Malaysian Journal of Social Sciences and Humanities (MJSSH) (e-ISSN : 2504-8562)
2022, Volume 7, Issue 4, e001422
DOI: https://doi.org/10.47405/mjssh.v7i4.1422

The Effect of Robotics Program on Students Attitude Towards Science

Thiwagar Muniandy[1], Sabariah Binti Sharif[2], Muralindran Mariappan[3*]

[1]Faculty of Psychology and Education, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia.
Email: thiwagarsmc@gmail.com
[2]Faculty of Psychology and Education, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia.
Email: sabariah@ums.edu.my
[3]Faculty of Engineering, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia.
Email: murali@ums.edu.my

CORRESPONDING AUTHOR (*):
Muralindran Mariappan
(murali@ums.edu.my)

KEYWORDS:
Robotics Program
Attitude Towards Science
Primary School Students

CITATION:
Thiwagar Muniandy, Sabariah Sharif, & Muralindran Mariappan. (2022). The Effect of Robotics Program on Students Attitude Towards Science. *Malaysian Journal of Social Sciences and Humanities (MJSSH), 7*(4), e001422. https://doi.org/10.47405/mjssh.v7i4.1422

ABSTRACT

The purpose of this research is to study the effect of robotics program on students attitude towards science. A total of 374 year 6 students (12years old) involving 10 primary schools from Malacca and Selangor have participated in this study. The researcher used Test of Science Related Attitudes (TOSRA) questionnaire developed by Fraser (1981) to measure students attitude towards science. In this study the researcher used a non-survey quantitative approach method with a quasi-experimental design involving treatment and control group. The changes in students attitude towards science was measured in three different times involving pre-test, post-test 1 and post-test 2. The researcher has performed two inferential statistical test, Repeated Measures Analysis of Variance (ANOVA) and One-way Analysis of Covariance (ANCOVA) at significant level of $\alpha < 0.05$. The analysis results showed both control and treatment groups have significant changes in attitude in three periods (Pre-test, Post-test 1 & Post-test 2). However, Subject Effect size shows that the treatment group has a high improvement and the desired effect in attitude towards science with robotics program compared with control group without robotics program.

Contribution/Originality: This study contributes to the existing literature related to the use of robotics program to improve students' attitude. This study uses new estimation methodology especially to teachers who are directly involved with students in the teaching process and hand on activities as well provided enlightenment to educators to make a paradigm shift from traditional teaching method to technology-assisted student oriented teaching.

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

1. Introduction

Malaysia continues to fall behind in international science and math assessment programmes such as the Program for International Student Assessment (PISA) for secondary students and the Trends in International Mathematics and Science Study (TIMSS). Malaysia's performance in TIMSS and PISA 2015 is still below the international average, and it lags well behind nations that teach science and mathematics in their native language (MOE, 2016). Malaysia's performance remains below the OECD's minimum threshold, according to the findings of the Organisation for Economic Co-operation and Development's (OECD) PISA 2018 (OECD, 2019). According to Chairman of the National STEM Movement Dato' Professor Dr. Noraini, only 19 percent of children participate in Science - related courses in secondary school and higher education, and students should be encouraged to take these courses starting in primary school (Chonghui, 2020). The International Federation of Robotics (IFR) predicts that 3 million robots will be marketed for educational purposes between 2016 and 2019. (Nugent et al., 2012). This breakthrough demonstrates that a robot is no longer only a science fiction creation, but is now being employed in the classroom as an instructional technology tool to enhance students' attitudes (Bers & Portsmore, 2005; Cejka et al., 2006; Chambers & Carbonaro, 2003; Groff & Pomalaza-Raez, 2001). Educators started brainstorming concepts for a robot-based activity in learning processes combining mathematics, science, and engineering (Hallak et al., 2019; Bratzel, 2005). Robots are frequently used in the learning process to play games (Challinger, 2005; Arkin, 1998). The game's design is a novel approach to teaching that allows students to be motivated and develop their science abilities. Therefore, it is crucial that robots be used in the classroom in order to generate children that have a good attitude toward science. Researcher believe through these strategy students will be intellectually and practically competent in the fourth industrial revolution.

1.2. Problem Statement

The Malaysian Ministry of Education has streamlined our educational system and developed subjects like *Reka Bentuk dan Teknologi (RBT)* and *Teknologi Maklumat dan Komunikasi (TMK)* to spark primary students' interest in science and improve their attitude toward science. In reality, these efforts have had only little influence on students attitudes toward science since the majority of students do not believe these subjects would aid them in their real lives, especially because these subjects are not part of their primary school examinations (Sahaat et al., 2020 & Mohd Zukilan Zakaria, 2015). Prof. Dato' Dr. Noraini, Chairman of the National STEM Movement, also said that students' interest in science has been deteriorating since primary school due to lack of students involvement in teaching and learning. In comparison to secondary and university education, primary school has less hands-on teaching (Chonghui, 2020). STEM (Science, Technology, Engineering, Mathematics) based activities and learning include a lot of science and problem-solving principles. However, there are yet less research on the impact of an integrated STEM approach on students' attitudes at the primary school level. According to research by Jayarajah, Saat, and Rauf (2014), the study of STEM-integrated student attitudes in Malaysia is mostly focused on higher education, with less attention at the primary school level. As a result, this study considers the lack of STEM integrated robotics education in primary schools in order to enhance students' attitudes toward science.

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

1.3. Research Objectives

The aim of this research is to see the effect of robotics program on students attitude towards science. Researcher has outlined research objectives as below:

i. To determine the effect of robotics program on student's attitude towards science for the experimental group.
ii. To determine the effect of traditional learning (no robotics program) on student's attitude towards science for the control group.

1.4. Research Questions

This study intends to address the following research questions based on the study's objectives:

- Is there a difference in the mean score of student's attitude towards science in three time periods for the experimental group?
- Is there a difference in the mean score of student's attitude towards science in three time periods for the control group?

1.5. Research Hypothesis

Based on the study questions, the researcher has proposed the following null hypotheses based on the level of significant at alpha α 0.05:

H_{01} There is no significant difference in the mean score of student's attitude towards science in three time periods for the experimental group.

H_{02} There is no significant difference in the mean score of student's attitude towards science in three time periods for the control group.

2. Literature Review

The term "attitude toward science" refers to how people feel about science. Although science educators believe that students' attitudes toward science play a significant role in their learning, the results of research evaluating the influence of this effective area on either students' performance or their interest in science have been mixed (Newell, et al., 2015; Zacharia & Barton, 2004). According to Papanastasiou (2004), the school environment, ambition level, parental control, and quality teaching techniques are the factors that impact students' attitudes toward science. On other hand, Greenfield states that younger kids have more positive attitudes about science than older students, and that middle school students have far more negative opinions toward science than primary or high school students (Jarvis & Pell, 2002). according to Koballa, attitudes may be changed, but these situations are not accidental (Zacharia & Barton, 2004). As attitudes can be transformed, it is critical that primary and

secondary schools engage with all students, regardless of race or gender or ethnicity, to establish a positive attitude toward science and to teach them that science is necessary and informative. Schlechty (2002) said "If children are engaged in the appropriate topics, they'll really learn what we want them to know.". Academic success was linked to student attitudes and interests. The term "attitude" is used to express students' natural enthusiasm for the subject they are learning. In this study, the researcher used RoboBuilder's robots to evaluate students' interest in science using a robotics

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

programme. Tomperi et al., (2020), Breakwell and Beardsell (1992) and Brown (1976) have highlighted the perception of the science teacher, nervousness toward science, the value of science, self-esteem in science, motivation towards science, enjoyment in science, attitudes of peers and friends towards science, attitudes of their parents towards science, the classroom environment, and achievement in science in their measures of attitudes to science. Besides that, gender, environmental variables, and the classroom/teachers aspect all have an impact on students' attitudes about science. Gardner observes that, in terms of gender, sex is likely the most significant aspect influencing students' attitudes toward science (Tytler et al., 2012). Teachers and classrooms have a critical influence in shaping students' attitudes toward science. The environment in the classroom is commonly measured using an instrument developed by Walberg (1969) and Fraser (1986), and it has a positive correlation with attitude. When students' attitudes toward science are measured, interactive classroom teaching combined with hands- on activities such as robotics will assure a favourable results.

3. Methodology

In this study, the researcher has used a quantitative and experimental method, that could test hypotheses in order to identify a statistical relationship (Noraini, 2010). Hence, the researcher in this study will use a quasi-experimental approach where treatment will be applied to the sample in advance. In quasi- experiment the samples cannot be randomly chosen, and it used to substitute true experimental studies (Odle & Mayer, 2009). In this study, the researcher has used nonequivalent groups with pre-test and post-test method. Both control and experimental group have undergone pre-test, post-test 1and post- test 2 during this 18 weeks of program.

3.1. Sample

The population of this study are year 6 primary school students involving 10 schools under Ministry of Education Malaysia from Malacca and Selangor. The researcher has used non-probability sampling method with purposive sampling technique. This is because, purposive sampling can determine the success of a programme or intervention (Bernard, 2002). Furthermore, this method of sampling allows researchers to choose samples that can offer them with information, information, or experience (Bernard, 2002). Total of 374 students have been choosen as sample for this study from Malacca (experiment group) and Selangor (control group).

3.2. Instrument

The researcher has used Test of Science Related Attitude (TOSRA) develop by Fraser (1978) to measure students attitude towards science. TOSRA consists of 70 questions in total with 7 dimensions namely Social Implications of Science, Normality of Scientists, Attitude of Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. Students have to answer all the positive and negative questions in TOSRA. For positive (+) items, scoring includes 5, 4, 3, 2, 1 for SA, A, N, D, SD responses, and for negative (-) 1, 2, 3, 4, 5 for SA, A, N, D, SD answers. Answers that are omitted or are incorrect are given a score of 3. Fraser (1978) said this instrument has Cronbach's alpha (alpha reliability coefficients) ranges from 0.66 to 0.93. Nevertheless, Table 1 shows the reliability score of Cronbach's alpha for all 70 questions in the TOSRA questionnaire was 0.90 in the pilot study done by the researcher. This indicates that the instrument has a high level of reliability among

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

primary school year 6 students. The optimal reliability value should greater than 0.7. (Pallant, 2010). The researcher has observed the changes in three time periods involving pre-test, post-test 1 and post-test 2 to determine the change in students attitude towards science among experimental group students.

Table 1: Cronbach's Alpha Reliability Value of Each Dimensions in TOSRA

Dimensions	Total Item	Cronbach's Alpha Value
Social Implications of Science (S)	10	0.84
Normality of Scientist (N)	10	0.80
Attitude to Inquiry (I)	10	0.83
Adoption of Scientific Attitudes (A)	10	0.70
Enjoyment of Science Lessons (E)	10	0.95
Leisure Interest in Science (L)	10	0.88
Career Interest in Science (C)	10	0.93
TOTAL	70	0.90

3.3. Tool

The researcher has used RoboBuilder RQ+110 robotic set as in Figure 1 in this study during robotics program. RoboBuilder RQ+110 is a versatile robotics set from South Korea manufacturer and locally retail and sole distributed by Kiroboot Technology Sdn Bhd. Students can build up to 10 different robots and do coding using open source SCRATCH. This robot can do the same operations as LEGO robots (which are frequently used in schools), but at a considerably lower cost. Students able to learn programming through SCRATCH coding which often learn by students in schools.

Figure 1: RoboBuilder RQ+110 Robotic Set

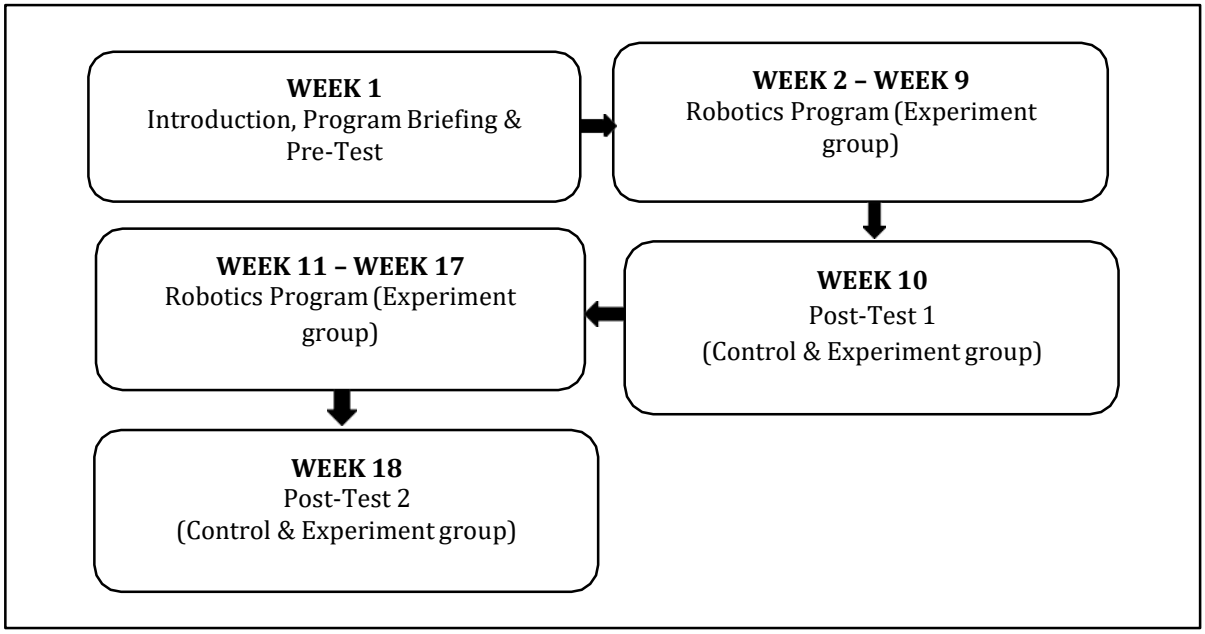


© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

3.4. Research Procedure

Majority of quasi-experimental studies took 8 to 18 weeks to complete (Fazzlijan, 2014), 10 weeks (Schmidt et al., 2009), 12 weeks (Martin et al., 2008), and 16 weeks to complete (Savin & Baden, 2008). Hence, in this study the researcher conducting the program for 18 weeks which include a pre- test (one week), intervention (15 weeks), and post-test 1 and post-test 2 (two weeks). The post-test 1 and post-test 2 tests are separated by seven weeks to examine if students can shift abstract information from short-term to long-term memory after the intervention. Figure 2 has outlined the research and data collection procedures.

Figure 2: Research and Data Collection Procedures Flow Chart



4. Result

4.1. Descriptive Statistical Analysis of Mean Score

The overall mean score at post-test 1 (3.5057) was greater than the mean score at pre-test (3.0896). The post-test 1 mean score increased by.4161 when compared to the pre-test mean score. In addition, there is a.0075 difference between the mean score of post-test 1 (3.5057) and the mean score of post-test 2 (3.5132). The minimum and maximum value pre-test are 2.74 and 3.46, respectively, whereas the post- test values are 2.93 and 4.54 for post-test 1 and 2.91 to 4.54 for post-test 2.

4.2. Hypothesis 1 Testing

H_{01} There is no significant difference in the mean score of student's attitude towards science in three time periods for the experimental group.

Since Mauchly's Test produced significant findings, df correction for one-way ANOVA testing should be conducted. A correction was required since the Mauchly's Test revealed that the sphericity assumption had been violated, x2 (2) = 171.463, p =.000 (significant). The Greenhouse-Geisser adjustment is only appropriate for a small sample,

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

but the lower bound correction is overly conservative and should not be used (Hinton et al., 2004). As a result, df should be adjusted, and the Huynh-Feldt adjustment should be reported as epsilon =.639. Because F (1.28, 270.73) = 274.14, p =.000, partial η2 =.564 was still significant when the revised df was used, the study shows that the pre-test, post-test 1 and post-test 2 had a significant influence on attitude toward science. Thus, the null hypothesis was rejected since there was a significant change in the mean score of student's attitude toward science throughout three time periods for the experimental group. The researcher achieved a partial value of η2 .564, indicating that there is a larger effect. Furthermore, a Multivariate test for three periods (pre- test, post-test 1 and post-test 2) revealed that the students' attitude toward science score was significantly affected, Wilks' Lambda V =.607, F (2, 205) = 160.20, p =.000. This illustrates that students in a robotics programme (experimental group) improved their attitude toward science scores throughout three periods (pre-test, post-test 1, and post-test 2). The difference between pre-test and post-test 1 score [F (1, 206) = 251.081, p<.05] was significant, as was the difference between post-test 1 score and post-test 2 score [F (1, 206) = 188.191, p<.05].

4.3. Hypothesis 2 Testing

H_{02} There is no significant difference in the mean score of student's attitude towards science in three time periods for the control group.

Since Mauchly's Test produced significant findings, df correction for one-way ANOVA testing should be conducted. A correction was required since the Mauchly's Test revealed that the sphericity assumption had been violated, x2 (2) = 15.834, p =.000 (significant). The Greenhouse-Geisser adjustment is only appropriate for a small sample, but the lower bound correction is overly conservative and should not be used (Hinton et al., 2004). As a result, df should be adjusted, and the Huynh-Feldt adjustment should be reported as epsilon =.832. Because F (1.69, 118.58) = 11.480, p =.000, partial η2 =.137 has very less effect but it was still significant when the revised df was used. Thus, the null hypothesis was rejected since there was a significant change in the mean score of student's attitude toward science throughout three time periods for the control group. Furthermore, a Multivariate test for three periods (pre-test, post-test 1 and post-test 2) revealed that the students' attitude toward science score was significantly affected, Wilks' Lambda V =.190, F (2, 60) = 8.609, p =.819. This illustrates that students without robotics programme (control group) had also minor effect on their attitude toward science scores throughout three periods (pre-test, post-test 1, and post-test 2). The difference between pre-test and post-test 1 score [F (1, 69) = 10.561, p = .001] was significant, as was the difference between post-test 1 score and post-test 2 score [F (1, 69) = 3.708, p =.054].

5. Discussion

Based on the findings, experiment group had a higher overall mean for student attitude toward science than control group. When compared to control pupils, experimental students had a much higher mean score for attitude toward science. These descriptive statistics indicate that the treatment group of students had an increase in mean score (difference between pre, post 1, and post 2 mean scores) for the three test time periods, whereas the Selangor group students had a minor improvement in mean score in attitude toward science. However, the empirical study indicates that both experiment and control groups had substantial improvements in their attitudes toward science, with

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

the experiment students demonstrating a bigger subject effect size, which is the anticipated outcome. The findings of this study agree with those of Simões et al. (2013), who found that using gamification techniques such as robots and other interactive technologies, either within students or between students and teachers, can lead to changes in behaviour and attitude. Therefore, it is advised that other researchers to conduct similar robotics programmes to see effectiveness and improvement in other attitudes such as communication, motivation, cooperation, collaboration, and critical thinking. Moreover, this research was done with students in year 6 at a primary school under the supervision of the Ministry of Education. Further research should be carried out in primary schools for lower primary students (year one, two, and three) or secondary schools. Furthermore, within the university, further research may be conducted by involving first-year students from various majors/faculties. The psychological/attitude features of students can be compared between faculty. For example, between science and arts faculty.

6. Conclusion

The robotics program has a positive and major impact on student attitude towards science. Therefore, the robotics program should be extended to many aspects especially if want to changes in attitude. This will influence students to remain focused and active in class. Hence, this robotics program strategy has been found and proved to increase students' attitudes about science using robotics.

Acknowledgement

Thank you to all the respondents, teachers, school management who have provided cooperation in making this research a success. Our utmost gratitude to *Pertubuhan Intelektual Dan Inovasi Malaysia (PIIM)* for providing expertise and assistance in conducting this robotics program as well Malaysian Indian Transformation Unit, (MITRA) for partial funding.

Funding

This study and publication received no funding. However, to conduct the robotics programs at schools *Pertubuhan Intelektual Dan Inovasi Malaysia (PIIM)* has received partial funding from Malaysian Indian Transformation Unit, (MITRA).

Conflict of Interests

The authors declare no conflict of interest in this study.

References

Arkin, R.C. (1998). *Behavior-based robotics*. Massachusets: The MIT Press, Cambridge.

Bernard, H.R. 2002. *Research methods in anthropology: qualitative and quantitative methods.* 3rd edition. California: AltaMira Press.

Bers, M. U., & Portsmore, M. 2005. Teaching partnerships: Early childhood and engineering students teaching math and science through robotics. *Journal of Science Education and Technology*, 14(1),59-73.

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

Bratzel, B. (2005). *Physics by design.* Knoxville, TN: College House Enterprises.

Breakwell, G. M. And Beardsell, S. 1992. Gender, parental and peer influences upon science attitudes and activities. *Public Understanding of Science,* 1, 183–197.

Brown, S. (1976). Attitude goals in secondary school science (Stirling: University of Stirling).

Cejka, E., Rogers, C., & Portsmore, M. (2006). Kindergarten robotics: Using robotics to motivate math, science, and engineering literacy in elementary school. *The International Journal of Engineering Education, 22*(4), 711-722.

Challinger, J. (2005). Efficient use of robots in the undergraduate curriculum. *ACM SIGCSE Bulletin*, *37*(1), 436-440.

Chambers, J. M., & Carbonaro, M. (2003). Designing, developing and implementing a course on LEGO robotics for technology teacher education. *Journal of Technology and Teacher Education, 11*(2), 209-241.

Chonghui, L. (2020). Don't Kill Interest in the Sciences. The Star. https://www.thestar.com.my/news/education/2020/08/23/dont-kill-interest-in-the-sciences

Fazzlijan Mohamad Ali Khan. (2014). Pembangunan dan keberkesanan perisian multimedia interaktif dengan tiga strategi berbeza dalam pembelajaran respirasi sel. Disertasi Doktor Falsafah: Universiti Sains Malaysia, Pulau Pinang.

Fraser, B. J. (1978). Development of a test of science-related attitudes. *Science Education*, 62, 509-515.

Fraser, B. J. (1986). Classroom environment (London: Croom Helm).

Groff, B. H., & Pomalaza-Ráez, C. A. (2001). Robot Omnium Horarum: A robot for all seasons. *Proceedings of the American Association for Artificial Intelligence Spring Symposium Series*.

Hallak, F. K., Armoni, M., & Ari, M. B. (2019). The Effect of Robotics Activities on Learning the Engineering Design Process. *Informatics in Education*, *18*(1), 105–129.

Hinton, P. R., Brownlow, C., & McMurray, I. (2004). *SPSS explained*. Routledge

Jarvis, T., & Pell, A. (2002). Changes in primary boys and girls attitudes to school and science during a two-year science in-service program. *Curriculum Journal* (13).

K. Jayarajah, R. Mohd Saat, and R. A. Abdul Rauf. (2014). A review of science, technology, engineering & mathematics (STEM) education research 1999-2013: A Malaysian perspectives. *Eurasia Journal of Mathematics, Science & Technology Education*, *10*(3), 155-163.

Martin, L., West, J. & Bill, K. (2008). Incorporating problem-based learning strategies to develop learner autonomy and employability skills in sport science undergraduate. *Journal of Hospitality, Leisure, Sport and Tourism Education.* 7: 18-30.

Ministry of Education Malaysia (MOE). (2016). PISA Report for 2015- Programme for International Student Assessment. Putrajaya, Planning and Research in Education Policy Department. Retrieved from https://www.moe.gov.my/index.php/en/pemberitahuan/120pemberitahuan/2016/2747-laporan- programmeforinternationalstudentassessment2015-pisa-2015?highlight=WyJwaXNhIl0=?templateStyle=16

Mohd Zukilan Zakaria. (2015). *Keberkesanan program mentor-menti terhadap pencapaian pelajar kolej matrikulasi kedah sesi 2014/2015*. Kolej Matrikulasi Kedah. Changlun.

Newell, A. D., Tharp, B. Z., Vogt, G. L., Moreno, N. P., & Zientek, L. R. (2015). Students' Attitudes Toward Science as Predictors of Gains on Student Content Knowledge: Benefits of an After- School Program. *School of Science and Mathematics Journal*.

Noraini Idris. Penyelidikan dalam pendidikan. (2010). Kuala Lumpur: McGraw-Hill Education.

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. I. (2012). Impact of robotics and geospatial technology interventions on youth STEM learning and attitudes. *Journal of Research on Technology in Education (International Society for Technology in Education)*, *42*(4), 391.

Odle, T. & Mayer, R. (2009). Experimental Research. Taken on December 12, 2020, http://www.education.com/reference/article/experimental-research/#B.

Organisation for Economic Co-operation and Development (OECD). (2019). PISA 2018 Results: Combined Executive Summaries Volume I, II, III. Secretary-General of the OECD.
https://www.oecd.org/pisa/Combined_Executive_Summaries_PISA_2018.pdf

Pallant, J. (2010). SPSS survival manual: *A step by step guide to data analysis using SPSS (4th ed)*. Maidenhead: Open University Press/McGraw-Hill.

Papanastasiou, C., & Papanastasiou, E. (2004). Major influences on attitudes towards science. *Educational Research and Education*, 10, 239-257.

Sahaat, Z., & Nasri, N. M. (2020). Cabaran Pelaksanaan Mata Pelajaran Reka Bentuk Teknologi dan Teknologi Maklumat. *Jurnal Pendidikan Malaysia 45(1) Isu Khas (2020):* 51-59.

Savin-Baden, M. (2008). A practical guide to problem-based learning online. London: Routhedge.

Schlechty, P. C. (2002). Working on the work: *An action plan for teachers, principals, and superintendents.* San Francisco, CA: Josey-Bass.

Schmidt, H.G., Van der Molen, H.T., Te Winkel, W.W.R., & Winjen, W.H.F.W. (2009). Constructivist, problem-based learning does work: meta-analysis of curricular comparisons involving a single medical school. *Educational Psychologist*, *44*(4), 227-249.

Simões, J., R. Díaz Redondo, A. Fernández Vilas. (2013). A social gamification framework for a K-6 learning platform. *Computers in Human Behavior*. 345-353.

Tomperi, P., Ryzhkova, I., Shestova, Y., Lyash, O., Lazareva, I., Lyash, A., Kvivesen, M., Manshadi, S., & Uteng, S. (2020). The three-factor model: A Study of Common Features in Students' Attitudes Towards Studying and Learning Science and Mathematics in The Three Countries of the North Calotte Region. *International Journal on Math, Science and Technology Education*.

Tytler, R., & Osborn, J. (2012). Student Attitudes and Aspirations Towards Science. *International Handbook of Science Education Journal*.

Walberg, H. J. (1969). Social environment as a mediator of classroom learning. *Journal of Educational Psychology,* 60, 443–448.

Zacharia, Z., & Barton, A. C. (2004). Urban middle school students' attitudes toward science. *Science Education*, *88*(2),197-222.

© 2022 by the authors. Published by Secholian Publication. This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY).