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Need Analysis for Physics Learning in Secondary School as Perceived by Teachers

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Abstract

Although Physics subject has been taught in Malaysian Secondary Schools since Integrated Secondary School Curriculum (KBSM) in 1989 and furthered with Standard Curriculum for Secondary Schools (KSSM) in 2017, recent studies indicated that secondary school students' achievement in Physics still needs to be improved. Therefore, this study aims to identify students' learning needs for Physics subject as perceived by teachers in secondary schools. The study employed qualitative research design and involved eight Physics teachers from eight secondary schools who taught Form Four Physics. Data was collected using semi-structure interview and analyzed thematically with the aid of Nvivo 14 Application. The findings showed that Gravitation is the most difficult topic for students to acquire in Physics Form Four. The findings also indicated the students' difficulties are influenced by the nature of the Gravitation topic, which is characterized by lacking general knowledge, the ability of students to visualize the concept and mathematical calculation difficulties. The study showed that there is a need for the development of teaching materials that integrate technological elements of visual, audio, video and augmented reality in order to facilitate students' learning in Gravitation topic and Physics generally. Accordingly, there is a need for Physics teachers in secondary schools to be involved in continuous training related to the use of technology in the development of teaching materials.

Keywords: Need Analysis, Physics

Introduction

The scenario of deterioration and less inclined students in the subject of Physics especially in Malaysia every day needs due attention. According to data released by the Education Ministry of Malaysia from 2017 to 2022, the proportion of upper secondary pupils enrolled in the Science, Technology, Engineering and Mathematics, STEM stream fell from 45.2% to 40.9%.(Dewi, 2023).The founder and president of the National STEM Association, Prof. Datuk Dr. Noraini Idris stated that fewer and fewer students are selecting STEM topics in school, especially over the last five years (Wen, 2023).There are various factors of declining student interest in STEM subjects. One of them, students are more interested in literature subjects

because they think science subjects are difficult, especially physics subjects (Osman et al., 2006).

The low entry level of students into the Pure Science stream as well as low achievement in international assessments such as the Program for International Student Assessment (PISA) and Trends in the International Mathematics and Science Study (TIMSS) is a great issue to talk about. According to the TIMSS Report, the position of Malaysian students has shown a slight decrease with the TIMSS 2011 Science score of 426, (TIMMS Report 2015, n.d.) score of 471 and (TIMSS Report 2019, n.d.) score of 460. Next, if more in-depth research is done for the details of the TIMSS Report 2019, the TIMSS Biology score is 463, Chemistry Score 434 while Physics Score 475. It is a relatively low score when compared to other countries such as Singapore. Likewise, if you look at the PISA Report score which is (OECD, 2015)the score is 501, then (OECD, 2018) the score is 493 and (OECD, n.d.)which is 438.

In this regard, the decline of students to the Pure Science stream, especially Physics, will affect the progress of the country and at the same time cause our dependence on experts - scientists from abroad. Students' attitudes in learning activities can help develop future knowledge and be able to work in the field of Physics (Narmadha & Chamundeswari, 2013). Physics is considered a difficult subject (Halim Roslan et al., 2022; Jufrida et al., 2019) and a boring subject in the school curriculum, which has caused enrollment in this subject to decrease in developed countries such as the United States, the United Kingdom, Germany and the Netherlands (Khan et al., 2021) especially at higher education levels (Checkley, 2010).

Learning physics whether in the classroom or through laboratory activities should apply the 21st century learning concept (Sumardani et al., 2019). It should be in line with the Malaysian Education Development Plan 2013-2025 (Kementerian Pendidikan Malaysia, 2013)which emphasizes STEM education at the school level through curriculum and co-curricular activities. It is also one of the other ways to increase interest and curb the decline in the number of students who choose to study pure science, which is becoming more and more worrying.

The practice in the education system in Malaysia which is exam-oriented does not provide an environment conducive to the culture and literacy of science as expected (Kamisah Osman et al., 2006). More emphasis is placed on how to answer exam questions in most teaching and learning sessions. The teaching practices of teachers and education systems that focus on preparing students to face exams have a negative impact, especially from the point of view of students in relation to teaching and learning practices.(Kamisah Osman et al., 2006)

The goal of the KSSM Physics High School Standard curriculum is to generate science-literate students who can use their knowledge of physics in a way that is consistent with modern scientific and technological advancements. Furthermore, the curriculum offers prospects for pursuing advanced study and a profession in the STEM fields (Bahagian Pembangunan Kurikulum, 2018). According to the KSSM Model of Physics, which is thinking skills and thinking strategies where thinking strategies are divided into three dimensions, namely conceptualizing, making decisions, and solving problems. Thinking strategy is also a structured and focused way of thinking to solve problems (Bahagian Pembangunan Kurikulum, 2018). There are seven themes organized in KSSM Physics Form four and Form Five which cover Basic Physics, Newtonian Mechanics, Heat, Waves, Light and Optics, Electricity and

Electromagnetism, Applied Physics and Modern Physics. In Form Four the theme will only be focusing on four themes which are Basic Physics, Newtonian Mechanics, Heat and Waves, Light and Optics.

Technology has demonstrated a significant ability to support teaching and learning. Augmented Reality has shown great potential to assist learning among students. It will also help to guide students in solving problems involving mathematical calculations. The use of models developed involving three dimensions using Augmented Reality (AR) technology can be implemented well to enrich the learning of Physics (Bakri et al., 2019). The use of AR was used by using Physics Simulator study that found that the AR Physics Simulator can help learning in Physics (Sung et al., 2019). AR can be an aid to motivate learning and understanding in students (Saat et al., 2021). Teaching and learning using AR in Physics for example 'GravityAR' has given a great potential in terms of understanding the concept of Gravitation by a study conducted in Croatia (Vidak et al., 2021). However, in Malaysia, research related to the use of technology among students is still at a new stage. There is a study involving students at the Matriculation level using technology in learning which has a good effect on students' achievement (Arif et al., 2021). To add to existing studies, this study aimed to identify the learning needs of Secondary School students in Physics. The finding of the study would help teachers to better design and develop learning materials to assist Physics classroom learning as perceived by teachers.

Literature Review

Physics Education

The goal of studying physics is to gain a basic grasp of the behaviour of matter and energy. Physics is a subject that is being introduced in Form Four students in secondary school in the curriculum in Malaysia. It is being offered together with Biology, Chemistry and Additional Mathematics. There are many major issues regarding physics education. Resolving students' misunderstandings and assumptions about diverse physics ideas is one of the major issues in physics education. Because physics requires understanding abstract concepts and makes complex assumptions, many students are not as interested in studying the subject (Afjar et al., 2020). Students continue to struggle with having trouble visualizing concepts (Susanti et al., 2022). Students find Physics difficult, boring and have problems in solving mathematical calculations (Ramli, 2016). Thus, they will encounter misconceptions in learning Physics. If students have trouble with mathematical calculations, they may lose interest in physics (Halim Roslan et al., 2022). Students with weak mathematical skills will also become weak in Physics skills (Chiu, 2016).

Researchers in physics education emphasize the creation of tools to measure student knowledge and evaluation procedures. These tools have played a significant role in the development of instructional practices and curriculum modifications in physics education research. Numerous conceptual inventories, including the Force Concept Inventory (FCI) (Savinainen & Viiri, 2008) and the Conceptual Survey of Electricity and Magnetism (CSEM) (Maloney et al., 2001) have been established by researchers to evaluate students intellectual grasp of physics concepts. There were also instruments in Physics education to measure students' perceptions and interest (Häussler, 1987). These instruments help the researchers in understanding the desired and students' perception in Physics.

Education in physics also addresses gender issues, highlighting the underrepresentation of women in science in general and physics in particular (Blue et al., 2019). Physics education research also involves pedagogy such as Culturally Relevant Pedagogy (CRP) is an approach to teaching that recognizes and builds upon students' cultural backgrounds, experiences, and interests in instruction (Mathis & Southerland, 2022) and implementing evidence-based teaching strategies in physics education which including real-world applications and illustrations of how to use successful teaching techniques in physics classes (Ashworth, 2022). To comprehend concepts when learning physics, one must be able to reason and think (Al-Masarweh, 2021). The development of a student's physics understanding requires both reasoning and idea interpretation. According to study on physics in Indonesia, students' comprehension of the idea of light refraction is severely hindered by light particles that cannot be seen. However, active learning approaches, such as practical, hands-on learning or the help of technology, can make students more engaged and help them to understand the concepts of physics they are learning (Wibowo et al., 2023). If the topic of the subject is quite difficult to observe and difficult to explain practically it might cause difficulties among students.

Physics education also involves researching in a study on the impact of technology on learning outcomes and student engagement, as well as instructional strategies, curriculum design, and assessment techniques. Study shows that students have better learning achievement in their study using Youtube presentation in Physics lessons (Rozal et al., 2021) and achieved learning outcome in AR experiment based in Physics (Zafeiropoulou et al., 2021) and high achievement in using learning media on Android-based snake and ladder (Kurnia et al., 2018). With emerging technologies, there is a need for integrating physics with education to make teaching and learning a better environment.

The Use of Technology in Learning Physics

Schools still use printed textbooks as their primary source of physics instruction, which makes them less engaging for pupils and thought to be less successful. (Astra et al., 2022). Studying physics enhances one's comprehension of the advancement of science and technology since science relies on experiments, observations, and mathematical analysis to describe a variety of natural occurrences (Suyidno et al., 2022).

The role of technology in teaching physics is to support the construction of knowledge and retention practices. Technology is seen to be able to help physics learning become better. Education in the 21st Century has brought about a paradigm shift that shifts conventional learning towards technology-based learning (Sumardani et al., 2019) . Study shows that the use of technology has help the learning in the development of interactive learning media Prezi-PowerPoint presentations (Widyastuti & Susiana, 2019) and the development of Actuarial Mathematics learning materials (Rosmiati & Siregar, 2021).

In the study of Physics domain, study shows the use of interactive Game-based Learning in Physics Domain shows high scores in achievement (Zeng et al., 2020). There is also a study on the topics of electricity shows great impact of the Physics crocodile simulator in Morocco (Hamamous & Benjelloun, 2022). A study on the topic of quantum mechanics in Physics education shows digital simulation able to help students to visualize the representation of phenomena in Quantum Physics and do further exploration (Vilarta Rodriguez et al., 2020). Study in matriculation college in Malaysia using technology Raspberry Pi in the topic of electricity that applied experiential learning has helped help improve students' abilities (Abdullah et al., 2021) .

Study on the use of worksheets with the integration of augmented reality (AR) videos shows it help in improving achievement in Physics high school students (Bakri et al., 2020). Another study in Physics Simulator using AR with the use of Kinect V2 technology shows that the respondents agreed on the use of AR to help the learning in better environment (Sung et al., 2019).

Factors Influencing Students' Learning Physics

Attitude is one of the factors affecting how well students learn physics. Attitudes, such as procrastination, significantly impact academic performance (Assem et al., 2023). Procrastinating is one of the mindsets that has a bigger effect on students' academic performance. When students have positive attitudes toward learning Physics, they will have more and high motivation to learn Physics even if it is perceived as difficult.

A study in China shows that Physics learning challenges among secondary school students in China are caused by both internal and external factors at the individual, school, home, subject, and sociocultural levels (Ma, 2023).This study suggests the need for better teacher diagnostic skills and home-school collaboration. Another study emphasis on the factors influenced learning Physics involved several factors, such as unfamiliarity, fear of failure, rote learning, and perception of difficulty, affect how well pupils learn physics (Djudin, 2020). This study suggests incorporating practical exercises and contextual relevance, to increase student interest.

A study on Physics students in a matriculation college in Malaysia in online learning Physics shows that there are four aspects that affect students' learning which are motivation, prior knowledge, learning preferences, and computer skills (Uden et al., 2022). The definition of motivation is a relationship with action or movement (Ryan & Deci, 2000). Motivation and learning have a positive relation (Lei et al., 2024). Students who have high motivation will tend to have a higher willingness to gain higher achievement.

One of the most important factors in learning Physics is prior knowledge. Prior knowledge serves as a basis for new knowledge, it is essential to learning and comprehending new information. Whenever individuals come across novel concepts or ideas, they usually draw parallels and integrate the new information with what they already understand. Depending on the nature of prior knowledge a student has, it can either aid or impair their ability to learn. (Van & Tinonas Diaz, 2019). Learning can be affected by four typical prior knowledge circumstances which are insufficient prior knowledge, inaccurate prior knowledge, inappropriate prior knowledge and inert prior knowledge (Gauthier, 2013).

Methodology

The study employed qualitative research design. When you need to investigate a study problem when you are unsure of the factors, qualitative research is the most appropriate method Creswell, 2012). Qualitative research study is a non-numeric or naturalistic data to create comprehensive explanations and rich descriptions that help improve our comprehension of complicated phenomena (Morse, 2012). Another characteristic that sets apart qualitative research is its focus on the viewpoints and experiences of its participants. Qualitative approach is being used to gain perspectives from the viewpoint of the teachers in Physics education. It involves a one-to-one interview. This used a semi-structured interview where the structures of the whole interview are written beforehand to ensure the interview will be going and align with the objectives. Semi structured interviews, represent one of the

most effective approaches we must understanding one another as people and were used to collect data (Butler et al., 2021). The interview is being done to gain information for this study. This study used purposive sampling among Physics teachers. Intentionally, subjects or respondents are selected based on attributes (e.g., age, race, diagnosis, relationships, and roles) that increase the likelihood that their viewpoints and experiences would improve the researchers' comprehension of the topic of interest (Butler et al., 2021). Therefore, the teachers are selected with teaching experience more than seven years of teaching Physics in secondary school. It is to ensure that the teachers are a well-trained teacher and experiencing the previous curriculum *Kurikulum Bersepadu Sekolah Menengah* (KBSM) and the new *Kurikulum Standard Sekolah Menengah* (KSSM). This will help to understand deeper the need analysis in teaching and learning Physics. This study has the permission from Education Policy Planning and Research Division, Ministry of Education Malaysia. There was a total of eight teachers from Negeri Sembilan, Kuala Lumpur and Selangor. The interview recording was transcribed and being analyses by Nvivo 14 using thematic analysis. The written transcription was then validated by the teachers to peer-review the whole analysis of the interviewed that has been done.

Profile of teachers	Working Experience	State
PK1	15	Selangor
PK2	9	Negeri Sembilan
PK3	14	Kuala Lumpur
PK4	14	Negeri Sembilan
PK5	13	Kuala Lumpur
PK6	14	Negeri Sembilan
PK7	9	Negeri Sembilan
PK8	9	Negeri Sembilan

Fig1.Show the Years of Experience and States of the Teacher's Profile.

Fig1 Shows the State where the Teachers are Working and the Years of Experience that they have in Teaching Physics Secondary School.

Results

The Most Difficult Topic in Form Four Physics

The interview reveals a few topics that teachers find difficult for students to understand. They agreed that students need more explanation and more exercises on the given difficult topics. The topics are Heat, Light and Gravitation that being the most topic that they encounter students having difficulties. Based on the interview that being done among the teachers, only one stated that the problem occurs in the topic of Heat. A teacher stated that:

Heat maybe. Because students are confused with specific latent heat and heat capacity. (PK6)

The teacher also found the topic of light has become one of the topics that students encounter problems in teaching and learning. Two of the teachers stated that:

From teacher's point of view. it thinks it is Light. There are so many things. Optical instrument section. It has a compound microscope. Even if it's just a little on the microscope it still has problems. Then, on Optical lens. (PK5)

Lens in the chapter light. Especially the lens. And focus on drawing ray diagrams. Many students take a long time to understand how images are produced. When in the classroom during discussion, they seem can understand. But when they must draw by themselves, it takes a bit of time to determine the position of the image and the characteristics of the image. (PK1)

However, the majority of the teachers stated that the topic of Gravitation is where the problems occur among students during teaching and learning, especially in the form four syllabus. Teachers stated that:

It's difficult because even the students themselves ,they don't have a good calculation. Gravitation involves a lot of numbers, big numbers, then they will have to use many standard forms. (PK6)

Based on the answering technique that I used to help the school, those who combine students from form four and form five during a seminar, most school will propose to include the topic of Gravitation. Furthermore, they encounter a lot of formulas. They also have problems, especially don't know how to use the calculator. Most of the time, they got the answer wrong. (PK3)

As in the topic of Gravitation, students will have calculation problems. (PK5)

Gravitation is one of them. It is recognized as the topics that students are having difficulties with. After all it's a relatively new chapter. It has many formulas. Yes, of course. After that, the formula was long. And, with quite long definition. (PK7)

Most of the teachers that have been interviewed view the topic of Gravitation as one of the topics that students have problem in teaching and learning. They were then further interviewed to find the criteria of Gravitation that has been one of the difficult topics faced by the students.

Characteristics of Gravitation Topic

The interview further indicated that Gravitation topic was selected by the teachers as the most difficult topic due to several factors. Among others, teachers stated that students do not have enough general knowledge, students cannot visualize the concepts in Gravitation and students have difficulties involving mathematical calculations.

Firstly, the topic of gravitation has become one of the difficult topics because students do not have enough general knowledge on the topics. Since this topic is about the outer space for example the Keplers' Law, escape velocity of planets, linear velocity, and man-made satellite, the many of the students does not have the general idea or previous knowledge on the topics. They are unable to relate what they have learned in their daily life. Teachers also stated that Gravitation has less hands-on activity that is impactful for the students to understand better. Teachers stated that:

There are students facing problems with the topic of Gravitation. They do not have general knowledge about the universe. To relate to daily life. (PK1)

Students have trouble relating it in real life. What does gravity have to do with velocity, my students seem to be confused there. They always questioned it. Students have trouble relating to real life. (PK3)

General knowledge on the outer space. Exposure is less. What is the design for that invention?For example, a rocket, or even satellite? Exposure to rocket design examples, not comprehensive. exposure in terms of general knowledge. When it is compared to the topic of radioactivity in another chapter, it is also having difficulties but there are hands-on activities. But the Radioactive chapter has a lot of available materials, various teaching aids. Gravitation has less hands-on activity. Then, if we talk about rockets to space, students sometimes are confused. Answers need to be logical and related to reason. Because the students' knowledge is lacking. I remembered when those time about Dr Sheikh Muzaffar. Our astronaut. A lot of exposure at that time. Now it seems aerospace knowledge is lacking. Students are too exposed to gadgets and are less aware of what is around them. Exposure on how to help them think. How to solve the problem. (PK8)

Secondly, students cannot visualize the concepts of Gravitation. The interview finds that the characteristic of Gravitation is that the topic involves imagining. The students should be able to visualize the concept. It is because the topics involve the dimension of the planets, Kepler's Law I, II and II and the force between the body in a system. When the students are unable to imagine, they also have problems in understanding. They cannot visualize the idea of certain concepts therefore they have been struggling. Thus, they tend to memorize.

They struggle. The students. I'm not sure why. Maybe it involved a lot of formulas. Numbers. I've also observed that they cannot see, they can't visualize. From the video alone, they can't get that desired understanding. Because when we do topics especially when involved with experiments, when the students can experience it. It helps with their understanding. But then, I am speaking as for me I am teaching ordinary school students. But should they also be treated the same way. (PK6)

In my opinion. The teacher is not yet a master in the topic. The teacher is still studying and still not skilled. It's hard for the students to imagine learning about outer space. Students also have difficulties in imagination. (PK7)

For example, the atomic bomb, right? Students can see it. Students can be helped to understand better. But in the topic Gravitation. Students are unable to see it. To imagine. They know the moon. They also know the earth. Then, when it is a subtopic of forces between two objects in the universe. So, when it involved a change in the object, the sun with another planet. They confuse. Then, there is also a satellite of a certain height. Yes. It cannot be seen. They have a little problem with imagining. (PK8)

Students cannot imagine. Students cannot imagine the attraction of gravity between bodies. Between planets. then they are confused. For example, symbol v, escape velocity or linear velocity. Students do not remember. Then they get confused, for escape velocity or linear velocity. After that, when you want to use certain formula. Even, students, confused. Even among the students that is quite smart students. Cannot imagine. (PK2)

Yes, this topic needs more animation so they can get the idea to see it. So that they can imagine, it's necessary. There is a corresponding animation. So that they can know and get involved in real motion. Or the real situation. But from the point of view of students, they will not be able to see.In my opinion, students with a higher level of understanding can imagine. Based on those who have an interest in this universe, they have no problem. Those who are not interested and have no exposure, it is quite problematic for them. Yes, not all. But the majority. It might help if we show video for them. Even among my students, especially female students, it's hard for them to imagine, when we say the sun is like that. They can imagine, but when if we show animation, it might reinforces understanding (PK1)

In subtopic man-made satellite. Students will memorize every feature. (PK8)

Thirdly, students have difficulties in mathematical calculation when doing Physics problems. Mathematical calculations problems are divided into two small themes, which are skills of scientific calculator and mathematical formula. Students seem to have problems integrating their knowledge of Mathematics with Physics. They were also having problems with parentheses and standard form. It is known that the topic of Gravitation is emphasized on the accuracy of the calculated value.

The students are having problems with the skills of using the scientific calculator. It is because the topics involve huge numbers when it comes to calculation, for example involve the radius of planet. Furthermore, the skills to use parentheses or brackets and the skills involving standard forms. Some of the teachers also stated that the need to emphasize the accurateness of the calculations. For example, when the answer involves the mass of a planet and the answer in standard form it should be in four or five decimal places so that the value of the accuracy is correct. It might also be a problem that students do not grab the knowledge of mathematics and integrate it when answering Physics problems.

Lack of calculator skills. Don't know the skill with scientific calculator. Because when they calculated with the calculator, it wasn't right. got the answer wrong. When I go to give a seminar or answering techniques, when the students involved are from form four and form five. They encounter problems. In terms of theory, it's good. They have understood. Just problem in terms of calculation. When involving the skills with the calculator. It is a about technical issue. Yes, the mathematics. Derivation. Basic student in mathematics. With the use and skills of calculator. I taught how to use the calculator with the students. I think it should be emphasized. Must teach. It is not encountered by the ordinary school; it also happens among those selected school students. It's the same. The problem is the same. I'm telling the truth. (PK3)

There is a problem using with the skill of using the calculator. They don't know how to use the calculator. When doing multiplication, they did not put parentheses, I mean, brackets. Then, it is wrong. The steps when involving the calculation, it already corrects. But then when calculated, it got wrong. That's normal. Because when it comes to this chapter, it has a lot of confusing calculations, right? There is a power of three, then you need to put parentheses. (PK7)

Careless students have problems in their skills of using calculator. For example, when it used the value of power of two or squared. In the standard form, they forgot to make parentheses.

If there are no parentheses, the answer will be wrong. Secondly, the problem, to emphasize with answers with more decimal places for the accuracy aspect. I think we should emphasize up to five decimal places. We encourage students to write answers with more decimal places. For the accuracy aspect. Students confused. When the calculations involve ratio. Because it is not visible. It's just a concept. (PK8)

Students have trouble with the skill of using the calculator. It was during the topic of Gravitation that I allocated some time, just to teach how to use the scientific calculator. It's quite a challenge. That's what I've been dealing with since the first year of teaching Gravitation. I'm not sure with their mathematical lessons when they were in lower form. (PK6)

The teachers involved in the interview also stated that the students are rather confused with the formula. Physics education has a lot of chapters. There are students who can excel and understand the topics, but when it comes to the topic of Gravitation, it is quite difficult for the students to grasp the knowledge. They are rather confused. There were also times when teachers have done a whole chapter of revision on this topic to the students when they are in Form Five. It might be time consuming for the teachers. The teacher also thinks that this topic is rather simple yet cannot stay in the long-term memory for the students. They seem to have problems connecting between each subtopic and the formula associated. When compared to other topics in Physics, it is known to have formulas. But they seem to be able to differentiate the formula. The students, for example, have also encountered problems when differentiating between the formula for escape velocity or linear velocity.

Students feel a bit affected by the many formulas. It's just that they may be confused about the formula. Whether it is linear velocity? Or escape velocity? Because v is the same. (PK1)

The topic of Gravitation, many formulas. Might be confusing. Students said there are a lot of formulas. Is it about derivation only, right? Anyway, I went to give a talk about Physics, students, when we discussed Gravitation. They will tell you. Lack of interest because there are many formulas. Confused with formula. Students are confused about how to relate the radius to the force. (PK3)

Problematic. Mathematical problems and definition meaning. They seem to have trouble differentiating between the law. The formula involved; they confused on which one to apply. With the previous syllabus, in my opinion, it only involved free fall. Now it's quite a lot. When there are a lot of confusing formulas, they tend to think it is difficult. They will not be interested because they feel it is difficult. It might affect the '60-40 science stream enrolment' in the school. Then, for example, there are topics of escape velocity and linear velocity. They must differentiate. They confused. Then, there are also forces between the two masses. They get confused, which mass do we want to take in terms of solving such problems in the exercises. (PK7)

Ways To Minimise Learning Difficulties In Gravitation Topic

During the interviews, the teachers are also proposing tools or ways to help the teaching and learning among the students in the topic of Gravitation. They emphasize the difficulties for students in visualizing.

The finding from the interview stated that teachers propose resources using technology rather than merely on textbooks. They are suggesting that the resources of material that might help are visual, audio, video, animation and AR which will be simplified and helpful resources. Most of the teachers stated that there is still a lack of resources in Gravitation. The material or resources that they intended are meaningful and have an impact among students. The resources should be able to be used in the classroom.

I just use a visualizer. If it's Gravitation, it is good if there is animation available. (PK8)

For example, like Kepler's Law II, the distance includes that, maybe if there is a video, show the movement, it takes time. The animation might help. (PK7)

I strongly think video is necessary. AR is very helpful. You might also need video. (PK5)

As an example of centripetal force, I will add a video that will involve circular movement. This is in the hammer and circular movement. (PK1)

Teachers also agreed that they need to do revision to the students at the end of the topics. They also agreed that the revision on Gravitation will also being done when the final examination of form four examination is going to held. Furthermore, when it comes to doing seminars, the topic of Gravitation has been the most proposed topic in SPM seminar. The fundamentals of each student are also important among students. They also do revision on definition involving Gravitation. Teachers stated that:

I really can't avoid it. Must do a revision. Half the class had to refresh the whole lessons they had been taught. The need to revise also on the mathematical part on standard form in calculation Mathematics lessons when they are in Form One. We do workshops. How to answer, the technique. We focus a lot on Gravitation. (PK1)

The calculation, we do the calculation many times. (PK6)

The students are sometimes confused. I will make sure to help in strengthening their fundamental aspect. I also strengthen the definition of students. We will find time later at the end of the year, we will strengthen the definition for students. Because to me, they must master the definition. Students are not guessing. So, when you want to answer a question, everything will be based on the definition back. What is the difference between Kepler's Laws II and Kepler's Laws III. What is the difference between them. What is the definition? For me a lot of referring to the definition. For example, Kepler's Laws III, sentences, and definitions will help for mastering the relationships. It will also relate in the calculation later. So, let's start with the definition first (PK8)

Discussion and Conclusion

The study shows that Gravitation is one of the difficult topics among students as perceived by the teachers. One of the characteristics of Gravitation is students cannot visualize the concepts in Gravitation. This is in line with a study that stated Gravitation is difficult to relate because the subtopic is comprehensive and demands a high level of imagination (Agustin et al., 2018). Interactive simulations of Newton's theory of gravity for example have been shown

to be effective teaching tools for enhancing student learning outcomes and helping to visualize the concepts (Susanti et al., 2022) and technology such AR have potential to revolutionize physics education by making challenging concepts visible and making it understandable (Al-Masarweh, 2021). With the help of technology, visualization will become better among students. It can aid students to see clearly and further make connection on their prior knowledge thus will make them understand better.

The characteristics that are further discussed are students do not have enough general knowledge on the topics. Students should have enough general knowledge to make them understand better. This is in line with a study assuming that Physics students will find the setting of science discussions in real-world scenarios to be engaging (Jari Lavonen et al., 2005). Students should be able to connect general and prior knowledge when learning Physics and integrating it with real life scenarios. Students also have better understanding when they can connect, engage and relate to real life of what they have been learning. They also do queries on how and why they should study those subtopics. It is the responsibility of the teachers to help to explain and make them understand better.

On the other hand, mathematical calculation seems to be a critical factor in Physics education. The idea that mathematics is the "language of physics" suggests a close relationship between the two fields (Pospiech, 2019). This is also in line with a study in Bhutan in student's perceived difficulties in studying Physics addressed apparent challenges by applying more time to understand how to solve the application of mathematics in Physics (Wangchuk et al., 2023). These results can help teachers of mathematics and physics realize how important it is to relate formulas and ideas that are understandable in both fields. This is also in line with a study emphasizing the structural component of mathematics must be constructed, but depending on the mathematical tools available, it may be possible to derive mathematical descriptions using a variety of tactics and patterns (Uden et al., 2022). The concept of number is essential to mathematical performance, thus before moving on to more complicated concepts, instruction should start slowly to make sure that the fundamentals of quantity and number representation have been properly learned (Chassy & Jones, 2019) . Thus, mathematical calculation plays an important role in learning Physics.

The finding from the interview stated that teachers suggest having resources of material using technology in the topic and also emphasizing doing revisions. It's critical to develop more adaptable methods for conveying to all students the significance and attraction of technical applications, especially using technology-based learning in Physics (Jari Lavonen et al., 2005). The use of technology can help in making the learning environment of Physics become better.This is in line with study in the topics of electromagnetics using mobile phone (Solihin et al., 2022) the use of augmented reality in solar eclipses (Baba & Zorlu, 2022) that shows technology enhanced students' learning and increase their level of success. The availability of technology has made it possible to assist difficult-to-imagine Physics topics with the use of simulations and other supporting media (Susanti et al., 2022).

The study indicated that in order to help students learn the concept of Gravitation and Physics in general, teaching materials incorporating technological components like visual, audio, video, and augmented reality are needed. Therefore, it is imperative that secondary school Physics teachers participate in ongoing training pertaining to the use of technology in the creation of instructional materials. This study aims to identify students' learning needs for Physics subject as perceived by teachers in secondary schools. It involved eight secondary school teachers to be interviewed. This study shows problems faced by the students in learning Physics among form four students. This study suggests that the design and

development of an AR learning kit for Physics is necessary to address the aforementioned issues and assist teachers and students. This needs analysis only involve among teachers from the three states. It is suggested that further studies be carried out which involve students in several classes in secondary schools to get a more comprehensive picture of the issues.

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