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The Effect of Smartphones Usability on High School Students' Science Literacy Ability in Physics Learning

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Abstract: Learning in high schools has used a lot of smartphone assistance to make it easier for students to understand the material explained by the teacher. However, with the many uses of smartphones in learning, of course, it must provide positive benefits to the ability of students, especially the science literacy ability. In this study, the objectives to be achieved are to examine how much the smartphone's usability in physics learning, examine students' science literacy and examine the effect of the smartphone's usability on students' science literacy in physics learning. The method used in this study is a quantitative method with a research design used is a one-shot case study. The data on smartphone usability is obtained using a questionnaire, and science literacy of students is obtained through on physics science literacy test. The results of this study indicate that the smartphones usability and students' science literacy in physics learning are respectively in the high and medium categories with a respective percentage of 57.20% and 36.36%. The students' science literacy is influenced by the smartphone's usability in physics learning by 34.30%. These results indicate that smartphone usability by most students is very high, but has not been able to contribute optimally to students' science literacy. Therefore, special treatment is needed in utilizing the use of smartphones in physics learning so that students' science literacy can be optimized.

Keywords: *High school students, physics learning, science literacy ability, smartphones, usability.*

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Introduction

Every high school wherever located, now it has been demanded to better utilize the use of technology and information advancements in carrying out any learning or non-learning activities. This is certainly done with the aim that new information from outside can be immediately known by teachers or high school students, so they can optimize their abilities (Annamalai, 2018). Technological advances that can mostly be utilized in learning at school can be in the form of internet use on laptops or smartphones (Talaee, 2019). The use of the laptop itself in learning at schools, especially in Indonesia is still not comprehensive or its use is still dominated in urban areas, while rural areas are still rare with a ratio of 5:1 (Syafrizal et al., 2019). Therefore, with the limited use of laptops in learning at school, certainly, other media are needed that can still support the implementation of learning by integrating technology and information advancements.

One of the media that integrates technology and information advancements and by the demands of the 21st-century development and the industrial revolution 4.0 is in the form of smartphones (Lee et al., 2018). The smartphone is a medium of communication and information that lately has been widely owned by everyone, including teachers and high school students. In line with this statement, almost 90% of high school students use smartphones in learning at school (Kermani, 2017). However, not all high school students use smartphones to assist facilitate learning. This is certainly what needs to be reviewed about the wisdom in using smartphones in learning at schools. In general, if a smartphone is used wisely and appropriately, the smartphone will have a positive impact on the wearer (Ikhsan et al., 2019). No exception in learning at schools, if high school students can use smartphones to be used wisely and

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appropriately, then they will be assisted in understanding the material explained by the teacher effectively and efficiently.

In general, if the smartphone is used by the wearer appropriately, the benefits contained far outweigh its disadvantages. In addition, the use of smartphones is also useful in terms of delivering information related to learning to high school students (Canessa et al., 2014). Smartphones can give high school students broader insights about what is happening in all corners of the world that assist them to optimize their abilities and interests (Dervić et al., 2018). With a smartphone, the teacher is assisted d in developing a variety of learning media and makes it easier for them to do a variety of learning, especially physics (Bílek et al., 2018). The efforts are needed from high school students and teachers in optimizing the benefits contained in smartphones so that they can assist in achieving the desired learning goals.

However, with the many positive benefits contained in smartphones that are very useful in learning especially physics learning, there are still some unwise actions shown by high school students and teachers. Unwise actions taken by teachers in using smartphones in learning can be demonstrated when explaining material to high school students, they sometimes call or receive calls from others (Feyzioğlu et al., 2018). This is certainly not permitted when learning is taking place, teachers or high school students call or receive calls from other people. This kind of action is not permitted because it is not polite if a teacher gives an example to a student to call someone using a smartphone in learning and can also interfere with the concentration of high school students in understanding material especially physics that has been explained by the teacher (Kaeophanuek & Na-Songkhla, 2019). Therefore, it is probable that high school students abuse the use of smartphones in learning if their teachers abuse the use of smartphones in learning to call or others.

Meanwhile, the misuse of smartphones by high school students is mostly done when physics learning such as playing video games, chatting, photos, or viewing social media and videos (Bennis & Amali, 2019). Therefore, with some cases of misuse of smartphone usage in physics learning, it is necessary to have introspection and clear policies governing smartphone use by high school students and teachers, so that the benefits contained in smartphones can be useful for teachers and especially school students intermediate in optimizing their abilities. This was immediately followed up by the school bureaucracy, given the benefits provided by smartphones in physics, learning are quite large as well as being able to assist explain the physics material done by teachers and assisted high school students in optimizing their science literacy abilities (Techakosit, 2018). Therefore, schools should need to realize policies in the use of smartphones by teachers and high school students in learning, with the hope that a smartphone can optimize the ability of high school students such as the science literacy ability.

Meanwhile, with the many high school students carrying and using smartphones in learning at school, it can certainly be a momentum to realize technological and information advancements in the world of education that is ready to face the demands of the 21st century and the industrial revolution 4.0. Staying smartphone users themselves teachers or high school students who want to take advantage of smartphones in learning at school. Efforts that can be made to take advantage of the use of smartphones in learning especially physics learning are by utilizing learning applications, learning simulations, or learning videos contained on smartphones that are online or offline that can be used anytime and anywhere (Yildiz et al., 2018). Some of the efforts made can make the use of smartphones more useful in learning especially physics in high schools in the hope that the ability of students can be achieved more optimally.

In general, smartphones are one of the communications and information media that most of the users are high school students (Mitsuhara et al., 2017). This is certainly due to the smartphone giving something of pleasure and satisfaction to high school students, so they are able and willing to linger to operate a smartphone (Techakosit & Nilsook, 2016). This should be utilized as a very important momentum in optimizing the ability of high school students, especially the science literacy ability in physics learning. Optimizing the ability of high school students especially the science literacy ability in physics learning can be done by integrating the use of smartphones in physics learning by considering indicators of science literacy ability of high school students to increase (Mudaly & Fletcher, 2019).

This can be done by explaining physics material that occurs in everyday life to students and integrating it into smartphones, which can be in the form of daily events simulations, Android-based traditional games, android-based physics comics, or virtual laboratories that can be operated through smartphones (Koğar, 2019). Therefore, with these various efforts, the science literacy ability of high school students in physics should be achieved optimally. That is because high school students in physics learning related to everyday events are integrated with smartphones that can be used anywhere and anytime (Polat et al., 2017). Abilities possessed by high school students as well as the science literacy ability in physics learning can be achieved optimally if high school students can understand the concepts of physics correctly without any misconceptions and can use the understanding of physics concepts in solving any physics problems that occur in everyday life (Karahoca et al., 2018). However, the science literacy ability of high school students in Indonesia is still very low and is still ranked low in the Southeast Asian region (Stacey, 2011). This is evidenced by the findings that show that the achievement of science literacy ability of high school students in Indonesia in Programme for International Student Assessment (PISA) in 2012 which was followed by 65 countries, Indonesia ranks second from the bottom with an average score of science literacy of students at 382 below the average score PISA average, which is 501 (Organisation for Economic Co-operation and Development (OECD), 2014).

This is certainly a hard slap for the world of education in Indonesia, which must integrate learning at schools with advances in information and communication technology to be able to deal with the demands of the 21st century and the industrial revolution 4.0, but the science literacy ability of students is still very low. The low science literacy ability of high school students is largely due to a variety of factors, such as the educational curriculum in Indonesia which is not in line with the characteristics of high school students in Indonesia which are highly heterogeneous, the use of instructional media is still very limited, and the lack of creativity of teachers and high school students in optimizing everything that can improve the ability of high school students (Sari et al., 2018). However, if there is a real commitment made by teachers and schools by integrating physics problems that occur in everyday life experienced by students into smartphones or the like, it is expected that the science literacy ability of high school students in Indonesia can be achieved optimally.

The science literacy ability is related to activities that are often carried out by students both at school and in everyday life that demand the ability to understand an event that can occur and solutions to solve these events using physics concepts that high school students know (Jonāne, 2015). In addition, activities related to science literacy ability such as observing natural or easy events such as playing traditional games or through video games on smartphones put forward the determination of the most effective and efficient strategies using an understanding of the concepts of physics they already have (Yilmaz et al., 2012). In line with this, a finding shows that physics learning done in Android-based high schools contained on smartphones can improve the science literacy ability of high school students (Liu et al., 2018). Thus, it can be concluded that high school students can optimize their science literacy abilities if they want to use their understanding of physics concepts to the analysis and solve every physics event that occurs in everyday life with the assistance of a smartphone or the like.

Furthermore, all media and learning models conducted by teachers can assist in enhancing the science literacy ability of high school students, provided that the implementation of learning can accommodate high school students in optimizing their science literacy abilities (Sinaga et al., 2017). In addition, the use of smartphones in learning also has a significant relationship and gives a positive influence on student learning outcomes, especially the science literacy ability of high school students (Pramuda et al., 2019). Therefore, it takes the participation of teachers and high school students together to collaborate in realizing physics learning that can improve the science literacy ability of high school students by utilizing the use of smartphones.

Meanwhile, high school students who have been able to find the best solutions that are most effective and efficient in solving various problems in daily life using physics concepts correctly without any misconceptions, it is likely that will be able to develop more diverse solutions with the assistance of progress technology like smartphones. Science literacy is an ability that arises because it often resolves physics problems that occur in everyday life using the correct understanding of physics concepts with the assist of media such as smartphones (Chen & Liu, 2018). Thus, one effort that needs to be done to improve the science literacy ability of high school students in physics learning is often to practice solving physics problems in daily life using an understanding of physics concepts that have been possessed appropriately, effectively, and efficiently with the assisted of a smartphone.

Based on these descriptions, this study aims to find out how much smartphones usability in physics learning, the science literacy ability of high school students, and the effect of smartphones' usability on the science literacy ability of high school students in physics learning. However, it is first necessary to develop the media used to obtain data about the smartphone's usability in physics learning and the science literacy ability of high school students in physics learning discussed in the method section.

Methodology

General Background

By the objectives in this study to get data about how much the smartphone's usability in physics learning, the science literacy ability of high school students, and the effect of the smartphone's usability on the science literacy ability of high school students in physics learning, the research method used is a method Quantitative research as a basis for discussing research results. The quantitative research method itself is a research method based on the philosophy of positivism, which is used in researching a particular population or sample, collecting data using research instruments, quantitative analysis, or statistical data, to test the hypotheses that have been established (Johnson & Christensen, 2019). Furthermore, this research was conducted by a survey by giving questionnaires to high school students to obtain data about the smartphone's usability in physics learning. In addition, high school students are also given a physics test instrument to measure their science literacy ability.

The next step, namely the regression research analysis, explains that the regression research aims to understand the influence between two or more research variables (Creswell, 2008). In this study, the dependent variable is the science literacy ability of high school students, while the independent variable is the smartphone's usability in physics learning. This research was conducted at the end of the even semester when high school students had completed physics learning for the final discussion of the material because it was considered necessary to investigate how much the usability arising related to the use of smartphones in physics learning and also its effect on the science literacy ability of

high school students. The results of this study can be used as a reference for teachers, researchers, or lecturers in optimizing the use of smartphones in physics learning in high schools as an effort to optimize the science literacy ability of high school students, as well as to face the challenges of the 21st century and the industrial revolution 4.0.

Research Samples

The samples used in this study were 264 grade 11 MIPA students from three high schools in Yogyakarta, Indonesia, namely SMA N 1 Depok-Sleman, SMA N 4 Yogyakarta, and SMA N 1 Sewon in the academic year 2018/2019. SMA itself is an abbreviation of state high school and MIPA is mathematics and natural sciences which are under the responsibility of the ministry of education and culture of the Indonesia Republic. Meanwhile, the sampling technique used to determine the sample in this study is to use the convenience sampling technique. The convenience sampling technique is one of the non-probability sampling methods in which the study population is ready and feasible to be used by researchers (Fraenkel et al., 2012). In this study, there were no high school students who refused to participate as a research sample. Therefore, all samples used in this study which amounted to 264 high school students provide valid information. Meanwhile, data collection techniques in the form of the smartphone's usability of high school students in physics learning are done using a questionnaire. Meanwhile, data on the science literacy ability of high school students was obtained using reasoned multiple-choice physics questions or second-level physics tests developed by researchers.

Instruments and Procedures

The first step undertaken in this study is to develop an instrument used to measure the smartphone usability of high school students in physics learning in the form of questionnaires and the science literacy ability of high school students in physics learning in the form of multiple-choice questions of valid and reliable. Researchers are more interested in developing new instruments to ensure that the two measuring instruments developed are relevant to student conditions, student characteristics, and physics curricula in high schools in Indonesia. Literature review of science literacy ability was carried out before designing the research instrument, which obtained 6 indicators that reflect the science literacy ability of high school students, namely content knowledge, procedural knowledge, epistemic knowledge, explaining phenomena scientifically, interpreting data and evidence scientifically, and evaluating processes scientific inquiry (Organisation for Economic Co-operation and Development (OEC), 2010). In this study, the two instruments used to measure these variables were validated by 6 expert validators before they were distributed to 264 high school students randomly selected from three high schools in Yogyakarta. Meanwhile, the instrument used to measure the smartphone's usability by high school students in physics learning is a questionnaire consisting of 12 statements. The statement items developed on the questionnaire used to measure the smartphone usability of high school students in physics learning consist of positive and negative statements that can be shown in Table 1 below. The positive statement items are items numbered 1, 2, 3, 5, 7, 9, 10, and 12. Meanwhile, the negative statement items are items number 4, 6, 8, and 11.

Table 1. Questionnaire on the Smartphone's Usability in Physics Learning

No.	Statement	1	2	3	4
1.	The use of android simulation media on smartphones in physics learning is more effective and efficient in helping me explain physics material.				
2.	Learning physics is easier, if explained by the teacher directly rather than using learning media independently.				
3.	Physics learning is more appropriate when combined using android simulation media on smartphones.				
4.	I become lazy when the teacher gives physics assignments through the help of a smartphone.				
5.	I find it easier to learn the physics material explained by the teacher with the smartphone assisted media.				

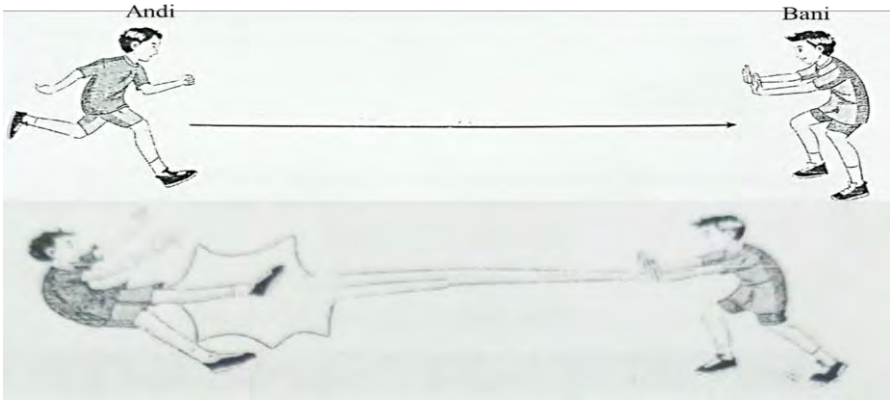
Table 1. Continued

No.	Statement	1	2	3	4
6.	I get confused when physics learning relates to everyday life like a traditional game.				
7.	Physics learning media that use android simulations on smartphones can increase my concentration of learning.				
8.	Even though I use android simulation media on a smartphone, I don't think I will understand the physics material.				
9.	I was helped when conducting a group discussion to solve physics problems using the android simulation media on smartphones.				
10.	Physics learning media that use simulations on smartphones makes me not bored to study physics.				
11.	Physics learning media in the form of an android simulation on a smartphone makes it difficult for me to learn independently.				
12.	The physics learning media in the form of an android simulation on a smartphone can make my smartphone more useful.				

Note: 1 is very disagree (VD), 2 is disagree (D), 3 is agree (A), and 4 is very agree (VA)

Meanwhile, the instrument used to measure the science literacy ability of high school students in physics learning is in the form of a reasoned multiple-choice physics test or a physics two-tier test consisting of 25 reasoned multiple-choice questions as follows.

Look at the picture of two children running around below!



Picture 1. Two children running around

Based on the picture above, Andi runs towards Bani at a certain speed. After Andi arrived at Bani, Bani pushed Andi to the back. The physical event that corresponds to the concept of Momentum and Impulse in this case is … and the reason is …

Option:

A. Andi will change his speed in both magnitude and direction of motion.

B. The children will change their speed in both magnitude and direction of motion.

C. Andi will not change his speed both in magnitude and direction of motion.

D. Bani pushes Andi with great force.

E. Bani pushed Andi with a small force.

Reason:

A. Andi did not hold back Bani's urges.

B. Andi runs at a low speed.

C. Andi runs at high speed.

D. Andi and Bani fell on each other after interacting.

E. Bani pushes Andi at certain intervals.

Look at the picture of a child who is blowing a balloon below!

Picture 2. A child who is blowing a balloon

If the child blows up the balloon to its maximum size and releases it, the balloon will fly. The event that corresponds to the concept of Momentum and Impulse in this case is … and the reason is …

Option:

A. The child blows the balloon so hard that the balloon will move quickly when it is released.

B. The released balloon will move uniformly at a constant speed every time.

C. When the balloon is moving, the mass of air in the balloon will always remain constant.

D. When the balloon is moving, its velocity will always remain constant.

E. As the balloon moves, the mass of air in the balloon and the velocity of the balloon change over time.

Reason:

A. There is a collision between the surface of the balloon with the air.

B. There is a push from inside the balloon.

C. There is an impulse carried by the air on the balloon.

D. There is great momentum in the balloon.

E. There is a difference in the velocity of the balloon.

However, the questionnaire and physics science literacy test were first tested for validity and reliability conducted by 6 expert validators to determine the validity and reliability. After the questionnaire and physics science literacy test were tested for their validity and reliability, then their validity was analyzed using the Aiken'sV equation like equation 1.

$$V = \sum \frac{r - l_o}{[n(c-1)]} \tag{1}$$

Where V is the validity value, r is the number given by the n^{th} validator, l_o is the lowest validity rating number, n is the number of validators, and c is the highest validity rating number. After the coefficient V is obtained, then the coefficient V is compared with the Aiken table. An item or questionnaire is said to be valid if the Aiken's coefficient validity value is greater or equal to the minimum value listed in the Aiken table (Aiken & Stephen, 1985). Meanwhile, the reliability of questionnaires and physics science literacy tests were tested using the item separation index (item estimate) and the person separation index (case estimate) through the Quest program (Subali & Suyata, 2011). If 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 partial credit model (PCM). In addition, the higher the value of the person separation index, the higher the consistency of each item in measuring the science literacy ability of a person (Subali & Suyata, 2011). The item estimates and case estimate criteria can be shown in Table 2 below.

Table 2. Value Criteria of Item and Case Estimate

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

The filling out of the questionnaire was carried out by high school students by implementing a modified Likert scale assessment with the rating scale being modified to just a scale of 4. Where a score of 1 is the same as strongly disagree, a score of 2 is the same as disagree, a score of 3 is the same as agreeing, and a score of 4 is the same as strongly agreeing (Sumintono & Widhiarso, 2015). Meanwhile, the measurement of science literacy ability of high school students is done by not only choosing the answer choice of a physics problem, but high school students are also required to choose the reason. In conducting this research, the research design used was a one-shot case study. Where high school students in the class used in this study were given treatment in the form of using a smartphone in physics learning. Furthermore, the science literacy ability of high school students was measured using a science choice of questions in the form of multiple-choice reasoning with 25 items. This is done to find out whether the smartphone's usability in physics learning provides benefits or influences the science literacy ability of high school students or not.

Data Analysis

The analysis used to determine the smartphones usability and the science literacy ability of high school students in physics learning is done using ideal average equations and standardized standards that are analyzed with the assist of MS. Excel program. Meanwhile, the technique used is to analyze the results of the questionnaire and physics science literacy test results of high school students into the very low, low, medium, 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 on the highest and lowest questionnaire and physics science literacy test (Azwar, 2012). The interval scores for the smartphone's usability and the science literacy ability of high school students can be shown in Table 3.

Table 3. Intensity Interval Scores of Smartphone Usability and Science Literacy Ability

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

Based on Table 3, θ shows the level of smartphones usability and the science literacy ability of high school students in physics learning. Furthermore, determining the effect of the smartphone's usability on the science literacy ability of high school students in physics learning can be analysed using regression analysis with the assist of the SPSS program. Regression analysis in this research states all assumptions that the data obtained in this study are normally distributed or have been tested for normality and there are no outliers. Meanwhile, the level of significance used in this study is 0.05. With the H_a hypothesis that the smartphone's usability significantly influences the science literacy ability of high school students in physics learning. Meanwhile, H_o hypothesizes that the smartphone's usability does not significantly influence the science literacy ability of high school students in physics learning. In general, the process carried out in this study can be illustrated in Figure 1 below.

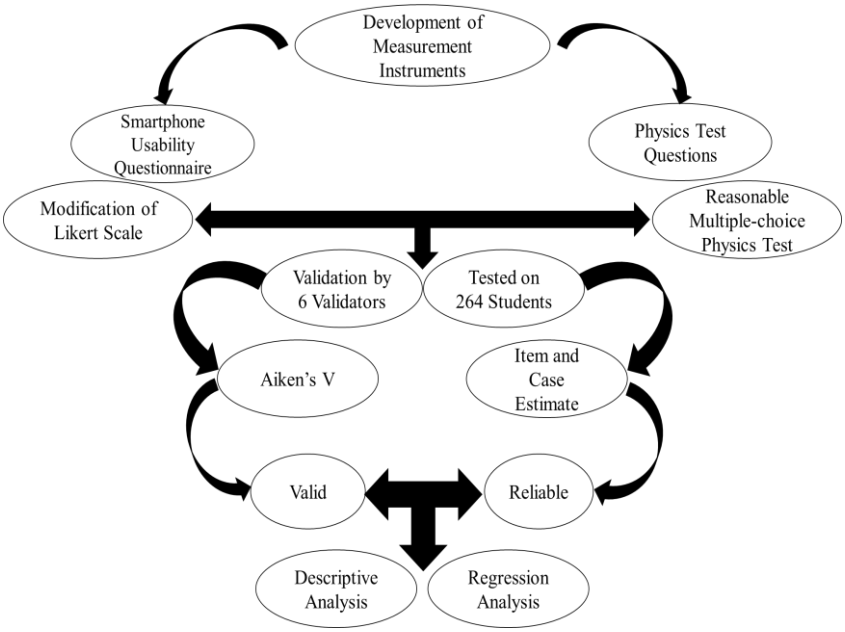


Figure 1. Process in research activities

The Validity and Reliability of Measurement Instruments

Before presenting the results about the smartphone's usability and its effect on the science literacy ability of high school students in physics learning, we first present the results about the feasibility of the measurement instruments that we have developed. The feasibility data of this measurement instrument includes the validity and reliability data of the measurement instruments in the form of questionnaires and physics science literacy tests. The results of the first analysis of this measurement instrument are the results of the analysis of the validity of the questionnaire and physics science literacy test analysis using the Aiken V equation as shown in equation 1. The results of the validity of the questionnaire and physics science literacy test used in this study can be shown in Table 4 below.

Table 4. The validity of Measurement Instruments

Measurement Instruments	Number of Items	Aiken's Validity Value	Criteria
Questionnaire of Smartphones Usability	12	0.903	Valid
Physics Science Literacy Test	25	0.926	Valid
Validity Value of Measurement Instruments		**0.915**	**Valid**

Expert validators who validated the questionnaire and physics science literacy test consisted of 6 people each. Therefore, the error level in the Aiken's V table used is 1% ($p < 0.01$) and the items in the questionnaire and physics science literacy test are valid if the Aiken coefficient ($V \geq 0.89$) (Aiken & Stephen, 1985). Based on Table 4, the results are obtained that the questionnaire and physics science literacy test are both valid because Aiken's validity value is greater than 0.89 ($V \geq 0.89$), which is equal to 0.915. Based on the results of the validity, it can be stated that the questionnaire and physics science literacy test is valid and feasible to measure smartphones usability and the science literacy ability of high school students in physics learning. After the validity of the questionnaire and physics science literacy test is an analysis using the Aiken V equation, the next step is to analyse its reliability. The reliability results are also used as a reference in determining the feasibility of questionnaires and physics science literacy tests that have been developed by researchers. The reliability results from the questionnaire and physics science literacy test can be presented in Table 5 below.

Table 5. Reliability of Measurement Instruments

Reliability	Reliability Coefficient		Category	
	Questionnaire	Physics Science Literacy Test	Questionnaire	Physics Science Literacy Test
Summary of item estimate	0.85	0.88	Reliable	Reliable
Summary of case estimate	0.89	0.83	Reliable	Reliable

Based on Table 5, it can be observed that the reliability coefficient for the measurement instrument in the form of a questionnaire obtained the value of summary items of estimates and summary cases of estimates that are more than 0.7 which are included in the reliable category. Meanwhile, for the measurement instrument in the form of a physics science literacy test, a value of a summary item of estimate and a summary case of the estimate of more than 0.7 are obtained which are included in the reliable category. Meanwhile, the value of the summary of item estimates and the summary of case estimate obtained in the questionnaire and physics science literacy test items shows that the questionnaire items and physics science literacy test developed both are included in good criteria. Furthermore, these items on the physics questionnaire and physics science literacy test show the exact consistency of the choice of high school students. In other words, each item in the questionnaire and physics science literacy test items show the same score, if assessed by different high school students. Therefore, based on validity and reliability data that have been obtained as shown in Table 4 and Table 5, it can be stated that the measurement instruments developed are feasible for use in measuring the smartphones usability and the science literacy ability of high school students in physics learning.

Findings

Smartphones Usability of High School Students in Physics Learning

After obtaining the results of the validity and reliability of measurement instruments in the form of questionnaires and physics science literacy tests, then we propose the results obtained next, the results of the smartphone's usability of high school students in physics learning. The smartphone usability of high school students in physics learning obtained through a questionnaire can be stated in Table 6 below.

Table 6. Smartphones Usability of High School Students in Physics Learning

Number of Students	Percentage (%)	Smartphones Usability
10	3.79	Very High
151	57.20	High
94	35.61	Moderate
9	3.41	Low
0	0.00	Very Low

Based on Table 6 it can be stated that the smartphone's usability of students in physics learning is at a high level with a percentage of 57.20% or equivalent to 151 students. In other words, as many as 151 high school students revealed that smartphones in physics learning provided positive benefits for them. These results certainly show that the benefits felt by students in using smartphones in physics learning are high, so there is a need for optimization in utilizing the use of smartphones in physics learning so that the science literacy ability of high school students can be increased.

High School Students' Science Literacy Ability in Physics Learning

After obtaining the results of smartphones usability of high school students in physics learning which are classified as high, then we present the results of the science literacy ability of high school students in physics learning. The results of the science literacy ability of high school students in physics learning obtained through physics tests in the form of reasonable multiple-choice tests can be stated in Table 7 below.

Table 7. High School Students' Science Literacy Ability in Physics Learning

Number of Students	Percentage (%)	Science Literacy Ability of Students
8	3.03	Very High
36	13.64	High
96	36.36	Moderate
87	32.95	Low
37	14.02	Very Low

Based on Table 7 it can be stated that the science literacy ability of high school students in physics learning is at a moderate level with a percentage of 36.36% or equivalent to 96 students. These results indicate that the science literacy ability of high school students in Indonesia in physics learning has a difference that is not much different from the science literacy ability of students at a low level, amounting to 3.41%. The results also indicate that the science literacy ability of students in high schools in physics learning is arguably still low. In other words, the maximum science literacy ability of high school students is at a very high level with a percentage of 3.03% or equivalent to 8 students whose science literacy abilities are very high compared to other students. These results indicate the need for more appropriate treatment in physics learning by teachers by integrating physics problems that occur in everyday life by utilizing the use of smartphones in physics learning so that the science literacy ability of high school students can be further increased.

The Effect of Smartphones Usability on High School Students' Science Literacy Ability in Physics Learning

After the results of the smartphone's usability and the science literacy ability of high school students in physics learning are obtained, then we propose the results of the effect of the smartphone's usability on the science literacy ability of high school students in physics learning. The results of the influence of these two variables can be stated in the following Table 8 below.

Table 8. Effect of Smartphones Usability on High School Students' Science Literacy Ability in Physics Learning

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
				R Square Change	F Change	Sig. F Change
.586	.343	.002	5.894	.357	3.595	.004

Based on the results obtained as shown in Table 8, the effect of smartphones usability on the science literacy ability of high school students in physics learning based on the results of the regression test has been confirmed $(R = 0.586, R_{square} = 0.342)$. According to the categorization of the regression coefficients proposed by Drape and Smith (1996), the results of the regression coefficients found in this study indicate a positive effect. In other words, the results of the regression coefficient indicate that the smartphone's usability affects the ability of science literacy ability of high school students in physics learning by 34.30% and the remaining 65.70% is influenced by other factors. These results cause the Ha that has been compiled can be accepted because the level of significance is smaller than 0.05, namely

0.004 or (0.05≥0.004). The smartphone's usability significantly influences the science literacy ability of high school students in physics learning. Therefore, the results of the regression analysis are by all assumptions that the data obtained in this research are normally distributed or have normality tested and there are no outliers.

Discussion

The purpose of this study was to determine how much the smartphone's usability of high school students in physics learning, the science ability literacy of high school students, and the effect of the smartphone's usability on the science literacy abilities of high school students in physics learning. Therefore, the results of the two measurement instruments that have been developed by researchers (questionnaire and physics science literacy test) are used are very feasible to measure the smartphones usability and science literacy ability of high school students in physics learning. Meanwhile, the results of filling out the questionnaire conducted by high school students related to the smartphone's usability in physics learning show that the smartphone's usability in physics learning provides high usability to high school students with a percentage of 57.20% as shown in Table 6. The high benefits provided from the smartphone's usability in physics learning occur because high school students have realized the importance of using smartphones in physics learning to assisted understand the physics material delivered by their teachers (Mekovec et al., 2018; Murtafiah et al., 2019). However, the high smartphone usability is also still being abused by students to play video games, browsing, photos, or catting with others, thereby disrupting the focus of students on physics materials that have been explained by the teacher and those being studied. Thus, there need to be clear rules from the school, especially from physics teachers related to the use of smartphones in physics learning, so that it can assist facilitate students in physics learning and assist in optimizing the science literacy ability of high school students.

Several previous studies also obtained similar results, which showed that many high school students have used smartphones in learning especially physics, both permitted or prohibited for use by the school (Hochberg et al., 2018). However, even though smartphone usage is still prohibited in learning at school, this can make students more curious to bring and use smartphones in learning at school (Lubrick et al., 2019). Therefore, students need to be given instructions and strict rules related to the use of smartphones in physics learning at school. Thus, it is expected that the high of smartphones usability in physics learning also have a positive impact on the abilities and skills of students that can benefit in their daily lives. Meanwhile, the results of research on the science literacy ability of high school students in physics learning are at a moderate level and have a difference that is not much different from the low category, so it can be said that the science literacy ability of high school students in physics learning is still in the low category. This certainly needs to be given a certain treatment in the process of physics learning so that the science literacy ability of high school students can be increased. In addition, it is necessary to allocate a considerable amount of time to practice the science literacy ability of high school students in physics learning.

Training on the science literacy ability of students can be done by providing physics problems that arise in the daily lives of students and then students are asked to solve physics problems they experience in daily life using physics concepts that they know exactly, effective, and efficient by utilizing the use of smartphones. This is in line with the findings that explore strategies in increasing the science literacy ability of high school students (for example, finding appropriate, effective, and efficient solutions to solve a physics problem experienced by students in daily life with a variety of approaches and also by utilizing advances in information and communication technology in the form of smartphones) (Karademir & Ulucinar, 2017). In addition, the findings obtained in this study also revealed that the science literacy ability of high school students in physics learning is in the moderate category with the percentage of students as much as 36.36%. In addition, there are even only 8 high school students who have science literacy ability reaching very high levels, equivalent to 3.03% of high school students only. This of course depends on each of the science literacy abilities possessed by students in using the physics concepts they already have to solve physics problems that occur in everyday life precisely, effectively, and efficiently by using the assist of a smartphone.

In addition, the pattern of tests given to high school students also affects the results of science literacy ability obtained. In line with the previous statement, that there are several groups of high school students who tend to find it more difficult to take physics tests in the form of reasonable multiple-choice than the essay physics tests or multiple-choice physics tests (Rusilowati et al., 2016). In line with these findings, the results found in this study also indicate that there are errors that occur in physics learning, both in terms of material explanation by teachers or high school students who do not understand the physics material explanation by teachers integrated with problems that occur in life that is experienced directly by students. This certainly needs to be immediately followed up and addressed if the science literacy ability of students in Indonesia is to be increased. These findings in detail can be displayed in Table 7. In line with these findings, there are similar findings that claim that the low science literacy ability of students in Indonesia in physics learning is due to the habits of students in Indonesia which are only demanded by teachers in solving physics problems contained in physics books and students are rarely asked by their teachers to solve every problem that occurs in the daily lives of students by using the physics concepts students have (Sutirman, 2019). There are many reasons behind the teacher's actions in physics learning, one of them is the fear of the teacher if the physics material taught is not by what has been planned and the teacher's fear of lack of learning time.

Such physics learning certainly only has a slight impact on optimizing the science literacy ability of students. The treatment given by such teachers is not able to optimize the science literacy ability of students to a higher level. This is because the science literacy ability that is developed is limited to solving existing problems in physics textbooks or only textually, it is not contextual or there is no such thing as exploring directly in daily life that is experienced by students to solving physics problems that occur in everyday environments using the concepts of physics they already have with the assist of smartphones (Psycharis & Kotzampasaki, 2019). Based on the findings of the smartphone's usability and the science literacy ability of high school students in physics learning, it can also discuss the effects of both. It has been confirmed earlier in this study that the smartphone usability of high school students in physics learning is high. However, the high smartphone's usability provided to students in physics learning still makes the science literacy ability of high school students low. Based on these findings, there should be a positive influence given from the use of smartphones on the science literacy ability of students in physics learning. This is in line with a finding that found that smartphone usage provides positive benefits for students' interest in learning and science literacy ability in high school (Alneyadi, 2019).

In this study, the effect of the smartphone's usability on the science literacy ability of high school students in physics learning is 34.30% as shown in Table 8. In general, the use of smartphones by these students has relatively small benefits to their science literacy abilities in physics learning, because the percentage is not yet close to 50%. The small effect of smartphone usability on the science literacy ability of high school students in physics learning is largely due to several factors. For one thing, high school students tend not to make good use of smartphones in physics learning, so their science literacy ability cannot be optimized even by using smartphones. However, high school students use smartphones for entertainment purposes only (Valova & Marinov, 2019). This certainly cannot provide meaningful benefits for optimizing the existing science literacy abilities of students. Based on these findings it can be stated that the science literacy ability of high school students in physics learning is influenced by other factors besides the smartphone's usability by 65.70%. This indicates that the use of smartphones is less usable to optimizing the science literacy ability of high school students in physics learning. The science literacy ability of high school students in physics learning is far more optimally achieved if the supervision of teachers and parents are also involved in physics learning that is carried out by students both at school and at home. This is in line with previous findings which found that the supervision of teachers and parents in physics learning that utilizes the use of smartphones is far more optimal in achieving the science literacy ability of high school students because supervision given by parents and teachers to students can reduce negative impacts arising from the use of the smartphone itself (Debeljuh et al., 2019).

Therefore, with the findings obtained in this study, physics teachers should not only transfer physics concepts through the teacher center method but the need for an integrated student center method with every event or problem in daily life experienced by students with utilizing a smartphone. In addition, physics learning conducted by teachers in high schools is mostly textual and rarely contextual by directly applying the physics concepts learned by students with every event or problem in daily life experienced by students by utilizing smartphones that lead to optimization of science literacy ability of students (Shabrina & Kuswanto, 2018). Thus, our results provide evidence that the low science literacy ability of high school students is not much influenced by the smartphone's usability in physics learning, but much is influenced by physics learning scenarios by more textual teachers and teacher centers.

Conclusion

The smartphone usability of high school students in physics learning was dominantly categorized high with a percentage of 57.20%. However, the science literacy ability of high school students in physics learning is still moderate or near low with a percentage of 36.36%. However, the use of smartphones by high school students can provide positive benefits to their science literacy abilities in physics learning by 34.30%. These findings have proven that the smartphone usability of high school students has not had a large positive effect on the science literacy ability in high school students in physics learning. Thus, special attention is needed by the teacher and parents of students in supervising the use of smartphones in physics learning that is integrated with problems or events that occur in daily life experienced by students.

Recommendations

It is also necessary for the teacher's participation to facilitate physics learning that leads to the achievement of high school students' science literacy ability in physics learning so that students' expected science literacy abilities in physics learning can be improved and be in a better category. In other words, teachers need to implement physics learning strategies that are more precise, effective, and efficient that are adapted to the conditions and characteristics of students by utilizing the use of smartphones wisely that leads to optimizing the science literacy ability of high school students. These strategies include providing an understanding of physics concepts and tasks related to physics problems that occur in daily life experienced by students by prioritizing the use of smartphones. Concerning further research, researchers are encouraged to expand this research by adding dependent variables, independent variables, and adding more students from different high schools and other scientific backgrounds.

Limitations

This research is only correlational. As a result, it is not strong to prove how the independent variables influence students' scientific literacy abilities. The scale used in this study was only statistically validated, not yet using a more comprehensive approach. Research participants are only limited to one area so that it is less representative to represent a larger number of scientific literacy skills.

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Authorship Contribution Statement

Putranta: Conceptualization, design, analysis, writing, drafting manuscript. Rukiyati: Conceptualization, analysis, securing funding. Supahar: Writing, drafting manuscript. Setiyatna: Critical revision of manuscript, securing funding.

References

Aiken, L. S., & Stephen, G. (1985). *Multiple regression: Testing and interpreting interactions*. Sage Publications.

Alneyadi, S. S. (2019). Virtual lab implementation in science literacy: Emirati science teachers' perspectives. *EURASIA Journal of Mathematics, Science, and Technology Education, 15*(12), 1-10. https://doi.org/10.29333/ejmste/109285

Annamalai, N. (2018). How do we know what is happening in WhatsApp: A case study investigating pre-service teachers' online activity? *Malaysian Journal of Learning and Instruction, 15*(2), 207-225. https://doi.org/10.32890/mjli2018.15.2.8

Azwar, S. (2012). *Reliability and validity* (4th ed.). Pustaka Pelajar.

Bennis, L., & Amali, S. (2019). From learning games to adaptive ubiquitous game-based learning. *International Journal of Emerging Technologies in Learning, 14*(16), 55-65. https://doi.org/10.3991/ijet.v14i16.10701

Bílek, M., Nodzyńska, M., Putała, W. K., & Piekarczyk, P. Z. (2018). Balancing chemical equations using sandwich-making computer simulation games as a supporting teaching method. *Problems of Education in the 21st Century, 76*(6), 779-799. https://doi.org/10.33225/pec/18.76.779

Canessa, E., Fonda, C., Tenze, L., & Zennaro, M. (2014). EyApp & AndrEyA-free apps for the automated recording of lessons by students. *International Journal of Emerging Technologies in Learning, 9*(1), 31-34. https://doi.org/10.3991/ijet.v9i1.3346

Chen, S. Y., & Liu, S. Y. (2018). Reinforcement of scientific literacy through effective argumentation on an energy-related environmental issue. *EURASIA Journal of Mathematics, Science, and Technology Education 14*(12), 1-15. https://doi.org/10.29333/ejmste/95171

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson Education.

Debeljuh, A., Kadum, S., & Emillia, D. C. (2019). Communication with parents using modern communication media: Attitudes of future preschool teachers. *TEM Journal, 8*(3), 1076-1083. https://doi.org/10.18421/TEM83-54

Dervić, D., Glamočić, D. S., Busuladžić, A. G., & Mešić, V. (2018). Teaching physics with simulations: Teacher-centered versus student centered approaches. *Journal of Baltic Science Education, 17*(2), 288-299. https://doi.org/10.33225/jbse/18.17.288

Drape, N. R., & Smith, H. (1996). *Applied regression analysis*. John Wiley and Sons Inc.

Feyzioğlu, E. Y., Akpinar, E., & Tatar, N. (2018). Effects of technology-enhanced metacognitive learning platform on students' monitoring accuracy and understanding of electricity. *Journal of Baltic Science Education, 17*(1), 43-64. https://doi.org/10.33225/jbse/18.17.43

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). McGraw-Hill.

Hochberg, K., Kuhn, J., & Müller, A. (2018). Using smartphones as experimental tools-effects on interest, curiosity, and learning in physics education. *Journal of Science Education and Technology, 27*(5), 385-403. https://doi.org/10.1007/s10956-018-9731-7

Ikhsan, J., Akhyar, M., & Nais, M. K. (2019). The effects of science-on-web learning media on junior high school students' learning independence levels and learning outcomes. *Journal of Turkish Science Education, 16*(2), 231-239.

Johnson, R. B., & Christensen, L. (2019). *Educational research: Quantitative, qualitative, and mixed approaches*. Sage Publications.

Jonāne, L. (2015). Analogies in science education. *Pedagogics/ Pedagogika, 119*(3), 116–125. https://doi.org/10.15823/p.2015.027

Kaeophanuek, S., & Na-Songkhla, J. (2019). A learning process model to enhance digital literacy using critical inquiry through digital storytelling (CIDST). *International Journal of Emerging Technologies in Learning, 14*(3), 22-37. https://doi.org/10.3991/ijet.v14i03.8326

Karademir, E., & Ulucinar, U. (2017). Examining the relationship between middle school students' critical reading skills, science literacy skills and attitudes: A structural equation modeling. *Journal of Education in Science, Environment and Health, 3*(1), 29-39. https://doi.org/10.21891/jeseh.275669

Karahoca, A., Yengin, I., & Karahoca, D. (2018). Cognitive dialog games as cognitive assistants: Tracking and adapting knowledge and interactions in student's dialogs. *International Journal of Cognitive Research in Science, Engineering and Education, 6*(1), 45-52. https://doi.org/10.5937/ijcrsee1801045K

Kermani, H. (2017). Computer mathematics games and conditions for enhancing young children's learning of number sense. *Malaysian Journal of Learning and Instruction, 14*(2), 23-57. https://doi.org/10.32890/mjli2017.14.2.2

Koğar, E. Y. (2019). The investigation of the relationship between mathematics and science literacy and information and communication technology variables. *International Electronic Journal of Elementary Education, 11*(3), 257-271. https://doi.org/10.26822/iejee.2019349250

Lee, T. T., Sharif, A. M., & Rahim, N. A. (2018). Designing e-content for teaching basic chemistry concepts in higher education: A needs analysis. *Journal of Turkish Science Education, 15*(4), 65-78.

Liu, Q., Gong, D., & Chen, M. (2018). Retraction of applying virtual reality to study the effects of environmental education on college students' ethics and environmental literacy. *EURASIA Journal of Mathematics, Science, and Technology Education, 15*(2), 2255–2263. https://doi.org/10.29333/ejmste/102285

Lubrick, M., Zhou, G., & Zhang, J. (2019). Is the future bright? The potential of light board videos for student achievement and engagement in learning. *EURASIA Journal of Mathematics, Science, and Technology Education, 15*(8), 1-14. https://doi.org/10.29333/ejmste/108437

Mekovec, R., Aničić, K. P., & Arbanas, K. (2018). Developing undergraduate IT students' generic competencies through problem-based learning. *TEM Journal, 7*(1), 193-200. https://doi.org/10.18421/TEM71-24

Mitsuhara, H., Iguchi, K., & Shishibori, M. (2017). Using the digital game augmented reality and head-mounted displays for immediate-action commander training. *International Journal of Emerging Technologies in Learning, 12*(2), 101-117. https://doi.org/10.3991/ijet.v12i02.6303

Mudaly, V., & Fletcher, T. (2019). The effectiveness of GeoGebra when teaching linear functions using the iPad. *Problems of Education in the 21st Century, 77*(1), 55-81. https://doi.org/10.33225/pec/19.77.55

Murtafiah, W., Sa'dijah, C., Chandra, T. D., & Susiswo, S. (2019). Decision-making of the winner of the national student creativity program in designing ICT-based learning media. *TEM Journal, 8*(3), 1039-1045. https://doi.org/10.18421/TEM83-49

Organisation for Economic Co-operation and Development. (2010). *PISA 2009 result: What students know and can do, student performance in reading, mathematics, and science*. OECD Publishing. https://doi.org/10.1787/9789264091450-sum-it

Organisation for Economic Co-operation and Development. (2014). *PISA 2012 results in focus: What 15-year-old know and what they can do with what they know*. OECD Publishing. https://cutt.ly/smn26Hu

Polat, D., Godek, Y., & Kaya, V. H. (2017). Determination of the relationship between mathematics literacy, mathematics content knowledge, and science literacy according to PISA 2012. *Research Journal of Business and Management, 8*(1), 84-89. https://doi.org/10.17261/Pressacademia.2017.373

Pramuda, A., Mundilarto, Kuswanto, H., & Hadiati, S. (2019). Effect of real-time physics organizer-based smartphone and indigenous technology to students' scientific literacy viewed from gender differences. *International Journal of Instruction, 12*(3), 253-270. https://doi.org/10.29333/iji.2019.12316a

Psycharis, S., & Kotzampasaki, E. (2019). The impact of a STEM inquiry game learning scenario on computational thinking and computer self-confidence. *EURASIA Journal of Mathematics, Science, and Technology Education, 15*(4), 1-18. https://doi.org/10.29333/ejmste/103071

Rusilowati, A., Kurniawati, L., Nugroho, S. E., & Widiyatmoko, A. (2016). Developing an instrument of scientific literacy assessment on the cycle theme. *International Journal of Environmental & Science Education, 11*(12), 5718-5727.

Sari, D. K., Supahar, & Ralmugiz, U. (2018). The influence of android-based isomorphic physics (FORFIS) application on analogical transfer and self-diagnosis skill of students at SMA Negeri 3 Kupang. *Journal of Indonesian Science Education/Jurnal Pendidikan IPA Indonesia, 7*(2), 154-161. https://doi.org/10.15294/jpii.v7i2.14268

Shabrina, & Kuswanto, H. (2018). Android-assisted mobile physics learning through Indonesian Batik culture: Improving students' creative thinking and problem-solving. *International Journal of Instruction, 11*(4), 287-302. https://doi.org/10.12973/iji.2018.11419a

Sinaga, P., Kaniawati, I., & Setiawan, A. (2017). Improving secondary school students' scientific literacy ability through the design of better science textbooks. *Journal of Turkish Science Education, 14*(4), 92-107.

Stacey, K. (2011). Mathematical and scientific literacy around the world. *Journal of Science and Mathematics Education in Southeast Asia, 33*(1), 1-16.

Subali, B., & Suyata, P. (2011). *Guide to analyzing educational measurement data to obtain empirical evidence of validity using the Quest program*. Institute for Research and Community Service at Yogyakarta State University.

Sumintono, B., & Widhiarso, W. (2015). *Rasch modeling application in educational assessments*. Trim Komunikata.

Sutirman, S. (2019). The differences in the effect of using video and modules as media in learning electronic record management. *TEM Journal, 8*(3), 984-991. https://doi.org/10.18421/TEM83-41

Syafrizal, S., Masrupi, M., & Mauludah, I. (2019). The impact of the experiential learning method and vocabulary mastery toward Indonesian students' reading comprehension through an animation video. *Journal for the Education of Gifted Young Scientists, 7*(3), 449-458. https://doi.org/10.17478/jegys.531412

Talaee, E. (2019). Longitudinal impacts of home computer use in early years on children's social and behavioral development. *International Electronic Journal of Elementary Education, 11*(3), 233-245. https://doi.org/10.26822/iejee.2019349248

Techakosit, S. (2018). The development of STEM literacy using the learning process of scientific Imagineering through AR. *International Journal of Emerging Technologies in Learning, 13*(1), 230-238. https://doi.org/10.3991/ijet.v13i01.7664

Techakosit, S., & Nilsook, P. (2016). The learning process of scientific imagineering through AR to enhance STEM literacy. *International Journal of Emerging Technologies in Learning, 11*(7), 57-63. https://doi.org/10.3991/ijet.v11i07.5357

Valova, I., & Marinov, M. (2019). Facebook as a tool aiding university education-whether it is possible and useful. *TEM Journal, 8*(2), 670-676. https://doi.org/10.18421/TEM82-48

Yildiz, E., Şimşek, Ü., & Ağdaş, H. (2018). The effects of educational game-integrated group research method on academic achievement, attitude towards school, and retention of knowledge in teaching regulatory system. *Journal of Turkish Science Education, 15*(3), 91-105.

Yilmaz, F., Sünkür, M. Ö., & İlhan, M. (2012). İlköğretim fen ve teknoloji dersi öğretim programında yer alan fiziksel olaylar öğrenme alanına ait kazanımlar ile fizik dersi öğretim programı kazanımlarının fen okuryazarlığı açısından karşılaştırılması [A comparison of physics events learning area acquisitions in primary school science and technology curriculum and physics curriculum acquisitions in terms of scientific literacy]. *Elementary Education Online, 11*(4), 915-926.