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# Enhancing Physics Engagement Among School Students Through Virtual Laboratory Inquiry

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## Abstract

Physics is recognized as one of the most difficult topics, which has resulted in a lack of enthusiasm and engagement among secondary students. Therefore, this study aims to (i) identify the difficulties encountered by students in learning Physics, (ii) determine the significant difference in students' performance in Force and Motion in Physics when using virtual laboratories based on gender, and (iii) identify the significant difference in students' performance in Force and Motion in Physics when using a virtual laboratory based on urban and suburban settings. Quasi-experimental research was employed to investigate students' difficulties in Force and Motion, with the research objective being to identify students' perception of computer simulation. The questionnaire was distributed via Google Forms to 40 respondents from secondary school students from Selangor, Malaysia. The findings of this study demonstrated that students encountered the expected problems and provided positive feedback after utilizing the virtual laboratory for learning Physics, indicating the effectiveness of computer simulation in Physics education. The data also revealed that gender did not influence interest in learning Physics, and rural areas showed no significant differences in student performance during the learning sessions. Furthermore, students provided positive feedback and agreed that the virtual laboratory teaching methods offer numerous advantages over traditional methods for teaching and learning Physics.

Keywords: Virtual Laboratory, Inquiry, Physics Engagement

## INTRODUCTION

Despite far-reaching applications, getting students interested in the field of Physics can be a difficult prospect. Most secondary school students find Physics fearsome and tend to lose interest when being taught traditionally, therefore developing a general dislike for the subject (Deslauriers, McCarty, Miller, Callaghan, & Kestin, 2019). This low involvement is because a lot of the students is not capable with that of the online concentration due to various of interruptions, in addition to battling with this particular fingers-on come across (Simamora, 2020). One potential approach for meeting these challenges is using Virtual Laboratory Inquiry (VLI). These virtual labs provide a high degree of interactivity and immersion, which can help make complex scientific concepts easier to understand and increase student engagement.

Introducing virtual laboratory applications into the classroom educators can offer students with a dynamic educational tool that maximizes their learning potential (Dalgarno, Bishop, Adlong, & Bedgood Jr, 2009). There are so many advantages of virtual laboratories that would help in overcoming challenges of student engagement in Physics. They present memorable laboratory levels and processing features, easy interfaces, and exact yields (Hernández-de-Menéndez, Vallejo Guevara, & Morales-Menendez, 2019). Such tools allow direct visualization of experiments thus making such environment facilitate interaction by allowing the students to perform practical experimentation and make improvements to enhance efficiency to be performed. Students could clone experiments on their own, which in turn would help them gain valuable practical experience and allowed for an individualistic insight and a more profound understanding of the elaborate underpinnings of experiments (Koretsky, Amatore, Barnes, & Kimura, 2008).

Furthermore, an improvement in the display devices and attached software makes it feasible to implement virtual technology within modern teaching approaches effectively (Matthew, Kazaure, & Okafor, 2021). Instead of traditional lab exercises that are time consuming, costly, and only possible for a certain amount of time, virtual laboratories gives a safer simulation of the actual encounter with the models and simulation not being limited to time and continuously usable without any added cost. This approach enables students to carry out assignments either independently or in groups with the use of virtual laboratory features regardless of the access to

physical school laboratories, chemicals, and equipment (Acarli & Kasap, 2022; Herga, Čagran, & Dinevski, 2016).

Literature review in this research has making it evident that virtual laboratories, boost the level of understanding and interest among students. They launch assistance in surmounting the barriers of conventional laboratory bend learning and assists contribute to paring educational objectives (Nirmala & Darmawati, 2021).

Therefore, this study aims to (i) identify the difficulties faced by students in learning Physics, (ii) identify the significance different of students' performance in Force and Motion in Physics by using virtual lab between genders, (iii) identify the significance different of students' performance in Force and Motion in Physics by using virtual lab between urban and sub-urban, and (iv) explore the perception of Virtual Lab on student's engagement in Physics.

## METHOD

The study approach was a mix of methods, combining quantitative and qualitative analysis, which entails gathering and analyzing quantitative data within a single data set to gain a thorough understanding of the topic. By using instruments such as questionnaires and open-ended questions, this case study design assesses the significant differences in students' performance before and after using the virtual lab, the problems encountered by students in contemporary physics, and, finally, how the virtual lab affects students' participation in physics class. As a result, data will be gathered based on these criteria to determine the level of participation among secondary school pupils. In addition, I will conduct a needs analysis on the two sample groups from two separate schools, focusing on the students' academic background, achievement, gender, and interest in physics.

### Research Sample

The researcher selected samples randomly from form 4 science students and assigned them to the experimental and control groups, each comprising 40 students with an equal number of males and females. Simple random sampling was used to ensure that every individual in the population had an equal chance of being selected as a sample. This technique was employed to prevent bias and ensure high generalizability of the findings, by randomly selecting students from a homogeneous population of 100 students who studied modern physics in both schools.

### Research Instrumentation

The instrument for this research is the use of questionnaires via Google

Forms to collect the necessary data. According to Roopa and Rani (2012), a questionnaire is an instrument used to collect data from specific subjects by asking them a set of oral or written questions. Since this is a descriptive study, a questionnaire is the best way to collect the data. Furthermore, using a questionnaire as an instrument will save costs and is an affordable way to collect quantitative data. It is quick, time-saving, and accessible due to its flexibility on any online platform. The instrument for this research will be adopted and adapted from two previous studies: "Science and Mathematics Education Centre Effectiveness of Virtual Laboratories in Terms of Achievement, Attitudes, and Learning Environment among High School Science Students" (Akhigbe & Adeyemi, 2020) and "The Impact of Using Virtual Lab Learning Experiences on 9th Grade Students' Achievement and Their Attitudes towards Science and Learning by Virtual Lab" (Musawi, Ambusaidi, Balushi, & Balushi, 2018). From these previous studies, the questionnaire items will be used by the researcher to gather data and answer the research objectives. Additionally, the researcher used open-ended questions in a survey to examine the students' perceptions of using virtual labs in learning physics.

**Data Collection and Analysis**

Data collection procedures are crucial before distributing research instruments to ensure a smooth process. The researcher began by developing tools, including questionnaire items adopted and adapted from past research relevant to the study's objectives, and an open-ended question. Once the instrument was ready, the researcher applied for approval to conduct research at SMK Batu Unjur and SM Sains Machang. Upon receiving approval and permission from class teachers and respondents, the researcher distributed the questionnaire to the targeted sample. Respondents were given 15 to 30 minutes to complete the questionnaire and the open-ended question.

The Statistical Package for the Social Sciences (SPSS) application was used to analyze the data collected for the project. Table 1 summarizes the details of the data analysis procedure.

Table 1. Data Analysis Procedure

| Section | Statistical Tool(s) |
|---|---|
| To identify the difficulties faced by students in learning Physics. | Descriptive analysis |
| To identify the significance different of students' performance in Force and Motion in Physics by using virtual lab between genders. | Independent sample T-Test |

| Section | Statistical Tool(s) |
|---|---|
| To identify the significance different of students' performance in Force and Motion in Physics by using virtual lab between urban and sub-urban. | Independent-sample T-Test |
| To explore the perception of Virtual Lab on student's engagement in Physics. | Thematic analysis |

**RESULTS AND DISCUSSION**

The analysis of this study reveals that all students have experienced at least one of the anticipated difficulties listed in relation to the topic of Force and Motion in Physics. Table 2 presents the summarized findings based on the research objective.

Table 2. Summary of Finding and Data Analysis

| Section | Findings |
|---|---|
| Demographic Data | The number of respondents for this study is 40.<br>50% (n=20) of the respondents are male students while another 50% (n=20) of the respondents are female students.<br><br>Students' Age:<br>All respondents (n=40) are Form 4 students, thus ages the same, 16 years old. The percentage are 100%.<br><br>Students' Race:<br>Malay (72.5%, n=29)<br>Chinese (15.0%, n=6)<br>Indian (12.5%, n=5)<br><br>Students' Community:<br>Urban (50%, n=20)<br>Sub-urban (50%, n=20) |
| To identify the difficulties faced by students in learning Physics. | The result shows that the level of expected difficulties encountered by students is high. Six (6) expected difficulties about learning Physics using traditional methods are raised in the questionnaire (Section A) to identify the difficulties faced by them in learning Physics. The difficulties were evaluated from the scale "neutral" up till "strongly agreed" chosen by students. Among the highest difficulties voted by them, shown based on the analysis are: "I cannot greatly explain the difference between distance and displacement" (mean=4.58) and second in line was "I cannot greatly explain the concept of inertia" (mean=4.28). |
| To identify the significance different of students' performance in Force and Motion in Physics by using virtual lab between genders. | The result shows that statistically there is no significant difference of students' performance between male and female students ($p = 0.478 > 0.05$). |

| Section | Findings |
|---|---|
| To identify the significance different of students' performance in Force and Motion in Physics by using virtual lab between urban and sub-urban. | The result shows that statistically there is no significant difference of students' performance between urban student and sub-urban student ($p = 0.877 > 0.05$). |
| To explore the perception of Virtual Lab on student's engagement in Physics. | The result indicates that all the responds by the student from the open-ended question came to the same output which is: Effective tools. |

**Analysis of difficulties faced by students in learning Physics**

The analysis of this chapter indicates that all students have encountered at least one of the list-expected difficulties related to the chapter Force and Motion in Physics. This part of the study is to determine the resemblances of difficulties encountered by the students. Students are considered to encounter expected difficulties regarding their old and traditional learning method, as they selected the right scale in Likert-scale items in this section. Descriptive analysis statistics have been used to evaluate the mean and standard deviation from the calculated tabulate data. Table 3 shows the type of difficulties encountered by the students towards chapter Force and Motion in Physics.

Table 3. Analysis Response for Section A: Likert-Scale Item

| Item | No. of sample | Mean | Standard Deviation |
|---|---|---|---|
| A1 I am not clearly understanding the concept of Force and Motion. | 40 | 3.88 | 0.686 |
| A2 I cannot greatly explain the concept of Force and Motion. | 40 | 4.10 | 0.545 |
| A3 I cannot greatly explain the difference between distance and displacement. | 40 | 4.58 | 0.636 |
| A4 I am not able to illustrate the correlation graph of length versus time. | 40 | 4.28 | 0.716 |
| A5 I am not able to explain the concept of momentum when involving 2 bodies. | 40 | 4.23 | 0.768 |
| A6 I cannot greatly explain the concept of inertia. | 40 | 4.28 | 0.716 |

Students felt "I cannot greatly explain the difference between distance and displacement" the most, as physics has legendarily been considered a difficult subject. Research has shown that many students in Physics courses are not developing a satisfactory conceptual understanding of basic physics (Adams et

al., 2008; Adeyemo, 2010; Kola & Taiwo, 2013). Despite their best efforts, many students emerge from their study of physics with serious gaps in their understanding of important topics. Traditionally, students receive one-way information when they hear the explanation made by the teacher in the classroom. The same goes for the second highest in line, where students felt "I cannot greatly explain the concept of inertia". According to (Oladejo, Olosunde, Ojebisi, & Isola, 2011), low mastery of scientific concepts arises from the traditional teaching approach. So, the issue arises: whether the physics subject is too difficult, or a poor approach has been used in teaching and learning physics. Teachers often focus on algebra/calculation aspects during teaching physics. Research by (Brissel, Morel, & Dupont, 2013) stated that we should optimize our senses such as eyesight, hearing, and other senses to analyze the stimulation in the environment. Eyesight and hearing are the two main senses that we use in the process of obtaining information.

The main problem faced by students in learning physics is the difficulty for students to master abstract physics concepts (Aina & Joseph, 2013; Volkmann, Abell, & Zgagacz, 2005). If the problem is allowed to continue, it is difficult for students to master an abstract concept, then they may lose interest or confidence to learn other topics in physics in which the student finds it difficult to imagine the flow of concepts relevant to a particular topic. The lowest, which is "I do not clearly understand the concept of Force and Motion", is a living example where students tend to understand more on definition as they can memorize it in words and hardly relate it to any conditions. When researchers questioned physics professors and high school graduates about what they thought were the most difficult and simplest physics topics, they discovered that "electromagnetic induction" is the most difficult and "substance and its characteristics" is the easiest. Some of the reasons why students struggle to learn physics topics have also been identified in the study (Aykutlu, 2017; Henke & Höttecke, 2015).

**Analysis of significance different of students' performance in Force and Motion in Physics by using virtual lab between genders**

To analyze the significant difference between males and females after applying the virtual lab in learning Physics, the researcher used a Likert-scale item. The levels of agreement and disagreement, denoted as "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," were used in the

research to enhance the accuracy of students' perceptions of the virtual lab. “Strongly agree” and “agree” indicate that students view the statement as correct, while “strongly disagree” and “disagree” indicate that they view the statement as incorrect. This comparison was made between males and females. To achieve this, the total means for males and females were compared, as shown in Table 4.

Table 4. Mean Score Among Male and Female Students in Experimental Group

| Item | Gender | N | Mean |
|---|---|---|---|
| B1 I was very excited to learn | Male | 20 | 4.10 |
| Physics using virtual lab. | Female | 20 | 4.10 |
| B2 Virtual lab increased my | Male | 20 | 4.00 |
| interest in learning Physics. | Female | 20 | 4.10 |
| B3 I like to participate in computer simulation activities | Male | 20 | 4.10 |
| during teaching and learning process. | Female | 20 | 3.90 |
| B4 Virtual lab motivated me to | Male | 20 | 4.05 |
| pay more attention towards Physics lesson. | Female | 20 | 3.80 |
| B5 Virtual lab engages me more | Male | 20 | 3.90 |
| in learning Physics. | Female | 20 | 3.95 |
| B6 I would like to continue to | Male | 20 | 4.20 |
| learn Physics using virtual lab in future. | Female | 20 | 4.05 |

The mean scores between male and female students in the experimental group were compared. It can be seen from the table that males have higher mean scores for most of the items compared to female students. An independent sample T-Test was further conducted to determine whether this difference was significant as shown in Table 5.

Table 5. Independent Sample T-Test Among Male and Female in Experimental Group

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| Item | | F | Sig. | T | df | Sig. (2-tailed) |
| Questionnaires | Equal variances assumed | 0.447 | 0.508 | 0.717 | 38 | 0.478 |
| | Equal variances not assumed | | | 0.717 | 34.107 | 0.479 |

The results show that the difference in the means between male and female students in the experimental group for the questionnaire was not significant ($t = 0.717$, $df = 18$, $p = 0.478$). This indicates that the mean scores for male and female students in the experimental group were approximately equal. It also suggests that the gender of the students did not significantly affect their achievement in learning Physics using the virtual lab.

From the descriptive analysis Table 4, it is proven that male students

have slightly outperformed female students in terms of learning scope, with the highest mean of 4.20 compared to the mean of 4.05 for female students. The findings of this research, analyzed using an independent samples T-Test, indicate that there is no significant difference in students' performance in learning Physics using virtual lab among male and female Form 4 students.

These findings are consistent with research conducted by Mkpanang (2016) and Mohidi (2023) found that gender did not influence students' achievement in Physics.

The results of this research also align with the findings of (Onwioduokit, Akinbobola, & Udoh, 2008) that gender has no effect on the academic achievement of Physics students when they are taught with good and motivating instructional strategies. The results are also in agreement with the findings of (Agboghoroma & Oyovwi, 2015; Wolf & Fraser, 2008) that any effective instructional strategy does not discriminate between genders in science teaching and learning.

The analysis in Table 5 showed that male Physics students are not significantly better than female students. This might be due to the fact that both male and female students interact with the teacher freely in a set environment, leading to the development of problem-solving skills, increased depth of understanding, enhanced motivation, and greater involvement of both male and female students with the concept. This is consistent with (Onwioduokit et al., 2008) and (Akinbobola, 2015), suggesting that if both sexes learn the same thing under the same conditions, they are likely to achieve in the same way. Based on these findings, it can be concluded that the gender of students does not influence performance in learning Physics using virtual lab.

**Analysis of significance different of students' performance in Force and Motion in Physics by using virtual lab between urban and sub-urban**

The total mean of community between urban and sub-urban students in the experimental group was compared. An independent sample T-Test was used to identify the differences in test scores on the Force and Motion test between urban and suburban students in the experimental group as shown in Table 6.

Table 6. Mean Community for Student From Urban and Sub-Urban in Experimental Group

| Item | Gender | N | Mean |
|---|---|---|---|
| B7 It is helpful to learn Physic using computer simulation. | Urban | 20 | 4.10 |
| | Sub-urban | 20 | 4.10 |
| B8 Virtual lab is an appropriate technique technique to learn about concepts in Physics. | Urban | 20 | 3.90 |
| | Sub-urban | 20 | 4.20 |
| B9 Virtual lab has made the learning more | Urban | 20 | 4.0 |

| Item | Gender | N | Mean |
|---|---|---|---|
| interesting than traditional method. | Sub-urban | 20 | 4.0 |
| B10 I prefer virtual lab method of teaching | Urban | 20 | 3.85 |
| rather than traditional method in learning Physics. | Sub-urban | 20 | 4.0 |
| B11 Learning with the virtual lab improved | Urban | 20 | 3.90 |
| my understanding of the basic principles of Physics. | Sub-urban | 20 | 3.95 |
| B12 Learning with the virtual lab increased | Urban | 20 | 4.00 |
| my factual knowledge of physics. | Sub-urban | 20 | 4.25 |
| B13 Virtual lab improved my ability to | Urban | 20 | 4.15 |
| think logically. | Sub-urban | 20 | 4.40 |
| B14 Virtual lab improved my ability to | Urban | 20 | 4.05 |
| learn independently. | Sub-urban | 20 | 4.35 |
| B15 Virtual lab should be used more | Urban | 20 | 4.05 |
| frequently in Physics learning and instruction. | Sub-urban | 20 | 4.25 |
| B16 Virtual lab develops good and | Urban | 20 | 4.05 |
| effective interaction between me and my teacher. | Sub-urban | 20 | 4.00 |

The mean community scores between urban and suburban students in the experimental group were compared. It can be seen from the table that students from urban areas have mean community scores equal to those of suburban students. An independent sample T-Test was further conducted to determine whether this difference was significant or not as shown in Table 7.

Table 7. Independent sample T-Test among urban and sub-urban in experimental group

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|---|
| Item | | F | Sig. | T | df | Sig. (2-tailed) |
| Questionnaires | Equal variances assumed | 11.366 | 0.002 | 0.156 | 38 | 0.877 |
| | Equal variances not assumed | | | 0.156 | 28.207 | 0.877 |

To inspect the difference in students' performance in learning a Physics chapter after applying to the Virtual Lab, the researcher used an independent sample t-test to answer the research question. Table 6 shows the statistics of students according to their living community, while Table 7 shows the analysis of the independent sample T-Test on the effectiveness of the virtual lab in learning the Force and Motion chapter in Physics.

Overall, the results indicate that there was no significant difference in students' performance in learning using the virtual lab when comparing their

living communities, urban and suburban areas. From the table above, it shows that t = 0.156 while p = 0.877. Therefore, since the requirement to reject the null hypothesis is that the value of p must be less than 0.05, it is concluded that there is no significant difference in students' performance according to their living community in learning the Physics chapter, especially the Force and Motion chapter.

This result is consistent with previous findings obtained by (Shah, Mahmood, & Harrison, 2013), but contrary to the results of the attitudes toward learning physics study conducted by (Ringo, Kuswanto, Samsudin, & Setiawan, 2021). They found that urban students had more positive attitudes toward physics learning than students in rural areas. The similar attitudes toward physics between rural and urban students in our findings probably appeared because the physics teaching experiences in the participating schools were not contrasting. Although schools in urban areas had advanced technology or facilities compared to schools in rural areas, urban teachers rarely used these facilities to improve their physics teaching.

Consequently, physics teaching practices in urban schools did not differ significantly from those in rural schools. In other words, teachers in urban schools had not maximally employed available tools in schools to refine their teaching. Teachers' unawareness of technology usage (Baek, Jung, & Kim, 2008; Md Ahir, 2008) and other useful facilities to enhance teaching quality should receive more attention from the government. Students in urban schools had somewhat better attitudes than those in rural schools, as reported by (Knoblauch & Chase, 2015; Zacharia & Barton, 2004). As a result, the location of the school does not appear to be a major predictor of attitude toward scientific instruction. This clearly shows that student living community and even school locality do not affect students' performance.

**Analysis of perception of virtual lab on students' engagement in Physics**

Five respondents were involved in answering the open-ended question, and their answers have been recorded. Based on their recorded answers, the researcher identified a theme using thematic analysis.

(i) Thematic Analysis: Effective tools

According to the answers from respondents 1, 2, and 3, they shared the same opinions about computer simulations as a method of learning Physics compared to other traditional methods. They stated:

"It is good to take students' interest in learning Physics…" (Respondent 1).

Regarding respondent 1's answer, he mentioned his interest in computer

simulations such as virtual labs. Virtual labs help to make learning sessions more engaging.

“In my view this approach is less complicated than more conventional approaches and is easily accessible over the internet.” (Respondent 2).

“It will facilitate the management of the procedure and in turn given us ample opportunity in doing the activity to avoid the mistake.” (Respondent 3).

Both respondents 2 and 3 said that an application which would be more convenient would be a computer simulation, for instance in Virtual Labs, assist in gaining a better understanding of the content. The benefits of virtual laboratory are as follows: Because of its flexibility it is very easy to use; it is also very easy to put right anything that the user did wrong.

“Everyone loves it due to its simplicity. It is quite straightforward.” (Respondent 4).

Respondent 4 noted that “it wasn’t very hard – things were easier and enjoyable, especially in virtual labs”. Furthermore, the respondent said that data collected was more accurate than the use of other methods or sources. This is because using virtual labs allows us to eliminate several types of errors that could potentially affect learning, especially during experiments. These errors might include human error, parallax error, and others.

“In my opinion, I think it is a good platform for students to learn. It attracts the students to explore more about Physics and make them more interested in learning Physics.” (Respondent 5)

Regarding respondent 5, he mentioned that virtual labs are a great platform for students to learn, as they attract students to explore more about the content, especially Physics, thus delivering interesting learning sessions for the users.

A thematic analysis was carried out to identify the themes from the students’ responses. They reflected on their experiences after using computer simulations. It was found that a theme emerged: Students’ Interest in Using Virtual Medium.

The researcher discovered that students were genuinely interested in using computer simulations such as virtual labs. Most of the students stated that virtual labs made them feel more interested in learning Physics compared to traditional methods. They expressed sentiments such as, “It is a good platform for students to learn and makes the learning sessions more interesting than usual.” Additionally, some responses mentioned, “It makes procedures easier, allowing us to have more time to repeat the activity,” and “It is easy and fun to

use, and the collected data is more accurate." The results show that the computer simulation method had a positive impact on students' learning of Physics. This implies that teachers should utilize computer simulations to achieve positive learning outcomes from students and to satisfy their teaching objectives.

Therefore, we can see that computer simulations, such as virtual labs, play a vital role in aiding students in learning Physics. Furthermore, based on the findings of this study, we can observe the advantages of virtual labs compared to traditional teaching methods in Physics education. This is supported by the data from open-ended questions asking students' opinions about computer simulations as a teaching method in Physics compared to traditional methods. Most students provided positive feedback on computer simulations, arguing that they offer many advantages over traditional methods.

Traditional learning, utilizing a behaviorist approach, is teacher-centered, where the teacher presents information while students passively listen. Students learn based on what is taught by the teacher, with teachers rarely asking questions or engaging students in learning activities. In contrast, virtual labs are based on the constructivist approach. According to the constructivist view, individuals actively construct their own knowledge by comparing new information with existing knowledge. This method allows for the resolution of disputes in ideas or opinions to reach a new understanding. Unlike the behavioral approach, where students depend solely on teachers for information and guidance, in the constructivist approach, students are actively involved in constructing their own reality and modifying it based on their experiences. They actively participate in their learning and could build knowledge and new concepts.

As indicated in several resources (Bayrak, 2008; Kabigting, 2021), computer simulation instruction allows learners to progress at their own pace, control their learning, participate more willingly in learning endeavors, learn more effectively, access a richer variety of instructional materials, keep track of their learning experiences, receive direct answers to their unique questions, obtain instant feedback regarding their strengths and weaknesses, conduct experiments that are hard to realize in real-life, and learn in a shorter time in a systematic way. Computers are usually more enjoyable than other traditional methods. The integration of computer simulation-assisted applications in Physics instruction might help solve some instructional problems experienced in

face-to-face instructional settings, as they require learners to actively participate in the learning process and interpret the content matter of the application to pursue further activities (Gönen, Kocakaya, & Inan, 2006; Mengistu & Kahsay, 2015).

## CONCLUSION

In conclusion, the data demonstrates that the use of virtual laboratories in teaching and learning enhances students' understanding of the fundamental principles of Physics. Virtual laboratories serve as a valuable addition to traditional classroom instruction. Additionally, the thematic analysis of responses from the open-ended question reveals that most students provide positive feedback and agree that computer simulation teaching methods offer numerous advantages over traditional methods in teaching and learning Physics.


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