THE EFFECT OF A ROBOTICS PROGRAM ON PRIMARY SCHOOL STUDENTS' ATTITUDE TOWARDS SCIENCE AND PROBLEM SOLVING

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FACULTY OF PSYCHOLOGY AND EDUCATION
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DECLARATION

I hereby declare that the material in this thesis is my own except for quoatations, equations, summaries and references, which have been duly acknowledged.

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08 August 2022

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ABSTRACT

This study was conducted to see the effect of robotics program on primary school students' attitude towards science and problem solving. Students interest towards science and mathematics already lacking as early of primary school because of less engagement in teaching and learning. There are less hands on teaching in primary school compare to secondary and tertiary education. This has lead to primary school students' attitude towards science and problem solving lacking. Besides that, studies related to Integrated STEM Approach with students attitude at primary school level are still lacking and it is largely focused on higher institutions. Hence, this study has been carried out to see the effect of robotics program on primary school students' attitude towards science and problem solving. This study uses a quantitative approach method with a quasi-experimental design involving treatment group (Malacca schools students) and control group (Selangor schools students). A total of 374 primary school students from year six under Ministry of Education Malaysia from Malacca and Selangor were involved in this study. Two questionnaires were used, namely the Test of Science Related Attitudes (TOSRA) was used to measure the attitude towards science of students as well as the Solving Problem Survey questionnaire on attitude towards problem solving. The statistical tests performed were the Repeated Analysis of variance (ANOVA), and One-way Analysis of Covariance (ANCOVA) at a significant level of $p < 0.05$. Researcher looked at the Mauchly's test for Sphericity as well as subject effect size because the measurements were performed at three different time periods (pre-test, post-test 1 and post-test 2). The results of the analysis showed that the treatment group (Malacca schools students) and control group showed significant changes in the three time periods. Yet the researcher looked at the subject effect size value, which showed the treatment group was higher than the control group. For attitude towards science and problem solving experiment group showed significant changes when compared with the control group.It is suggested that the robotics program can be applied to see improvement in primary school students attitude towards science and problem solving. However, this method needs to be tested using other attitudes so that the effect of robotics program can be seen more holistically.

Keywords: Robotics; Attitude Towards Science; Attitude Towards Problem Solving

ABSTRAK

KESAN PROGRAM ROBOTIK DALAM SIKAP PELAJAR SEKOLAH RENDAH TERHADAP SAINS DAN PENYELESAIAN MASALAH

Kajian ini dijalankan untuk melihat kesan program robotik dalam sikap pelajar sekolah rendah terhadap sains dan penyelesaian masalah. Minat pelajar terhadap sains dan matematik sudah berkurangan seawal sekolah rendah kerana kurang penglibatan dalam pengajaran dan pembelajaran. Pembelajaran berasaskan hands on di sekolah rendah kurang berbanding dengan sekolah menengah dan pengajian tinggi. Ini telah menyebabkan sikap pelajar sekolah rendah terhadap sains dan kurang menyelesaikan masalah. Selain itu, kajian berkaitan Pendekatan STEM Bersepadu dengan sikap pelajar di peringkat sekolah rendah masih kurang dan ia banyak tertumpu kepada institusi tinggi. Justeru, kajian ini telah dijalankan untuk melihat kesan program robotik terhadap sikap pelajar sekolah rendah terhadap sains dan penyelesaian masalah. Kajian ini menggunakan kaedah pendekatan kuantitatif dengan reka bentuk kuasi eksperimen melibatkan kumpulan rawatan (pelajar sekolah Melaka) dan kumpulan kawalan (pelajar sekolah Selangor). Seramai 374 orang murid sekolah rendah tahun enam di bawah Kementerian Pendidikan Malaysia dari Melaka dan Selangor telah terlibat dalam kajian ini. Dua soal selidik telah digunakan iaitu Ujian Sikap Berkaitan Sains (TOSRA) digunakan untuk mengukur sikap terhadap sains pelajar serta soal selidik Tinjauan Penyelesaian Masalah (Solving Problem Survey) mengukur sikap terhadap penyelesaian masalah. Ujian statistik yang dilakukan ialah analisis pengulangan Analysis of variance (ANOVA), dan Analysis of Covariance (ANCOVA) satu hala pada tahap signifikan p <0.05. Penyelidik melihat ujian Mauchly untuk Sphericity serta saiz kesan subjek kerana pengukuran dilakukan pada tiga tempoh masa yang berbeza (ujian pra, ujian pasca 1 dan ujian pasca 2). Hasil analisis menunjukkan kumpulan rawatan (pelajar sekolah Melaka) dan kumpulan kawalan menunjukkan perubahan yang ketara dalam tiga tempoh masa. Namun pengkaji melihat nilai saiz kesan subjek, yang menunjukkan kumpulan rawatan adalah lebih tinggi daripada kumpulan kawalan. Bagi kumpulan eksperimen sikap terhadap sains dan penyelesaian masalah menunjukkan perubahan yang ketara jika dibandingkan dengan kumpulan kawalan. Program robotik dicadangkan untuk melihat peningkatan sikap pelajar sekolah rendah terhadap sains dan penyelesaian masalah. Walaubagaimanapun, kaedah ini perlu diuji menggunakan sikap lain supaya kesan program robotik dilihat secara lebih holistik.

Kata Kunci: Robotik, Sikap Terhadap Sains, Sikap Terhadap Penyelesaian Masalah

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LIST OF ABBREVIATIONS

ARCS	-	Attention, Relevance, Confidence, Satisfaction
HOTS	-	High Order Thinking Skills
ICT	-	Information and Communication Technology
IFR	-	International Federation of Robotics
IR	-	Industrial Revolution
MOE	-	Ministry of Education
NCTM	-	National Council of Mathematics Teachers
OECD	-	Organisation for Economic Co-operation and Developments
PISA	-	Program for International Student Assessment
PYD	-	Positive Youth Development
RBT	-	*Reka Bentuk dan Teknologi*
SJK T	-	*Sekolah Jenis Kebangsaan Tamil*
STEM	-	Science, Technology, Engineering, Mathematics
TIMSS	-	Trends in the International Mathematics and Science Stusy
TMK	-	*Teknologi Maklumat dan Komunikasi*
TOSRA	-	Test of Science Related Attitude

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CHAPTER 1

INTRODUCTION

1.1 Introduction

From the advent of modern mankind 3 Industrial Revolutions (IR) have changed and redesigned the human landscape. The first Industrial Revolutions (IR 1.0) took place in year 1784 which focus on mechanization, IR 2.0 in year 1870 focusing on mass production, and the IR 3.0 on year 1969 which focuses on automation. Now, we are at the verge of Forth Industrial Revolution (IR4.0) defines by borderless technology, augmented reality, artificial intelligent and robotics. The World Bank predicts in 30 years only 1% of current knowledge will remain relevant. Many initiatives & policies was initiated by Malaysia government to improve students attitude towards science and problem solving, particularly on the year 2012 through Science to Action (S2A) policy to achieve Science to Arts ratio of 60:40. But in reality, it's still remained unachievable.

Nevertheless, Malaysia has been still lagging behind in international Science and Mathematical assessment programs such as the Program for International Student Assessment (PISA) for secondary students and the Trends in the International Mathematics and Science Study (TIMSS). Malaysia's achievement in TIMSS & PISA 2015, still below the international average and well below countries that use their mother tongue in the teaching of Science and Mathematics (MOE, 2016). Almost 60% of Malaysian students fail to achieve a minimum benchmark in Mathematics, which is the basic proficiency that students need for active and productive participation in life. Similarly, 43% of students did not achieve a minimum benchmark in Science. According to the Organisation for Economic Co-operation and Development's (OECD) PISA 2018 findings, Malaysia's performance remains below

the OECD's minimal standard (OECD, 2019). In 2020 National STEM Movement Chairman Dato' Professor Dr. Noraini has mentioned only 19% of students enrolling to STEM related courses in secondary school and higher institutions and the encouragement to pick up these courses should be given to students from primary schooling time (Chonghui, 2020). This shows Malaysia students interest and attitude towards science and problem solving is lacking behind.

Many research indicates that the motivation and attitude of children towards science and problem solving decreases from primary to secondary school. In United Kingdom, evidence shows that even in primary school children's attitudes towards school science are deteriorating (Murphy and Beggs 2001; Pell and Jarvis 2001). Besides that, a study involving year 7 to 8 (12years old) students conducted in United Kingdom on a topic Young People's Views on Science Education. The study has indicated the students less enjoy studying Science related subjects from primary school (Hamlyn et al., 2020). Another research concluded that the attitudes of students towards science are continuously increasing negatively as their ages grow, and that student's behavior towards science and technology are formed between the ages of 10-14 has a huge effect on their future professional desires (Osborne, as cited in Denessen et al.,2015). In a survey conducted with fourth to eighth grade students, the findings show that the attitudes of students towards science reduced as the class level increased (Kapici & Akcay, 2016), and the attitudes of students towards science typically declined in middle and high school years (George, 2000).

Lyons (2006) cites that the English, Australian, and Swedish students' express the science content is often boring and irrelevant to the preferences and expectations of students without attempting to engage their interest or establish application to "everyday life" contexts. It is just like United States & Turkey students who think too much memorization exists in science (Tasci, 2020; Ye et al., 1998). In Sweden and Australia, Lyons states that "students bring to non-science subjects to meet the interests that science courses should address" (Lyons, 2006). The term "boring" was used to describe their science learning process by more than one in five of Australia's highly successful students, and students who plan to continue studying science. Boredom with the content of the course is so widespread in Sweden make students

who originally aim to careers involving science finally conclude that "science is so boring that they have given it up" (Lyons, 2006,). It is crucial to take note students are turning down because less engaging learning materials as well a lot of memorizing contents in science and eventually this lead to students attitude towards science constantly decreases.

Many professional and industry positions in coming years require employees who are skilled in the areas of Science, Technology, Engineering, and Mathematics (STEM). Realizing this, the researcher believes 21st century students must equip with STEM knowledge which can improve their attitude towards science and problem solving to remain relevant in future. One of the best way to do this is through robotics program in schools. Robotics is compact with hands on practical which train students towards Science, Technology, Engineering, Mathematics (STEM). The researcher also has strong believe, through robotics program students' attitude towards Science and Problem-Solving Skills will improve. Robotics also can be integrated with many subjects such as Science, Mathematics, ICT and etc. Robotics programs not only limited to fixing and unfixing robotics parts but in wider scope. Learning robotics will expose students to hardware functions & troubleshooting such as sensors, motors, battery, and wires. Students also will be learning softwares and digital languages which includes coding and programming such as SCRATCH, C++, Python, Java etc. The combinations of learning hardware and software through robotics will improve student's attitude towards science and problem solving.

There are new areas such as artificial intelligence, genome, mobile computing, smart phones, virtual reality, metadata and 3D printing that dominate the manufacturing market (Nordkvelle & Olson, 2005). Many industrial experts have seen that the human being is replaced by the expertise of the field of artificial intelligence with millions of people may lose jobs especially in the manufacturing sector (Sima et al., 2020; Marsili, 2005). The world has also witnessed a change in job landscape focusing on the field of artificial intelligence and complex information network. Artificial Intelligence has been the pillar of the revolution to reduce human error by using the latest technology acumen (Owen et al., 2013). Artificial intelligence is widely used to create an effective working environment in terms of cost and to

reduce human error for a product production (Owen et al., 2013). Hence, the emergence of the fourth industrial revolution had impacted and reconstituted the economy, social and education to be in line with the need to expand the revolution (Roberts, 2016).

Education has been the most important element in providing skilled workers who been backbone of the artificial intelligence (Roberts, 2016). This had affects the use of artificial intelligence products in class for early exposure for students. One of the most frequently used artificial intelligence products is the robot which is a machine that make humans easier to be used in areas such as engineering, computer science and science. Williams et al. (2007) stated that the robot is used in various fields of knowledge from mechatronics to the theory as well as from electronic to computer science. The field of robotic has developed its use to the exploration of space, military and heavy Industries (Gallagher et al., 2016) as well as domestic life (Frennert, 2016). Between 2014 to 2015 robot sales increased to 25% in the field of professional services, 16% of the personal service field and 45% in the field of education (Rosenthal & Krämer, 2014). The International Federation of Robotics (IFR) also released their annual World Robotics Report on 18 September 2019 saying in 2018 global robot installations increased by 6% to 422,271 units, worth USD 16.5 billion (without software and peripherals) compared to 2017. IFR also predict 2019 shipment will have slight reduce but they expecting 12% of average growth per year from 2020 – 2022. The International Federation of Robotics (IFR) expects 3 million robots to be sold over 2016 to 2019 for the purpose of education (Nugent et al., 2012). This development shows that a robot is not only an invention of science fiction, but also the robot begins to be used in class as an educational technology tool involved in the learning process to improve students attitudes (Bers & Portsmore, 2005; Cejka et al., 2006; Chambers & Carbonaro, 2003; Groff & Pomalaza-Raez, 2001).

Educators began to create ideas to develop a robot-based activity in learning processes involving mathematical, science and engineering subjects (Hallak et al., 2019; Bratzel, 2005). The use of robots in the learning process often involves games (Challinger, 2005; Arkin, 1998). The concept of the game is the new idea that leads

to the education system to allow students to be motivated, improve their science and problem solving skills to explore content through the mechanical and dynamic concepts found in the game process (Losup & Epema, 2014). A robot integration as a real object in the game was introduced in the 21st century and it is a new teaching technique that teachers can explore in tandem with the development of the dominant robotic technology in this century (Reich-Stiebert & Eyssel, 2015). The use of game robots in learning process is guided by the latest technology to improve education quality by attracting awareness and motivation of students for the mastery of learning content, perhaps students attitude towards science (Metta et al., 2010; Petre & Price, 2004) to be in line with the development of the fourth industrial revolution (Sung et al., 2009). This is because students are able to learn the technical elements involving in the robot and the contents through a game designed by the teacher (Losup & Epema, 2014).

Apart from that, this fourth industrial revolutionary growth demands teachers to produce competitive students with the theories and concepts mastery for the purpose of integration in advanced technology (Sharkey, 2016). Students who are weak in academic especially in content mastery should be addressed so they are not be missed in the learning process. This will lead them not only mastering in content but develop their problem solving and STEM skills which eventually will show positive attitude improvement towards science and problem solving. The vast academic divide effects the quality of the current workforce as the mastery of content needs to be in line with the latest skills (Reich-Stiebert & Eyssel, 2015; Leyzberg, 2014; Sidner et al., 2005). Skilled labour personals need to have creative and innovative thinking, able to solve problems, literacy on technology and have effective communication so as to interact well with artificial intelligence technology (Sidner et al., 2005). Besides that, for students, educational robotics can be used to enhance their learning as well improve their attitudes. In British secondary schools, there was a substantial increase in math test scores compared to previous years in students who participated in project-based programs like robotics (Boaler, 1999). Additional research indicates that student learning through project-based programs can result in high test scores in mathematics, science and writing (Honey & Henriquez, 1996). Introducing robotics programs to students are a proactive step in promoting science and technology