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Feasibility Test of Guided Inquiry Model Learning Devices Assisted by 3D Experimental Media on Sound Wave Material

Yulina Hasnaini[1*], Aris Doyan[1,2], Sutrio[1]

[1] Department of Physics Education, FKIP, Universitas Mataram, Mataram, Lombok, Indonesia.
[2] Science Education Master's Program, Universitas Mataram, Lombok, Indonesia.

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Corresponding Author:
Yulina Hasnaini
yulinahasnaini@gmail.com

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Abstract: This research aims to determine the feasibility of a guided inquiry model physics learning device assisted by 3D experimental media on sound wave material. The type of research used is research and development with a 4D research model. The products developed are syllabi, learning implementation plans (RPP), student worksheets (LKPD), and test instruments. Data collection was carried out through validation sheets of learning tools by expert validators and practitioners, and reliability analysis using percentage of agreement (PA). The validation results obtained show that the syllabus, RPP, LKPD and test instruments with an overall average of 86.29% are in very valid criteria and the results of the reliability analysis show that the overall average value of the learning tools is 93.32% in reliable criteria. Based on this, it can be concluded that the guided inquiry learning tool assisted by 3D experimental media is suitable for application in learning sound waves in the classroom.

Keywords: Eligibility test; Guided inquiry; Learning tools; Sound waves; 3D experiment media

Introduction

The increasingly rapid development of science and technology needs to be balanced with improvements in the quality of education. The government has made various efforts to improve the quality of education, for example teacher certification, and improving the Education Unit Level Curriculum (KTSP) to become the 2013 Curriculum. The implementation of the 2013 Curriculum aims to produce Indonesian people who are productive, creative, innovative and affective through strengthening attitudes, skills, and integrated knowledge, to achieve the intended goals. This goal can be achieved by designing learning activities that are in accordance with the demands of the 2013 curriculum. Pujiningrum et al. (2017) stated that an adequate learning process is needed to encourage students to be active in carrying out investigations to find facts and be able to explore knowledge through skills-scientific process skills.

Based on the results of observations at SMAN 1 Batukliang, Physics learning that occurs in the field is still not able to develop students' abilities optimally. This is because Physics learning in schools is still monotonous, only presenting material and discussing questions and rarely doing practical work, so it has a tendency to only hone aspects of remembering and understanding, lacking in training students' skills in inquiry or finding their own knowledge through experimentation. Learning activities carried out in class also cannot optimize students to be active in learning so that teachers still dominate learning in class.

Based on the results of interviews with class given. This is what causes low student learning outcomes. Teachers as educators should choose a learning model that is able to stimulate student activity in the ongoing learning process. One alternative solution is to develop a guided inquiry model learning tool. The guided inquiry model is an inquiry-based learning model that can be used in physics learning. Pramesti et al. (2020)

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stated that the guided inquiry learning model is suitable for application in the physics learning process because students can be maximally involved in investigating and formulating their own problems given by the teacher during learning. Amijaya et al. (2018) also explained that the guided inquiry model is a learning model that can actively encourage students to explore their own knowledge so that students can become independent, active and skilled individuals in solving problems based on the knowledge information they have obtained.

The guided inquiry model is a learning model that involves students in asking questions, searching for information, and carrying out investigations, most of which are planned by the teacher so that students not only receive explanations from the teacher, but students also play a role in finding the learning material themselves (Zikri et al., 2020). The guided inquiry model emphasizes the discovery process so that students are given the opportunity to participate in the learning process (Iman et al., 2017). Guided inquiry learning is carried out through several stages, starting from questions asked by the teacher, then brainstorming about the questions given and then creating hypotheses to be tested, then designing and conducting experiments and collecting data based on experiments to draw conclusions (Margunayasa et al., 2019). The application of the guided inquiry model causes students to become more scientific (Yunianti et al., 2019). The guided inquiry learning model can also improve students' cognitive physics learning outcomes because the activities in the guided inquiry learning steps facilitate students in gaining experience both physically and mentally, so that physics learning in the classroom is more meaningful (Nurmayani et al., 2018).

The use of the guided inquiry learning model is effective in improving students' concept mastery and problem solving abilities (Nidda et al., 2022). Suantara et al. (2022) also stated that learning tools have a significant effect on student learning outcomes, where learning outcomes (N-Gain) in the form of mastery of concepts and science process skills are in the medium category. The use of the guided inquiry model in students' learning activities can also improve students' critical thinking abilities (Payu et al., 2022). Masitoh et al. (2017) stated that through the application of the guided inquiry model, students' critical thinking abilities develop at every step in learning activities. The use of learning media is also one of the things that can support students' understanding in addition to the use of learning models. The use of learning media apart from creating a happy atmosphere that is received by students, learning media also makes it easier for teachers to deliver the material and easy for students to receive the material delivered as a return for the process (Setiawan et al., 2022).

Sound waves are also a type of physics material that is classified as complex because it has abstract characteristics so the use of media is very necessary to make it easier for students to understand it. 3D (3 Dimensional) experimental media is a learning media that is suitable for use in studying sound waves. Three-dimensional learning media is learning media whose appearance can be observed from any viewing direction and has dimensions of length, width, height or thickness and is mostly an actual object (Arsyad, 2013), while experimentation is an activity of observing an event to prove a hypothesis or recognizing cause-and-effect relationships between symptoms.

Thus, 3D experimental media can be interpreted as learning media that is structured in the form of a set of 3D experiments or direct experiments using real objects whose appearance can be observed and measured from any viewing direction. The use of 3D experimental media in sound wave material will help students understand sound wave material more easily. The application of the guided inquiry model in combination with 3D experimental media will make learning more meaningful and interesting. This is in line with the research results of Alfiyani et al. (2020) who stated that the application of the guided inquiry model assisted by media will attract more interest and improve student learning outcomes, as well as the research results of Ulfayantik et al. (2022) which states that the media-assisted guided inquiry model is effective for improving students' science process skills.

Based on the description above, the aim of this research is to develop a guided inquiry model learning tool with the help of 3D experimental media on sound wave material that is suitable for use in learning. This research is supported by research conducted by Doyan et al. (2020) who stated that the application of learning tools developed using the media-assisted guided inquiry model was effective in learning.

Method

The type of research used in this research is the research and development (R&D) method. Sugiyono (2018) states that the R&D method is a method used to produce certain products and test the effectiveness of these products. In this research, researchers developed learning tools using the Four D Models (4-D) development research model. The research design for developing a 4-D model consists of the definition stage, design stage, development stage and dissemination stage. To determine the feasibility of the learning tools being developed, the data collection technique used in this research is: giving a validation questionnaire to validators consisting of 3 physics education lecturers and 3 physics subject teachers. The content statement relates to the learning device validation questionnaire score of 1 to 5 to determine the suitability of the learning device. The validation data obtained was then analyzed using the following equation.

$$\%Validation = \frac{The\ total\ score\ of\ the\ assessors}{Maximum\ total\ score} x100\% \quad (1)$$

The average percentage is calculated using the following equation.

$$\bar{X} = \frac{The\ total\ value\ of\ each\ validator}{number\ of\ validators} \times 100\% \quad (2)$$

Eligibility criteria are determined based on table 1.

Table 1. Instrument Validation Criteria (Arikunto, 2019)

Validation % Value Range	Validation Level
0-20	Very invalid
21-40	Not valid
41-60	Fairly valid
61-80	Valid
81-100	Very valid

Next, the agreement between validators (reliability) is calculated using the percentage of agreement (PA) equation as follows.

$$PA = \left(1 - \frac{A-B}{A+B}\right) x\ 100\% \quad (3)$$

Where:
PA = Percentage of agreement
A = Frequency of assessment by experts give high marks
B = Frequency of assessment by experts give low marks

Learning tools are said to be reliable if the percentage of agreement is ≥ 75%. If a value <75% is obtained, it must be tested for clarity and agreement from the observer (Borich, 1994).

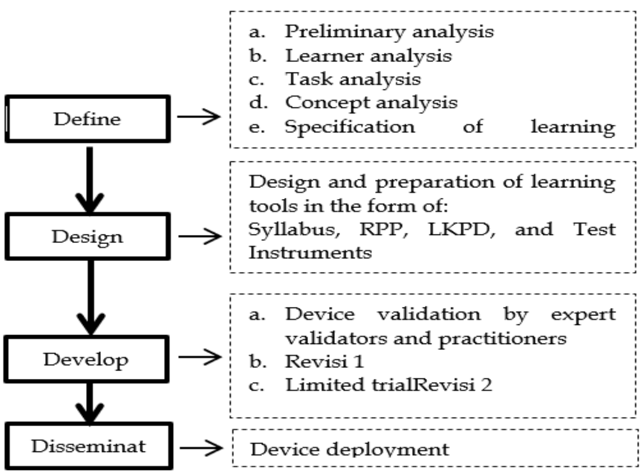

Figure 1 . Four D model

Result and Discussion

The development of learning tools begins with the definition stage. The definition stage aims to determine the problems that arise during the learning process (Saputri et al., 2022). The definition stage was carried out by observing and interviewing physics subject teachers and class XI MIPA students at SMAN 1 Batukliang, Central Lombok. Observations and interviews were carried out to determine the situation and conditions of physics learning at school related to the development research that will be carried out. Based on the results of observations and interviews, it is known that learning activities are still one-way, namely from teacher to student and have not been able to implement the demands of the 2013 curriculum optimally and teachers rarely and almost never carry out experiments in physics learning activities so that learning activities are carried out in a monotonous manner, which makes it more difficult for students to understand abstract material.

At the task analysis stage, the main material is sound waves and concept analysis is carried out. Concept analysis aims to analyze and compile relevant concepts in a subject matter which is then used as a reference in preparing learning objectives to be achieved during the learning process (Novsiani et al., 2022). Concept analysis is carried out by identifying the concept of sound waves being taught, arranging sound wave material in a systematic and relevant manner. The design stage is the stage of designing the initial draft of learning tools that will be used in learning (Satria et al., 2020). In the design stage, learning media and learning device formats are selected. In selecting media, based on the analysis that has been carried out, sound waves are one of the physics materials that are abstract and have many concepts that are difficult for students to understand. The researcher chose to use a guided inquiry model and used 3D experimental media in the form of a set of direct experiments which can be a tool to help students understand sound wave material.

In selecting the format, the format for compiling learning tools is in accordance with the syntax of guided inquiry model activities assisted by 3D experimental media in learning sound waves. Researchers also combine the steps of the guided inquiry model assisted by 3D experimental media with several teaching methods including discussion, question and answer, experiments and presentations to help activate students in learning. The learning resources used are in accordance with the revised 2013 curriculum book and other appropriate sources. After selecting the media and format, an initial design of the learning tools that have been developed is produced. The initial design of the learning tools developed can be seen in figures 2, 3, 4 and 5.

Basic Competencies	Learning Materials	Learning Activities	Indicators	Assessment	Time Allocation	Learning Resources
3.10 Applying the concepts and principles of sound and light waves in technology. 4.10 Carrying out experiments on sound and/or light waves, along with a presentation of the results and their physical meaning, for example sonometers and diffraction gratings.	Sound Waves: - Characteristics of sound waves - Fast propagation of sound waves - Symptoms of sound waves - The phenomenon of strings and organ pipes - Intensity and intensity levels - Application of sound waves in technology.	• Observe problems regarding phenomena in sound waves. • Carrying out experiments to investigate the characteristics of sound waves, speed of sound propagation, Doppler effect, sound waves in strings and organ pipes. • Determine examples of the application of sound wave principles in everyday life. • Discuss the characteristics of sound waves, the speed of sound propagation, the Doopler effect, the phenomena of strings and organ pipes as well as the intensity	3.10.1 Explain the characteristics and properties of sound waves and classify sounds based on their frequency. 3.10.2 Apply the concept of sound waves to find the speed of sound. 3.10.3 Analyze the phenomena of sound waves. 3.10.4 Analyze the symptoms of the Doppler effect on sound waves. 3.10.5 Formulate intensity equations and sound intensity levels. 3.10.6 Determine the speed of sound propagation and resonance frequency in sound producing devices. 4.10.1 Carry out experiments using a	Cognition : Writing test Form: Multiple Choice (PG) Psychomotor: Pick test Affection: Attitude observation sheet	2 JP X 3	- Teaching materials and environment - Internet - Class XI High School Physics textbook

Figure 2. Initial draft of the syllabus

LESSON PLAN
(RPP)

Education Unit : High School
Subject : Physics
Class/Semester : XI/II
Main Material : Sound Waves
Time Allocation : 2 JP (45 x 2 JP)
Meeting : First (I)

A. Core Competencies

KI 1 : Live and practice the teachings of the religion he adheres to.

KI 2 : Appreciate and practice honest, disciplined, responsible, caring behavior (mutual cooperation, cooperation, tolerance, peace), polite, responsive and pro-active and demonstrate an attitude as part of the solution to various problems in interacting effectively with the social environment and nature and in placing oneself as a reflection of the nation in world relations.

KI 3 : Understand, apply, analyze factual, conceptual, procedural knowledge based on curiosity about science, technology, arts, culture and humanities with insight into humanity, nationality, statehood and civilization regarding the causes of phenomena and events, as well as applying procedural knowledge in the field of study specific ones according to their talents and interests in solving problems.

KI 4 : Processing, reasoning and presenting in the concrete and abstract domains are related to the development of what they learn at school independently and are able to use methods according to scientific principles.

B. Basic Competencies and Indicators

Basic Competencies	Indicators
3.10 Applying concepts and principles of sound and light waves in technology	3.10.1 Explain the characteristics and properties of sound waves and classify sounds based on their frequency. 3.10.2 Apply the concept of sound waves to find the speed of sound.
4.10 Doing experiments about sound and/or light waves, following is a presentation of the results and their physical meaning, for example sonometers and diffraction gratings	4.10.1 Carry out experiments using a set of sound wave experimental equipment. 4.10.2 Present the results of experiments on sound waves

Figure 3. Initial lesson plan design

Figure 4. Initial design of 3D experimental student worksheet

QUESTION SHEET
YEAR 2022/2023

Education Unit : High School...
Subject : PHYSICS
Material : Sound waves
Class/Semester : XI/Even
Time : 2 x 45 minutes

Question Taking Instructions:
- Write your name and roll number on the answer sheet provided!
- Maximum time to complete questions is 90 minutes!
- Put a cross (X) for the correct answer on the answer sheet provided!
- Review your answers before submitting them!

1. Sound cannot propagate in a medium....
   a. Congested
   b. Air
   c. Water
   d. Oxygen gas
   e. Vacuum

2. Pay attention to the characteristics of the following waves!
   1) Longitudinal waves
   2) Transverse waves
   3) Cannot propagate through gaseous substances
   4) Cannot propagate through vacuum

Figure 5. Initial design of the test instrument

Next, at the development stage, a feasibility test of the learning tools is carried out. The feasibility test is carried out to determine whether or not the learning tools developed are suitable for use in learning. The feasibility test of learning devices is carried out through validity and reliability tests of learning devices. Validation of the learning tools was carried out by 3 expert validators and 3 practitioner validators so that validation scores for the learning tools were produced in accordance with the validity test scores from the expert and practitioner validators, then revisions were made to the learning tools based on suggestions from the validators.

Suggestions and input from validators are used as the main basis for correcting and revising learning tools so that a suitable and usable product is obtained. Validation of learning tools aims to determine the validity of the learning tools developed which are then used as a reference to determine whether or not the learning tools are suitable for application in learning. Validation was carried out by 3 expert validators from physics education lecturers and 3 practitioner validators consisting of 3 physics subject teachers. The results of the validation analysis of learning tools by expert validators are presented in Table 2.

Table 2. Results of Validity Analysis of Learning Tools by Expert Validators

Product	Average(%)	Category
Syllabus	84.66	Very valid
lesson plan	84.21	Very valid
Student worksheet	83.07	Very valid
Test instrument	82.86	Very valid

Based on Table 2, it is known that the learning tools developed including the syllabus, lesson plan, student worksheet, and test instruments have very valid criteria. The results of the average percentage of learning device validation by expert validators can be seen in Figure 6.

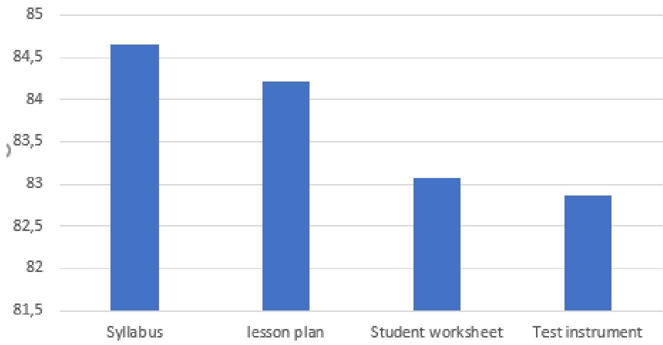

Figure 6. Graph of average % validation of learning tools by expert validators

Figure 5 shows that all the learning tools developed are in the very valid category with the percentage value of syllabus validation reaching 84.66%, RPP reaching 84.21%, LKPD reaching 83.07%, and test instruments reaching 82.86%. Furthermore, the results of validation of learning tools by practitioners are presented in Table 3.

Table 3. Results of Validity Analysis of Learning Tools by Practitioner Validators

Product	% Average	Category
Syllabus	88.67	Very valid
lesson plan	87.72	Very valid
Student worksheet	87.69	Very valid
Test instrument	91.42	Very valid

Based on Table 3, it is known that the learning tools developed in the form of syllabus, lesson plan, student worksheet and test instruments are also in the very valid category. The results of the average percentage of learning device validation by trainee validators can be seen in Figure 7.

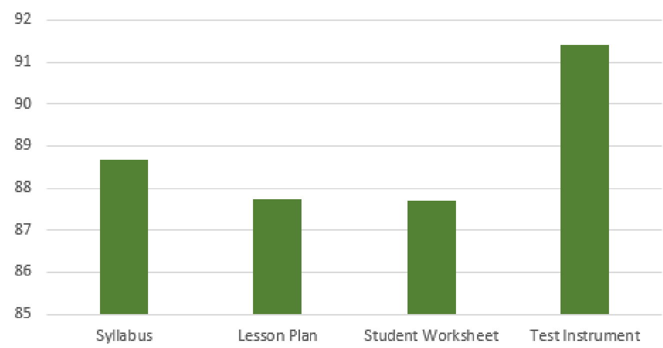

Figure 7. Graph of average % validation of learning tools by practitioner validators

Figure 7 shows that the learning tools developed in the form of syllabus, lesson plans, LKPD and test instruments are in the very valid category with the validation percentage value of the syllabus reaching 88.67%, lesson plans reaching 87.72%, LKPD reaching 87.69%, and test instruments reached 91.42%. Next, a reliability analysis of the learning tools was carried out. Reliability analysis was carried out with the aim of analyzing the agreement between expert validators and practitioner validators. Analysis is carried out by comparing the validation results between one validator and another validator. Device reliability analysis was carried out using the percentage of agreement (PA) equation. The results of the reliability analysis of learning devices are presented in Table 4.

Table 4. Results of Learning Device Reliability Analysis

Product		%PA	Average	Category
	expert	Practitioner		
Syllabus	88.69	97.04	92.86	Reliabel
Lesson plan	93.72	96.10	94.91	Reliabel
LKPD	91.96	97.15	94.55	Reliabel
Test instrument	88.30	93.65	90.97	Reliabel

Based on Table 4, it is known that the learning tools developed in the form of syllabus, RPP, LKPD, and test instruments are in the reliable category. The results of the reliability test can be seen in Figure 8.

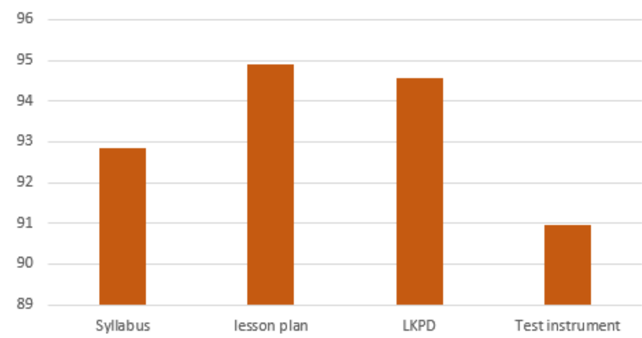

Figure 8. Graph of average % reliability of learning tools by expert validators and practitioners

Figure 8 shows that the learning tools developed in the form of syllabus, lesson plan, student worksheet, and test instruments have an average reliability percentage value of 92.86, 94.91, 94.55, and 90.97% respectively in the reliable category. Based on the results of the validity and reliability tests carried out on learning devices, learning devices were obtained that were suitable for use in learning sound waves in schools. This means that the preparation of learning tools is in accordance with the learning objectives. The results of this research are in accordance with the research of Saputra et al. (2021) who also succeeded in developing a media-assisted guided inquiry learning tool that is valid and reliable. Kartini et al. (2019) stated that learning tools are said to be appropriate if their preparation is based on strong theory and is in accordance with the learning objectives to be achieved.

The final stage of this development research is the dissemination stage. The dissemination stage is the stage of disseminating the final research product. In its implementation, articles resulting from this research were published online in e-journals. The aim of this research is to obtain a learning tool for a guided inquiry model assisted by 3D experimental media on sound wave material that is feasible. The feasibility of learning devices is obtained through validity and reliability tests of learning devices. Syllabus validity was obtained through syllabus validation scores by expert validators and practitioners who then obtained an average syllabus validation score of 86.66% in the very valid category.

Next, a syllabus reliability analysis was carried out using the Percentage of Agreement (PA) equation, obtaining an average value of 92.86 in the reliable category. This means that the syllabus developed is suitable for use in studying sound waves. The syllabus is suitable for use in learning because its preparation is in accordance with the demands of the 2013 curriculum implemented in schools. Yuliati et al. (2021) stated that the syllabus is appropriate because the preparation of the syllabus is systematic and contains components according to the applicable curriculum. The syllabus is prepared according to the curriculum which includes indicators, learning activities, assessment forms and time allocation (Yuliana et al., 2021).

The validity of the lesson plan is obtained through the lesson plan validation value by expert validators and practitioners who then obtain an average RPP validation value of 85.96% in the very valid category. Next, a reliability analysis of the RPP was carried out using the Percentage of Agreement (PA) equation, obtaining an average value of 94.91 in the reliable category. This means that the lesson plan developed is suitable for use in studying sound waves. The RPP is suitable for use in learning because in its preparation, the RPP developed is in accordance with the syllabus and the RPP developed also meets the process standards set by the Ministry of Education and Culture (2016) which include, school identity, subject identity, class and semester, subject matter, allocation. time, goals achieved, KI, KD as well as indicators of competency achievement, teaching materials, methods used, media used, learning resources, learning activities which include opening, core and closing activities, as well as techniques for assessing learning outcomes.

The validity of the student worksheet was obtained through the validation value of the worksheet by expert validators and practitioners who then obtained an average student worksheet validation value of 85.38% in the very valid category. Next, a reliability analysis of the student worksheet was carried out using the Percentage of Agreement (PA) equation, obtaining an average value of 94.55 in the reliable category. This means that the student developed is suitable for use in studying sound waves. The validity of the student was obtained through the validation value of the student by expert validators and practitioners who then obtained an average student validation value of 85.38% in the very valid category. Next, a reliability analysis of the student was carried out using the Percentage of Agreement (PA) equation, obtaining an average value of 94.55 in the reliable category. This means that the student developed is suitable for use in studying sound waves.

The validity of the test instrument was obtained through the validation value of the test instrument by expert validators and practitioners who then obtained an average test instrument validation value of 85.38% in the very valid category. Next, an analysis of the reliability of the test instrument was carried out using the Percentage of Agreement (PA) equation, obtaining an average value of 94.55 in the reliable category. This means that the test instrument developed is suitable for use in studying sound waves. The test instrument is appropriate because it meets the assessment criteria including suitability of questions to learning objectives, aspects to be measured, clear question formulation, and covers learning material in a representative manner.

The use of guided inquiry model learning tools assisted by 3D experimental media can facilitate students' understanding of sound wave concepts which are abstract and difficult to understand. This is because the guided inquiry model provides students with the opportunity to discover knowledge through experiments or experiments to discover for themselves the concepts to be studied so that learning becomes more meaningful.

The application of the media-assisted guided inquiry model in learning can help improve students' mastery of concepts and thinking skills. The guided inquiry model has advantages over conventional learning models in terms of fostering critical thinking skills (Seranica et al., 2018). Several research results conducted by Yudiafarani et al. (2022), Pramudyawan et al. (2020), and Nurmaya et al. (2021) obtained results that the guided inquiry model learning tool was valid and reliable for increasing students' mastery of concepts.

Based on the explanation above, the learning tools developed, namely syllabus, lesson Plan, Student Worksheet, and test instruments can be used in learning. This is in accordance with research conducted by Najwa et al. (2022) and Pratiwi et al. (2021) who developed a guided inquiry model learning tool which produced validation values that were within very valid criteria and reliable reliability values so that it could be said that the tools developed could be used in the learning process. This research is also in accordance with the results of research conducted by Doyan et al. (2020) and Ulfa et al. (2022) also stated that learning tools developed using the guided inquiry model assisted by media were effective in learning.

Conclusion

The guided inquiry model learning tool assisted by 3D experimental media that was developed is suitable for application in learning sound waves in the classroom.

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Author Contributions

All authors have their respective responsibilities in preparing the article, namely conceptualization, methodology, investigation and preparation of the original draft. Research by Y. H, validation of learning tools, review and editing by A. D, validation by S.

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Conflict of Interest

The authors declare no conflict of interest.

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