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Education 4.0: The Impact of Computer Architecture and Organization Course on Students' Computer Anxiety and Computer Self-Efficacy

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ABSTRACT

For the last 250 years, the world has experienced four educational revolutions, which have drastically changed the educational landscape as we know it. Today, the fourth (4th.) educational revolution has been making a profound impact on student learning by emphasizing on the following: (a) computer skills, (b) ICT and collaborative skills, and (c) lifelong learning. Premised in this context, this research was carried out to examine the impact of the Computer Architecture and Organization (CAO) course on student learning. A quantitative approach using the *pre-test post-test design* was used to collect and analyze the research data. The sample consisted of 80 computer science students of the Sultan Idris Education University, who were learning the CAO course. In the study, they were required to learn to carry out the following tasks in a computer laboratory: (a) assembling PC hardware, (b) installing the operating system, and (c) troubleshooting the PC. Pre-test and post-test were carried out at the beginning sessions and at the end of practical sessions, respectively. The data elicited from these tests were then analyzed using SPPS. The analysis of the pre-test scores revealed that only 40% of the students were able to correctly answer the test questions before the learning sessions. Interestingly, after the learning sessions, the analysis of the post-test scores showed that the number of students who managed to provide the correct answers had had increased substantially. More revealingly, 94% of the students managed to attain high scores in the practical test. In addition, the learning sessions managed to reduce computer anxiety and improve computer self-efficacy among the students. In view of these promising findings, it becomes the imperative of instructors and lecturers to focus on not only the theoretical aspects but also the practical aspects of the subject matter.

Key words: Computer architecture and organization, computer anxiety, computer self-efficacy, Education 4.0.

1. INTRODUCTION

In the era of smartphone classrooms, robotic home help, and online examination, among other novel applications, Education 4.0 is a new concept that was conceptualized to respond to the pressing needs of the forth industrial revolution (IR 4.0) where humans and machines are aligned with one another to seek solutions, to troubleshoot problems, and, of course, to discover new possibilities of innovation. In this regard, Sinlarat (2016) [6] asserts that the learning management of this era entails a new learning system that allows the learner to grow with knowledge and skills throughout his or her life, not just to know how to read and write. Hence, it is very crucial that an individual needs to have a strong ability to live in today's challenging society.

In recent years, the educational landscape has been shaped to improve the quality of education from the elementary to the tertiary level. It has become a global phenomenon that many universities are now focusing on their efforts to improve their academic programs to ensure students will have the sufficient level of knowledge and skills that are needed by the industries. For example, in the Computer Science degree program, the curriculum of the Computer Architecture and Organization (CAO) course has been updated and revised to improve its contents and pedagogical approach. In almost all institutions of higher learning (IHLs), this course is one of the core courses that computer science students need to master. Essentially, CAO emphasizes the association between computer hardware and software. It also focuses on many aspects of programming and software components in the computer system. To help gain the practical aspects of the course, students are trained to assemble all the critical computer components into a working computer with the necessary system software. Based on the principles of Education 4.0, the learning of CAO should focus on reducing computer anxiety and improving computer self-efficacy among students. Accordingly, this paper discusses the methodology of CAO assessment experiment, the analysis of CAO assessment experiment, and the impact of CAO course on Education 4.0.

2. METHODOLOGY OF THE CAO ASSESSMENT

The main objective of the assessment of the Computer Architecture and Organization (CAO) course is to evaluate the level of computer skills or competency of students in performing the following tasks: (a) Assembling computer, (b) Installing the windows operating system, and (c) Troubleshooting computer. This assessment contributes 30% of the overall students' marks for the CAO course. As such, all students are required to attend the practical sessions in the computer laboratory that is typically equipped with the latest hardware and software. Their work performances will be monitored and assessed by qualified demonstrators. In this study, we adopted the Standard Operating Procedure (SOP) as the methodology in this experiment to help us collect the experimental data from all the demonstrators. Effectively, we implemented the SOP in 3 phases as follows: (a) Introduction Session, (b) Assembling Task, and (c) Recording Results. In the introduction session phase, the CAO course coordinators briefly explained to the students the SOP and the method to record the results. The demonstrators started the first practical session with a computerized survey to determine students' prior knowledge of computers and educational background as shown in Figure 1.

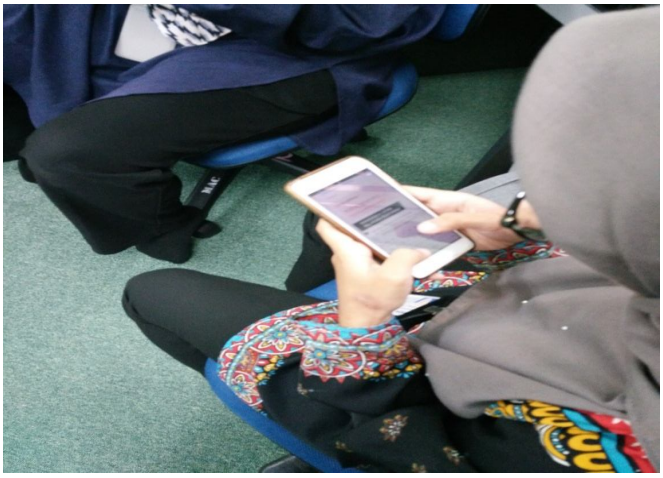

Figure 1. Introduction Phase: Students answering survey questions

Then, they used a computer model to explore and learn the basic computer components and how to assemble such components into a working computer. Subsequently, in the assembling task phase, the students were required to identify, select, and assemble the computer components correctly as shown in Figure 2. In the Recording Result phase, the demonstrators examined every student's assembled computer to determine if it would function perfectly. In addition, they would instruct the students to correctly identify specific computer components to test students' knowledge of the computer system.

Figure 2. Assembling Task Phase: Students assembling a computer.

3. RESEARCH FINDINGS

For the CAO assessment, both pre-test and post-test of students' understanding of the subject matter were carried out, allowing the researchers to determine if there was a significant impact of the practical sessions on students' understanding. Figure 3 and Figure 4 summarize the results of the pre-test and post-test of students' understanding of the computer system. As shown in Figure 3, overall knowledge of the of the students was quite poor, with 55 out of 80 (60%) failed to correctly answer the pre-test questions as opposed to only 40% who managed otherwise. Specifically, those who managed to correctly identify such components and devices of the computer system were represented by 40% of the students. Furthermore, more than two-thirds (75%) of the students failed to correctly identify the main components of the computer system.

In contrast, only 25% of the students managed to correctly identify such components. Likewise, more than half (62%) of the students failed to correctly identify the peripheral components. The remaining 38% of the students were able to correctly identify such components. Similarly, almost two–thirds (65%) of the students failed to correctly identify the input and output devices of the computer system. By contrast, only 35% of the students managed to correctly identify such components. Overall, the majority of the students, at 60%, was not able to identify the various components and devices of the computer system. Those who managed to correctly identify such components and devices of the computer system were represented by 40% of the students.

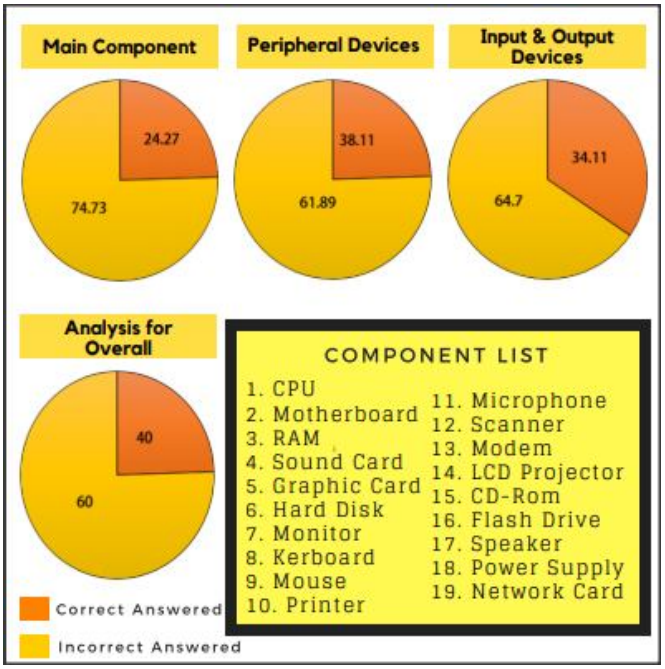

Figure 3. Pre-test Results

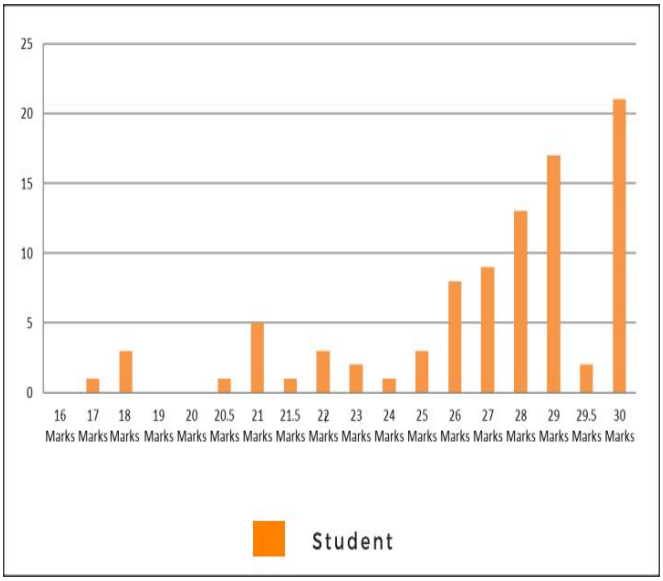

Figure 4. Post-test Results

Immediately after the last practical session on the eight week of the semester, the students took the post-test with the same questions as those of the pre-test. Figure 4 summarizes the individual students' overall scores of the post-test. Evidently, an overwhelming majority of the students (n= 64 or 80%) managed to correctly the questions. After taking the practical lessons, most students managed to improve their knowledge and skills in identifying, assembling, and installing computer components into a working computer system and in testing and troubleshooting such a system. Clearly, such an improvement strongly suggests that students need sufficient, well-crafted practical sessions to help reduce computer anxiety and to improve computer self-efficacy among students. As demonstrated in this study, the assessment of the CAO practical work will have a profound impact on enhancing students' computer skills.

4. **DISCUSSION**

As agreed by all, the Computer Architecture and Organization (CAO) course plays a central role in helping students to gain sufficient knowledge and skills of the computer system in almost all IHLs throughout the world. For example, in the Department of Computing of Sultan Idris Education University, Malaysia, CAO is a mandatory course that every computer science students has to learn and pass with a high grade before they are allowed to take other courses. In this course, students will learn all aspects of the design and organization of the central processing unit, memory, input/output (I/O) subsystem, and their incorporation into a computer system. While the computer architecture component of the CAO course mainly deals with the programmer's abstract view of the machine, the computer organization component of the subject matter deals with the practical view with regard to the implementation of the computer system in detail.

Arguably, these two views cannot be treated separately because of their strong mutual relationship. Obviously, mastering the CAO course entails students to have a sound understanding of both the theoretical and practical aspects and principles. In view of this imperative, the CAO course assessment should focus on providing students with hands-on experiences to help them bridge the gap between theoretical knowledge and practical problems. More importantly, from the perspective of Education 4.0, the synergistic fusion of the theoretical and practical aspects can help develop highly competent and skilled computer science students who have sound problem-solving ability, critical thinking, creative mind, decision-making skills, and cognitive flexibility. On a broader standpoint of Education 4.0, the CAO course can also has a great impact on the society by providing basic computing education for everybody.

Generally, the interdisciplinary concept of computing education is based on three pillars as follows: (a) computer science as exact and analytic science (informatics), (b) ICT user skills (digital literacy), and (c) digital media literacy. Based on the interdisciplinary concept, the CAO course contributes significantly to the development of the necessary ICT user skills of students. For instance, mathematics, writing, and the design and development of a prototype can be learned with the use of a computer. As observed in this study, the CAO course can also improve computer self-efficacy and reduce computer anxiety among students, making the aspirations of Education 4.0 a reality. As one of the Education 4.0's goals is to educate young generation, such that they can become a valuable human asset who can effectively and efficiently use machines and computers, the role played by the CAO assessment should not be understated. In this regard, improving students' self-efficacy through the CAO assessment can serve as the first step to preparing students in

Industry 4.0 where automation will be a common place. In conclusion, the CAO course can help realize the aims of Education 4.0 by continually reshaping and enhancing students' mind in order to face Industry 4.0, which particularly emphasizes the importance of computing skills.

5. CONCLUSION

The findings of this research clearly shows how the Computer Architecture and Organization course can have a profound impact on Educational 4.0 by reducing computer anxiety and improving computer self-efficacy among students through proper assessment. Essentially, Education 4.0 is student-centered education by recognizing that students are not alike, who do not have the same level of knowledge and skill and who learn at different paces, thus requiring constant guidance from teachers and instructors. In fact, the need for such guidance is important for students pursuing challenging degree programs, such as computer science. For example, as highlighted in this research, the CAO course plays a vital role in helping students to effectively learn all the critical theoretical principles and components of the computer system and to apply such elements in a practical context in which a working computer system will be designed, developed, and tested. In a sense, this combination of theoretical knowledge and practical skills mirrors the alignment of Education 4.0 with Industry 4.0, the aim of which is to prepare students for the next industrial revolution, which inevitably will take place in their later life. To summarize, the Computer Architecture and Organization course can help reduce computer anxiety and improve computer self-efficacy among students using the Educational 4.0 approach, whose knowledge and skills will be crucial in making our economy more sustainable and vibrant over the long run.

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