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The Effect of Smartphone Usage Intensity on High School Students' Higher Order Thinking Skills in Physics Learning

Abstract. *Smartphones are no longer just a communication tool but also a means of exchanging information by students. Hence, smartphones may also positively contribute upon higher order thinking skills (HOTS) of students in physics learning. This research aimed to determine the smartphone usage intensity, the HOTS level of students, and the effect of the smartphone usage intensity on students' HOTS in physics learning. The data of smartphone usage intensity was obtained using a questionnaire and students' HOTS were obtained through solving physics HOTS test. The results of this research indicate that the smartphone usage intensity and the HOTS level of students in physics learning are in high and low categories with percentages of 48.72% and 51.28%, respectively. Therefore, students' HOTS are affected by the intensity of the use of smartphones in physics learning by 21.07%. These results indicate that the smartphone usage intensity of most students is very high, but not yet able to contribute optimally to the students' HOTS. Therefore, there needs to be a special treatment in utilizing smartphones in physics learning to optimize the students' HOTS.*

Keywords: *higher order thinking skills, high school students, physics learning, smartphones usage intensity*

Introduction

In the current era, it can be said that almost all aspects of human life have faced or interacted with digital systems. This is in line with the demands of the 21st century and also in the context of facing the 4.0 industrial revolution where all aspects of human life need to be carried out in a beneficial, effective, and efficient manner, one of which is done using smartphone assistance (Suprapto, Chang, & Ku, 2017). This is also true in the world of education. The usage of smartphones is very important in terms of delivering information and making it easier for students to learn (Awedh, Mueen, Zafar, & Manzoor, 2014). In addition, through the help of smartphones it is also easier for teachers to conduct variations in the implementation of learning (Coca & Slisko, 2013). Therefore, the usage of smartphones is very important to advance education and knowledge of students and teachers provided that the smartphones are used wisely.

It cannot be denied that smartphones are sometimes unwisely used by students such that misuses and deviations occur. The misuse of smartphones by students is mostly done during learning when the teachers deliver the learning material (Hochberg, Kuhn, & Müller, 2018). Abuses of smatphones committed by students such as playing video games, chatting, photos, or viewing social media and videos (Lu, 2017; Martinez & Garaizar, 2014). Therefore, with the cases of smartphones misuse in learning, some high schools have issued regulations that prohibit the usage of smartphones when learning (Azizah, Suyatna, & Wahyudi, 2017). There are many reasons behind the ban, e.g.: the lack of students' concentration, the teacher's explanation may

not be heard, and students are not focused on learning causing poor learning outcomes (Chalim & Anwas, 2018; Wahyuningsih, Suprihartini, & Si, 2017).

However, this smatphone ban has also caused many pros and cons for students and teachers. Teachers reasoned that with the development of the world today learning needs to be integrated with the demands of 21st century and 4.0 industrial revolution (Liu, Wu, Wong, Lien, & Chao, 2017). One of them is through the usage of smartphones that are specifically intended to help teahcers in explaining the material and also help students optimize their abilities and learning outcomes (Klein, Hirth, Gröber, Kuhn, & Müller, 2014). Therefore, the usage of smartphones in learning should still be allowed provided that students are given the responsibility to use smartphones to help understand the material and optimize their abilities. The fact is that almost all students bring and use smartphones in high school (Astuti, Dasmo, & Nurullaeli, 2018; Sukardiyono, Rosana, & Dwandaru, 2019). Actually this has made it easier for schools and teachers to realize digitalization in accordance with the demands of the 21st century and the 4.0 industrial revolution. All that remains is the participation of teachers and schools in utilizing this momentum so that the usage of smartphones by students does not violate the rules. One effort that can be done is that teachers develop learning media or physics learning assisted by smartphones (Kuhn & Vogt, 2013; van Deursen, Bolle, Hegner, & Kommers, 2015). This certainly makes smartphones more useful in physics learning with the hope that the ability of students can improve.

In general, something that is currently trending in smartphones give students pleasure so they do not get bored (Klein, Kuhn, Müller, & Gröber, 2015; Mulyeni, Jamaris, & Supriyati, 2019). This is certainly an important point that may be used to optimize the higher order thinking skills (HOTS) of students in physics learning. One way to optimize the HOTS ability of students who enjoy using smartphones is to integrate physics learning, physics demonstrations, group discussions, or physics experiments with smartphones (Fatimah & Mufti, 2014; Svensson, 2017). The HOTS ability of students can be improved because they enjoy the physics learning through smartphones. Moreover, HOTS ability can be achieved optimally if students enjoy, feel happy, and comfortable in learning so they can easily understand and resolve problems (Ramos, Dolipas, & Villamor, 2013; Zohar & Dori, 2009).

HOTS are related to activities that are often carried out by students both in and out of school that require thinking abilities, such as playing games that require strategy on smartphones

(Sinambela & Saragih, 2018). Mardiana and Kuswanto (2017) found that physics learning based on Android can increase the HOTS ability of students. They produced and developed a learning media based on Android called physics mobile learning (PML) which used a software equipped with Android package. The PML may be accessed anywhere and anytime as long students have electronic gadgets, such as smartphones. This is in accordance with Adi and Kurniawan (2018) that also developed and produced android learning media in order to improve students' HOTS. Meanwhile, all learning models and methods conducted by teachers can help increase the HOTS ability of students, provided that in the implementation of learning they are able to give a good impression to students (Cheng, Yang, Chang, & Kuo, 2015; Saregar, Latifah, & Sari, 2016). This is in line with previous findings that smartphone usage has a significant effect on students' learning outcomes, especially their HOTS (Khaeriyah & Mahmud, 2017; Manumpil, Ismanto, & Onibala, 2015). Therefore, the participation of teachers is needed in creating a learning atmosphere that can be enjoyed by students by utilizing smartphones to improve students' HOTS ability.

Students who have the ability to solve various problems using physics concepts are likely to develop more diverse ways of solving other problems using HOTS (Fehabutar & Jatmiko, 2019; Mahmudi, 2018). HOTS is basically a skill to solve problems using learning media that facilitates higher-order thinking activities (Malik, Ertikanto, & Suyatna, 2015; Susilo & Yanto, 2018). Therefore, one effort to improve HOTS is to practice solving physics problems asssisted by media that facilitates such thinking activities, which is in this case using smartphones. HOTS is a thinking skill proposed by Bloom in addition to low-order thinking skills (LOTS) that students must have (Hugerat & Kortam, 2014; Saido, Siraj, Nordin, & Al-Amedy, 2015). However, the results of TIMSS show that the average achievement of HOTS of Indonesian students is low (Wartono, Hudha, & Batlolona, 2018). Therefore, the achievement of HOTS of high school students in Indonesia is low (Jayanti, Romlah, & Saregar, 2016) and thus it is ranked low in the Southeas Asian region (Adi & Kurniawan, 2018; Yusuf & Widyaningsih, 2018). The low achievement of HOTS can be caused by the lack of learning media usage (Handayani, Hartono, & Lestari, 2019). In addition, this can also be caused by school's demands related to HOTS are too high, so students do not enjoy the learning process (Mahmudi, 2018; Rusnilawati, 2018). Hence, this causes a major blow in Indonesia's education. Therefore, a solution is needed to overcome the above problem. In this research, we offer integrating HOTS with smartphones

enjoyed by students. It is hoped that the HOTS abiliy of students may be improved and thus improving the HOTS ranking of Indonesia's student.

Based on the above explanations, this research aimed to find out the effect of smartphones usage intensity towards students' HOTS in physics learning. Moreover, it is necessary to develop a learning media that is used to obtain the data concerning the smartphone usage intensity and high school students' HOTS discussed in the method section.

Research Questions

Physics learning in Indonesia should be integrated with technology, i.e.: smartphones. Physics learning that integrates the use of smartphones has been considered effective in developing high school students' HOTS. Therefore, to further optimize the HOTS of students, teachers need to integrate the use of smartphones in physics learning appropriately, wisely, and be able to provide the comfort of students in physics learning. Therefore, the research questions were as follows:

a. How intense is smartphone usage of high school students in physics learning?
b. What is the level of high school students' HOTS in physics learning?
c. What is the effect of smartphone usage intensity on high school students' HOTS in physics learning?

In addition, it is also hoped that when students do physics learning assisted by smartphones their HOTS can be improved.

Research Focus

This research focuses on analyzing high school students' HOTS level based on the smartphones usage intensity in physics learning physics. The regression between the smartphones usage intensity and high school students' HOTS in physics learning is also explored. The results of this research can be used as a reference for teachers, researchers, or lecturers in optimizing the usage of smartphones in physics learning as an effort to face the challenges of the 21st century and the 4.0 industrial revolution. In addition, it can also be used as a guide in improving the ability of students, especially HOTS.

Research Methodology

General Background

The research method used was quantitative method as the basis to discuss the research results. The quantitative method is a research method, which is used to examine a particular population or sample, data collection using research instruments, quantitative or statistical data analysis, with the aim of testing established hypotheses (Johnson & Christensen, 2019). Furthermore, this research was conducted by means of survey by giving questionnaires to students in high school to obtain data about the smartphone usage intensity in physics learning. In addition, students are also given a physics test instrument to measure their HOTS.

The next step was regression analysis. This analysis aims to understand the effect between two or more research variables (Creswell, 2008; Rawlings, Pantula, & Dickey, 2001). In this research, students' HOTS are the dependent variable, while the smartphone usage intensity is the independent variable. This research was conducted at the end of the semester when students had finished attending physics learning for the final discussion of the material.

Research Sample

The sample used in this research were 312 students of grade XI of Science class from four senior high schools in Yogyakarta, Indonesia in the 2018/2019 academic year. The technique used to determine the sample in this research was convenience sampling technique. This sampling technique is one of the non-probability sampling methods, in which the research population is ready and feasible to be used by researchers (Fraenkel, Wallen, & Hyun, 2012). In this research, there were no students who refused to participate as research samples. Therefore, all samples used in this research provided valid information. Meanwhile, the technique of collecting data was done using questionnaire of HOTS for students via reasoned multiple-choice physics test or two-tier physics tests. Ethical procedures were followed by the researchers in the data collecting process.

Instrument and Procedures

The first step undertaken in this research was to develop instruments used to measure the smartphone usage intensity by students in the form of questionnaires and students' HOTS in the form of reasoned multiple-choice physics test that are valid and reliable. The researchers develop new instruments to ensure that the two measuring instruments developed are relevant to the condition of students, student characteristics, and the physics curriculum in Indonesia. Literature

review of HOTS was carried out before designing the research instrument, which produced three indicators that reflect students' HOTS, i.e.: analyzing, evaluating, and creating (Anderson & Krathwohl, 2014; Yee, Yunos, Othman, Hassan, Tee, & Mohamad, 2015). The two instruments used to measure these variables were validated by 6 expert validators before being distributed to 312 students randomly selected from four high schools in Yogyakarta. Meanwhile, the instrument used to measure the smartphone usage intensity by students is a questionnaire consisting of 8 questions that can be shown in Figure 2 (see Appendix A). Meanwhile, the instrument used to measure students' HOTS is in the form of reasoned multiple-choice physics test or physics two-tier test consisting of 25 reasoned multiple-choice questions that can be shown in Figure 3 (see Appendix B). In general, the procedure carried out in this research can be illustrated in Figure 1.

Based on Figure 2 (Appendix A), the physics test looks more like typical and general physics problem solving ability. However, the problems were not just choosing the correct answer, but also having the ability to choose the correct reason as well. This additional thinking demand indicated that the problems were elevated to HOTS. The indicators of the problems were indeed based on the 3 indicators of HOTS, i.e.: analyze, evaluate, and create, e.g.: problems No. 1 to 3 (see Figure 3 in Appendix B) were related to the analyze indicator. An example of a physics problem concerning the evaluate indication was given as follows:

Dani fell from a tree and landed on an empty sled that was sliding on ice without friction. Hence, the correct prediction that corresponds to the event is ... and the reason is...

Option:

A. The speed of the sled is faster.

B. The speed of the sled is slower.

C. The speed of the sled is equal to zero.

D. The speed of the sled is great both before and after Dani's ride.

E. The speed of the sled is maximum.

Reason:

A. The system mass decreases.

B. The skateboard mass is larger than the Dani mass.

C. The mass of the system increases.

D. The mass of Dani is greater than the sled.

E. The system mass is zero.

Finally, an example of the physics problem that corresponds to the create indicator was given as follows:

A man drives his car at high speed such that an accidence occurs. If the air bag of the car expands and minimizes the driver from a collision, then the explanation of the impulse material in accordance with the event is ... and the reason is ...

Option:

A. If the driver's head and upper body are pushed forward, the air bag does not expand.

B. If the driver's head and upper body are pushed forward, the expanded air bag will not hold it.

C. If the driver's head and upper body are pushed forward, the expanded air bag will hold it.

D. If the driver's head and upper body are pushed back, the inflated air bag will hold it.

E. If the driver's head and upper body are pushed back, the air bag will not expand.

Reason:

A. The air bag functions to increase the collision time interval so that the reaction force exerted by the dashboard is smaller, so the risk of collision is reduced.

B. Air bags reduce the collision time interval so that the reaction force exerted by the dashboard is smaller, so the risk of collisions increases.

C. The air bag functions to increase the collision time interval so that the reaction force exerted by the dashboard is greater, so the risk of collision is reduced.

D. Air bags reduce the collision time interval so that the reaction force exerted by the dashboard is greater, so the risk of collisions increases.

E. Air bags reduce the collision time interval so that the reaction force exerted by the dashboard is smaller, so the risk of collision is reduced.

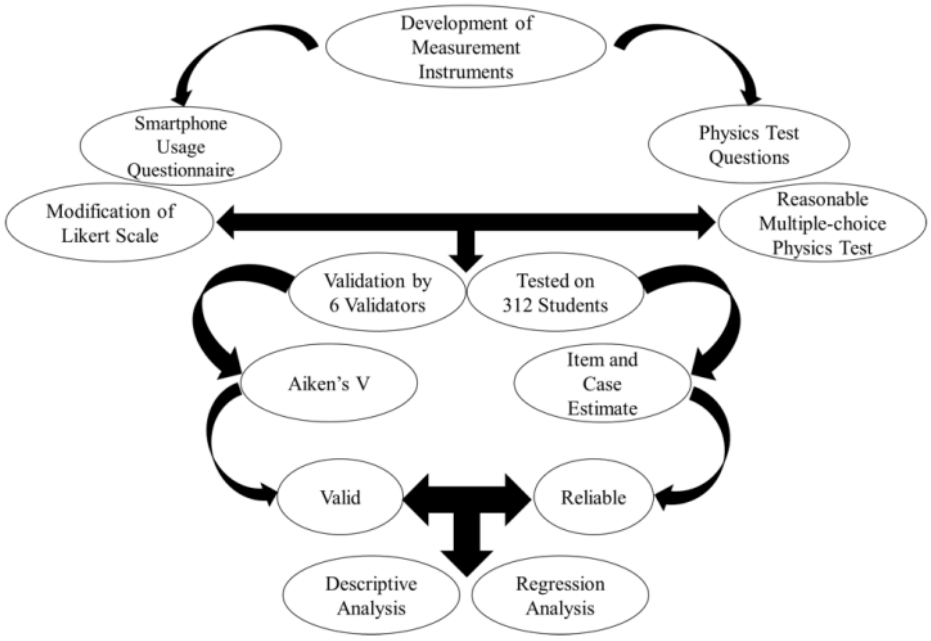

Figure 1. Process in research activities.

The questionnaire and HOTS test in the form of reasoned multiple-choice are firstly tested for validity and reliability conducted by 6 expert validators. The questionnaire and HOTS test were then analyzed using the Aiken's V formula. The Aiken's V coefficient was then compared with the Aiken's table. An item in the test or questionnaire was said to be valid if the Aiken's coefficient value is greater or equal to the minimum value listed in the Aiken's table (Aiken & Stephen, 1985). Meanwhile, the reliability of the questionnaire and reasoned multiple-choice test were tested using the item separation index (item estimate) and person separation index (case estimate) through the Quest program (Subali & Suyata, 2011). The greater the index value of the test item separation, the greater the overall accuracy of the questionnaire items and tests with the model used, namely PCM. In addition, the higher the value of the person separation index, the higher the consistency of each item in measuring the ability of people (Subali & Suyata, 2011). The item and case estimates criteria is shown in Table 1.

Table 1. Item and case estimate value criteria.

Value of Item and Case Estimate Reliability	Criteria
> 0.94	Excellent
0.91 - 0.94	Very good
0.81 - 0.90	Good
0.67 - 0.80	Moderate
< 0.67	Poor

(Sumintono & Widhiarso, 2015).

The completion of the questionnaire was carried out by the students by implementing a Likert scale assessment, which was modified to a scale of 4, i.e.: score 1, 2, 3, and 4 meaning strongly disagree, disagree, agree, and strongly agree, respectively. Meanwhile, the measurement of students' HOTS was done by not only choosing the correct answer choice of an item, but students are also required to choose the correct reason as well. In conducting this research, the research design used was posttest-only design. Students were given treatment in the form of smartphone usage in physics learning. This was used to find out whether the usage of smartphones in physics learning affects students' HOTS.

Data Analysis

The analysis used to determine the smartphone usage intensity and students' HOTS in physics learning was done using standardized equations with the help of MS Excel software. The technique used was to enter the results of the students' HOTS questions into very low, low, moderate, high, or very high categories through the ideal average equation (M_i) and standard deviation (SD_i). This analysis technique was carried out using each score obtained from questionnaire and HOTS physics test (Azwar, 2012). The interval scores for the smartphone usage intensity and students' HOTS can be shown in Table 2.

There were 8 items in the questionnaire. A student checked or chosen one value, i.e.: 1 to 4 corresponding to strongly disagree to strongly agree for each item. Then, the scored entered by the student was summed from item 1 to 8 and divided by the total score, i.e.: 32. This ratio was then put into a scale system given in Table 2, hence each student should fall into one given category of very high to very low smartphone usage intensity. The number of students that falls within each category was summed and divided by the total number of students to obtain the percentage in Table 5.

Moreover, the students' HOTS was also determined in a similar way as the smartphone use intensity level above. However, a scoring system was needed for the physics test. The scoring system was given as follows:

i) if the answer and the reason were all correct the score is 4,
ii) if the answer was incorrect, but the reason was correct the score is 3,
iii) if the answer was correct, but the reason was incorrect the score is 2,
iv) if the answer and the reason were all incorrect the score is 1.

Table 2. Scores interval of smartphone usage intensity and HOTS.

No.	Score Interval	Category
1	$M_i + 1.5\,SD_i < \theta$	Very High
2	$M_i + 0.5\,SD_i < \theta \leq M_i + 1.5\,SD_i$	High
3	$M_i - 0.5\,SD_i < \theta \leq M_i + 0.5\,SD_i$	Moderate
4	$M_i - 1.5\,SD_i < \theta \leq M_i - 0.5\,SD_i$	Low
5	$\theta < M_i - 1.5\,SD_i$	Very Low

Based on Table 2 it can be stated that θ is the level of smartphone usage intensity and HOTS of students. Furthermore, the effect of smartphone usage intensity on students' HOTS in physics learning was determined using regression analysis with the help of the SPSS software. The significant level used in this research was .05 with H_a was the hypothesis that the smartphone usage intensity significantly affect the HOTS of students in physics learning, while H_o was the hypothesis that the smartphone usage intensity does not significantly affect HOTS of students in physics learning.

Results of Validity and Reliability of Measurement Instruments

We first present the feasibility results of the measurement instruments that have been developed. The feasibility data of this measurement instrument includes the validity and reliability of the questionnaires and reasoned multiple-choice physics test. The first results are the validity of the questionnaires and reasoned multiple-choice test that are analyzed using the Aiken's V formula, which is shown in Table 3.

Table 3. Validity of measurement instruments.

Measurement Instruments	Number of Items	Aiken's Validity Value	Category
The Questionnaire	8	0.921	Valid
Physics HOTS test	25	0.918	Valid
Validity Value of Measurement Instruments		**0.92**	**Valid**

The number of validators who validated the questionnaire and physics test were 6 experts. Therefore, the error rate in Aiken's V table used was 1% ($p < .01$) (Aiken & Stephen, 1985). Based on Table 3, the questionnaire and physics test were both valid because the Aiken's validity values were greater than 0.89 ($V \geq 0.89$), which was equal to 0.92. It can be stated that the questionnaire and physics test were feasible to measure the smartphones usage intensity and HOTS ability of students in physics learning.

Table 4. Reliability of measurement instruments.

Reliability	Reliability Coefficient		Category	
	Questionnaire	Physics HOTS Test	Questionnaire	Physics HOTS Test
item estimate	0.87	0.79	Reliable	Reliable
case estimate	0.89	0.80	Reliable	Reliable

The reliability is also used to determine the feasibility of questionnaire and physics test that have been developed by researchers. The reliability results can be presented in Table 4. It can be observed that the reliability coefficients of the questionnaire for the item and case estimates are larger than 0.7, which are included in the reliable category. Meanwhile, the measurement instrument of the physics test for the item and case estimates are also larger than 0.7, which are also included in the reliable category. Meanwhile, the values of item and case estimates indicate that the questionnaire and the physics test developed are included in good and sufficient criterias, respectively. Furthermore, this questionnaire and physics test show the correct consistency of the choice of students. In other words, each item of the questionnaire and physics test show the same score if assessed by different students. So, it can be stated that the measurement instruments are suitable for usage in measuring the smartphone usage and HOTS of students in physics learning.

Research Results

Students' Smartphone Usage Intensity in Physics Learning

Here, we discussed the results obtained, i.e.: the results of the smartphone usage intensity by high school students in physics learning. The smartphone usage intensity by high school students in physics learning obtained through a questionnaire is given in Table 5. It can be observed that 48.7% and 44.55% of students used the smartphones with high and moderate intensities, respectively. These results indicate that the smartphone usage intensity by high school students in Indonesia in physics learning is high. Hence, there is a need for smartphone utilization that provides positive benefits in physics learning.

Table 5. Smartphone usage intensity in physics learning.

Number of Students	Percentage (%)	Smartphone Usage Intensity
9	2.88	Very High
152	48.72	High
139	44.55	Moderate
12	3.85	Low
0	0.00	Very Low

Students' HOTS Levels in Physics Learning

Next, we presented the results of students' HOTS in physics learning. The students' HOTS level in physics learning obtained through the physics test in the form of reasoned multiple-choice tests is observed in Table 6. It can be stated that the HOTS for students in physics learning is at a low level with a percentage of 51.28% or equivalent to 160 students. These results indicated that the HOTS level of high school students in physics learning is still relatively low because no students obtained very high HOTS level. The maximum HOTS level of students is at a high level with a percentage of 0.96% or equal to 3 students. These results indicated the need for appropriate treatment in physics learning by teachers, both in the explanation of physics material or the use of smartphones in physics learning.

Table 6. Students' HOTS levels in physics learning.

Number of Students	Percentage (%)	Students' HOTS Level
0	0.00	Very High
3	0.96	High
6	1.92	Moderate
160	51.28	Low
143	45.83	Very Low

The Effect of Smartphone Usage Intensity on Students' HOTS

Next, we showed the results of the effect of the smartphone usage intensity on high school students' HOTS in physics learning. The results of the effect of these two variables is stated in Table 7. The effect of the smartphone usage intensity on students' HOTS in physics learning based on the results of the regression test has been confirmed with R = .459 and R^2 = .211. According to Drape and Smith (1996), the results of the regression coefficients found in this study indicated a positive effect. In other words, the results of the regression coefficient indicated that the smartphone usage intensity affects the HOTS of students in physics learning by 21.07% and the remaining 78.93% is influenced by other factors. These results caused the H_a to be accepted because the significance level is smaller than .05, which was .06. So, the smartphone usage intensity significantly influenced the HOTS of students in physics learning.

Table 7. The effect of smartphone usage intensity on students' HOTS in physics learning.

R	R Square	Adjusted R Square	Std. Error of the Estimate	Statistics		
				R Square Dif.	F Dif.	Sig. F Dif.
.459	.211	.201	6.764	.211	2.291	.006

Discussion

The purpose of this research was to determine the level of smartphone usage intensity by students, the students' HOTS level, and the effect of the ismartphone usage intensity on students' HOTS in physics learning. The results of the two measurement instruments (questionnaire and physics test) are feasible to measure the smartphone usage intensity and the students' HOTS level. Meanwhile, the results of the questionnaire showed that the smartphone usage intensity in

physics learning was high with a percentage of 48.72% as shown in Table 5. The high smartphones usage in physics learning occurs because teachers have realized the importance of using smartphones to help understand the physics material delivered to their students. However, the high smartphone usage intensity was also abused by students to play video games or catting with others, thus disrupting the course of physics learning and causing students to lose concentration on the material learned (Karanfiller, Göksu, & Yurtkan, 2017; Mertala, 2016). Therefore, it is necessary to have policies and wisdom from physics teachers related to the smartphones usage in physics learning, so that it can help facilitate students in physics learning and achieving the desired abilities.

Previous studies also obtained similar results, e.g.: Alzubi and Singh (2018) showed that many students from elementary schools to senior high schools had used smartphones in learning especially physics in their schools, both permit or prohibited for use by the school. However, although it was prohibited students unconsciously become more curious to bring and use smartphones in learning in schools (Shi, Sun, Huan, & Huan, 2016). Therefore, students were not only given verbal instructions related to the smartphones usage in physics learning, but the need for the smartphones usage that directly involve students as well as facilitating the smartphones usage (smartphone technology development) in the curriculum or in special subjects. Thus, it is expected that the high smartphone usage intensity by students in physics learning also has a positive impact on students' knowledge and skills that can be implemented in daily life.

Meanwhile, the results of students' HOTS level in physics learning is at a low level, but certain treatments needed to be given in the learning process so that their HOTS can increase. In addition, it is necessary to allocate a considerable amount of time to train HOTS of students in physics learning (Utomo & Narulita, 2018). HOTS training for students can be done by utilizing the use of smartphones to help students in solving various physics problems that required HOTS. This is in line with the result by Al-Mashaqbeh (2016) who explored strategies in improving students' HOTS for example, analyzing a physics problem with various approaches, evaluating the solution to solve various physics problems, and trying to create of solution the easiest and most recent. The research findings reveal that students in high school in physics learning have a low level of HOTS with a percentage of students as much as 51.28%. In addition, only 0.96% of the students had the very high HOTS level. This of course depends on each student's ability to

identify physics concepts that arise in the problem and find the best solution to solve the physics problems (Prayogi, Muhali, Yuliyanti, Asy'ari, Azmi, & Verawati, 2019).

The test pattern also influences the HOTS results, for example there are several groups of students who tend to find it more difficult in carrying out physics tests in the form of reasoned multiple-choice or description test (Hadi, Retnawati, Munadi, Apino, & Wulandari, 2018). In line with these findings, the results found in this study indicate that there are errors that occur in physics learning, both in terms of the explanation of physics material by teachers or students who do not understand the physics material delivered by the teacher. This certainly needs to be immediately introspected and addressed if students' HOTS want to be improved. These findings in detail can be displayed in Table 6. In line with these findings, Retnawati, Djidu, Kartianom, Apino, and Anazifa (2018) claim that the low level of high school students' HOTS in physics learning is due to the habits of students, which are only demanded by teachers in solving physics problems contained in physics text books. This of course only provides a slight benefit to students' thinking skills at a low level (Istiyono, 2017). The treatment given by such teachers is not able to develop HOTS because the skills developed are only limited to understanding and repeating. There is no exploring students' thinking to solve real physics problems that occur in everyday environments.

It has been confirmed earlier in this research that the smartphone usage intensity by students in physics learning is high. However, with the high smartphone usage intensity in physics learning still causes students' HOTS are low. Based on these findings, there should be an influence of the high smartphone usage intensity on HOTS of students in physics learning. This is in line with the findings of Khaeriyah and Mahmud (2017) that the smartphone usage intensity had a positive effect on learning motivation and student learning outcomes in high school. Here, the effect of the smartphone usage intensity on students' HOTS in physics learning is 21.07% as shown in Table 7. In general, the smartphone usage intensity by students has a relatively small effect on their HOTS in physics learning, because the percentage is not close to 50%. The effect of the smartphone usage intensity on the students' HOTS in physics learning is caused by several factors. Students tend not to use smartphones for good use in physics learning. They use smartphones only for entertainment purposes and to carry out tasks assigned by teachers carelessly or ask diligent friends in their groups to complete the assignments given by the teacher (Kwon, Kang, & Bae, 2014). This certainly does not able to optimize the HOTS of students.

Based on these findings it can be stated that the HOTS of students in physics learning is influenced by other factors besides the smartphone usage intensity by 78.93%. This indicates that the smartphone usage intensity is less influential on HOTS achieved by students in physics learning. The students' HOTS in physics learning is far more optimally achieved if the supervision of teachers and parents is also involved in learning activities in addition to the smartphone usage intensity. This is in line with the findings of Wahyuningsih et al. (2017) who found that the supervision of teachers and parents in physics learning that utilizes the smartphones usage is far more optimal in the achievement of students' skills because the supervision given to students can reduce the negative impact arising from the smartphone usage itself. In addition, Vieyra, Vieyra, Jeanjacquot, Marti, and Monteiro (2015) also stated their findings in line with previous findings that smartphones usage in learning has a positive and negative effects on the skills of students. These influences can arise depending on the discretion of students who utilizes a smartphone.

The results found in this research also showed that students with higher HOTS scores tend to use the smartphone appropriately in physics learning. These results are also consistent with the findings of Rabacal (2016) who found that students' thinking skills have a positive relationship with smartphones and helps in optimizing their thinking skills. This is also supported by the opinion of Pogrow (2005) that students' thinking skills are more optimal if obtained through things they like and meaningful experience. The findings of this research imply that physics learning needs to take serious attention regarding the role of the learning environment on the thinking skills achieved by students. Physics teachers should also not only transfer physics concepts, but the need for a student center method by utilizing technological advancements such as smartphones. In addition, physics learning conducted by teachers in high schools has not yet applied an effective learning method by linking physics concepts with real physics problems that occur in daily life that lead to optimizing HOTS of students (Heong, Yunos, Othman, Hassan, Kiong, & Mohamad, 2012). Thus, in general our results provide evidence that the HOTS of students is significantly influenced by the smartphone usage intensity, but also influenced by the physics learning itself.

Conclusions and Recommendations

The smartphone usage intensity by high school students is dominantly high in intensity with a percentage of 48.72%. However, the level of students' HOTS in physics learning is still low with a percentage of 51.28%. However, the smartphone usage intensity by high school students influenced their HOTS by 21.07%. These findings proved that the smartphone usage intensity by high school students does not have much positive effect on HOTS for high school students in physics learning. Thus, special attention needs to be given by the teachers and parents of students in supervising the smartphones usage in physics learning. It is also necessary for the participation of teachers to facilitate learning that leads to the achievement of students' HOTS in physics learning, so that it is expected that HOTS of students in physics learning can increase and be in a better category. In other words, teachers need to implement an effective physics learning strategy by utilizing smartphone usage wisely by students which leads to optimizing students' HOTS. Researchers are encourage to expand this research by adding dependent variables, independent variables, and adding more students from different high schools and other scientific backgrounds. Finally, a practical implication of this research may be realized for the government or policymakers, especially those who are concern in Education to produce policies that guide students in using smartphones for learning, especially in physics. Hence, reducing the negative impacts of smartphones usage by students.

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Appendix A

The Questionnaire about the Intensity of Smartphone Use by Students in Physics Learning Activities

Instruction:

1. Read each statement carefully and thoroughly!
2. Answer each statement as honestly as you think!
3. Not cheating or imitating answers from friends!
4. Put a check mark (✓) in the column that matches your opinion in the space provided with the score description as follows.

1 : Strongly Disagree (SD) 3 : Agree (A)

2 : Disagree (D) 4 : Strongly Agree (SA)

No.	Statement	1	2	3	4
1.	I always use physics learning media in the form of simulations or android applications through smartphones.				
3.	I chose to use learning media in the form of books, videos, or power points rather than the android simulation media on smartphones.				
4.	I learned a little bit of physics material through teacher explanations rather than through learning media on smartphones.				
5.	The teacher needs to vary the physics learning media by using an android simulation on a smartphone.				
6.	I use a smartphone only to play games and social media.				
7.	I rarely play smartphone when the teacher is explaining physics material.				
8.	Physics learning that I obtained rarely uses android simulation media on smartphones.				

Student's signature,

.....

Figure 2. Questionnaire on the smartphone usage intensity in physics learning

Appendix B

HOTS Assessment Instrument for Students in Physics Subjects

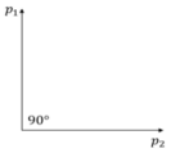
Subjects	: Physics	Name	:
Class/Program	: X/IPA	Presence Number/Class	:
Time	: 45 Minutes	Date	:

Instruction:

1. Write down the name, presence number /class number, and date of the test on the answer sheet provided!
2. Pray before working on test questions!
3. Read the test questions first!
4. Do the problems that you think are easier first!
5. Choose by giving a sign $(\times)$ in the answer and the reason that you think is most appropriate!

Re-examine your work before it is submitted to the supervisor!

1. Two bullets each have a mass of 5 grams and 10 grams. The two tulip bullets were fired from the same position simultaneously and the trajectory of the two tulip bullets formed at an angle of 90° as shown below. If the speed of the first and second tulup bullets are 40 m/s and 5 m/s, then the result of the analysis of the total momentum of the two tulup bullets is right ... kg.m/s and the reason is …



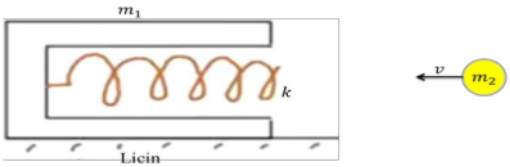
Answer:

A. 0.01
B. 0.21
C. 0.43
D. 0.50
E. 0.39

Reason:

A. $p_{total} = \sqrt{p_1 + p_2}$
B. $p_{total} = \sqrt{p_1 - p_2}$
C. $p_{total} = \sqrt{{p_1}^2 + {p_2}^2}$
D. $p_{total} = \sqrt{2p_1p_2cos90°}$
E. $p_{total} = \sqrt{\frac{p_1}{p_2}}$

2. A bullet with mass m_2 is fired with velocity v at an object with mass m_1 as shown below. If the object being shot has a hole which contains a spring (spring constant = k) and at first be quiet, then the right spring deviation analysis result is … and the reason is …



Answer:

A. $x = \frac{m_1 m_2 v^2}{k(m_{1+}m_2)}$

B. $x = \sqrt{\frac{m_1 m_2}{k(m_1+m_2)}}$

C. $x = \frac{m_1 m_2 v^2}{(m_1+m_2)}$

A. $x = \sqrt{\frac{m_1 m_2 v^2}{(m_1+m_2)}}$

B. $x = \sqrt{\frac{m_1 m_2 v^2}{k(m_1+m_2)}}$

Reason:

A. $v' = \sqrt{\frac{m_2 v}{m_1+m_2}}$ and $m_2 v^2 = (m_1 + m_2)(v')^2 + kx^2$

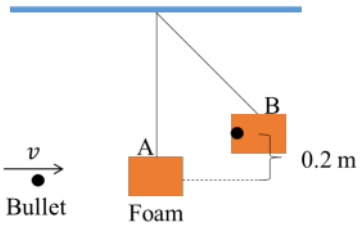
B. $v' = \sqrt{\frac{m_2 m_1}{m_1+m_2}}$ and $m_2 v^2 = (m_1 + m_2)(v')^2 + kx^2$

C. $v' = \sqrt{\frac{m_2 v}{m_1+m_2}}$ and $m_2 v^2 = (m_1 + m_2)(v')^2 + x^2$

D. $v' = \sqrt{\frac{m_1 v}{m_1+m_2}}$ and $m_2 v^2 = (m_1 + m_2)(v')^2 + kx^2$

E. $v' = \sqrt{\frac{m_1 v}{m_1+m_2}}$ and $m_2 v^2 = (m_1 + m_2)(v')^2 + x^2$

3. Observe the motion picture of the bullet fired on the ballistic swing below!



When a bullet with a 0.01 kg mass is fired at a ballistic swing made of foam with a mass of 0.25 kg, so the bullet attaches to the ballistic swing. When the swing reaches its maximum height, the swing rises 0.2 m from its original position. If g = 10 m/s^2, then the results of the analysis of the velocity of the bullet fired on the ballistic swing is … m/s and the reason is …

Answer:

A. 14

B. 36

C. 52

D. 77

E. 91

Reason:

A. $v = \frac{(m_p+m_b)\sqrt{gh}}{m_p}$

B. $v = \frac{(m_p+m_b)\sqrt{2gh}}{m_p}$

C. $v = \frac{(m_p+m_b)\sqrt{2h}}{m_p}$

D. $v = (m_p + m_b)\sqrt{2gh}$

E. $v = (m_p + m_b)\sqrt{gh}$

Figure 3. Physics HOTS test.

TUSED_Hery

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