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Physics Learning Media Based on Mobile Learning on the Android Platform to Increase Student's HOTS

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Abstract: This research was motivated by the need for media for learning physics that can be used anytime and anywhere to improve students' HOTS physics skills, the researchers designed learning media based on mobile learning on the Android platform. This study aims to: develop physics learning media to improve students' physics HOTS skills, designing physics learning media for learning valid, effective and practical students. The research subjects were students of class X MIPA at MAN 3 Sleman. The instruments used are questionnaires and tests. This research uses research and development or what is known as Research and Development (R&D) with the ADDIE development model consisting of 5 (five) stages, namely Analysis, Design, Development, Implementation, and Evaluation. The results of the validity test from material and media experts obtained that physics learning media based on mobile learning on the Android platform was included in the eligibility criteria which were very valid and could be used. The practicality test by students on learning media users found that physics-based mobile learning media on the Android platform were included in very practical criteria. As for the effectiveness test of the product developed, it was found that physics learning media based on mobile learning on the Android platform was effective in improving physics HOTS skills.

Keywords: Android; HOTS skills; Learning media; Mobile learning

Introduction

Learning is a process of interaction between teachers and students in a learning environment. Learning activities are designed to create mental and physical processes in students in order to achieve basic competencies (Warsita, 2018). The learning process is an effort and desire to make students understand the material presented according to the objectives (Lodge et al., 2018). The learning process is a process of changing a person's behavior and thought patterns which cannot be separated from the education process (Wisman, 2020). One strategy that can be used to bridge these obstacles in learning is choosing learning media. Learning media is a device that helps the learning process and has the function of making it easier for teachers to deliver material, communicate information, so that it can stimulate students' thinking power, students' learning readiness and be able to realize learning goals (Fachrunnisak & Susanti, 2022). The right learning media used in the learning process will create efficient and effective learning activities (Junaidi, 2019) so that the material presented by the teacher can be understood and absorbed optimally by students.

Learning media is used as a teacher's tool to support classroom learning, teachers use learning media adapted to the students' abilities so that the designed learning objectives are achieved. The benefits of learning media (Fitriyah & Dewi, 2022) are that it is easier for students to learn individually or in groups, it helps and makes it easier to deliver the material. In essence, the use of learning media aims to create more communicative

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and meaningful learning for students. There are many alternative learning media used by educators to help students when learning, with the help of technology which is developing rapidly, it can make it easier for educators to share knowledge. One lesson that can use learning media is physics.

Physics learning studies natural phenomena (Fitriani & Syarkowi, 2021). Physics is a science that links natural events and the surrounding environment. One of the materials in physics is alternative energy. Alternative energy is energy that can be used as a substitute for conventional fuels and can reduce the use of hydrocarbon fuels which cause environmental damage (Supriatna et al., 2020). The learning process on alternative energy material experiences problems, namely the ability of students (Medved et al., 2023). This problem is because the teacher only applies a learning model using the lecture method, so that students' thinking abilities are low. If you only use the lecture method, it will make students bored and bored (Liu et al., 2023; Schmidt et al., 2015). There must be other methods used by teachers to change students' mindsets.

The results of observations at one of the madrasahs, the author found that the madrasah had adequate facilities and infrastructure, one of which was the availability of LCD projectors in several classes. However, this is not balanced with appropriate utilization, of course this is something that is unfortunate. Another finding from the results of this observation is that 95% of students already have an Android-based smartphone (Khair et al., 2023). However, these smartphones have not been utilized optimally because students have not used Android smartphones as a learning medium. Students use smartphones with the Android platform more to play games and explore various social networking sites.

The second observation was carried out in the classroom, the observation was carried out on February 22 2023. The results of this observation indicate that the physics learning process that takes place in the classroom is still teacher centered, even though the independent curriculum has been implemented in the school. The method used by educators is conventional, namely the lecture method and taking notes on the blackboard, without using other learning media. Moreover, physics subjects are known to be difficult, making students lazy and bored while studying. Students' dependence on educators is also still very high, as can be seen from the activities in class (Hidayaty et al., 2022).

The results of an interview with one of the class X physics teachers said that there were still students who lacked speaking up skills in learning. This is indicated by the fact that there are still many students who are less active in class, when the teacher asks questions about the material being taught. If the teacher is unable to attend, students will not study or complete the assignments given. Apart from that, the learning media used by educators is still print media such as textbooks and modules without using other learning media, such as technology-based. This is due to the limited understanding that educators have in creating learning media. In overcoming these problems, it is necessary to innovate learning media that can improve students' HOTS skills in order to achieve good physics learning goals. One of the media developed is technology-based learning media. One of the technologies that people love is smartphones. Smartphones are a technology that has many benefits, especially in the world of education. Smartphones can be collaborated with education, known as mobile learning.

Today's technological developments are widely used in various fields of human life, such as social, cultural, economic and educational. We often encounter science and technology updates in the education sector with the term mobile learning (Aini et al., 2021). Mobile learning is a technology that varies learning by utilizing IT (Mohtar et al., 2023). Mobile learning media can focus students' attention because the content of the media is in the form of text, animation, video and multimedia (Wulandari et al., 2019). Learning by using cellphone media or mobile learning provides new experiences in learning. Learning with cellphones or mobile learning provides widespread opportunities for learning because it can be done anytime and anywhere and can be used without an internet network (Wang et al., 2023).

From the results of the researcher's overall analysis of the media that previous researchers have developed, the media is good in terms of use in the field, with the addition of videos, practice questions, teaching materials, and solutions to support apperception and application in everyday life. Researchers use to make the display design on the media as attractive as possible so that students do not get too bored when reading the material. Learning media can be developed in the physics learning process to make it easier for students to support their learning success and improve HOTS skills in alternative energy materials. The aims of this research are to: test the validity of mobile learning-based physics learning media on the Android platform; test the level of practicality of learning media according to students; and testing the level of effectiveness of mobile learning-based physics learning media on the Android platform in improving students' HOTS physics skills.

Method

This research uses a type of research and development or what is known as Research and Development (R&D) which is designed to produce a

product, namely mobile learning-based learning media on the Android platform to increase students' HOTS in feasible, practical and effective physics learning adapted from Erni et al. (2021). In this research, a development model is used, namely the ADDIE model. The ADDIE model is a research and development model which consists of 5 (five) stages, namely Analysis, Design, Development, Implementation, and Evaluation. These five stages must be carried out in a structured and continuous manner.

The analysis stage, the aim is to have the ability to ask questions related to products that are applied to answer problems in physics learning. The analysis stage includes media analysis, curriculum analysis and material analysis. The stages that must be followed in the analysis are collecting and mobilizing various information related to the implementation of physics learning activities at MAN 3 Sleman through techniques for obtaining data based on interviews, observations and questionnaires, carefully study the curriculum system used in schools to obtain standardization in the implementation of physics learning, analyzing learning media and teaching materials in the actualization of physics learning.

The design stage aims to produce an initial product (prototype) or product design that is adapted to the analysis that has been carried out. The activities carried out at this stage are selecting the format and initial framework as well as selecting instruments. Next, The Development Stage, at this stage, the design of the learning media that has been created is carried out. This development stage consists of several steps including: developing a design for the learning media framework and instruments created in the previous stage, which will then be evaluated by experts, Assessment of the learning media carried out by experts who are competent in the media field and materials and be able to provide criticism and suggestions so that media preparation can be better, and carry out revisions to media that have been validated based on suggestions and criticism from media and material experts.

The Implementation stage aims to find out which learning media has been developed and declared feasible by testing material experts and media experts, then tested on research subjects. At this stage the researcher conducted a pretest-posttest to measure the effectiveness of increasing HOTS before and after media use. Finally, The Evaluation Stage, a final revision was carried out on the learning media developed based on questionnaires and observation sheets obtained in the field. The subjects of this research and development are 35 students of class X MIPA-B at MAN 3 Sleman in the even semester of the 2022/2023 academic year. The object of research and development is mobile learning physics-based learning media on the Android platform to improve students' HOTS skills.

The data collection techniques used in this research are: Validation sheet, which is submitted to participants to obtain comments, suggestions or criticism as a basis for product revision to determine product suitability; Media questionnaire sheet, which is handed over to students as research subjects to determine the extent of students' responses to the learning media being developed; The test instruments, namely pretest and posttest, are prepared based on indicators of students' HOTS improvement abilities, to measure the extent to which students' HOTS physics skills are improved before and after using the media.

Selecting the format for developing physics learning media based on mobile learning on the Android platform for alternative energy material begins with selecting an appropriate and attractive design and is accompanied by selecting a source book that contains alternative energy learning for class X SMA/MA. The design of the appearance and content of mobile learning-based physics learning media is designed to make it easier for students to understand and study physics subjects, especially alternative energy material.

The validation sheet and student response questionnaire use a Likert scale. The data obtained from the questionnaire was then analyzed by multiplying the frequency of answers for each alternative chosen by the respondent by 100%. The results of the eligibility percentage are converted into categories or eligibility criteria based on Table 1. The pretest and posttest results to measure improvement in HOTS skills before and after using the developed learning media were analyzed using normality gain (N-gain) and statistical analysis of the paired-sample t-test. Calculation of normality gain (N-gain) uses formula (1).

$$Ngain = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}} \quad (1)$$

Information: N-gain = normality of gain; S_{post} = average posttest score; S_{pre} = average pretest score.

Table 1. Assessment Levels and Assessment Qualifications

	Criteria	
Eligibility Percentage	Validity	Practicality
$P \leq 20$	Invalid	Not practical
$60 < P \leq 80$	Valid	Practical
$P \leq 80$	Very valid	Very Practical

Table 2. N-gain Value Criteria

Value Range	Criteria
N-gain > 0.70	High
0.30 ≤ N-gain ≤ 0.70	Currently
N-gain < 0.30	Low

Result and Discussion

Result

The model used in this research and development is the ADDIE model which consists of 5 (five) stages, namely Analysis, Design, Development, Implementation, and Evaluation. The description of the results of these stages is as follows:

Analysis Stage

Based on the results of observations made by researchers regarding physics learning at MAN 3 Sleman class each student has a smartphone to support learning when they don't know the material being provided. Android platform learning media provides interesting advantages, it can be accessed anywhere, making it easier for students to learn (Dhawan, 2020). The learning media developed contains video or audio-visual studies, a collection of varied practice questions and discussion forums. This media has an attractive design appearance, both in terms of color, writing, images and animation. This media is easy to operate, understand and easy for student users to understand (Dwivedi et al., 2021).

Mobile learning was chosen because this application is very user-friendly, easy to use and does not require a complicated programming language. Next, curriculum analysis is carried out to review the curriculum so that the learning media developed is in accordance with the applicable curriculum. Based on the curriculum that applies in class From the results of the curriculum analysis, material analysis was carried out to determine the material that will be studied in learning using the media developed. The researcher chose a material topic entitled "Energi Alternatif".

Design Stage

At this stage an initial product (prototype) or product design is produced which is adapted to the analysis that has been carried out. The selection of material on the topic of alternative energy was prepared based on references from several physics book sources. In making the mobile learning application, the researcher used the help of APP Inventor. At this stage, the researcher began downloading the application version 3.0 and began designing the appearance in the application for the start page (home page) and menus available on the media. Apart from that, researchers also started collecting assets such as images, accompanying music and videos for the purposes of making buttons and complete materials. The following is an image of the home page (start page) which is also used as an application icon called "ENERGY" (Figure 1).

Figure 1. Start page and application icon

Some of the menus available in the ENERGI application include the user manual menu, materials, quizzes and profiles. The following is an image of a page that contains several menus in the application (Figure 2).

Figure 2. Application menu page

The material display in the ENERGI application (Figure 3). Apart from that, there is a display in the application regarding students' investigation exercises and practice questions (quizzes) (Figure 4 and 5).

At the end there is a summary evaluation containing material and HOTS physics improvement test questions as well as about the product which contains the identity of the product and the development team (Figures 6 and 7).

Figure 3. Contents of the material in the application

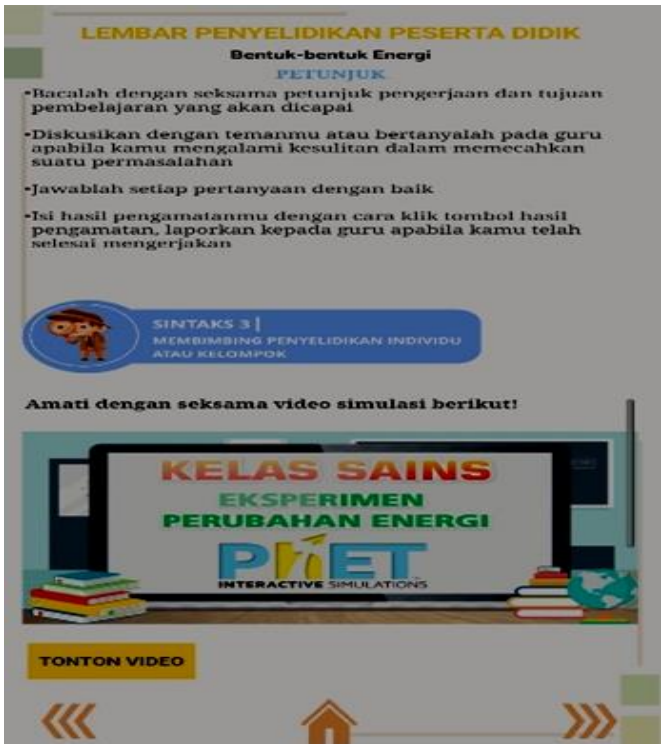

Figure 4. Student investigation practice

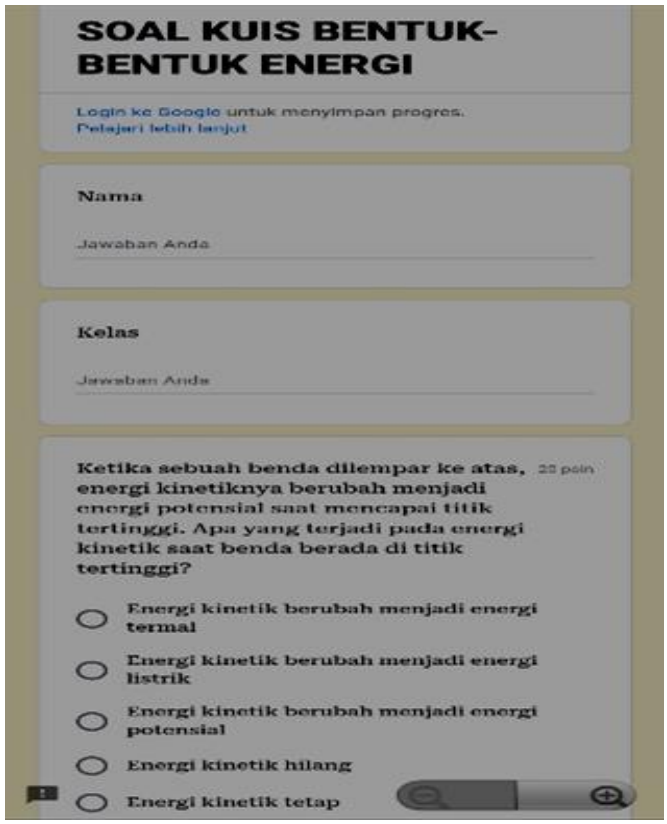

Figure 5. Quiz questions about energy

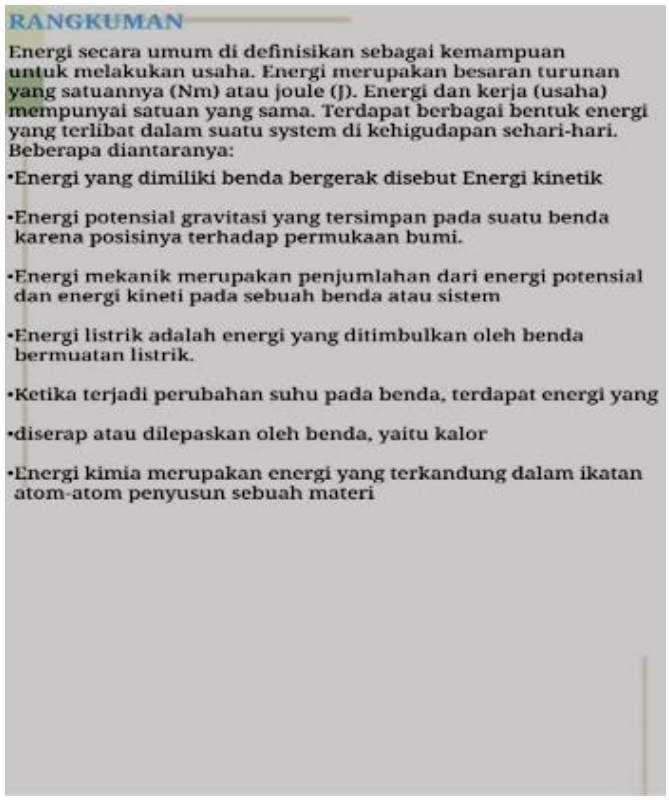

Figure 6. Summary of material

Figure 7. Developer Identity

Development Stage

The development stage involves developing the design of the learning media framework and instruments created in the previous stage. The product developed in this research is in the form of physics learning media which contains material on the topic of Alternative Energy. As for the assessment instrument, namely in the form of a pretest and posttest (evaluation) arranged based on indicators of increasing students' HOTS. After the product is developed, it is then validated by experts consisting of material experts and media experts. Validation is carried out in the form of an assessment through a validation sheet which contains several indicators. From the results of the expert assessments, a recapitulation of the assessment results was obtained (Table 3).

Table 3. Recapitulation of Expert Assessment Results

Validator	Persentase (%)	Criteria
Material Expert	81	Very Worthy
Media Expert	94.16	Very Worthy
	87.58	Very Worthy

Based on table 3, it shows that the assessment results from experts, both material experts and media experts, are in the very feasible criteria. Thus, the product being developed is suitable for use. However, there are several comments, suggestions from experts to improve the quality of the products being developed. The suggestions from material experts are to add more varied and applicable examples of questions to the material so that students' HOTS improvement can be more honed. Meanwhile, suggestions from media experts are that if the icon animation is too stiff, perhaps it could be improved or changed to another animation, so that it is not too monotonous. Comments from other media experts stated that this application was very good.

Implementasion Stage

After the product developed is validated and declared very valid and suitable for use, the product is then used on research subjects on a small scale. At this stage a pretest-posttest was also carried out to measure the effectiveness of increasing HOTS before and after product use. The product that has been developed has the .apk extension and is then saved to Google Drive and the access link is shared with research subjects to download and install on their respective smartphones.

After the product was used on the research subjects, statistical analysis of the paired sample t-test was then used to determine whether there was a significant difference between the ability to increase students' HOTS before and after using the product developed, namely mobile learning-based learning media on the Android platform. The requirement for carrying out a paired sample t-test is that the data used must be normally distributed. In the research, normality and homogeneity tests were carried out. The next step was to carry out a paired sample t-test, the results of which are presented in Table 4.

Table 4. Paired Sample T-Test Results

		t	df	Sig. (2-tailed)
Pair 1	Pretest-Posttest	-15.78		.000

Hypothesis:

H_0: There is no significant difference between the results of the pretest and posttest in the ability to improve HOTS in physics.

Ha: There is a significant difference between the pretest and posttest results of the ability to improve HOTS in physics.

Test criteria: accept H_0 if sig. > 0.05, and reject H_0 if sig. < 0.05.

The second part at this stage is testing the effectiveness of product use in improving students' physics HOTS which is carried out through data analysis of pretest-posttest results. The pretest-posttest uses a written test instrument in the form of multiple choices which is prepared based on HOTS physics indicators after validity and reliability have been carried out before the test instrument is used. The data from the pretest-

posttest results were analyzed using normality gain (N-gain) and statistical analysis using the paired sample t-test assisted by IBM SPSS version 25 software. Based on the normality gain (N-gain) analysis, the results obtained were:

Based on table 6, the Sig value is obtained. (2-tailed) with α =0.05 of 0.000 so Sig. < 0.05, thus it can be concluded that it is rejected and accepted, which means there is a significant difference between the pretest and posttest results in increasing students' physics HOTS. These results indicate that the use of mobile learning-based physics learning media on the Android platform is effective in increasing students' physics HOTS.

$$Ngain = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

$$Ngain = \frac{79-48}{100-48}$$

$$Ngain = 0.6$$

Based on calculations, the normality gain (N-gain) is 0.6 and is included in the medium criteria. Next, a test was carried out on the level of practicality of the product being developed through assessing student response questionnaires. The recapitulation of student response assessments regarding the level of practicality of the product being developed is presented in Table 5. Based on this table, the average percentage of student response assessment is 88.08% so that the level of product practicality is included in the very practical criteria. It is very practical to use, namely it can be used anytime and anywhere.

Table 5. Recapitulation of Student Response Assessments Regarding the Level of Product Practicality

Aspect	Persentase (%)	Criteria
Media	89.14	Very Practical
Material	89.31	Very Practical
Benefit	85.81	Very Practical
	88.08	Very Practical

Evaluation Stage

Based on data analysis resulting from assessments by material and media experts, it was concluded that the product being developed was suitable for use, but taking into account the suggestions and input provided by material experts and media experts. The following are suggestions given by material experts and media experts (Table 6).

Table 6. Suggestions and Input from Learning Media Assessment Results

Improvement suggestions	Follow-up
From material experts: examples of questions that are less varied and applicable.	Add examples of varied and applicable questions on alternative energy material
From media experts: icon animations are too stiff and monotonous	Change and add icon animations so they are not too stiff and monotonous.

Discussions

The final product of developing this learning media is a physics application called "Energy" for Alternative Energy Material (Iwung & Nugraha, 2022; Anggraini et al., 2020). This media is in the form of an application extension file that can be installed on all Android-based smartphones. This media can be said to be a finished product and can be used in physics learning. Based on the research results, it shows that physics learning media based on mobile learning on the Android platform can be used to improve the quality of the learning process (Fathurohman et al., 2023; Setya et al., 2024).

The results of this research state that the development of mobile learning media has an influence on student learning outcomes. By using learning media, the material presented by the teacher is clearer and more interesting so that it is in accordance with the learning objectives (Ratnasari & Haryanto, 2019). The impact of the research results shows that the use of mobile learning-based physics learning media on the Android platform can increase students' physics HOTS (Arzak & Prahani, 2023; Erlin Eveline et al., 2019). This is because this media combines several elements such as video, audio, images and writing which makes learning physics relaxed, thereby increasing students' experience, understanding, interest and attention to the material (Nicolaou et al., 2019; Palioura & Dimoulas, 2022).

The implications of physics learning media based on mobile learning on the Android platform should continue to be developed considering the increasingly rapid development of science and technology (IPTEK). So that physics learning is not monotonous and develops according to today's times (Cárdenas-Sainz et al., 2023; Rahim et al., 2022). Moreover, Android-based smartphone users are currently very high, especially in teenagers. Students are more likely to choose to open gadgets rather than conventional textbooks to look for references for learning material (Li et al., 2022; Setiadi et al., 2019). Thus, the research results show that learning media can stimulate and optimize students' improvement in physics HOTS.

The use of mobile learning media in learning can help students and teachers, including during learning, giving assignments and quizzes, so that students'

interest, interest and enthusiasm are high (Rahmat et al., 2019). This research was developed with the aim of making it easier for students and teachers when studying, especially on alternative energy material. Physics is a subject that has abilities with a good cognitive level. One of the abilities possessed is the ability to think at a high level (HOTS) (Minata et al., 2022). Higher Order Thinking Skill (HOTS) is a high-level thinking ability that does not just memorize, but connects abilities, manipulates and transfers existing knowledge to be applied in solving problems and determining new decisions critically and creatively (Aspini, 2020).

HOTS has characteristics that are non-algorithmic, complex, have many solutions, and apply many criteria and are effective (Kurniasi & Arsisari, 2020). Higher order thinking skills are oriented towards critical and creative thinking abilities (Nurhayani & Retnowati, 2022). This ability must be possessed by every student. Students are trained to solve a problem by including a conclusion. According to Dwijayanti (2021), student activities in HOTS-based learning are active in thinking, formulating problems, studying complex problems, thinking divergently and developing ideas, seeking information from various sources, thinking critically and solving problems creatively as well as thinking analytically, evaluatively and make decision.

Teachers can apply HOTS learning by utilizing various digital applications in the form of mobile learning-based learning media as a teaching and learning process. In the learning context, students' high-level thinking skills are able to connect and transform the knowledge they already have with the things or problems given. Thinking skills at a higher level cannot be obtained directly so they need to be trained through learning activities (Rofiah et al., 2018). The existence of various digital applications means that individuals can be helped to solve problems by thinking critically. This situation can be used as motivation by teachers to package the material as attractively as possible, innovatively and creatively.

Conclusion

Based on the results of the research and discussion, it can be concluded that: the physics learning media based on mobile learning on the Android platform that has been developed has very valid criteria and is suitable for use according to the assessment of material and media experts; Student responses to the use of mobile learning-based physics learning media on the Android platform show that this media is very practical in terms of media, materials and benefits; The results of the effectiveness test by analyzing pretest-posttest scores show that mobile learning-based physics learning media on the Android platform is effective in improving students' HOTS physics skills.

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Author Contributions

In this study, the author makes a different contribution. Theory analysis, data collection, analysis, and paper writing were carried out by D. R. A, while the supervision and review of writing was carried out by I. W.

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Conflicts of Interest

The authors declare no conflict of interest.

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