How are students' Higher Order Thinking Skills with Integrated Physics E-module Local Wisdom and Android Applications?

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Abstract: This study aims to evaluate the feasibility and effectiveness of the gendang beleq integrated e-module with the concept of vibration and waves that have been developed. This study is a development research with a 4D model, which is one of the media development models with the stages of define, design, develop, and disseminate. The effectiveness test of the e-module uses the t-test on SPSS 24, which is a popular statistical tool used in research. The population of the study was students of class XI IPA at SMAN 5 Mataram and the sample was students of class XI IPA 1, 2, 3, and 4. The average value of media validation was 4.8 (very valid) and learning validation was 4.7 (very valid) with a Likert scale of 5. Based on these results, the developed e-module is feasible to use. The results of the effectiveness test showed a sig value of 0.000 <0.05, Partial Eta Squared 0.994, and the average of the experimental and control classes were 80.32 and 75.81. These data show that the use of the developed e-module is effective in improving students' HOT such as analyzing, evaluating, and creating.

Keywords: Android application; E-module; HOTS; Local wisdom

Introduction

21st century learning is learning that requires students to have soft skills and hard skills (Yulianti et al., 2019). Soft skills are identical to the ability to interact with others and how someone is able to overcome problems in a situation they face, such as communication skills, collaboration, critical thinking, problem solving, and creative thinking (Anggraeni et al., 2022). While hard skills are technical abilities and are usually obtained through training, workshops, and experience, such as the ability to operate computer software, operate machines, repair electronics, and so on (Cleeton, 2011). At the cognitive level (Bloom's taxonomy), high-level thinking skills (HOTS) consist of the ability to analyze, evaluate, and create (Hadisaputra et al., 2020). All of these HOTS abilities are important components for everyone to face life in the 4.0 era which

is identical to technology and the 5.0 era which is identical to social (Muntaha et al., 2021). HOTS can be obtained through various academic processes in schools or colleges through real studies of phenomena experienced every day (Cleeton, 2011). Various real situations in life can be used as objects of study in physics learning which are then continued with the stages of finding solutions through simple experiments and trials. Through these trials and experiments, students will build their understanding systematically, analytically, critically, creatively, and as problem solvers.

Abstract conceptual understanding and low student interest in learning are challenges in learning at school (Rivai et al., 2021). Therefore, real learning media are needed that are not far from students' lives, so that students can illustrate the objects of physics study (Wulandari, 2020). Through audio-visual media such as Android, students can easily access the information they

need flexibly, effectively, and efficiently (Al-idrus, 2017). So far, physics has been taught with various innovative works, both textual, visual, and audio-visual media. However, there is still a need for development on how to make textual, visual, and audio-visual learning materials into one container that can be presented to students. Therefore, the integration of e-modules in Android applications is very much needed to help students learn physics practically and effectively (Zaini et al., 2024). One of the real phenomena that is close to students' lives is the culture or customs of the local community (Risma & Yulkifli, 2022). This culture needs to be brought into physics learning in appropriate material so that what is experienced in the environment becomes an object of study in learning at school. From here, students will feel that physics is a science concept that is close to human life.

Teaching materials such as modules are able to accommodate various needs in learning physics such as teaching materials based on local wisdom phenomena (Yuliarta et al., 2024), student worksheets to conduct simple experiments that can encourage students in the thinking process (Taqiyyah et al., 2023), simulations and learning videos that help students understand concepts, as well as examples of questions and evaluation questions that encourage students to have high-level thinking skills (HOTS) (Ali & Zaini, 2023). Students' HOTS abilities will be formed through the processes presented in the e-module, so that they will form students' deep understanding through the experiences they have (Jihannita et al., 2023). In addition, the integration of culture and physics concepts is something that really needs to be considered in compiling teaching materials in schools because it can be used as a medium to invite students to learn more contextually from the everyday life environment. Studies on how digital media influences student learning outcomes have been widely conducted before, but HOTS capabilities as an assessment indicator in learning using Android-based applications still need to be developed in physics learning (Hadiati et al., 2023; Ibrahim et al., 2024). Likewise, research studies that combine physics concepts, local wisdom, Android applications in one source as well as learning media in the form of e-modules still need to be developed and implemented comprehensively in learning in schools (Supriyanto & Nursa, 2025). In schools, students and teachers still predominantly use printed books as teaching materials, where not all of the material presented can be experienced directly by students and results in non-contextual physics learning (A'yun & Wilujeng, 2024). With the integration of local wisdom and physics concepts created as Android-based e-modules (Muskhir & Luthfi, 2024), students will learn more effectively, efficiently, and flexibly because learning can occur anywhere and anytime without having to be in the classroom.

Learning through e-modules integrated with local wisdom and android applications will provide a new color for students, they will learn through things that are not far from the habits they live in their living environment. The paradigm they have had so far is that physics is a difficult subject, lots of calculations, not relevant to everyday life will shift to the paradigm that physics is a concept that is inseparable from everyday natural, social, and cultural phenomena (Kasper & Vogt, 2020). Physics can almost enter all aspects of human life, including local culture will be a place to understand the concept of physics more simply (Diani et al., 2021). Technological advances in the 4.0 era also need to be considered to support learning, such as android applications that are difficult to separate from all human activities (Nur et al., 2020). Therefore, a strong integration of traditional and modern aspects is needed to make a product that is more useful for education in Indonesia (Asrial et al., 2022). Indonesia's cultural richness is a good vehicle for the development of media and learning resources in schools and in the independent learning curriculum, the important point is how integration can be used as a tool to facilitate learning (Setianingrum et al., 2023).

Several previous studies that are the subject of this research are the development of Android-based LKPD with a STEM approach to improve students' critical thinking, but have not yet led to the development of e-modules for students' HOTS abilities (Taqiyyah et al., 2023). Research with the development of ethnophysics-based teaching materials to improve students' self-regulation skills, but this study has not examined HOTS abilities in its research variables and the teaching materials developed have not been integrated with Android (Habibi et al., 2023). Research by developing AR (augmented reality) media based on ethnophysics, but has not referred to the effectiveness test on HOTS and Android applications (Virijai & Asrizal, 2023). This research will be a link between several previous developments with the research theme of developing e-modules based on local wisdom based on Android applications to improve students' high-level thinking skills (HOTS) as a need in learning in the 21st century.

Method

This e-module is designed as an innovation in physics learning at schools to enhance high school students' abilities from lower-order thinking skills (LOTS) to higher-order thinking skills (HOTS). This study employs a development research method using the 4D model, which consists of the stages: define, design, develop, and disseminate. In the define stage,

the researcher analyzes phenomena at schools, such as the curriculum, students' learning styles, teachers' teaching methods, as well as learning resources and media used. In the design stage, the researcher prepares plans to address the needs of students and teachers, such as learning modules. During the develop stage, the

learning product is created and validated by experts, including lecturers and teachers. In the disseminate stage, the developed product is implemented in schools. The research development process is illustrated in Figure 1.
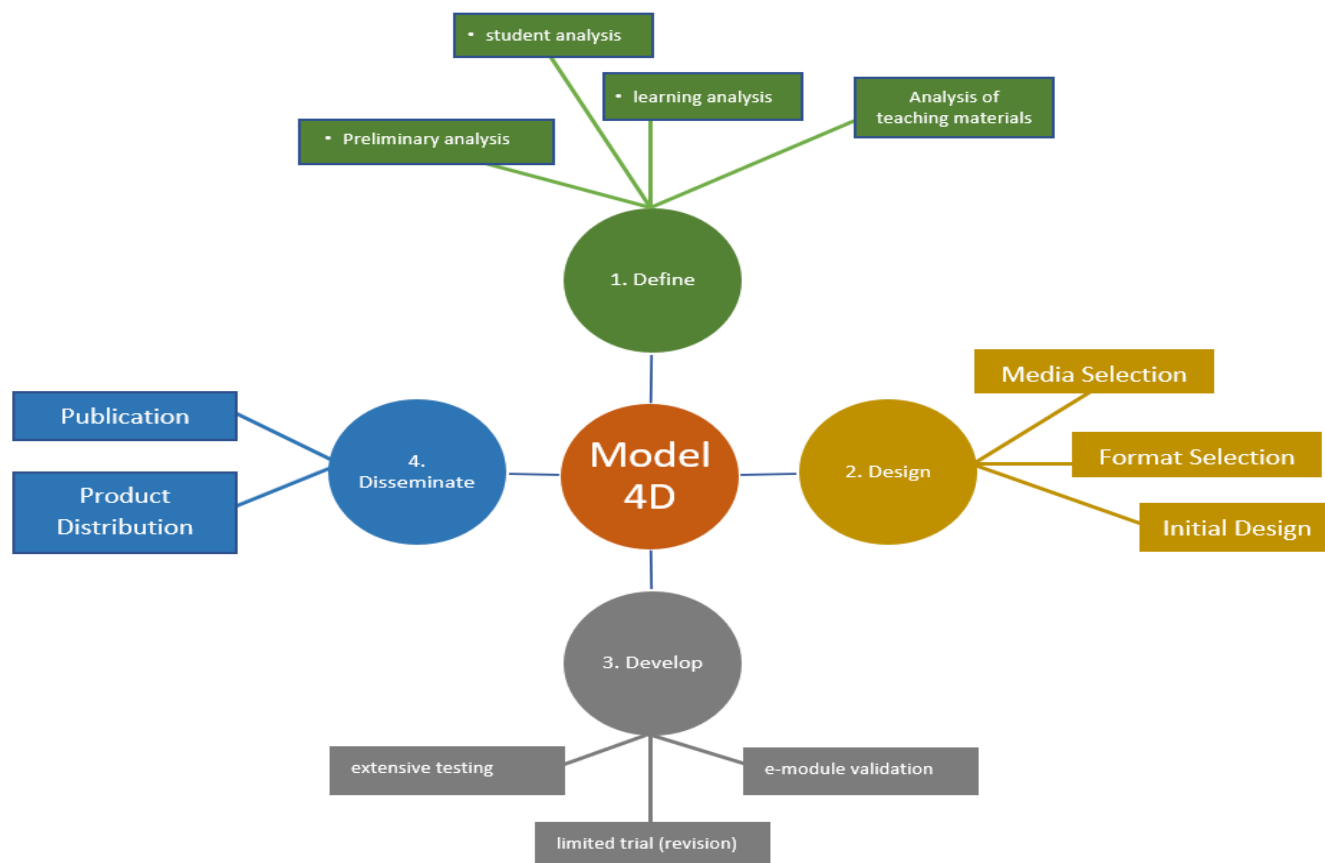

Figure 1. 4D models

The population of this study was 245 students in class XI IPA SMAN 5 Mataram, and the sample was from class XI IPA 1 with 31 students, XI IPA 2 with 30 students, XI IPA 3 with 32 students, and XI IPA 4 with 29 students. The sample was selected using the purposive sampling technique because information from the teacher explained that classes XI IPA 1 to 4 are students whose interests are physics and their learning motivation is higher than other classes. Android application validation is carried out by providing an assessment instrument in the form of a questionnaire to the validator. The questionnaire grid consists of several assessment aspects such as the appearance of the Android application, ease of use, grammar used, how the application visualization such as images, backgrounds, and a combination of appropriate and attractive writing/image colors. The assessment score guidelines for the questionnaire consist of very good answers (score 5), good (score 4), sufficient (score 3), not good (score 2), and very bad (1). The analysis of the

validator's assessment results uses a 5-point Likert scale, with the calculation using the following Aiken's formula.

$$V = \frac{\sum s}{n(e-1)} \tag{1}$$

Information:
V = Aiken's V validity index
$s = r - l_o$
r = number given by the validator
l_o = lowest rating number
n = number of raters
e = number of categories that the rater can choose

After calculating the results of the Android application media validation, it is then transformed into several validity criteria, such as the following table.

Table 1. Aiken Index and Its Categories

Aikens Index (AI)	Criteria
AI ≥ 0.8	High Validity
0.8 > AI ≥ 0.4	Moderate Validity
AI < 0.4	Low Validity

To determine the level of reliability of the questions, a reliability test was conducted using SPSS 24 software. If the data obtained from the statistical output at the Cronbach's Alpha reliability value is greater than 0.6, then the value is concluded to have strong reliability. The effectiveness test of the integrated local wisdom physics e-module and android application in improving students' high-level thinking skills was measured using the t-test on SPSS 24. The test decision is if the significance value is less than 0.05, then it is concluded that the developed e-module is effective in improving students' HOTS. Meanwhile, to find out the extent to which the level of improvement in students' high-level thinking skills is, it is determined by using the normalized gain formula with the following formula criteria:

$$<g> = \frac{<s_f> - <s_i>}{maximum\ value - <s_i>} \qquad (2)$$

Information:
g = Value of Gain
S_f = average final value
S_i = average initial value
The N-Gain value conversion consists of several categories as follows:

Table 2. The Categories of N-Gain Value

Interval	Categories
(g) ≥ 0.7	High
0.7 > (g) ≥ 0.3	Medium
(g) < 0.3	Low

If the g value is greater than 0.7, then the student's HOTS increase is high, the g value is between 0.3 to 0.7, the student's HOTS increase is moderate, and if the g value is smaller than 0.3, the HOTS increase is low.

Result and Discussion

Result
Media Development Analysis
The results of the research through the application of the 4D model consisting of the stages of define, design, develop, and disseminate can be seen in table 3.

Table 3. The Result of Research Used the 4D Model

4D Model	Development stage analysis	Activities in the research field
Define	Job Gap Analysis	worksheets from books that have limited information and Limited information via WA group
	Identify student characteristics	Students do not have long focus in learning and Students have difficulty understanding concepts
	Resources and student needs	limited number of LCDs so that they are used interchangeably, computer laboratories, WiFi and libraries.
	Instructional Objectives	it is necessary to use teaching materials based on Android applications with the aim of making it easier and helping students in carrying out the physics learning process at school or learning activities outside of school.
	Preparation of Work Plans	the researcher will take in compiling teaching materials based on the local wisdom of traditional Lombok music and used as Android application media.
Design	Material Selection	Determine core competencies, basic competencies, learning indicators, and learning objectives to be achieved
	Designing the product model	Android application-based modules are developed with the help of MS Word, Power Point and Photoshop, edit several images to match the colors and topics discussed in the Android application, The contents of the Android application-based e-module are Introductory menu features, Material menu features, Video menu feature, Simulation menu feature, Evaluation menu featur, Exit menu feature
	Development of a validation instrument	The questionnaire contains ten questions and each has a five-point rating scale.
Develop	Making a Physics E-Module Based on an Android Application	Using MS Word, Powerpoint and Photoshop applications, Entering modules into the application, Determine the menus, the contents into the Android application being developed Validation of the Android Application-Based Physics E-Module, the contents of the material menu, Entering the contents of the video, the contents of the simulation, the contents of the evaluation, the contents of the sub menu into the application

4D Model	Development stage analysis	Activities in the research field
Disseminate	This disseminate stage is the stage of distributing the product to schools (students and teachers) who study physics	The distribution of this development product was carried out to class X Science2 students at SMA Negeri 5 Mataram, consisting of 32 students. In this session the researcher gave a questionnaire to students regarding their responses to the use of Android applications in the learning process

Feasibility Analysis of Android Based E-module

The integrated local wisdom physics e-module and android application that has been developed are then validated by material experts, media experts, and learning experts. The validator of the material validation is a physics learning lecturer, the validator of the media validation is a physics learning media lecturer, and the learning validator is a physics subject teacher at SMA Ngeri 5 Mataram. The results of the e-module validation can be seen in Figure 2.
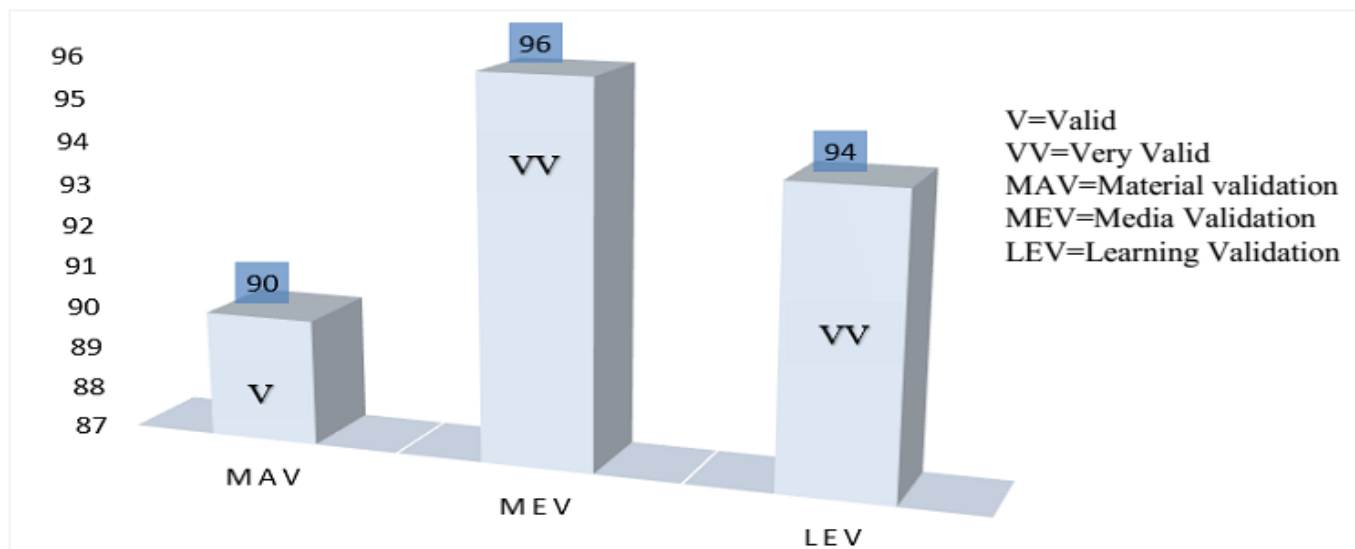

Figure 2. Validation results

Analysis of Media Interest Level

In addition to asking for assessments from material, media, and learning experts. Researchers also asked for students' assessments (responses) of their experiences using applications used in learning physics, especially vibration and wave materials. Figure 3 below presents detailed data on the level of student interest in the integrated local wisdom physics e-module and android application.
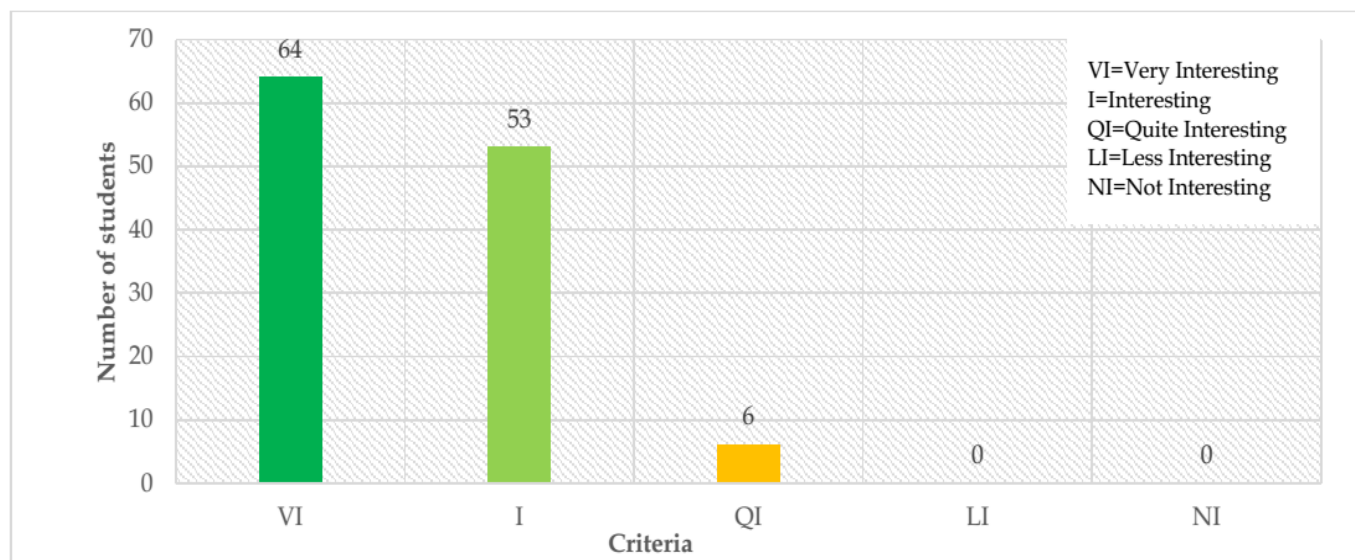

Figure 3. Level of Interest of E-modules For Students

The Effectiveness of E-Modules on Student Learning

This descriptive data analysis is intended to find out a general picture related to the pretest and posttest values that have been obtained through the administration of tests to the experimental class and control class. The following figure 4 shows the results of descriptive data analysis using SPSS.
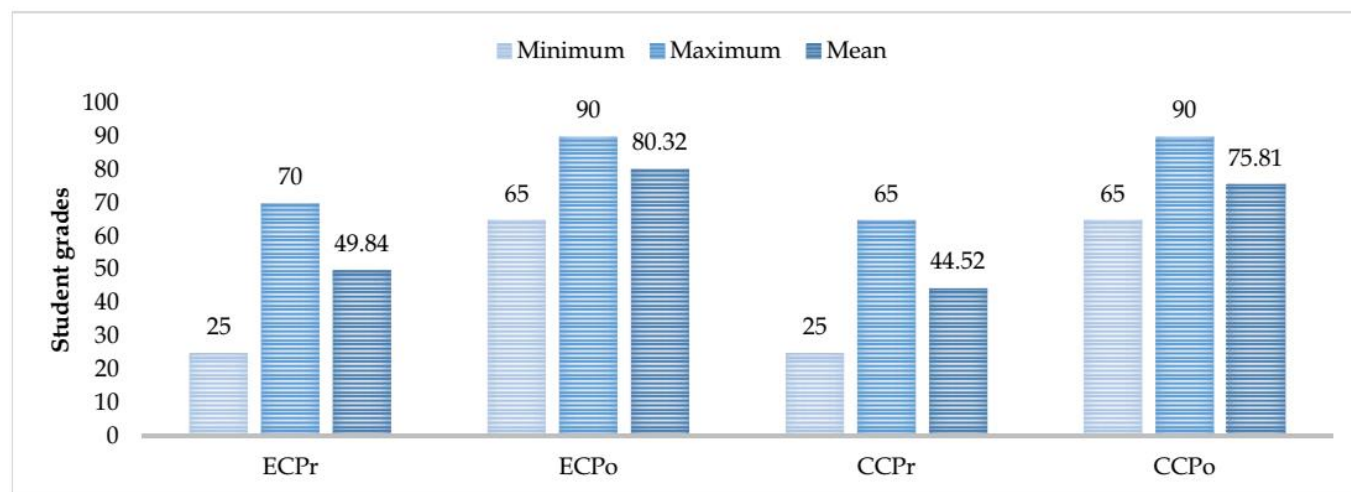

Figure 4. Descriptive statistics

The data in table 5 are descriptive data from the experimental class and the control class after being given a pretest and posttest. From the table above, it is described that the average pretest value of the experimental class is 49.84 (minimum value of 25 and maximum value of 70) and the average posttest value of the experimental class is 80.32 (minimum value of 65 and maximum value of 90). In addition to the experimental class data, there is also control class data when the pretest and posttest were given. The average pretest value of the control class is 44.52 (minimum value of 25 and maximum value of 65) and the average posttest value of the control class is 75.81 (minimum value of 65 and maximum value of 90). To see the level of significance of the research results using the t-test. The following data can be seen in table 4.

Table 4. Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	316.129a	1	316.129	7.737	.007	.114
Intercept	377832.258	1	377832.258	9246.947	.000	.994
Class	316.129	1	316.129	7.737	.007	.114
Error	2451.613	60	40.860			
Total	380600.000	62				
Corrected Total	2767.742	61				

a. R Squared = .114 (Adjusted R Squared = .099)

Discussion
Media Development Analysis

The development of this Android-based e-module has been tailored to fit both the content and design compatible with mobile devices. Elements such as colors, fonts, menus, and other features have been adjusted to match the characteristics of class XI students at SMAN 5 Mataram. This e-module is designed to offer students greater convenience in accessing learning materials through media that can be used anytime and anywhere, removing the barrier of limited learning resources when seeking relevant information. By utilizing this Android-based e-module, students can access information whenever and wherever they are (Sari et al., 2021). This flexibility in gathering information helps broaden students' knowledge, enhances their understanding, and improves their abilities from lower to higher levels.

Feasibility Analysis of Android Based E-module

The material used in this research is class X high school material, namely vibrations and waves. The material of vibrations and waves is explored in the local wisdom of the Sasak community, especially the traditional music art 'gendang beleq'. The concept of vibrations and waves can be seen directly in drums and other musical instruments which produce vibrations and sounds and then the sounds can be heard by other people, this is the concept of waves that propagate through the medium of air. From this traditional music,

it can also be analyzed what type of waves are produced and how period, frequency, amplitude and others influence the sound produced. The material validation results that have been obtained are 94 with a very valid category. So, based on the validation results, it can be concluded that the e-module which is integrated with local wisdom, traditional Monday music, gendang beleq, based on an Android application, has been tested well, so it can be tested in limited classes (Ali & Zaini, 2023). During the validation process of this material, several suggestions and input were also obtained from the validator regarding the material displayed in the e-module, such as the use of words and sentences that must be in accordance with standard language, as well as increasing the number of practice questions accompanied by ways of answering them that have been completed and corrected by the researcher.

This e-module, which integrates local wisdom and traditional music, Gendang Beleq, based on an Android application, has also been validated from the design and function aspects of the media being developed. The score obtained from the validation of this media is 96 with a very valid score category, so it can be concluded that the media is suitable and interesting to be implemented at SMAN 5 Mataram class XI Science.

Through this media validation process, the researcher also received several suggestions from the validator, such as not showing too many videos and showing enough to be easy and simple so that students can easily understand, paying more attention to the use of colors and background so that they can be read clearly. The suggestions from the validator serve as guidelines for researchers to improve the application being developed and make it more suitable for application in schools.

Analysis of Media Interest Level

The e-module being developed is an e-module which discusses the material of vibrations and waves by integrating the concept with local culture (local wisdom) of the Sasak people, namely the traditional music arts of Lombok. Lombok traditional music is a type of music that continues to be preserved by the Sasak community and has even become a characteristic of the local community. Therefore, researchers examine physics concepts through local culture, apart from being a physics lesson, it can also be a means of education so as not to forget the culture of each region, especially Lombok. In this e-module, apart from presenting vibration and wave materials, it also displays videos about the concept of vibration and waves, simulations about vibrations and waves, and questions about evaluating vibrations and waves. The following are the results of the analysis of the level of attractiveness of the e-module integrated with local wisdom, Lombok's traditional music art, gendang beleq, based on an Android application.
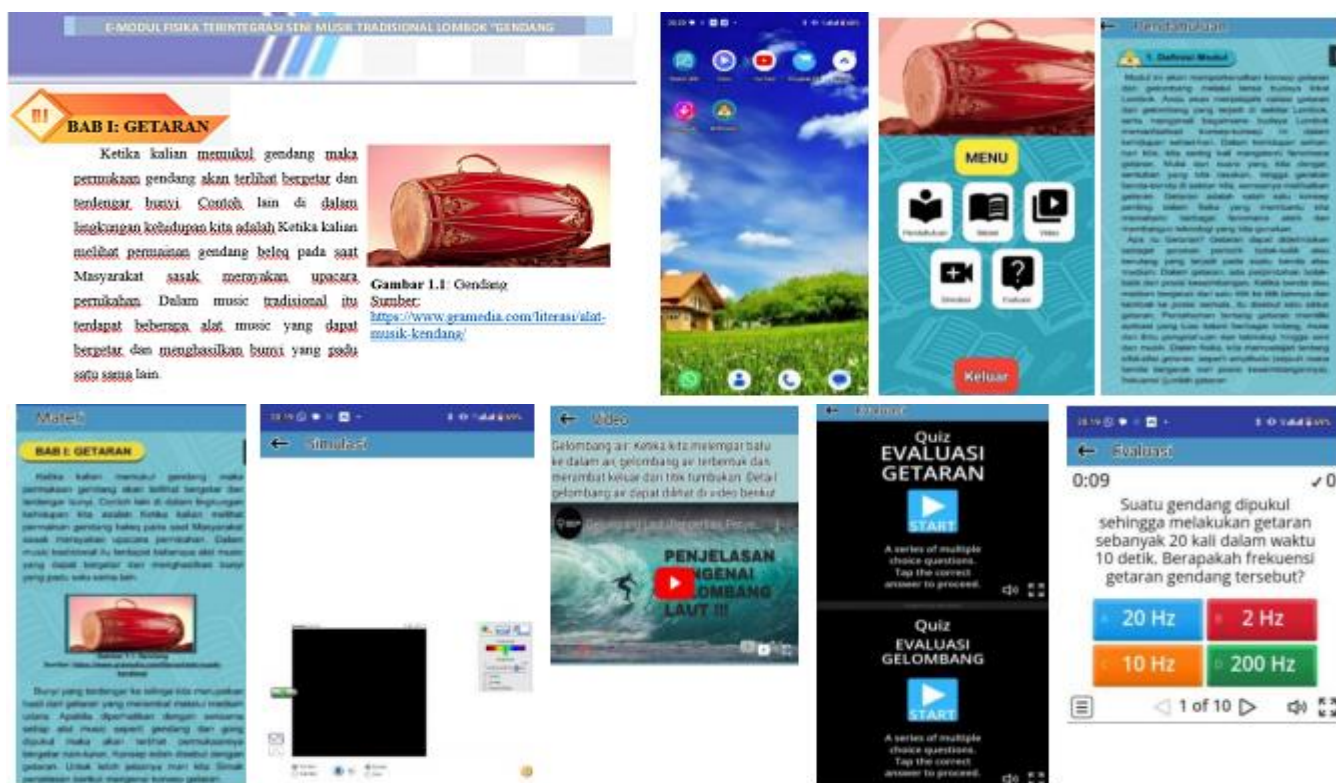

Figure 5. Several images of the android-based e-modules that were developed

The implementation of e-modules based on Android applications increases students' curiosity in learning physics, students find it easier and get a lot of information related to the concept of vibrations and waves. In the aspect of fostering curiosity, students gave very satisfactory marks and students strongly agreed with the use of Android application-based e-modules in learning physics, with this, students' motivation to learn physics increased and gave a new color to learning (Chanifah, 2021). During classroom learning, researchers observed that all students were happy with learning using Android applications. The positive response from students brought new energy to studying physics. The increase in students' curiosity to learn physics is directly proportional to student learning outcomes that are better than before. Students admitted that learning to use Android applications was more realistic to feel and see in everyday life

The use of an integrated e-module with local wisdom based on an Android application attracts students' interest in learning physics. Most students provided information that using Android applications in learning made students more motivated. They thought that physics, which is usually considered difficult and has many formulas, actually had applications in the surrounding environment. One thing that is interesting according to students is that there are learning videos which are a supporting source for studying vibration and wave material and there are physical simulations which help students to understand the relationship between each vibration and wave quantity.

The implementation of an integrated e-module of local wisdom of traditional music art gendang beleq based on an android application has a positive impact on students' physics learning outcomes. This is proven by the increase in students' physics learning outcomes. The implementation of android-based learning media is easier to understand and imagine so that the physics process can be illustrated by students so that students' abilities become more communicative, critical, creative and able to solve their own problems. Some images of the Android-based e-modules that were developed can be seen in Figure 5.

The Effectiveness of E-Modules on Student Learning

The average pretest and posttest scores of students in the experimental class were 49.84 and 80.32. Meanwhile, the average pretest and posttest scores of students in the control class were 44.52 and 75.81. The standard deviation data in the experimental class during the pretest and posttest were 11.44 and 5.91, while the standard deviation in the control class during the pretest and posttest were 9.34 and 6.84. These data show that the scores of students in the experimental class are higher than those in the control class. Based on the results of the paired sample t-test, the sig. value is 0.000 <0.05 so that it can be seen that there is a significant difference in HOTS scores between before and after using android-based learning resources. Thus, it can be concluded that the average of the experimental class and the control class are significantly different. Therefore, android-based e-module physics learning resources for class X are more efficient than traditional learning methods.

The developed android media has been assessed by experts regarding color, writing, menus and other features and how all of them can support the android application operating system to be applied in physics learning on vibration and wave material (Kiong, 2023). The combination of android applications and learning modules can make it easier for students to gain an understanding of physics concepts. various menus such as videos, simulations, images, sample questions and answers, evaluation questions, and others can be the advantages of learning using android-based e-modules (Aroyandini & Aloysius, 2021). Students can read the material, practice, and observe phenomena contextually to build students' thinking processes such as being critical, creative, and being able to solve problems. The ease of using android-based e-modules also makes students' enthusiasm for learning better, because the information obtained is flexible and more comprehensive (Aminah et al., 2020). Therefore, android-based e-modules not only affect students' cognitive abilities, but can also have a positive impact on students' affective and psychomotor aspects which are of course closely related to students' success in learning.

In the current era, students and teachers are required to be creative subjects in every teaching and learning activity (Sari et al., 2021). Active and creative students certainly need a lot of information to build their own knowledge and skills. Likewise, teachers should be able to be creative and innovative facilitators in directing students to build their own understanding. Student centers, which are the goal of education today, must be equipped with facilities that are easy to use according to students' learning needs.

One of the important things to give to students is teaching materials as a learning resource for students (Chanifah, 2021). Flexible learning resources used anytime and anywhere are an important need for students to continue to search for accurate information according to their needs (Hakiki et al., 2021). Therefore, e-modules with new colors need to be developed for students, such as e-modules that are integrated with the local wisdom of Lombok's traditional music art 'gendang beleq' and can be accessed via an Android application.

Based on the results of the questionnaire distributed, students reported that they were more

motivated and stimulated their curiosity in learning physics using e-modules based on Android applications. Students feel something different compared to learning using teaching materials in the form of textbooks as usual. According to students, learning with e-modules via Android is very interesting, because it contains videos, images, simulations, and evaluation questions and the material discussed is the concept of vibrations and waves in traditional Gendang Beleq music so that students can more easily understand the concept of the material provided. The e-module being developed is also equipped with examples of questions which are accompanied by a solution process, so that students are trained to solve questions in that material. Therefore, students who were initially only able to solve LOTS type questions have been able to solve HOTS category questions. This is in accordance with research conducted by Ali et al. (2023) which revealed that the application of e-modules with the integration of local wisdom was able to increase students' higher order thinking skills because it was able to provide new enthusiasm for students in studying physics. Motivation and interest in physics material really depends on how a teacher packages models, methods, strategies and learning techniques in the classroom.

Innovative and creative learning styles provide a new learning atmosphere for students at school. Modifying learning styles will provide positive energy for students' learning success and prevent them from getting bored with a monotonous learning style (Devi et al., 2021). The use of integrated local wisdom e-modules based on Android applications for students not only influences students' cognitive abilities, but also influences students' motivation, interest and curiosity (çimen et al., 2020). Aspects of motivation, interest and curiosity are certainly very important for students to grow individual student understanding and knowledge at a higher level.

The development of an Android-based e-module integrated with local wisdom has significant implications for physics learning in schools (Gola et al., 2022). Based on student responses to the e-module developed, students have increased motivation and interest in learning physics because it is taught using online media and is easily accessible anytime and anywhere so that learning can be done anywhere by opening the application.

Students' motivation and passion in learning changed significantly and had positive implications for their understanding of physics learning (Puri & Diyana, 2023). Student activity in communicating physics is better than before because easily accessible information provides a broad understanding that physics is close to life and even all daily activities are directly related to physics (Lesmana & Nurussaniah, 2022). Literacy skills, especially in students' cultural literacy, are also increasingly profound, so that learning physics is no longer seen as just learning formulas and calculations that have a distant correlation with life, but students' views have shifted to the understanding that physics is a subject that is integrated with human life such as the involvement of physics in discussing the concept of gendang beleq with vibration and wave material.

Conclusion

Based on the results of the research and discussion that have been presented, it can be concluded that the integrated e-module of local wisdom of traditional Lombok music art gendang beleq based on an android application is feasible to be used in learning in high schools on vibration and wave material after being assessed by several experts from lecturers and physics teachers. The practicality of the developed e-module can attract students' interest in learning the concept of vibration and waves which is equipped with a learning menu such as introduction, material, simulation videos, student worksheets, sample questions, and evaluation questions about students' abilities in analyzing, evaluating, and synthesizing (creating). The application of the integrated e-module of local wisdom of traditional Lombok music art gendang beleq based on an android application in the experimental and control classes shows a difference in students' HOTS abilities, where the HOTS score in the experimental class is higher than the HOTS score in the control class. Therefore, the developed e-module is effective in improving students' HOTS, in other words, students' cognitive level has been able to analyze local cultural phenomena as study materials in learning physics, able to evaluate concepts that are directly related to physics and local culture, and able to synthesize the concept of vibration and waves through various experiments using simple tools and materials that are easy to find in the surrounding environment. Therefore, the developed e-module can be implemented in high schools on vibration and wave materials.

Author Contributions
This article is a collaborative work of several lecturers and education teachers, of course each researcher has an important

role in this work such as conceptualization, M.Zn, M.K; Methodology, M.Zh, L.S.H; Validation, M, K.A, L.A.D.M, S.L; Formal analysis, M.Zn; Investigation, M; Data curation, M.Zh; Writing-preparation of the original draft, M.K; writing-editing review, M.Zn; Visualization, L.S.H. All authors read and approved the published version of the manuscript.

Conflicts of Interest
No conflict interest.

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