SOUTH ASIAN JOURNAL OF SOCIAL SCIENCES & HUMANITIES ISSN: 2582-7065 (Online) SAJSSH, VOL 3, ISSUE 2, PP. 73-88

Effects of Phet Interactive Simulation Activities on Secondary School Students' Physics Achievement

Mohd Nizar Mohd Najib[1], Ruzlan Md-Ali[2] & Aizan Yaacob[3]

[1,2,3] *School of Education, Universiti Utara Malaysia*

Corresponding Author: Mohd Nizar Mohd Najib **Email:** m.nizar_m.najib@ahsgs.uum.edu.my

Received: 12th February 2022 **Accepted:** 19th March 2022 **Published:** 5th April 2022

ABSTRACT

PhET (Physics Education Technology) interactive simulation is a website-based simulation developed by simulation experts from the University of Colorado Boulder to help students learn physics through simulated learning. This research aims to examine students' achievement after utilized simulated learning and teaching. A module and teaching plan have been specifically designed by researchers to be integrated with PhET simulation in the students' teaching and learning processes. This research utilized a quasi-experimental design where pre-and post-tests are multiple choice type of test involved 30 students in the experimental group (using simulated learning) and 30 students in the control group (using conventional learning). The results showed that there were significant differences in pre-and post-tests means scores for the experimental group. On the other hand, the control group showed no significant differences. This proved that PhET simulation, with well-designed module and teaching plan can improve students' achievement in physics.

Keywords: Interactive Simulation, Learning Module, Physics, Daily Lesson Plan, PhET, Physics Achievement.

DOI: 10.48165/sajssh.2022.3204

INTRODUCTION

Physics is a field of science that explains various situations and phenomena found in the universe. It is also related to the events that occur around us and allows us to deal with various things in everyday life (Aykutlu, Bezen & Bayrak, 2015). The knowledge gained in physics can be applied in technology and engineering, and this is certainly beneficial for the developing countries (Gutulo & Ousman, 2015). Physics is one of the most important areas to explore in this modern age. However, there are fewer students studying physics as compared to other subjects at higher education level (Salmiza, 2014). Physics is considered as difficult, boring, less well-liked and irrelevant subject (Salmiza, 2014). This is because students have difficulty connecting the concept of physics to their scientific reasoning skills to explain a phenomenon (Srisawasdi & Kroothkeaw, 2014; Sopiah & Adilah, 2008). Problems in teaching and learning physics have become a worldwide problem. A study conducted by Gutulo and Ousman (2015) in Ethiopia at high school and preparatory schools' levels reported that 377 students (48.45%) were moderately interested in physics, 66 (8.48%) and 38 (4.88%) respectively were less interested in studying physics . Among these students, 362 (46.7%), 312 (40.10%) and 104 (13.36%) claimed that they were less interested due to the difficulty of the subject, inefficient teaching and unclear direction respectively. Studies on physics education have also shown that the level of interest and motivation in physics class, the inability to relate meaning to abstract physics' concepts, incorrect use of the concepts in relation to scientific thinking and belief and misunderstanding of concepts in relation to the models and theories were among the reasons that make physics difficult to learn (Aykutlu et al., 2015).

Since 1994, a mission has been launched by the Malaysian Ministry of Education (MOE) to ensure that there will be 60% science stream students and 40% arts stream students at the upper secondary school level with the objective to encourage more students to pursue studies in science such as engineering, health, science education, ICT and others (Salmiza, 2014). However, according to Salmiza (2014), the 60:40 ratios between science stream and arts stream students are still lagging behind. In other words, there is less than 40% science students in most schools in Malaysia as compared to arts students (Utusan Malaysia, 2009).

Generally, in Malaysia, science subjects are taught at the primary and lower secondary levels. At the upper secondary school level, all Science stream students study Pure Physics, Pure Biology and Pure Chemistry as part of the core subjects to pass the examination. Students who

DOI: 10.48165/sajssh.2022.3204

are not a science major (other than the science stream) only study General Science. All science subjects such as physics, biology, and chemistry have been implemented in the Integrated Secondary School Curriculum (KBSM). Since 2017, all syllabi including all science subjects have been converted to the Secondary School Standard Curriculum (KSSM). The changes are made to meet the requirements of the Curriculum and Assessment Standard Document (DSKP). Based on the Ministry of Education (2015), all science textbooks have incorporated special features that place more emphasis on science, technology, engineering and mathematics (STEM), thinking skills, scientific skills and computational thinking (CT) to equip the learners with the 21st century skills and become scientifically minded individuals. Needless to say, most secondary schools still use less technology in the teaching and learning processes, particularly in physics. Conventional teaching and learning still continues. Hence, the goals of the Ministry of Education will not be achieved unless schools and institutions integrate technology in their teaching and learning processes extensively. In Malaysia, studies conducted on Physics have shown that lack of understanding of the concept of physics has become a serious phenomenon at the upper secondary school level (Sopiah & Adilah, 2008). As part of the requirements in the Sijil Pelajaran Malaysia (SPM), students are required to achieve excellent results to place themselves in institutions of higher learning. However, students found it difficult to understand the basic concepts of Physics and were more focused on numerical operations (Kolcak, Mogol & Unsal, 2014; Salmiza, 2014). Sopiah and Adilah (2008) found that students performed poorly in science items especially in scientific reasoning related to physics. As a result, the number of students who avoid taking physics-related courses at the tertiary level is very high (Salmiza, 2014). Many studies also showed that students' motivation to study physics has decreased below acceptable levels (Salmiza, 2014; Utusan Malaysia, 2009; Sidin, 2004).

RESEARCH QUESTIONS

This study attempts to answer the following research questions:

1. Is there a significant difference in student achievement between pre and post-tests after using simulated learning and teaching in the experimental group (EG)?
2. Is there a significant difference in student achievement between pre and post-tests after using conventional learning and teaching methods in the control group (CG)?

DOI: 10.48165/sajssh.2022.3204

Hypotheses

Two hypotheses were formulated based on the research questions:

H1: There is no significant difference between pre and post-tests results in the experimental group (EG) which used simulated learning and teaching methods for physics subjects.

H2: There is no significant difference between pre and post-tests results in the control group (CG) which used conventional learning and teaching methods for physics subjects.

LITERATURE REVIEW

Simulation as a Teaching and Learning Strategy

Findley, Whitacre and Hensberry (2017) defines interactive simulations as dynamic environments that model concepts, correlations, systems, or phenomena and allow users to interact with models in those environments. Simulations can facilitate the use of various representations, support students' efforts to build their knowledge, draw students' attention to conceptual ideas as well as provide instant feedback to students (Hensberry, Moore & Perkins, 2015). In addition, according to Joyce, Weil, and Calhoun (2011), the simulation uses a behavioral model to generate a better understanding of what students are doing. Predictions can be made of students who often use simulations because it stimulates real-life situations (Ibtesam, 2014). Simulations can be used in the classroom to improve learning as well as in the teacher's teaching process. To create a simulation program, a simulator needs to be developed. Generally, the development of simulators is based on cybernatic principles, which mimic or can be described as comparative studies of human control mechanisms and electromechanical systems such as computers (Joyce et al., 2011).

Simulation is a good design by experts, and it can closely mimic real life situations (Ibtesam, 2014). According to Salmiza (2014), learning physics using conventional methods in secondary schools in Malaysia may boost their motivation but is not very interesting. With proper simulator design and simulation program, this learning style not only helps students in understanding concepts, but it can also increase students’ motivation towards learning as well as improve their achievement in selected topics (Chen, Pan, Sung & Chang, 2012; Ornek, 2012).

DOI: 10.48165/sajssh.2022.3204

Widodo, Maria and Fitriani (2017) argue that one of the good components for developing effective learning modules is through designing appropriate learning activities. This will stimulate their active learning process with various learning activities so that they not only gain knowledge, but they will also easily remember what they have learnt (Ali, Ghazi, Khan, Hussain & Faitma, 2010). A good module and daily teaching plan (DLP) need to be designed as a guide for students and teachers so that the learning and teaching process using simulation becomes more effective (Awang & Zakaria, 2012).

PhET interactive simulation also integrates technology. The practice of integrating technology in the learning process is highly encouraged among teachers. For example, in the context of our country, Malaysia, Yaacob, Siti, Noor and Ruzlan (2021) had integrated technology in primary school-level English education, i.e. by using *Storybird* to rural ESL students. At the higher education level, ICT integration is very promising. For example, Nurulwahida and Ruzlan (2020) in their study have used Successful Intelligence Interactive Module (SIIM) which implements the use of thinking skills using intelligence theory. Coherently, the integration of ICT in the teaching and learning process has become a big concern among many educators especially the physics subject teachers. As stated by Batuyong and Antonio (2018), in their findings, it is proven that interactive teaching strategies stimulate students' interest in improving the teaching and learning of physics.

Past studies have shown the positive effects of using computer simulation in Physics. It has been proven to be one of the effective tools in the teaching and learning process (Ulen, Cagran, Slavenic & Gerlic, 2014; Ajredini, Zajkov and Mahmudi, 2012; Sopiah and Adilah, 2008). Based on a study by Ajredini, Zajkov and Mahmudi (2012), the influence of computer simulation was revealed to impart more quality knowledge and skills to the experimental group than the control group where traditional teaching was used. By injecting computer simulations into teaching and learning, it can develop students' high-level thinking skills as well as better understanding (Ajredini et al., 2012). A similar study was conducted by Sopiah and Adilah (2008), where the use of computer simulations enhances students' scientific reasoning and conceptual understanding in learning. According to Ibtesam (2014), the findings of the study showed that students in the experimental group using computer simulation instruction (CSI) have shown positive achievement on the mastery of concepts in the subject of chemistry. This proves that the findings of the study are consistent in that the teaching and learning of science through computer

DOI: 10.48165/sajssh.2022.3204

simulations will help students better understand the concept of science; improve high-level thinking skills as well as their achievement.

Although physics education applies simulation-based learning, this method of learning is still not fully applicable. Teachers tend to apply teacher-centered teaching methods in which students copy and memorize concepts in physics (Elangovan & Zurida, 2013). Besides, learning through simulation alone without good guidance can lead students towards misconceptions and lack of understanding in physics (Srisawasdi & Kroothkeaw, 2014). According to Zulfah and Aznam (2018), the material found in the textbook is still incomplete and part of the learning activities are not contextual and systematic. Similarly, Novitasari, Mohammad and Nonoh (2016) found that modules with appropriate learning activities will not only stimulate learning, but they also have good psychological effects on students. Therefore, in the context of this study, researchers have developed a Physics Interactive Simulation Learning Module (MoPSIF) and DLP based on simulations that have been validated by experienced experts in the field of education.

Based on the above reviews, effective simulated learning requires learning guidelines such as interactive modules. The modules need to be tested first to ensure that they are effective in helping students learn the subject of physics through simulated learning.

METHODOLOGY

Research Design

This study employed a quasi-experimental design by conducting pre-tests and post-tests (Creswell, 2014). The sample was divided into two (2) groups. The experimental group (EG) used simulated learning while the control group (CG) used conventional learning methods.

Study Participants

This study was conducted on 60 Form 4 students in one of the districts in Kedah. They were randomly selected from two schools and were later divided into two (2) groups; 30 students in the experimental group (EG) and 30 students in the control group (CG). The sample in the EG underwent simulation learning, while the sample in CG underwent conventional learning.

Research Instrument

DOI: 10.48165/sajssh.2022.3204

In this study, the researchers used the Physics Interactive Simulation Learning Module (MoPSIF) as a guide to students who underwent simulated learning in the experimental group (EG). MoPSIF was specifically designed to suit the used of Physics Education Technology (PhET) interactive simulation. PhET interactive simulation developed by simulation experts from the University of Colorado Boulder to help students learn physics through simulated learning. The simulated Daily Teaching Plan (DLP) was also provided to Physics teachers who handled the EG group to help with the process of implementing using the PhET simulator. For the data collection of this quantitative study, two sets of multiple-choice type questions, UP1 and UP1R, were used in the pre-test (UP1) and post-test (UP1R) on both study groups (EG and CG).

Consequently, three expert evaluators were selected to evaluate MoPSIF and DLP, while two experienced physics subject expert teachers evaluated UP1 and UP1R. All evaluators were experts in the field of physics education with at least five years of experience in the field of education.

Data Collection Procedures

Quasi-experiment was carried out after the improvement and refinement of the study instrument was implemented. As indicated in **Figure 1**, selection and distribution of study sample was conducted. Both experimental (30 students) and control group (30 students) underwent pre-test by answering UP1. The duration of intervention on the experimental (simulation learning) and control (conventional learning) groups were three weeks. Then, both groups underwent post-test by answering UP1R. The achievement data based on their pre-and post-tests results had been analyzed by using SPSS.

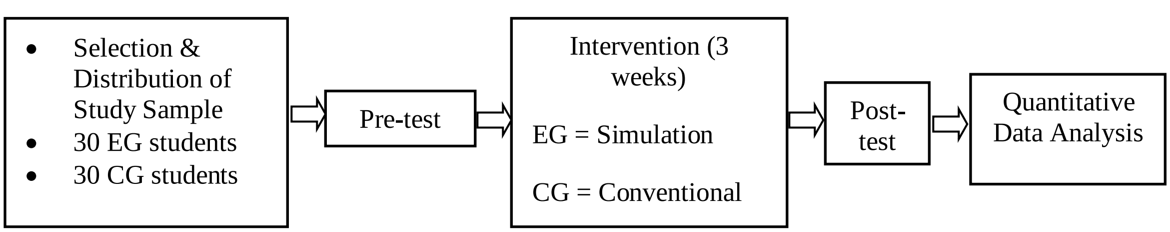

Figure 1: Structure of the Quasi Experiment

DOI: 10.48165/sajssh.2022.3204

DATA ANALYSIS

The data collected by the researchers from the pre-test and post-test were analyzed quantitatively. The data were initially analyzed using ANCOVA. Normality tests and homogeneity tests have shown that the data obtained did not violate the ANCOVA assumptions. Descriptive statistical analysis was applied on EG and CG through pre-test and post-test using SPSS where the dependent variable (DV) was student achievement in physics. The independent variable (IV) was the learning method using simulation for EG and conventional for CG.

RESULTS AND DISCUSSION

The results of the study were reported quantitatively. These include validity and reliability test results, as well as the effectiveness of PhET simulation on both experimental and control groups.

Validity and Reliability Tests

Validity of the module was conducted by three expert lecturers in education from three different institutions of higher learning. Each aspect of the validity category and the mean score value are shown in **Table 1**.

Table 1 shows that the mean value of learning outcomes, assessment activities as well as teaching processes and procedures was 4.00. Materials and use of technology was 3.92. The introduction, conclusion and professional writing of the modules were 2.42, 3.67 and 3.00 respectively. The average mean score for all aspects of the module was 3.57. Based on the average mean scores for all aspects of validity, the module was categorized as very good and good in terms of its suitability.

Table 1: *Results of MoPSIF and DLP Evaluation by Experts in Terms of Aspects of Validity and Suitability.*

Validity	Panels (P)			Average	Category
	P1	P2	P3		
Learning Outcomes	4.00	4.00	4.00	4.00	Very Good
Materials & Use of	4.00	3.75	4.00	3.92	Very Good

DOI: 10.48165/sajssh.2022.3204

Technology					
Introduction	2.00	2.75	2.50	2.42	Good
Teaching Process & Procedure	4.00	4.00	4.00	4.00	Very Good
Assessment Activities	4.00	4.00	4.00	4.00	Very Good
Conclusion	3.00	4.00	4.00	3.67	Very Good
Professional Writing	3.00	3.00	3.00	3.00	Very Good

In addition to module validity from experts, a survey was constructed. To determine the appropriateness of the survey, a reliability test was conducted on each item. Based on Nunnaly (1998); Nunnaly and Bernstein (1994), alpha reliability values above 0.70 were consistent for each dimension in this study. **Table 2** shows the reliability test results for each dimension of the survey.

Table 2: *Reliability Test Results of Survey Question for Each Dimension in the Researcher's Study.*

Scale	**No. of items**	**Cronbach's Alpha**
Students' perceptions of simulated learning using module.	10	0.77
Students' attitudes towards simulated learning using module.	10	0.70
Teacher guidance	7	0.71

DOI: 10.48165/sajssh.2022.3204

Teachers' knowledge of learning by simulation and module.	7	0.70
Group work support by teachers in the classroom.	6	0.71

Once the product has been certified and validated as reliable, the product was applied in field testing.

Analysis of the Effectiveness of PhET Simulation

For the collection of reliability test data, a set of survey was given to each student in the experimental group (CG). All 40 items in the survey were divided into five scales as shown in **Table 3**. Both study groups went through pre-test and post-test. Post-test data was analyzed after three (3) weeks of intervention on EG who had undergone simulated learning and CG who had undergone conventional learning.

A test was conducted on 30 students in the experimental group and 30 students in the control group. The results of the experimental group (EG) and control group (CG) studies are shown in **Table 3 and Table 4** respectively. Based on **Table 3**, the paired sample t-test was significant ($t(29) = -11.98$, $p < .05$). According to Creswell (2014), a p value $< .05$ indicates that there is a significant difference between pre-test and post-test results. The result of the study successfully rejected H1. These results also proved that there was a significant difference between pre-test and post-test results in the experimental group. The mean score (13.20) after simulated learning, was higher than the mean score (9.27) before simulated learning was conducted.

Table 3: *Effectiveness of PhET Simulated Learning in Physics for Experimental Group.*

Tests	**N**	**Mean**	**Standard Deviation**	**df**	**t**	**P**
Pre	30	9.27	2.56	29	-11.98	.00*
Post	30	13.20	1.90			

*p < .05

DOI: 10.48165/sajssh.2022.3204

As indicated in **Table 4**, the paired sample t-test was insignificant (t (29) = .98, p> .05). According to Creswell (2014), a p value> .05 indicates that there is no significant difference between pre-test and post-test resuts. The results of the study failed to reject H2. They also proved that there was no significant difference between pre-test and post-test results in the experimental group. The mean score (9.33) after going through conventional learning, was almost the same as the mean score (9.47) before going through conventional learning in physics subject.

Table 4: *Results using Conventional Learning in Physics of the Control Group*.

Tests	N	Mean	Standard Deviation	df	t	P
Pre	30	9.47	2.43	29	.44	.67*
Post	30	9.33	2.73			

*p > .05

The findings indicate that, the experimental group (EG) showed significant difference compared to the control group (CG) based on the pre-test and post-test mean scores. The same mean score value by CG on pre-test and post-test results proved that there was no improvement in student achievement by using conventional methods in the classroom. The findings of the current study are in line with the findings of previous studies (Batuyong & Antonio, 2018; Ibtesam, 2014; Ajredini et al., 2012). It was evident that using simulation learning among students has had a great impact on their learning outcomes, thus improving their achievement in physics subjects. This is also in line with the findings of previous studies, namely simulation is an effective tool in the teaching and learning process for physics subject in secondary schools (Batuyong & Antonio, 2018; Ulen et al., 2014; Ajdredini et al., 2012). The good design and use of good learning module has proven effective in facilitating the teaching and learning process of physics by using PhET interactive simulation. As stated by Widodo et al., 2017 and Ali et al., 2010, the production of effective activities through good modules greatly helps students in teaching and learning process and is able to improve students' performance.

DOI: 10.48165/sajssh.2022.3204

LIMITATIONS OF THE STUDY

There are some limitations in this study. Firstly, the sample size and the number of schools involved in this research can be done on a larger scale. The location for the selection of schools is not limited to one state only but can also cover schools in various states in Malaysia. Secondly, the data collection was performed at the initial stage of COVID-19 outbreak transmission for conventional method, and it was difficult to collect additional data for subsequent interventions due to the implementation of movement control order (MCO). Therefore, it is recommended that the future study should look at simulated learning with implementation of home teaching and learning (PdPR) without making comparison with conventional learning systems. Thirdly, this study focused on student achievement by using simulation method and simulation learning modules for physics subject. As such, future study needs to examine the deeper impact on students' motivation to learn using simulation methods in physics.

We feel that this study is significant for physics teachers because they can integrate simulated learning into conventional learning in the classroom. We have provided evidence that learning by simulation is able to improve student achievement in physics. Stake holders such as State Education Officers (JPN), District Education Officers (PPD) can organize workshops, seminars or courses for physics teachers on the use of PhET interactive simulations. This will indirectly reveal new experiences to teachers through PhET simulated teaching and learning for creative new ideas in the production of technology-based activities. Learning modules should also be built for each topic related to the simulator designed so that learning can be done independently and as a guide when using interactive simulations by students. It is very much in line with the current situation, especially during the COVID-19 outbreak.

CONCLUSION

In conclusion, learning by simulation can improve the level of student achievement in physics compared to students who study physics conventionally. Interactive simulation learning, together with simulation learning modules, namely the Physics Interactive Simulation Learning Module (MoPSIF) and the simulated Daily Teaching Plan (DLP) are suitable as one of the effective teachings and learning of physics subjects in schools. Good simulation design accompanied by implementation guide and simulation activities (MoPSIF and DLP) are relevant online learning

DOI: 10.48165/sajssh.2022.3204

Students' misconceptions in physics can be eliminated by using PhET interactive simulations. Students can repeat the PhET simulation as many times as they like until they reach an understanding of the topic. The MoPSIF provided helps students to undergo PhET simulation learning with or without the help of a teacher, and this also encourages simulation learning either in groups or independently.

DOI: 10.48165/sajssh.2022.3204

REFERENCES

Ajredini, F., Zajkov, O., & Mahmudi, N. (2012). Case study on the influence of simulations and real experiments on higher order skills. *Macedonian Physics Teacher, 48*, 29-34. ISSN 0352-0986

Ali, R., Ghazi, S. R., Khan, M. S., Hussain, S., & Faitma, Z. T. (2010). Effectiveness of modular teaching in Biology at secondary level. *Canadian Center of Science and Education, 6*(9), 49-54. ISSN 1911-2025

Awang & Zakaria (2012). Module for Learning Integral Calculus with Maple: Lecturers' Views. *Journal of Education Technology* (11) 3: 234

Aykutlu, I., Bezen, S., & Bayrak, C. (2015). Teacher opinions about the conceptual challenges experienced in teaching Physics curriculum topics. *Procedia-Social and Behavioral Sciences, 174,* 390-405.

Barron, B. & Hammond, L.D. (2008). *Teaching For Meaningful Learning: A Review of Researchon Inquiry-Based and Cooperative Learning*. San Francisco: The George Lucas Educational Foundation.

Batuyong, C. T. & Antonio, V.V. (2018). Exploring the effect of PhET interactive simulation-based activities on students' performance and learning experiences in electromagnetism. *Asia Pasific Journal of Multidisciplinary Research*, *6*(2), 121-131.

Chen, Y.-L., Pan, P. -R., Sung, Y. -T., & Chang, K. -E. (2013). Correcting Misconceptions on Electronics: Effects of simulation-based learning environment backed by a conceptual change model. *Educational Technology & Society*, *16*(2), 212-227.

Creswell, J. (2014). *Educational research: Planning, conducting and evaluating quantitative and qualitative research (4th ed.).* Essex, England: Pearson.

Elangovan, T. & Zurida Ismail (2013). The effect of realistic simulation and non-realistic simulation on Biology students' achievement. *Scientific & Academic Publishing, 3*(4), 231-241. doi:10.5923/j.edu.20130304.03

Findley, K., Whitacre, I. & Hensberry, K. (2017). Intergrating interactive simulations into the mathematics classroom: Supplementing, enhancing, or driving? In Galindo, E., & Newton, J. (Eds.). *Proceedings of the 39th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education 2017* (pp.1297-1304). Hoosier Association of Mathematics Teacher Educators.

Gunta, S. & Ousman, K (2015). Problems in the teaching and learning of Physics in the secondary and preparatory schools, the cases of Wolaita and Dwuro zones. In Rajan, D. S., Tekalegn, W, Asmare, A. Desta, T., Alemaychu, B. & Getachew, T. (Eds.), *Proceedings of the third annual research proceeding of Wolaita Sodo University 2015* (pp. 129-138). Academia.

DOI: 10.48165/sajssh.2022.3204

Hensberry, K. K. R., Moore, E. B., & Perkins, K. K. (2015). Effective student learning of fractions with an interactive simulation. *Journal of Computers in Mathematics and Science Teaching*, *34*(3), 273-298.

Ibtesam Al-Mashaqbeh (2014). Computer simulation instruction: Carrying out chemical experiments. *I.J. Modern Education and Computer Science*, *5*, 1-7. doi: 10.5815/ijmecs.2014.05.01

Joyce, B., Weil, M., & Calhoun, E. (2011). *Models of teaching* (8th ed.). Boston, USA: Pearson

Kolcak, D. Y., Mogol, S., & Unsal, Y. (2014). A Comparison of the Effects of Laboratory Method and Computer Simulations to Avoid Misconceptions in Physics Education. *Education and Science*, *175*(39), 154-171. doi:10.15390/EB.2014.2052

Liu, Y.-C., Kuo, R.-L., & Shih, S.-R. (2020). COVID-19: The first documented coronavirus pandemic in history. *Biomedical Journal*, *43*(2020), 328-333.

Ministry of Education (2013). *STEM education: Policies and prospects toward achieving international standard and meeting national development needs* [PDF text]. Retrieved from www.moe.gov.my

Ministry of Education (2015). *Malaysia education for all: End decade review report 2000-2015* [PDF text]. Retrieved from www.moe.gov.my

Ministry of Education (2020). *Pemakluman Pelaksanaan Pengajaran Dan Pembelajaran Di Rumah (PDPR)* [PDF text]. Retrieved from https://www.moe.gov.my/en/pemberitahuan/announcement/pemakluman-pdpr

Ministry of Health (2021). *Status Terkini Variant of Interest (VOI) dan Variant of Concern (VOC) di Malaysia Sehingga 31/05/2021*[PDF text]. Retrieved from http://covid-19.moh.gov.my/semasa-kkm/2021/06/situasi-terkini-voi-dan-voc-31052021

Novitasari, E., Mohammad, M., & Nonoh, S. A. (2016). Pengembangan Modul Pembelajaran IPA Terpadu Berbaris Inkuiri Terbimbing Tema Matahari Sebagai Sumber Energi Alternatif Di Kelas VII SMP/MTs. *Jurnal Inkuiri*, *5*(1): 112-121.

Nunnaly, J.C. (1978). *Psychometric theory* (2nd ed.). USA: McGraw-Hill

Nunnaly, J.C. & Bernstein, I.H. (1994). Psychometric theory (3rd ed.). USA: McGraw-Hill

Ornek, F. (2012). The role of computer modelling in enhancing students' conceptual understanding of Physics. *Bulgarian Journal of Science and Education Policy*, *6*(1), 67-87.

Salmiza Saleh (2014). Malaysian students' motivation towards Physics learning. *European Journal of Science and Mathematics Education*, *2*(4), 223-232.

Sidin, R. (2004). Pembudayaan Sains dan Teknologi: Satu Cadangan Piawai [Socialization of science and technology: a standard proposal]. *Jurnal Pendidikan* (UKM), 47-63.

DOI: 10.48165/sajssh.2022.3204

Sopiah Abdullah & Adilah Shariff (2008). The effects of inquiry-based computer simulation with cooperative learning on scientific thinking and conceptual understanding of Gas Laws. *Eurasia Journal of Mathematics, Science & Technology Education, 4*(4), 387-398.

Srisawasdi, N. & Kroothkeaw, S. (2014). Supporting students' conceptual development of light refraction by simulation-based open inquiry with dual-situated learning model. *Journal of Computers in Education*, *1*(1), 49-79.

Ulen, S., Cagran, B., Slavinec, M., & Gerlic, I. (2014). Designing and evaluating the effectiveness of Physlet-based learning materials in supporting conceptual learning in secondary school Physics. *Journal of Science Education and Technology, 23*(5), 658-667. doi:101007/s10956-014-9492-x

Utusan Malaysia. (2009). "Dasar 40:60 pelajar sastera sains belum tercapai."

World Health Organization (2020). *Coronavirus disease (COVID-19) pandemic* [PDF text]. Retrieved from https://www.who.int/emergencies/diseases/novel-coronavirus-2019

Widodo, A., Maria, R.A., & Fitriani, A. (2017). Constructivist Learning Environment During Virtual and Real Laboratory Activities. *Biosaintifika, 9*(1): 11-18.

Yaacob, A., Siti, N. S., Noor, A. M. & Ruzlan, M. A. (2021). Exploring the use of Storybird application for rural ESL teachers' professional development. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12*(3), 1200-1210.

Zulfah, H., & Aznam, N. (2018). Development of Natural Sciences Module with Reflective Learning Journal to Enhance Student's Reporting-Interpretative Skills. *Biosaintifika: Journal of Biology & Biology Education*, *10*(2), 362-368.

DOI: 10.48165/sajssh.2022.3204