arduino programming and collaborative learning?
What is the result of the post-test after using the Arduino programming and collaborating learning?
Do Arduino programming and collaborative learning exert a significant effect on students' motivation?
Do Arduino programming and collaborative learning exert a significant effect on students' academic performance?
What are the collaborative learning that the students experienced during and after the test?
The results of this study could offer valuable insights to various stakeholders:

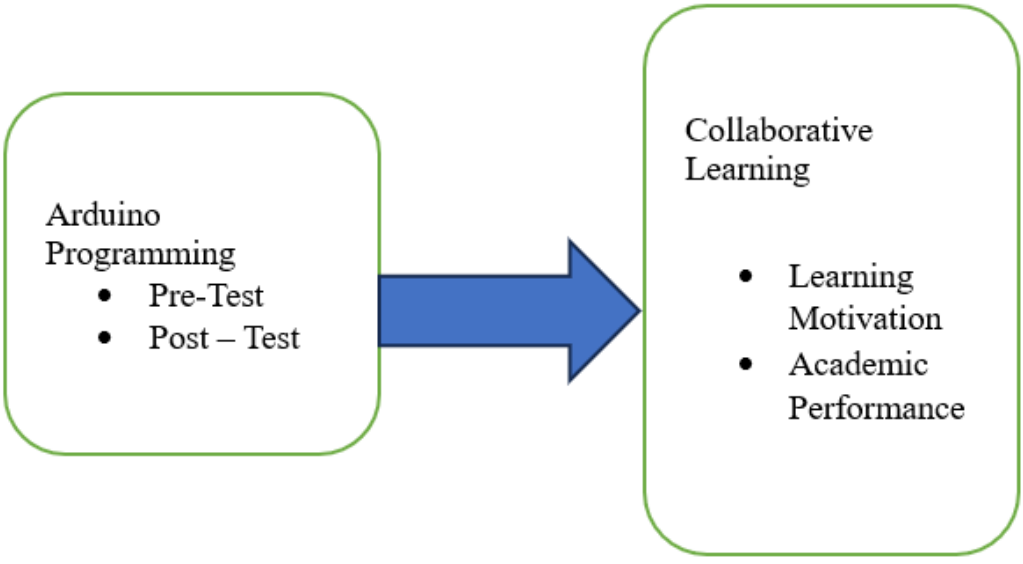
Administrators: This research has the potential to help administrators at the National University Bulacan campus understand the effectiveness of interventions using Arduino programming, providing valuable knowledge for decision-making.

Teachers: Educators can benefit from this study by gaining awareness of different interventions and their impact on students' motivation and academic performance. It can enhance their self-efficacy and teaching methods, aligning them with the educational system's goals.

Students: The study's findings can significantly influence students' learning achievements. By understanding the factors affecting their confidence and performance, students can work towards improving their academic skills and development.

Future Researchers: The research outcomes can serve as a valuable resource for future researchers, offering a foundational piece of literature. It can guide those interested in conducting similar studies, providing essential insights and a reference point for their research endeavors.

This study is anchored in Wing's (2006) research, which suggests that prioritizing the teaching of computational thinking is essential, even over traditional subjects like writing, reading, and mathematics. The research underscores the idea that every student has untapped potential in computational thinking, and this potential can be unlocked through the creation and practical application of programs. It emphasizes that CT is a skill that can be acquired through learning, rather than being an innate talent.



To evaluate the impact of Arduino programming and collaborative learning, the research requires an experimental design. The experimental group would be exposed to and taught with the use of both face-to-face classes and a demonstration of Arduino programming while the control group would only be given rubrics which are considered the traditional approach to learning.
The respondents of the study are 31 second-year computer engineering students in the age bracket of 19 to 22 years old at the National University Bulacan, this academic year 2022 – 2023.

As the primary tools for assessing the impact of Arduino programming and collaborative learning, the researchers would use teacher-made tests for the pre- and post-assessment tests.
The second-year computer engineering and grade 12 STEM students would be given diagnostic and pre-assessment tests prior to the implementation of Arduino programming and collaborative learning. The principal of the school, the Dean, and the program chair of the National University Bulacan would all be consulted before the researchers begin the actual research.
After receiving permission, the researchers would seek the approval of the parents or legal guardians of the students who would participate in the intervention program he or she has created. The researchers would now carry out the intervention program after receiving the consent. The intervention would be periodically reviewed and evaluated.

Data analysis software would help with the data obtained for the analysis, while the researchers would ask the statistician for assistance in the statistical treatment of the data. The information gathered through questionnaires would be processed by the computerized system using the Statistical Packages for Social Sciences (SPSS).

Findings

1. The investigation revealed that Arduino programming and collaborative learning have a substantial impact on both students' motivation (1.1) and their academic performance (1.2). The integration of these methodologies positively influences students' engagement and understanding, leading to improved performance.

2. Prior to the implementation of Arduino programming and collaborative learning, the pre-test results indicated students' baseline knowledge and motivation levels.

3. Following the application of Arduino programming and collaborative learning, the post-test results demonstrated notable improvements in students' understanding and motivation.

4. The study confirmed that Arduino programming and collaborative learning exert a significant positive effect on students' motivation.

5. The research also established that the combined use of Arduino programming and collaborative learning significantly enhances students' academic performance.

6. The findings shed light on the collaborative learning experiences that students encountered during and after the testing phase. These experiences fostered active participation, peer interaction, and problem-solving skills among the students.

In conclusion, Arduino programming and collaborative learning are valuable pedagogical approaches that enhance students' motivation and academic performance. The study suggests that educators and institutions should consider integrating these methods into their curricula to promote engaged and effective learning. Moreover, fostering collaborative learning experiences is imperative for achieving positive educational outcomes.

Recommendations:

1. Institutions should consider incorporating Arduino programming and collaborative learning into their teaching methodologies to bolster students' motivation and academic achievements.

2. Instructors should receive training and support to effectively implement Arduino programming and collaborative learning strategies, ensuring they can maximize the benefits of these approaches.

3. Further research is encouraged to delve into the long-term effects and scalability of these methods in diverse educational settings and subjects to better understand their potential advantages and limitations.

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