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ACADEMIC WORLD: HOW DO WE FACE THE CHALLENGES OF FOURTH INDUSTRIAL REVOLUTION?

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Abstract

The fourth industrial revolution is impacting everyone in certain aspects. Entering the digital age in this 21st century, digital literacy appeared to be an advantage to better suit in this era especially for an engineer with the background of computer science or electrical and electronic engineering. Yet, in Malaysia, for educators especially teachers in primary and secondary schools, it might be a bit challenging for them. The Design and Technology subject, as the replacement for Integrated Living Skill subject, is hoped to get the younger generation ready for challenges in the fourth industrial revolution. The Standard Document for Curriculum and Assessment of the Design and Technology subject uses Magnetcode as main tool for programming and system control. The aim of this study is to investigate the capability and readiness of non-engineering and non-information-technology teacher trainees in facing the era of forth industrial revolution via project development. Subject of this study is final year undergraduate students under the program of Agricultural Science and Home Economics. Formative assessment is used to evaluate the output. In conclusion, multidiscipline appeared to be a solution for current generation to face the challenges by fourth industrial revolution, especially for those who are not from engineering or information technology backgrounds. Suitable platform with sufficient facilitations, facilities and resources could help to prepare those non-engineering and non-information-technology background teacher trainees to be more ready for fourth industrial revolution.

Keywords: Design and technology, educators, fourth industrial revolution, Magnetcode.

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1. Introduction

The fourth industrial revolution is changing all disciplines, impacting individuals and societies in certain aspects (Forum, 2016; Hammes, 2017; Peters, 2017). This is an era with the advancement in technologies which integrates the digital, physical as well as the biological systems, fundamentally altering and reshaping various disciplines, including the way we live, work, and relate to one another. Artificial intelligence, robotics, machine learning, big data analytic, virtual reality and augmented reality are some keywords relevant nowadays in this digital era. Whilst technological advancements are undoubtedly improving life quality, concerns over job disappearance arises (Butler-Adam, 2018; Hirschi, 2018). Digital literacy apparently becomes an advantage to suit better in this era (Caruso, 2018; Petrillo, De Felice, Cioffi, & Zomparelli, 2018).

In academic world, science, technology, engineering and mathematics (STEM) as a curriculum that fuses the four disciplines together into a cohesive learning paradigm for real-world applications is becoming more and more important. As educators, it is necessarily to be equipped with soft skills apart from the fundamental knowledge in the specialized fields (Lindborg, 2017; Penprase, 2018). Educators are not only for delivering theories but also to promote character qualities as well as interpersonal skills. Teacher trainees who will soon become the teachers of young generation should realize and aware of their responsibility and accountability. They are playing significant roles in shaping their students to be ready to face the challenges of the fourth industrial revolution (Anangisye, 2011; Bailey, 2014; Cardullo, Wilson, & Zygouris-Coe, 2018; Jones, 2000). Future graduates are expected to possess knowledge, skills and values which enable them to walk confidently into a number of careers (Tang, Tan, Che'Rus, Azman, & Hanapi, 2018). As a result, responsibilities of educators are undeniably huge.

Recently, active learning is gaining its popularity in higher education institutions (Christie & de Graaff, 2017; Kaiser & Menkhoff, 2018; Karabulut-Ilgu, Jaramillo Cherrez, & Jahren, 2018). It emphasizes on students' full involvement and engagement throughout the learning process. Examples of active learning instructional strategies include class discussions, group presentations such as debate and role play, project-based learning, flipped classroom, problem-based learning etc. Studies revealed that active learning is effective, particularly in the improvement of learning performance (Akçayır & Akçayır, 2018; Al-Zahrani, 2015; Loeb, 2015).

2. Problem Statement

In the secondary schools in Malaysia, from year 2017, the Design and Technology subject gradually replaced the Integrated Living Skill subject (which was introduced since 1989) with the aim to get the younger generation ready for challenges in the fourth industrial revolution. This're-branded' subject emphasizes on product development based on technology. The syllabus covers several fields, including civil, electrical and electronic, mechanical, home science, agricultural science and financial management. Sometimes, a subject was taught by teachers from non-option (Halim, Samsudin, Meerah, & Osman, 2006; Hwang & Embi, 2007; Wee, 2013). Thus, apart from the lacking of the knowledge and skills in the relevant fields, the teachers might suffer from health problem resulting from stress in handling those subjects.

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As mentioned, one of the issues arise is the lacking of the knowledge and skills in the relevant fields. The Standard Document for Curriculum and Assessment of the Design and Technology subject uses Magnetcode as main tool for programming and system control. Although the coding method and command syntax of Magnetcode appeared to be simple, secondary school teachers are facing challenges in learning and teaching the programming part as they do not have any basic knowledge in relevant fields. Furthermore, lack of training opportunities and time to practice, together with the lack of initiative to learn new things might further worsen the condition.

3. Research Questions

This study is conducted to answer the following research questions:

3.1. How can non-engineering and non-information-technology teacher trainees prepared themselves to be ready for fourth industrial revolution?

Fourth industrial revolution is closely related to technologies. Apparently, those without background knowledge of relevant fields might eventually end up as ‘end-user’ or victims under the revolution. The changes occurred have its pros and cons. The human life quality has unquestionably improved in many aspects. Yet, it is predicted that many jobs are going to disappear as they are replaceable by automated robots. In order to remain relevant, it is therefore necessary to be alert with current trend and take effort to minimize the knowledge gap. In other words, this study seeks answer for question “what are the challenges faced by non-engineering and non-information-technology teacher trainees”.

3.2. Is Magnetcode a suitable platform for beginners to learn programming?

The Standard Document for Curriculum and Assessment of the Design and Technology subject uses Magnetcode as main tool for programming and system control. The question here is whether this tool is suitable to be used for beginners without basic in programming to learn programming as well as the interfacing among devices. Current situation reveals that the secondary school teachers might not be exposed to programming or hardware interfacing throughout their career as teachers.

4. Purpose of the Study

Fourth industrial revolution is a fusion of advances in multiple fields of technologies, including Internet of Things, artificial intelligence, machine learning etc. The concern arises here is whether teacher trainees without prior knowledge in relevant fields such as programming are capable to reduce the gap between themselves and fourth industrial revolution, and at the same time keep themselves remain relevant and employable in this storm of technologies. The aim of this study is to investigate the capability and readiness of non-engineering and non-information-technology teacher trainees in facing the era of fourth industrial revolution via project development. Also, this study aims to know if the Magnetcode, the main tool for programming and system control used in the Standard Document for Curriculum and Assessment of the Design and Technology subject, serves as a suitable platform for beginners to learn the main idea of basic programming.

5. Research Methods

There are three phases in this study, namely training, product development and evaluation. Active learning through project-based learning is employed. In this study, the subjects of interest are 92 final year undergraduate students from non-engineering and non-information-technology backgrounds. More specifically, they are teacher trainees undertaking the Bachelor of Education (Agricultural Science) and Bachelor of Education (Home Economics) in a Malaysian public university. The platform for this study is the Magnetcode, the main tool for programming and system control used in the Standard Document for Curriculum and Assessment of the Design and Technology subject. The interfacing and usage of Magnetcode is relatively simple as compared to other programming languages and thus enables educational-background teacher trainees to learn basic programming as well as interfacing among sensors, controllers and actuator during the development of projects.

5.1. Training via Active Learning

Teacher trainees were divided into 25 groups with 3 to 5 members. They attended a six-hour workshop to learn the basic operation about Magnetcode, beginning with the architecture of the Carrot Project Board such as input and output pins to the programming. These teacher trainees also learnt about the interfacing of devices, such as temperature sensor, relay, motor etc. with Carrot Project Board and control via mobile phones. A Magnetcode Kit was provided to every group, which includes Carrot Project Board as processor with other electronic components and devices. These teacher trainees are expected to be fully engaged throughout the workshop.

5.2. Product Development

The coding method and command syntax of Magnetcode is relatively simple. The teacher trainees were guided to develop simple projects such as automated fire extinguisher and automated hand washing machine. Project based learning exposes them to not only core academic knowledge, but also let the teacher trainees to encounter with real problem-solving situations. During the problem-solving process, they get to develop their virtues and skills. After the workshop, teacher trainees were given a week to propose idea on the project that they wished to develop. After proposal defence, they were given three weeks to develop product based on Magnetcode. They received guidance and supervision by three specialist staffs and a technician. They were also required to prepare a report that offers these teacher trainees an opportunity to write scientifically their leaning process as well as outcomes.

5.3. Product Evaluation

A competition was organized to evaluate the products by teacher trainees. Rubric with ten evaluation criteria was developed. A total of fourteen panels were invited. Twelve out of fourteen panels are with qualification of Doctor of Philosophy while the remaining has qualification of Master Degree. Panels were given the evaluation rubric. Ten evaluation criteria used are as demonstrated in Table 01.

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Table 01. Evaluation criteria with mark distribution

No.	Evaluation Category	Evaluation Criterion	Marks (%)
1	Product	Novelty of idea	10
2		Appearance of product	10
3		Functionality	10
4		Suitability of materials and tools	10
5		Marketability	10
6		Level of complexity	10
7	Presentation	Tone of voice and vocal clarity	10
8		Content	10
9		Self confidence, posture and body language	10
10		Ability to answer questions	10

6. Findings

Findings of this study are divided into two parts:

6.1. Training

Based on the investigation by speaker and facilitators, all teacher trainees were able to follow steps and successfully performed the programming and hardware interfacing tasks. During the hand-ons, teacher trainees actively participated. Based on feedbacks by a few randomly selected teacher trainees, the workshop is beneficial to them. Parts of the comments by teacher trainees are as demonstrated in Table 02.

Table 02. Participants' comment regarding the workshop

Respondent No.	Comments
1	*It was a great experience. Before this, it was impossible for me to learn programming. I always thought that only engineers learn programming.*
2	*Programming is something totally new to me. I have learnt a lot from the workshop.*
3	*I enjoyed this workshop.*
4	*I did not expect that programming can be done by me one day.*
5	*I am happy with the hand-ons results. It really works.*
6	*Programming is not that difficult as I thought before.*

Based on Table 02, it can be concluded that for non-engineering and non-information-technology teacher trainees, Magnetcode has successfully open their minded about programming. The teacher trainees enjoyed the workshop while gaining new experience and knowledge. Magnetcode appeared to be a good choice for beginner to get know about basic programming.

6.2. Competition

The teacher trainees successfully developed various products using Magnetcode. Examples of products are demonstrated in Figures 01, 02, 03, 04 and 05. Model is developed based on the defended proposal. There were both positive and negative feedbacks from panels. Parts of these comments are as presented in Table 03.

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Figure 01. Smart Home

Figure 02. Automated gate control for railway station

Figure 03. Automated roof

Figure 04. Automated gate

Figure 05. Automated bridge

Table 03. Panels' comment regarding the competition

Panel No.	Comments
1	*All teacher trainees demonstrated great potential in product development using microcontroller.*
2	*Innovative products. Can be improved by using TRIZ (i.e., Theory of Inventive Problem Solving) method.*
3	*The teacher trainees know well about what they are doing. They are able to give justification on the choices of product.*
4	*The products should be further improved, especially for the materials.*
5	*The teacher trainees should improve their presentation skills.*

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Table 04 presents the mean and standard deviation of scores for every evaluation criterion. The range of mean value lies between 6 and 7, indicating an average performance in overall. The standard deviation is highest for the evaluation criterion of functionality. This is due to the extreme case where there is a product that failed to function on the day of competition. In terms of product, the highest mean score is achieved by the evaluation criterion of functionally, revealing that most of the products are capable to perform the desired function as proposed. An evaluation criterion for the novelty of idea has the lowest mean score (i.e., 6.176). This shows that the teacher trainees still lack of creativity during product development. This may be contributed by several factors, including lacking in product development time, lacking in product development experience that is based on programming and cost constrain.

On the other hand, for the evaluation category of presentation, the highest mean score is posses by the evaluation criterion of self-confidence, posture and body language, with a value of 7.255. This indicated that the teacher trainees are well-trained in terms of their confident level, whereby they did not have social anxiety with nervous body language. This can be credited to years of training as teachers via numerous presentations and teaching training. Nonetheless, the lowest score is obtained for the evaluation criterion of content. This is in line with some of the comments by panels, where the teacher trainees did not highlight the issues they were trying to solve, but only presented details about the developed products. Standard deviation values are similar for all the four evaluation criteria, falls between 1.452 and 1.596. This shows that the panels' scores averagely different around 1 to 2 marks, indicating that the evaluation is relatively homogeneous.

Table 04. Mean and standard deviation of scores for every evaluation criteria (Note that the largest value for each evaluation category is bolded)

No.	Evaluation Category	Evaluation Criterion	Mean	Standard Deviation
1	Product	Novelty of idea	6.176	1.740
2		Appearance of product	6.353	1.718
3		Functionality	**7.275**	**2.031**
4		Suitability of materials and tools	6.902	1.418
5		Marketability	6.314	1.703
6		Level of complexity	6.216	1.826
7	Presentation	Tone of voice and vocal clarity	7.176	1.452
8		Content	6.824	**1.596**
9		Self-confidence, posture and body language	**7.255**	1.481
10		Ability to answer questions	7.176	1.493

Findings from this study should be interpreted with caution due to several study limitations. The study involved relatively heterogeneous population. The sample is restricted to the teacher trainees from a faculty of a Malaysian university only. Future studies should include data from faculties from multiple universities in Malaysia. Another limitation of the present study is the potential bias arising from subjective evaluation during competition, peer pressure and ill communication.

7. Conclusion

Multidiscipline could be a possible solution for current generation to face the challenges by fourth industrial revolution, especially for those who are not from engineering or information technology backgrounds. Suitable platform with sufficient facilitations, facilities and resources could help to prepare non-engineering and non-information-technology background teacher trainees to fill the knowledge gap between them and fourth industrial revolution. Full support to cater the needs of teacher trainees helps to keep them relevant in the era of fourth industrial revolution while facing the storm of technologies. Besides, this study shows that Magnetcode appeared to be one of the suitable platforms for beginners to learn programming and hardware interfacing. A Magnetcode Kit that includes Carrot Project Board as processor with other electronic components enables educational-background teacher trainees to learn basic programming as well as interfacing among sensors, controllers and actuator during the development of projects easily. Given the positive output results, this paper concludes with a call for more study and further research into this pedagogy for multidiscipline to contribute to its knowledge base across disciplines.

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