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SUPPORTING SECONDARY SCHOOL STUDENTS' LEARNING OF PHYSICS: EXPLORING THE EFFECTS OF PhET SIMULATION AND MoPSIF MODULE

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ABSTRACT

Mastery of the Physics concept and the ability to apply this knowledge in everyday life can contribute to the development of the country. However, the skills of secondary school students in physics subject are less impressive. The fact is that learning experience in the classroom, also known as conventional learning, leaves a meaningful impression on students. Thus, a study on the topic of Forces and Motion – Forces in Equilibrium was conducted on Form Four students at a secondary school in the Northern Peninsular Malaysia. Qualitative data through in-depth semi-structured interviews were conducted on four students from the experimental group. The main purpose of the study was to explore students' opinion on learning physics by using conventional method as opposed to learn physics using PhET Simulation supported by MoPSIF Module. Thematic analysis from the interview found that the characteristics of students who learned physics via conventional

method were lack of interest, boredom, not actively engaging in group activities, less friendly teacher-student interactions, and limited to reference books and textbooks for self-learning. On the other hand, learning physics using PhET Simulation and MoPSIF Module had a positive impact on students' interest and motivation, the pleasure of studying as a group or self-learning, help to study for exams, and suitable as a method of learning physics for home-based teaching and learning. It is recommended that PhET Simulation supported by MoPSIF Module be used to enhance students' learning in physics subject especially during pandemic.

Keywords: Physics, PhET, Interactive Simulation, Simulation Learning, Conventional Learning, Learning Module, Pandemic.

INTRODUCTION

Learning can be seen occurring in two main contexts, namely active learning and passive learning (Ferguson, 2010; Ferguson, Hickey, Ferns, & Savelle, 2019). Nalevska and Kuzmanovska (2020) view passive learning as passive acceptance of information while active learning involves interaction between learners and materials, during the process of analyzing, comparing, inferencing, or critically evaluating. Researchers and educators opine that active learning is an approach where students engage in the learning process through the construction of knowledge and understanding which usually occurs while they are in school; and act on the learning opportunities provided by their teachers (Cambridge Assessment International Education, 2019).

Theoretically, the notion of active and passive learners is that there are two broad pedagogical worldviews underlying the selection of teaching and learning models, namely the instructivist perspective and the constructivist worldview (Ang, Afzal, & Crawford, 2021). From the instructivist perspective, teaching and learning are guided and controlled by teachers who they convey the knowledge and content to the students with minimal interaction. On the other hand, the constructivist point of view sees learning as a more student-centered where learning is built through conversations, interactions and collaborations between students and their friends and the teachers act as facilitators. In other words, students co-construct their own

learning based on their interaction with others. Teaching that triggers active learning is among the new formats of teaching that involves the use of simulations, experiments and lectures directly in the curriculum or teaching process, and the use of teaching technologies that enable active learning which improves teachers' self-efficacy as well as the quality of teaching and learning (Tien & Hamid, 2020). Educators have long supported an innovative transformation in education where teaching and learning practices are based on the integration of technology to accommodate the needs of different and diverse students with the changing trends and the emerging patterns of global education that facilitate lifelong learning (Fisher et al., 2020).

Today's learning environment has changed a lot which leads to the importance of self-directed learning among students and at the same time opens up opportunities for instructors to improve students' learning experiences regardless of whether the learning takes place in the classroom or online (Ang, Afzal, & Crawford, 2021).

CHARACTERISTICS OF LEARNING USING SIMULATION

Many educators accept that teaching methods that actively involve students can achieve learning goals better (Behmanesh et al., 2020). Among them is simulated learning method (Ajredini, Zajkov & Mahmudi, 2012). According to Joyce et al., (2011), simulation is a method used to explain and predict a situation, phenomenon or process virtually where simulations are similar to real conditions using cybernatic principles. Simulated learning not only makes it easier for students to understand a concept or theory, but it attracts students to be engaged in the subject (Liu, Horton, Olmansen & Toprac, 2011). Simulation also encourages students to further explore information through simulated activities that have been prepared in groups or independently. According to Mhamed Ben Ouhi et al., (2021), simulations, especially computerized simulations, are based on the philosophy of constructivism principles that prioritize the learning of science through experience and explanation of a concept, animation and visualization. This coincides with a study from University of Colorado, Boulder experts who developed the Physics Education Technology (PhET) simulator where simulated teaching and learning was conducted extensively and involved students studying physics with an intuitive environment such as games through exploration

and discovery. This is in line with the Yunzal and Casinillo (2020) in their article stating that students engage in simulations and repeat them with different variable values in order to obtain different results. Repetitive simulation is a simulation that is applied into a computerized simulation in which students are able to repeat simulated activities by changing variables to obtain varying variable values (Joyce et al., 2011). Haryadi and Pujiastuti (2019), claim that this feature promotes repetitive learning.

There are a few considerations to be made when designing a simulation teaching module. Rosmiati, Rahmawati and Suswati (2017) and Zulfah and Aznam (2018) argue that the use of designed simulation learning modules should meet the needs of the topics studied in line with the use of simulators. The simulation module acts as a guide for students to conduct simulated activities either in groups or on their own (Halim, Soewarno, Elmi, Zainuddin, Huda & Irwandi, 2020). The findings of Rosmiati et al. (2017) found that the design of a good physics learning module using PhET simulations can improve the understanding of students' physics concepts. In this study, the Interactive Physics Simulation Learning Module (MoPSIF) was designed by the researchers to assist students on the topic of Forces in Equilibrium in line with a simulator developed by the University of Colorado Boulder, a website-based simulation, PhET. MoPSIF was designed in Bahasa Malaysia by the researchers and all guidelines were translated from English into Bahasa Malaysia to facilitate student learning in physics subjects.

PROBLEM STATEMENT

Many students find physics subject difficult and dreadful to study (Salmiza, 2014). Students at school tend to stay away from this subject or any field related to the subject either directly or indirectly (Bunyamin & Finley, 2016; Utusan Malaysia, 2009). This problem stems from teaching and learning techniques in the classroom that still practice conventional teaching techniques, namely using black/white boards and lack of exposure to the use of teaching and learning in line with the 21st century (Bunyamin & Finley, 2016).

According to Yunzal and Casinillo (2020) and Liu et al., (2011), learning physics using conventional learning method invites various

negative feelings from the students such as not interesting, difficult to understand and irrelevant to real life situations. The students found it difficult to understand the basic concepts of physics and focused only on numerical operations i.e. calculation (Kolcak, Mogol, & Unsal, 2014). Learning and teaching methods need to be changed from using teacher-centered method to student-centered method in order to overcome these problems. This is also in line with the evolution of education in the 21st century where a curriculum based on Science, Technology, Engineering and Mathematics (STEM) is being implemented (Bunyamin & Finley, 2016).

Studies on the use of simulations in classroom learning and teaching have been conducted by previous researchers (Chen, Pan, Sung, & Chang, 2013; Elangovan & Zurida, 2013; Sopiah & Adilah, 2008; Ulen, Cangran, Slavinec & Gerlic, 2014) and learning using simulations have shown positive results. Simulated learning not only makes it easier for students to understand a concept or theory but it attracts students to study the subject (Liu et al., 2011). This is because simulated learning is clearer and efficient than conventional learning which uses text and diagrams that do not have any animation. Simulated learning proves that students are actively involved in learning (Ajredini, Zajkov, & Mahmudi, 2012).

Although studies using simulations have been conducted at school and higher education levels, the studies conducted in Malaysia are minimal compared to other countries (Elangovan & Zurida, 2013). As a result, the application of simulated learning and teaching is not fully maximized in schools. Nowadays, most schools have computer labs for students to use and it is suitable for students and teachers to spend time in computer labs to study the science subjects. However, studies on simulations are more focused on biological and chemical subjects (Elangovan & Zurida, 2013, Ibtesam, 2014).

In addition, even though past studies have shown significant results using interactive simulations, there are still fewer qualitative studies on learning using PhET Simulation in physics, especially its effectiveness to students in the topic Forces and Motion: Forces in Equilibrium. Therefore, this study attempted to examine the effectiveness of learning physics through PhET Simulation and the comparison of this method with conventional learning methods through the views of students at the secondary school level.

CONTEXT OF THE STUDY

Conventional teaching and learning refers to lecture techniques (Bunyamin & Finley, 2016; Salmiza, 2014). This method focuses on the presentation of learning content rather than methodology. For example, in physics subject, the content of teaching and learning will be carried out in the classroom, where the teacher will lecture in front of the students along with the main teaching aids such as whiteboards or blackboards while for practical sessions, students conduct experiments in the physics laboratory. This teaching technique involves less two-way communication and only allows one-way communication where the teacher teaches and the student listens and sees what is taught.

In contrast to the conventional method, of the simulated learning method can be implemented in the classroom or at home. Indirectly, simulated learning methods can be done in groups or on their own. The simulation used a computerized interactive simulator. The simulator used is an interactive simulation of Physics Education Technology (PhET) designed by simulation experts from the University of Colorado Boulder. All simulators produced by PhET are website-based and this allows users to learn to use simulations directly from the PhET website or download into the user's personal computer. This new method of learning is suitable with the phenomenon that is plaguing the world, including Malaysia, the COVID-19 pandemic, where according to the Liu, Kuo and Shih (2020) study, the rate of infection of the virus is very high and can evolve rapidly among the human population. The implementation of the Movement Control Order (MCO) and SOP compliance by the government resulted in limited outdoor activities, including educational centers such as kindergartens, schools and higher learning centers.

In the context of this study, the researchers compared the effects of conventional learning method and simulated learning method using interactive simulation of PhET together with MoPSIF Module. PhET simulation teaching and learning was conducted in classes under the guidance of the teacher throughout the duration of treatment given and students could learn physics by conducting simulation activities at home on their own. This is because PhET simulation is a website-based simulation and students need not necessarily download the simulation. Qualitative data collection was also conducted on research participants who have undergone simulated learning session and

conventional learning session for physics subject in school. However, the original procedure for qualitative data collection had to be changed due to the COVID-19 pandemic. This situation has made it difficult for researchers to conduct face-to-face interviews in schools or in open locations or in public places as a result of the implementation of MCO as directed by the Ministry of Health Malaysia (2020) and agreed by the Ministry of Education Malaysia (2020).

This paper provides a glimpse into four secondary school students' thoughts on their usual physics classroom learning. They were asked to share with the researchers the kind of teaching and learning activities that normally happened in their classroom before they experienced the learning physics using the PhET simulation.

The research questions for this study are as follows:

1. What are the secondary school students' thoughts on their usual classroom learning of physics?

2. What are the secondary school students' thoughts on the learning of Forces and Motion: Forces in Equilibrium in physics subject using PhET simulation and MoPSIF module?

METHODOLOGY

A quasi-experiment research design was used in the broader study whereby the quantitative approach preceded the qualitative approach. Pre-test and post-test was implemented during the quantitative phase (Najib, Md-Ali, & Yaacob, 2022). The qualitative phase was implemented as suggested by Creswell and Creswell (2017) which was to use face-to-face interviews followed by analyzing transcripts of interviews.

In-depth semi-structured interviews were carried out on the study participants to obtain information about their experiences and feelings in studying physics. Two phases of the interviews have been set for this study. The first phase involved interviewing participants from the experimental group before they went through a learning session using PhET simulation. The second phase was when they have completed learning the topic of Forces and Motion using PhET simulation.

The COVID-19 pandemic has affected conventional learning and teaching sessions in schools as students were not allowed to go to school. Instead, conventional learning and teaching sessions were conducted at their homes through online classes between teachers and students (teaching and learning from home or PdPR) including the physics subject. This resulted in limited teaching and learning because for physics subject such as practical training could not be carried out according to the physics syllabus.

RESEARCH PARTICIPANTS

Four (4) Form Four secondary school students in a district in a northern state of Peninsular Malaysia were randomly selected from the experimental group to undergo the interview sessions. Based on information obtained from their teachers, all of them were students with average achievement. Table 1 below shows more information about the participants of this study. They were interviewed by the main researcher.

Table 1

Research Participants

Research Participants	Gender	Age (Years)	Field/Course
RP1	Male	16	Pure Science
RP2	Female	16	Pure Science
RP3	Male	16	Pure Science
RP4	Female	16	Pure Science

INTERVIEW PROTOCOL

The interview protocol was prepared by the researchers and was evaluated by a group of experts. Among the examples of questions in the protocol are as follows:

1. Can you tell me the physics learning instructions that usually happen in your classroom?
2. During physics lessons, how do you usually feel?
3. To what extent have the text book and the reference books helped you in learning the physics topics?

4. Learning in small groups in class can help you understand physics better. Do you agree? Why?
5. Do you always revise the physics topics at home?
6. Between online learning in school and online learning at home, which do you prefer?
7. What can you share about learning the topic of Forces and Motion – Forces in Equilibrium using the PhET simulation and MoPSIF module?
8. In your opinion, should the use of simulations and modules be used for the learning of other topics in the subject of physics?

The time and location were set by the main researcher after the approval of the study participants. Interviews conducted on respondents were recorded using a mobile phone. This allowed the researcher to retype the entire interview in the form of a transcript and translate the interview in a more orderly manner (Creswell, 2014; Creswell et al., 2017). SOP compliance as stipulated by the Ministry of Health (2020) and the Ministry of Education (2020) which is the wearing of face masks, face shields, hand sanitation and social distancing of one meter (minimum), was observed. The interview took place at the compound of the main researcher's house to avoid being in a public place during the MCO. The respondents' personal information were also kept confidential and replaced with an acronym, for example, Research Participant 1 represented by RP1.

DATA ANALYSIS

The interview data was fully transcribed by the research team. Next the data was organized and thematically analyzed (Fuziah, Ruzlan & Nor Azimah, 2018). Thematic analysis is a widely adopted method for analyzing interview data (Braun & Clarke, 2006; Bogdan & Biglen, 2007; Creswell et al., 2017). The thematic approach used in this study is very suitable for enlightening and understanding the respondents of the study more deeply after the treatment is given (Bogdan & Biglen, 2007; Braun & Clarke, 2006; Novell, Norris, White & Moules, 2017). An additional interview session can be conducted by the researchers for a more detailed and relevant explanation to clear any doubts or ambiguity during the study (Braun & Clarke, 2006; Fraenkel & Wallen, 2000; Fraenkel, Wallen & Hyun, 1993, 2019). The researchers ensured that the findings of the interview results answered the study

questions. According to Braun and Clarke (2006), the interview data should be reviewed to be in line with the study questions and contain the complete information required by the researchers. This was very important to get significant themes in a study.

RESULTS AND DISCUSSION

Students' Thoughts on Their Usual Classroom Learning of Physics

The analysis of the interview data found that the learning experiences that typically occurred in their classrooms were related to internal aspects as well as external aspects. The internal aspect was the assessment of self-achievement in physics while the external aspect involved the physics subject teacher. Although the number of interviewees was not large, their thoughts have provided insights into the real situation in the classroom. Hence, these students' thoughts should be considered as the basis for improving and enhancing the teaching and learning process of physics in schools as well as online during this pandemic era.

Conventional Classroom and Reference Books

Based on the responses of the study participants, the classroom instructions were still adopting a conventional approach. Among its features was that physics teachers in his school preferred to use alternative references as opposed to using textbooks when teaching. This finding is in line with the opinion of Yap (2016) which states that in conventional teaching teachers focus more on the content of textbooks and notes. According to RP1,

> *"Teachers like to use various reference books in class… They seldom use the textbook." (RP1).*

The textbooks and other reference books used were less helpful to students to understand the content of physics. They found it difficult to imagine a situation, phenomenon or process related to the content of the lesson through reading because the images in the reading materials, reference books and textbooks were static or stationary.

> *"The pictures or images in the books are all static. Not moving…like frozen. It is often too difficult for me to imagine how things work." (RP1).*

Conventional Classroom and Fear

According to RP2, he has a fear of asking the teacher a question. This causes conventional learning in the classroom to be one-way learning only and students lack understanding of the content of the physics subject. The teacher's attitude was described as fierce and often angry when students asked him questions. Indirectly, the study participants and their colleagues became less interested in studying physics. RP2 stated,

> *"Actually, I have no interest in learning Physics… difficult to understand… during Physics lesson, my mind became fuzzy. When I asked my friends, they too have the same problem … I feel like Physics is a difficult subject to understand. I dared not ask the teacher because she is quite fierce… there was one time, my friend went to the teacher to seek for an explanation…because he couldn't understand the lesson. Well, the teacher scolded him." (RP2).*

Conventional Classroom and Boredom

RP1 said he felt bored during physics lessons in the classroom. This stemmed from his failure to understand what the teacher was describing during the teaching and learning sessions, to the extent that he stopped listening or paying attention to what the teacher was explaining. According to him,

> *"I felt bored…. I was also confused with the teacher's explanation… Sometimes my mind just shut off. That was why I became sleepy in class. When it felt hard to grasp what the teacher was trying to say, I just stopped listening …" (RP1).*

Conventional Classroom and Group Activities

When asked about group learning while in conventional physics class, RP1 stated that he preferred to study on his own than in groups. This was because the focus was always interrupted while studying in groups. Students chatted more than performed the tasks they were told

to do. Group activities were not very helpful in learning. According to RP1,

> *"When the teacher gave us activities to be in done in groups, usually I would not focus because there would be a lot of chatting and laughing, and less work was done. We learnt only a little from the activities… We only sat in groups when there was a presentation… I did not really contribute much ..... it was more like I did not help or contribute anything at all". (RP1).*

Participation in group work during physics lesson was only limited to presentations and conducting experiments in the laboratory. This is in line with the views of Bunyamin & Finley (2016) and Salmiza (2014). Lack of diversity of group activities was also a factor in students becoming bored and less interested in physics subject. RP2 stated,

> *"Other than presentation, there was no other group work activity… for example discussion. It was always group presentation and doing experiments in the lab. That was all"(RP2).*

Learning Physics at Home

Self-learning in physics was also difficult because reference resources at home were limited. Learning physics at home depended only on reference books and notes. Any incomprehensible things would get to be asked to the teacher the next day because no one could help at home. As commented by RP1,

> *"At home, I have only the textbook and notes to refer to. I did only a bit of revision and homework… If I did not understand a certain point, I would ask the teacher the next day. But, sometimes I forgot to do so… There was nobody at home who could help me. I only relied on the text book, notes and reference books… I would say these resources have not helped me that much". (RP1).*

> *"At home, I did the learning alone. There was nobody whom I could ask for help. I could not have a study group outside school hours because all my friends live far away from each other. I would say that it was difficult to even organise a study group once a month outside school hours" (RP2).*

Students' Thoughts on learning the topic Forces and Motion: Forces in Equilibrium Using PhET Simulation and MoPSIF Module

Simulation Approach Facilitates Learning during Pandemic

Research participants were also concerned about the spread of COVID-19. Conventional teaching and learning in schools was disrupted and became unworkable. The pandemic has forced students to undergo home-based teaching and learning (PdPR). RP1 was worried that he would be left behind in his physics lessons and suggested that his Physics teacher come up with another approach of teaching during PdPR. RP1 stated,

> *"I am worried that I will be infected with the virus if I go to school… My parents are also worried if I have to go to school… For now, best I stay at home…. But if I dont go to school, I will miss a lot of lessons. If there is no lessons conducted ini school who will teach me? At the moment, going to school is not a good idea… Although we have SOP, not all students will follow. Maybe the physic teacher has to think of a way to teach us Physics during PdPR." (RP1).*

> *"I fear I will be infected when sitting in the classroom. I feel not all follow the SOP. Students walk here and there… At the moment, studying in class is not suitable… I can guarantee majority of the students do not follow the SOP. It is difficult to practice social distancing in class. I hope the Physics teacher can teach us in a new way during this PdPR." (RP2).*

The study participants also suggested that their teacher make learning physics more interesting. They have suggested that conventional teaching and learning should be changed to other alternative methods to suit the current situation (the spread of COVID-19) and also to avoid boredom when studying physics. Just as stated by RP1,

> *"We are all very familiar with teacher's method of teaching… I would prefer another method. It is difficult for me to imagine the process that is happening just through reading or explanation by the teacher. If there is an alternative way to make us see the process and make*

> *us easier to understand what we are learning, that would be very helpful and maybe can make us like the Physics subject… I want to learn and I am sure my friends want to learn too but the subject is just too difficult to grasp, especially in this current situation with COVID and PdPR. Learning Physics has become more challenging. We need a new method of learning the subject." (RP1).*

RP2 was also of the opinion that changes should be made to conventional learning methods as it is now the age of IT literacy. According to him,

> *"I think we need to change the way… We don't know how long Covid will be here.My suggestion is learning through the computer, smart phones for this way, we will be safe from the virus. Furthermore, it is high time that we learn using modern technology. Maybe it will be difficult or awkward at first but in the long run, we will be able to adapt to the new way of teaching and learning" (RP2).*

Simulation Approach Helps Imagine Process and Calculation

The research participant RP3 stated that the topic taught was easy to understand and he was not bored. The process or phenomenon could be easily described. This was because the pictures could move and the method of calculation could be made easily. According to RP3, the simulation activity carried out by the respondents was repetitive simulation. This statement also conformed to the characteristics of simulated learning stated by Joyce et. al. (2011).

> *"This new method made it is for me to understand… I have problems in this sub-topic… resolution of forces……! I am still not clear about its calculation. It is hard for me to imagine it when the teacher is explaining. When I look at the picture or the diagram, I cannot understand because it doesn't move… Through simulation, I can understand it easily. I can also calculate easily because I can understand the concept. The pictures move… and we can repeat the process… It is not boring… This is the best way to learn!" (RP3).*

According to RP3, learning experience with PhET simulation was more meaningful than conventional learning. He felt that it was difficult to understand the information provided in writing as found in the textbook. The use of PhET simulation could help students imagine the process that occurred when values were changed and that made it easy for students to grasp the concept of Forces and Motion. Says RP3,

> *"Through simulation learning, we can actually see how the process works compared to pictures in books. It is the same with a certain phenomena. Explanation in words does not help us imagine or understand the process" (RP3).*

> *"It is difficult to imagine a certain phenomena or concept. I am afraid that I might have a different imagination from others. Sometimes I could not imagine at all a certain concept… So, this simulation has helped me a lot" (RP3).*

Simulation Approach Helps Summarises Lesson Content

Learning through PhET simulation helped students draw conclusions after understanding the sub-topics of Forces and Motion: Forces in Equilibrium, and repeatedly trying and observing the changes that occurred when different values were included. According to RP4,

> *"We could see the actual motion… If the horizontal plane was tilted, we could actually see its influence on the force… And that made me understand things easily. My friends and I could repeat the process just by changing the values and see what the results are. It was really easy to understand" (RP4).*

Use of Module Supports Simulation Approach

Learning using PhET simulation was made easier with the availability of the MoPSIF module. RP3 and classmates have shown the initiative to 'play' with the simulation even after completing all the activities in MoPSIF. This showed that the simulated learning has encouraged self-exploration whether it was a group learning or self-learning in

their homes. If something was not understood, the students would first ask their friends, followed by referring to the guide in the MoPSIF module before subsequently asking the teacher if the problem still could not be solved. Hence, it can be said that the MoPSIF module built by the researchers has also supported the learning process of Forces and Motion: Forces in Equilibrium for the group in this study. RP3 informed,

> *"First, we did the experiment alone. Then we repeated using other values… we also tried many different things which were not in the module just to see the result… If there was anything that we did not understand we referred to the module. If we still could not understand, we asked the teacher" (RP3).*

> *"I find it difficult to do it at home at first, because if I don't understand or I m stuck there will be no one to help. But, the module was very helpful. There was a guide on how to do the experiment… it was easy to follow and it was easy to understand… The tasks in the module also helped me how to go about doing the simulation" (RP3).*

Simulation Approach Changes Perceptions towards Group Activities

Students' perceptions changed from not being interested in group activities to being interested in working as a group after using PhET Simulation and MoPSIF Module. RP4 explained that the focus to learn physics through group simulation method has improved and the respondents' classmates have also shown the initiative to 'play' with simulations even after completing the activities in MoPSIF. He also added that the effectiveness of simulated teaching and learning has provided understanding and fun in learning in the classroom and self-learning at home. RP4 commented that learning content could be better remembered by using simulations in school. This supports the view of Ajredini, Zajkov and Mahmudi (2012) which states that the involvement of students in learning through simulation is active. This finding is also in line with Tien and Hamid's (2020) view that the use of teaching technology allows active learning to occur and can improve the quality of teaching and learning. RP4 said,

> *"When we did the simulation, we were in groups... Previously, I did not like working in groups because*

> *usually we would be playing around. But, when doing the simulation, we became focused. We completed the task in the module. It was really helpful and we really enjoyed the learning. I feel I had fun and I also enjoyed working in groups when using the simulation. I like doing the experiments now. The simulation has really helped me understand the concept and to remember the important points easily" (RP4).*

Simulation Approach and Relevant Module for Home-based Teaching and Learning

According to RP3, the concern for learning physics at home was overcame by the learning simulation method for hoe-based teaching and learning (PdPR). PdPR for physics subject was smoothly run when using learning simulation and MoPSIF.

> *"it is a very suitable learning method ... especially during the pandemic. Simulation learning is the best way, in my opinion. The link to the website was already there. We just needed the internet. And there was also the module. The module really helped us how to do the task. It was really helpful especially when we could not attend school" (RP3).*

According to RP4, the simulation learning could overcome learning problem during the pandemic because indirectly the effect was better compared to conventional method. He said changes should be made using a new learning method (simulation) replacing the old (conventional) learning method. The preparation of appropriate modules could improve learning using simulation in PdPR. The findings of this study are in line with the findings of Rosmiati et al. (2017) study which proved that the design of a good physics learning module using PhET simulations can improve the students' understanding of the physics concepts. According to RP4,

> *"The simulation was easy because there was the module as guide, with the pandemic; we have to observe social distancing. Our house is the only safe place. So, when teacher gave us the simulation and the module, I felt it was the suitable way of learning. It was more efficient than the previous method. This new method was also*

more interesting. I could easily understand the concept. I am now interested to learn more in Physics subject. It is hightime we use the new method of teaching and learning" (RP4).

Extend PhET Simulation to other Topics in Physics

RP3 hoped that simulated learning could be extended to other topics in physics besides the topic Forces and Motion: Forces in Equilibrium. According to the respondent, the simulated learning was interesting, he was not bored and the learning was like playing a video game. Indirectly, simulated learning has enhanced students' confidence and encouraged students' exploration of a topic.

"I think we should continue using the simulation method because I can now understand things easily. I am the type who doesn't like to read a lot. I tend to get lost in my reading. We have to do a lot of reading in other subjects too. This simulation learning was really enjoyable. I did not feel bored. Furthermore, it was more like playing a game. We could change the situation and see the result." (RP3).

RP4 also felt that learning other topics in the physics subject would be more meaningful and effective by using simulation methods and assisted by appropriate modules.

"For this topic, with the use of simulation, I have understood the content. It is really easy actually. So, maybe it can be used for other topics as well? It would be easier if the topic is easy. And it would be very helpful if the topic is difficult to understand. As for calculation, we really need to understand to be able to do it" (RP4).

RP4 added the simulation method was compatible with her way of learning. She also did a revision of the topic using the simulation method because she wanted to achieve the best grades so as to fulfill her ambition to study in a university. RP4 said,

"I feel the simulated learning suits me best. We do help each other to get good grades in our exam. Only the ones

with good result will be accepted to enter university. I too would like to further my study. So, it is like a competition now. I want to get good grades too and I think simulated learning can help me understand better" (RP4).

Learning this topic using the simulation became more interesting because students felt like they were playing a game. This showed that there was an element of gamification that attracted their focus and thus distracted them from getting bored when studying the topic such as the findings of the study by Yunzal and Casinillo (2020) where students play with simulations by changing variable values to get varying results. This coincides with the research from University of Colorado, Boulder where their goal was to produce game-like simulation to encourage exploration and discovery.

"When it comes to the part where we have to do a lot of reading, I get bored easily. But with the simulated learning I could interact with it and understand easily the function and process of certain things. I enjoyed best when I could replace the values just to see what happens. I didn't feel bored at all. And if I made a mistake somewhere, there was always the reset button. Just click and it would go back to normal. It was just like playing the computer games" (RP3).

REFLECTION FOR PRACTITIONER RESEACHERS

The above results and discussions indicated that the use of PhET Simulation learning methods together with the MoPSIF module has the potential to have a positive impact on the learning of the topic Forces and Motion: Forces in Equilibrium. It was able to attract students as stated by Liu et al., (2011). Teachers and educators are able to change their teaching and learning technique by substituting conventional learning with technological integrated learning instruction such as simulation. Table 2 provides a summary to the opinions of the research participants in this study which may benefits teachers and educators to utilize simulation in physics subject.

Table 2

Comparison of the participants' thoughts before and after using PhET Simulation and MoPSIF Module

Students' Thoughts on Conventional Classroom Learning of Physics	Students' Thoughts on Learning Physics using PhET Simulation and MoPSIF
• Learning physics is boring and dreadful. • Lack of interest in physics. • Group distraction • Lack of diversity in teaching approaches (except for practical/ experimental activities in the physics laboratory). • Fear being scolded • Self-learning is limited to reference books and textbooks.	• Learning physics is fun because it is like playing a video game. • Students become more interested in physics. • Group activities become more fun and active. • Increased students' imagination and calculation in physics. • Understood the concept in physics. • Relevant for online learning and self-learning • Simulated learning encourages repetitive simulation. • MoPSIF has helped simulation learning process. • Recommend for expanding simulation learning on other topics in physics. • Changes need to be made with IT learning methods.

The limitation of PhET Simulation is not based on the Malaysia education physics syllabus. The simulators and simulation activities which can integrate with other topics in physics subject for secondary school in Malaysia are limited. Experts from education field and software developers in our country are proposed to develop our own simulator that fits the physics learning syllabus. With this, a module containing simulation activities that are compatible with the simulator can be developed to aid the learning process as well as teaching using simulation method.

CONCLUSION

In conclusion, teachers should be sensitive to the physics learning patterns that students preferred. Teachers need to be creative in diversifying the teaching and learning approach of physics topics so that students have a positive attitude towards the subject of physics. The use of simulation together with modules is an approach to teaching and learning physics topics in secondary schools that has the potential to attract students to the subject and support meaningful and active learning, whether in the physics classroom or during PdPR. In fact, the use of PhET simulation with relevant modules has the potential to make students more excited and meaningfully involved in the topic of physics subject as opposed to conventional learning.

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