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Development of Ethnophysics-Based Augmented Reality Assisted Digital Teaching Material for 21st Century Learning

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Abstract: Twenty-first century learning includes 21st century skills, but the facts show that students' 21st century skills are still low. The solution to this problem is to develop digital teaching materials integrated with AR and ethnophysics. The purpose of this study was to determine the initial study, validity, and practicality of using ethnophysics-integrated digital AR teaching materials. The research method used is development research with the Plomp model. The research instruments used include needs analysis instruments, validation questionnaires and practicality. The data analysis technique used is descriptive statistics. Based on the data that has been analyzed there are three research results. *First*, the results of the needs analysis obtained an average value of 63 with a good enough category. *Second*, product validation results obtained an average value of 90.5 with a very good category. *Third*, the product practicality results obtained an average value of 89.9 in the very good category. The implication of the research results is that teachers can construct student skills through digital teaching materials. The results of this study concluded that ethnophysics-based AR-assisted digital teaching materials are valid and practical for use in learning.

Keywords: Augmented Reality; Ethnophysics; Digital Teaching Materials; Twenty First Century Learning.

Introduction

Today humanity is challenged with the progress of the 21st century. The progress of the 21st century is marked by human work being facilitated by digital (Syamsuar & Reflianto, 2019; Satya, 2018). To prepare the ability required an education that can develop 21st century skills. Twenty first century skills include learner-centred learning, the linkage of learning with the real world, the development of critical thinking, creative, collaboration and communication skills. Learning needs to be designed through learning tools and resources that are in line with the challenges of the 21st century. Mastery of technology in education can be done through technological innovation. In the world of education, technology is growing.

Twenty first century skills are skills that need to be mastered by society so as not to be left behind by global society. These skills can be trained and formed through education. In developing 21st century skills, one can develop human resource capabilities, starting with students in educational units. Capabilities in the aspects of knowledge, skills, attitudes, and superior values continue to be prepared to foster 21st century skills in learning. Learning with 21st century skills can be combined with local culture to improve students academics, knowledge, attitudes, and skills (Asrizal, et al, 2018; Derlina, et al. 2021; Chongo & Baliga, 2019). These 21st century skills need to be incorporated into the learning process to meet the needs of students.

Twenty first century learning is characterized by the proximity of digital learning. Education that used to be manual has now been converted into a digital form that is more effective and efficient. Various teaching materials in the average school have been replaced in digital form. Almost all human activities are assisted by the sophistication of science and technology. Qualified human resources are needed in this era of advanced technology. Education graduates must master science and technology in order to be able to take advantage of

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the sophistication of this century's technology. Education is a place to prepare good quality human resources. Education is a conscious and planned activity that functions as a vessel for transferring knowledge from teacher to student. Education is a means to prepare quality human resources. Graduates of educational units must be competent and qualified. Educated graduates have innovative, creative, and competent skills at a global level (Usmeldi, et al., 2017; Asrizal, et al, 2018).

Students' 21st century skills are indispensable. However, in the field it was found that students' 21st century skills were still low. Learning physics is a subject that has problems. Students consider physics to be a difficult subject, teachers have not found the right approach and teaching materials, and practical activities are limited, so students do not play an active role in learning. These things are a few of the existing physics learning problems. Even at the tertiary level, participation in the physics program is relatively low, from several science choices only a few choose physics (Istyowati, 2017; Meli, 2018). Therefore it is important to make physics learning more innovative and interactive in the classroom.

The real conditions in the field describe the results of the needs analysis for the use of ICT (Information, Communication, and Technology) in teaching material obtained at schools. The instrument used is a questionnaire sheet. This questionnaire assessment was conducted on students at three public high schools in the city of Padang with high, medium and low level categories. The results of the anget analysis stated a value of 78.9. The second real condition relates to students' 21st century skills in teaching materials at students. The instruments used are essay question sheets to assess critical thinking skills and creative thinking, as well as performance assessment instruments to assess collaboration and communication skills. The value of critical thinking skills has an average value of 53.1, the value of creative thinking is 54.0, the average value of collaboration skills is 53.7, and the average value of communication skills is 56.8. The third real condition relates to student analysis.

The results of the student analysis were obtained from the analysis of student learning outcomes. The analysis of these results is obtained from the results of document analysis in the form of student midterm scores (MTS). The average MTS score of students is 57.5 and is included in the low category. Many of these problems need to be addressed. One alternative that needs to be developed is to develop a digital teaching material that can improve students' 21st century skills. Digital teaching materials can be linked to Augmented Reality (AR) and integrated with ethnophysics to make teaching material more interesting. AR-assisted digital teaching material integrated with ethnophysics as the use of ICT in the 21st century in learning.

Utilization of ICT in learning can be implemented into digital teaching materials. The use of digital teaching material in learning can strengthen students' interest and interest in learning (Siskawati, 2016; Wahyuningsih, 2012). Digital-based teaching material not only increase interest in learning, but can also train scientific attitudes (Marlina, 2019; Munandar, et al, 2018; Purwasih, et al, 2018; Saputi & Wilujeng, 2016). Utilizing information and communication technology in learning activities will be very useful (Darimi, 2017; Chandrashekar & Sahin, 2014). The integration of information and communication technology in education has the ability to enhance the quality and effectiveness of the learning process. One of the digital teaching materials that can be used in physics learning and is still new is AR.

Selection of the use of appropriate learning resources can support the running of the educational process in the 21st century era. One source of learning is teaching materials. Teaching materials that are in accordance with the needs of the 21st century and in accordance with the characteristics of students can encourage students' abilities to be more effective and efficient (Asrizal, 2020; Syahroni, 2020). Thus, appropriate teaching materials help the learning process and increase student success from the aspect of 21st century students' knowledge and skills. Digital teaching materials need to be developed.

Good teaching materials are those that can deliver to learning objectives. Teaching materials are developed to achieve learning objectives. Teaching materials help teachers in delivering teaching materials. Teaching materials are all materials, tools, media, information arranged systematically which displays the competencies needed by students to facilitate the learning process (Asrizal, 2017; Arif, 2019). This 21st century teaching material is known as digital teaching material which makes it easy and attractive for students because it is connected to the internet (Rahmatullah, et al, 2023; Akram, et al, 2023). To meet the demands of the 21st century, the teaching materials used are digital teaching materials. One of the interesting digital teaching materials is integrated AR digital teaching materials.

Augmented Reality (AR) is a virtual reality that depicts an abstract picture of the real world with a 3-dimensional (3D) view. The use of AR makes it easier to visualize images because they feel similar to real-world objects and events and create a feeling of being present in a virtual world (Sulistyowati & Rachman, 2017; Gupta, 2014). AR-assisted digital teaching materials that are implemented with local culture have attractiveness and are useful in using them for students (Dewi, P.S., et al, 2023). The characteristics of AR are that it has a three-dimensional view, is realistic, and is fun. AR can help digital teaching materials attract more students' interest and enthusiasm for learning so that students' skills, knowledge, and characteristics develop.

Ethnophysics is physics learning based on local wisdom that transforms original physics with people's beliefs or culture in applying it to scientific concepts (Hasanah et al., 2021). This ethnophysics is in the form of a correlation between physics learning and local wisdom (Novitasari, 2017; Wulansari, 2021; Astuti, 2021). Combining physics with local culture can enhance students' 21st century knowledge and skills through local customs. Ethnophysics is obtained from various cultures such as in Indonesia there are various traditional houses, food, musical instruments, dances and games (Gumbo, 2021; Astuti, 2022). Digital teaching materials that are integrated with ethnophysics can increase students' interest in the culture that has the concept of physics.

Relevant research on ethnophysics-integrated teaching materials shows that student responses are very good. Ethnophysics in learning can increase students' knowledge and sharpen students' creative skills related to local wisdom which is implemented in physics lessons. Ethnophysics in the form of games can also be developed into media or teaching materials that promote transitional games into physics lessons (Assiddiqi, 2023; Astuti, 2022; Febrianty, 2023). Ethnophysics in learning makes students familiar with local culture and wisdom in their area. This ethnophysics can be developed into a digital teaching material.

The use of ethnophysics integrated AR digital teaching materials in improving 21st century skills will provide an unusual and interesting teaching material for students. In addition, the developed teaching materials are equipped with AR animations, videos, student worksheets, and evaluations. The purpose of this study was to determine the results of the initial study, the validity of digital teaching materials, and to determine the practicality test results in using digital teaching materials. The research instruments used include needs analysis instruments, validation questionnaires and practicality. The data analysis technique used is descriptive statistics.

Method

The type of research used is Research and Development (R&D). The development model in this study is guided by the Ploom development model. The Ploom model has several advantages. First, this model is more appropriate for product development, one of which is interactive multimedia. Second, the description of each step in this multimedia is complete and systematic. Third, there are individual and small group evaluations. Fourth, there is an emphasis on preliminary research activities carried out at an early stage as a basis for formulating problems and finding appropriate solutions (Plomp, 2013). The various stages of the Plomp model's systematic educational design can be seen in Figure 1.

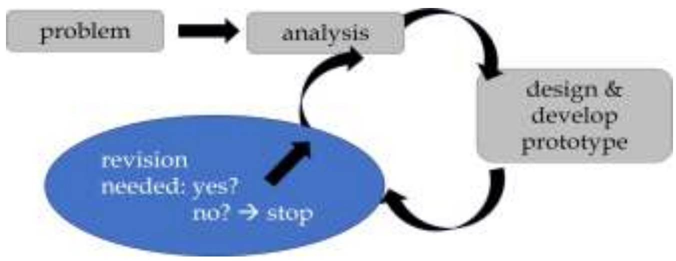


Figure 1. Stages of Plomp Model Systematic Educational Design

Based on Figure 1, it can be explained the stages of the Ploom model's systematic educational design. The starting point for development research is to identify educational issues. Educational issues can be obtained through previous research materials and literature review. In addition, analysis, design, evaluation, and revision activities are repeated until a balance is achieved between goals and realization. The Ploom development model consists of three research phases, namely the initial research phase, the development or prototype phase (prototyping phase) and the assessment phase.

The initial phase (preliminary research) consists of three stages, namely the stages of needs and context analysis, literature review, and development of a conceptual or theoretical framework (Plomp, 2013). Preliminary research emphasizes the analysis of learning problems, student analysis, and analysis of learning settings. The stages carried out in the early phase of preliminary research can be seen in Table 1.

Table 1. Preliminary Research Stage

Analysis	Data Collection Technique	Research Instruments
Learning problems	Questionnaire	Questionnaire sheet
Student	Documentation study	Field notes
Learning setting	Documentation study	Field notes

Based on Table 1, it was found that the preliminary analysis consisted of needs analysis, student analysis, and learning setting analysis. The results of the preliminary analysis will be used as a benchmark so that products are made according to the needs, abilities of students, and competency demands. The second phase is development (prototype). In this phase the product is developed, evaluated and revised iteratively. The design results at this stage produce a prototype. Then a formative evaluation of the prototype is carried out. Formative evaluation is an evaluation proposed for improvement, present in all phases and repeated cycles of design research

The third phase is the assessment phase. At this stage a field test was carried out to see the practicality of interactive multimedia teaching materials. The practicality of digital teaching materials is seen by giving student and teacher response questionnaires after using the product. Development of ethnophysics-integrated AR-assisted digital teaching materials to enhance students' valid and practical 21st century skills. The assessment phase aims to determine the effectiveness of the developed multimedia. Effectiveness is observed in the learning process using teaching material.

This study used instruments to collect data in the form of validation and practicality questionnaires. Data analysis techniques in this study used descriptive statistics. Statistical analysis is displayed in graphical form. The validation questionnaire was validated by a validator of 3 experts who were FMIPA UNP lecturers consisting of material substance components, learning design validation, visual communication display validation, software utilization validation and ethnophysics integration validation. Validation analysis and practicality can be obtained by dividing the score obtained by the maximum score then multiplied by one hundred percent (Riduwan, 2009). The validity and practicality value categories range from 0 to 20 which are not good, 21 to 40 are not good, 41 to 60 are quite good, 61 to 80 are good, 80 to 100 are very good.

Result and Discussion

Based on the data that has been analyzed, there are three research results according to the stages, namely the results of needs analysis, validity, and practicality of digital teaching materials. The first analysis of needs is an analysis of learning problems at SMAN 2 Padang. The instrument used was a questionnaire of learning problems obtained from 3 teachers at SMAN 6 Padang. Some of the learning problems obtained from the teacher's questionnaire are shown in Table 2.

Table 2. Results of the Analysis of Learning Problems

Identification of Physics Learning Problems	Value
Constraints in designing digital teaching materials	68
Obstacles in making digital teaching materials	70
Obstacles in mastering the software	64
Obstacles in making digital teaching materials with software	63
Constraints in using digital teaching materials in learning	64

Based on Table 2, it is found that the problems in learning physics at school are in the range of 63 to 70. The range of problems 63 to 70 is included in the fairly high category. The first is the obstacle in designing digital teaching materials with a score of 68. Teachers have difficulty making covers, designing content, student worksheets, animations and videos, as well as designing evaluations of digital teaching materials. Second, the constraints on how to make digital teaching materials are at 70 with a fairly high category. Teachers have difficulty making digital teaching materials that are easy and practical. Third, the obstacle in mastering the software for making teaching materials is at a score of 64 (high enough category). Fourth, the obstacle in the form of making digital teaching materials with software is at a value of 63 (high enough category). Lastly, fifth, the constraints in learning physics are at a value of 64 (high enough category).

The second analysis of needs is an analysis of the characteristics of students in class XI at four public high schools in the city of Padang. The instrument used was a student characteristic questionnaire. Analysis of student characteristics has 4 components, namely student background (LB), interest in learning (MiB), learning motivation (MoB), visual learning style (GBV), audio learning style (GBA), and kinesthetic learning style (GBK). The results of the analysis of student characteristics data can be seen in Figure 2.

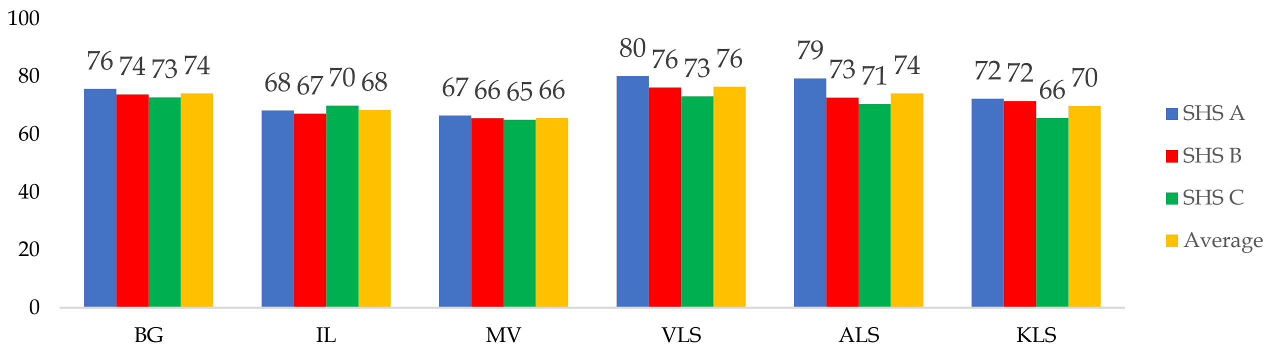


Figure 2. Results of Analysis of Student Characteristics

Based on a student characteristic questionnaire distributed by the four schools in Padang City in class XI, 32 people were taken from each school, so a total of 126 respondents. First, the average background (BG) of students is 74 in the good category. This means that the average student is already familiar with digital. Second, the average student interest in learning (IL) is 68, including the good category. This means that students have a good interest. Third, the average motivation (MoB) of students is 65, including the good category. This means that the average student has good learning motivation. Fourth, the average visual learning style (VLS) of students is 77, including the good category. This means that the average student has a good visual learning style. Fifth, the average student audio learning style (ALS) is 74, including the good category. This means that the average student is good at the audio learning style. Sixth, the average value of the kinesthetic learning style (KLS) of students is 70, including the good category. This means that on average students like to learn in a kinesthetic/moving style.

The third analysis of needs is an analysis of student characteristics related to creativethinking skills (CTS), communication skills (CS), and student knowledge. Analysis data can be seen in Table 3.

Table 3. Statistical Parameter Values of CTS, CS, and Knowledge Data

Statistical Parameters	CTS	CS	Knowledge
Average	45	57	56
Mode	41	50	40
Median	43	55	42
Lowest value	35	40	25
The highest score	65	78	85
Reach	35	38	63

Based on Table 3, it can be explained that the lowest scores for assessing creative thinking skills, communication skills, and student knowledge are 35, 40, and 25 respectively. Meanwhile, the highest scores are 65, 78, and 85 respectively. students' creative thinking is 45, communication skills are 57, and students' knowledge is 56. This shows that the average value of students' creative thinking skills, communication skills, and knowledge is in the low category. The range of scores from the results of the assessment of students' creative thinking skills, communication skills, and knowledge were 35, 38, and 63 respectively. The scores that often appeared in the assessment of students' creative thinking skills, communication skills, and knowledge respectively were 43, 55, and 42. These three values are in the low category. The median scores for the research on students' creative thinking skills, communication skills, and knowledge were 35, 40, and 25. These three scores were also in low scores. Based on these three assessments, it can be seen that students' creative thinking skills, communication skills, and knowledge have not achieved the expected results, so this requires an innovation in learning so that results are more optimal and in line with expectations.

The fourth needs analysis is the analysis of learning objectives for 3 physics materials through the design of the physics teacher's learning implementation. The observation instrument used is guided by the suitability of using the ABCD structure for the learning objectives set by the teacher. The components in the preparation of teaching materials use the components of audience (AC), knowledge behavior (BP), attitude behavior (BS), skill behavior (BK), condition (CD) and degree (DR). The audience component is a component of a learning objective aimed at students. The behavior component is a component that emphasizes something that must be possessed by students such as knowledge, attitudes, and skills. The condition component is something that is used as a reference for achieving learning objectives such as the application of a learning model to learning objectives. The degree component is something that is emphasized in the success of learning objectives. Analysis of the completeness of the learning objectives based on the learning implementation plan can be seen in Figure 3.

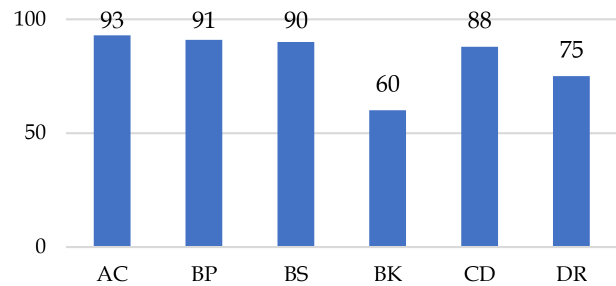


Figure 3. Results of Learning Objectives Analysis

Based on the observation sheet analysis of learning objectives, the results were in the range of 60 to 93. The results for the audience component of 93 were categorized as very good, this was because the learning objectives were mostly aimed at students. The results for knowledge behavior of 91 are categorized as very good, this is because the learning objectives focus on students' knowledge with appropriate operational verbs. The result for attitude behavior is 90, this is because some learning objectives do not include the attitudes that students must have. The results for skill behavior of 60 are categorized as quite good, this is because the learning objectives have not used C6 operational verbs to conduct experiments. The results for the condition and degree are categorized as good because the learning objectives use a learning model and also emphasize the criteria for learning success.

The fifth needs analysis is analysis of learning settings. The observation instruments used are guided by the 2016 Minister of Education and Culture Number 22 concerning the process of learning activities that take place in class. The process of learning activities is carried out by implementing the lesson plans that have been made by the teacher. The learning activities carried out include preliminary activities (INA), core activities (COA) and closing activities (CLA). Analysis of learning problems can be seen in Figure 4.

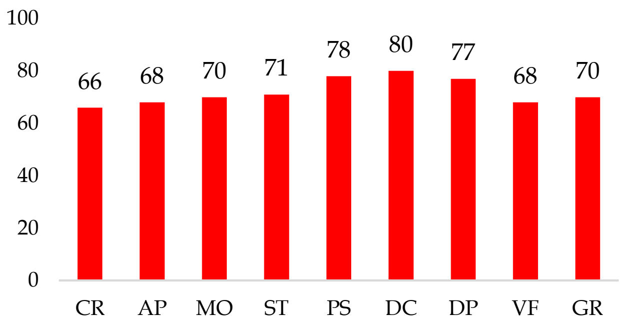


Figure 4. Results of Learning Setting Analysis

Based on the results of observations on the learning setting analysis table related to the analysis of activities during the learning process, namely opening activities, content activities and closing activities of the lesson. Opening learning activities consist of checking class readiness (CR), appreciation activities (AP), and motivational activities (MO). From the data it was found that class activity checking (CR) got a score of 66, appreciation activities (AP) got a score of 68, and motivational activities got a score of 70. The average opening activity is 68 with a pretty good category.

The second learning setting activity is the core activity. The core activities consist of stimulation activities (ST), problem statements (PS), data collection (DC), data processing (DP), and verification (VF). The score obtained in the stimulation activity was 71 in the good category, 78 problem statements in the good category, 80 in the very good category for data collection, 77 in the good category for data processing (DP), and the 68 for verification in the good category. The average of the core activities is 75 in the good category.The third activity of the learning setting is closing. This closing activity is a generalization activity (GR). From the data it was found that the value of the generalization was 70 with a fairly good category. This generalization activity needs to be done to close learning activities and conclude from learning activities. Overall the average value obtained is 71 learning activities in accordance with the implementation of ideal learning. The implementation of physics learning has not used AR-assisted teaching materials with an ethnophysics approach to learning.

Validation Test Results of Ethnophysics Integrated AR Assisted Digital Teaching Materials

The next result is the result of product validation. The e-module that has been developed is then validated by experts to determine the validity of the e-module. The validation instrument used has an assessment component which includes material substance (SM), learning design (DP), visual communication (KV), and software utilization (SU). Product validation results can be seen in Figure 5. Based on the data analysis in Figure 6, it can be explained that the value of each component varies with the lowest score of 89 and the highest score of 91. The value of the validation test results according to experts on digital teaching materials can be determined by finding the average value of all assessment components. The average value of the validation results of ethnophysics-assisted digital AR-assisted teaching materials according to experts is 90.5 which is in the very good category.

The material substance component (SM) consists of four indicators, namely correctness, material coverage, contemporaryness, and readability. The validation results of the three validators for material substance with an average of 89. The value given by the validator for each material substance component can be categorized as very good. The learning design component (DP) consists of 6 indicators, namely titles, learning objectives, materials, sample questions, exercises, and references. The validation results for learning designs average 91. Thus, overall the appearance of the e-module design is in the very good category. The third component is the appearance of visual communication related to the display of digital teaching materials. The validation results of visual communication display (KV) with an average of 91. Thus, the display of visual communication on digital teaching materials can make it easy for students to carry out teaching materials with a clear navigation display, legible display of letters, media to help learning, and color combinations which is proportional and there is already a media such as videos and pictures that can motivate student learning.

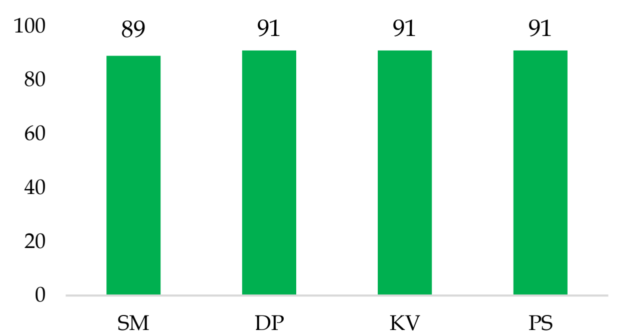
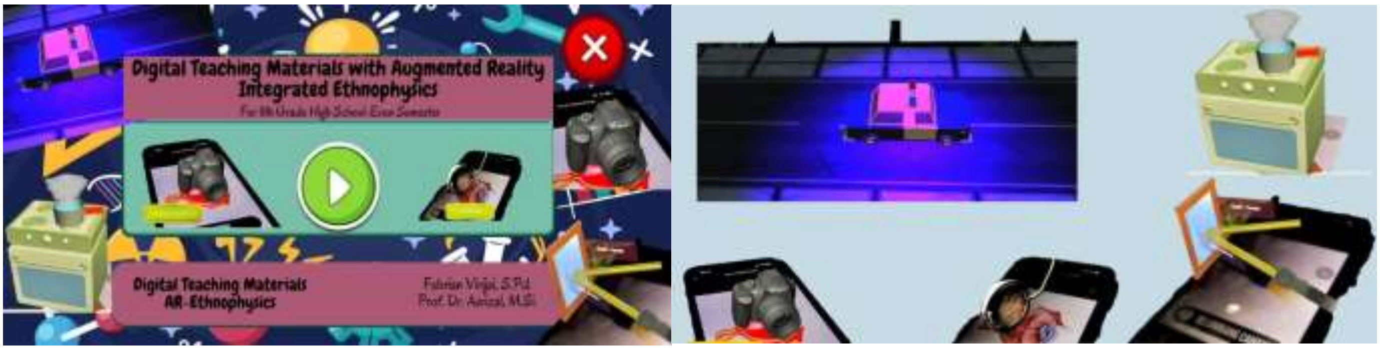


Figure 5. Results of Validation of Digital Teaching Materials by Experts

The software utilization component (PS) consists of 4 indicators, namely the addition of images, videos and AR animations, ease of access, assisting in making, and easy to publish online. Validation results Software utilization is rated with an average of 91. The results of the validity of the 3 indicators show that indicators with a very good category are at a value of 91 in the good category. Thus the use of software in digital teaching materials can make it easier for users to use digital AR teaching materials.

Description of Ethnophysics Integrated AR Digital Teaching Materials

The results of the next study are product descriptions. The product developed is in the form of AR-assisted digital teaching materials integrated with ethnophysics in improving students' 21st century skills. Digital teaching materials designed based on the structure of writing teaching materials. The following are the results of covering digital teaching materials which can be seen in Figure 6.



(a) (b)

Figure 6. (a) Cover Display of Digital Teaching Materials; (b) AR on Digital Teaching Materials

At the beginning of this digital teaching material there is a cover and main menu. On the cover display of digital teaching materials which contain titles, authors, semesters, classes, and educational units. The title section explains the material to be studied, namely sound waves, light waves, temperature & heat, and optical instruments. This digital teaching material is provided for class XI high school students in semester 2. The cover displays sentences written in English and is made as attractive as possible by balancing the colors. On the cover of the digital teaching materials there is a submarine which represents the material of sound waves, light waves, temperature & heat, and optical instruments that will be studied. In the display section of the digital teaching materials menu which contains a list of contents in digital teaching materials. In learning activities there are learning objectives, material descriptions which contain material with AR animation, implementation of ethnophysics on material, videos, and evaluations. In the learning evaluation, objective test questions related to ethnophysics and critical and creative thinking skills are given which are packaged in an interactive display so that they can be tested independently. In the evaluation questions, answer keys are given at the end of this digital teaching material as a form of feedback to students.

AR digital teaching materials integrated with ethnophysics are produced so that they are of high quality, the validator provides various suggestions for improving digital teaching materials. The advice given by several validators is in the form of input given by the validator on the quality of the product being developed. There are several main suggestions from the validator. First, the appearance of the cover on digital teaching materials is adjusted to the material being taught. Second, learning objectives are adjusted to their cognitive level. Third, ethnophysics is still not visible in digital teaching materials. Fourth, AR animation needs to be made even more interesting. Fifth, the images contained in digital teaching materials have not included references. The suggestions given by the validator are used as a first step to improve digital teaching materials.

Improvements to digital teaching materials were carried out according to the validator's suggestions. Improved covers of digital teaching materials by adding images of sound waves, light, temperature & heat, as well as optical devices in them to suit the material. Improve learning objectives by adjusting the operational verbs used. Improved integration of ethnophysics into digital teaching materials by adding examples of ethnicity in West Sumatra related to sound waves, light, temperature & heat, and optical devices related to real life around students. Adding references at the bottom of the digital teaching material images. The improvement of digital teaching materials aims to make digital teaching materials valid and can be used.

Practicality Test Results of Ethnophysics-Assisted Digital AR Assisted Teaching Materials

The results of the research after the product has been validated, practicality tests are then carried out on students to find out the practicality of the product that has been developed. The practicality instrument used has an assessment component which includes usability (US), easy to use (EU), attractiveness/appelling (AP), clarity/clear (CL), cost-effective/low cost (LC). Data analysis of each practicality component by students can be seen in Figure 7.

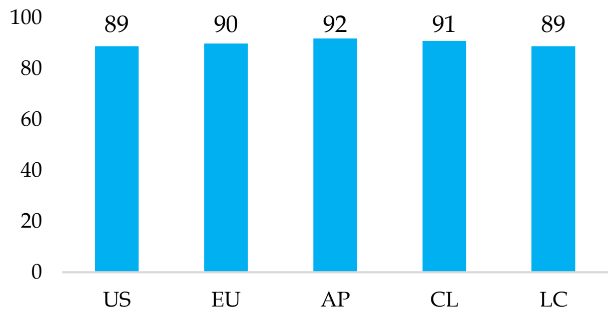


Figure 7. Analysis of Practicality Test Results by Students

The practicality test data by these students was carried out in 1 class at SMAN 2 Padang with a total of 32 respondents. The results of the data show that the value of the benefit aspect 89 is in the very good category. The value of the easy-to-use aspect is 90, including the very good category. The value of the attractiveness aspect is 92, including the very good category. The value of the clarity aspect is 91, including the very good category. Great aspect value costs 89, including the very good category. From the data, it can be concluded that digital teaching materials are very practical for students.

The results of the research after the product has been validated, a practicality test is then carried out on the teacher to find out the practicality of the product that has been developed. These results are used to see the views of teachers in using this digital teaching material. The practicality instrument used has an assessment component which includes usability (US), easy to use (EU), appelling (AP), clear (CL), cost-effective/low cost (LC). Data analysis of each practicality component by students can be seen in Figure 8.

The practicality test data by these students was carried out on 2 teachers who taught in class XI at SMAN 2 Padang. The teacher tries out this digital teaching material before giving an assessment of the practicality of digital teaching materials. The results of the data show that the value of the benefit aspect of 90 is in the very good category. The value of the easy-to-use aspect is 91, including the very good category. The value of the attractiveness aspect is 93, including the very good category. The value of the clarity aspect is 91, including the very good category. Great aspect value costs 89, including the very good category. From the data, it can be concluded that this ethnophysics-integrated AR digital teaching material is very practical for teachers in teaching in class.

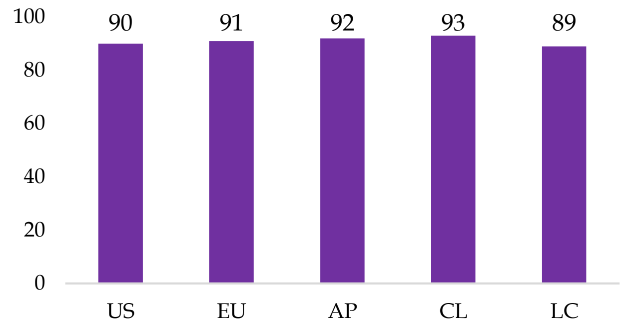


Figure 8. Analysis of Practicality Test Results by Teachers

Based on the results of the needs analysis research, the learning process found in the field has followed the demands of the curriculum. However, ordinary learning does not improve student learning outcomes and students' creative and critical thinking skills. This was triggered by the use of teaching materials that were not yet integrated with 21st century skills, ethnophysics, and teaching materials that were not yet in an attractive digital form such as AR. This can be seen from the low learning outcomes of students at SMAN 2 Padang. Followed by critical and creative thinking skills which are also in the low category. It is necessary to use digital teaching materials that are integrated with ethnophysics and are able to improve students' 21st century skills.

Conclusion

Based on the objectives and results of the research, three conclusions can be drawn. First, the results of the needs analysis with an average of 69.4 are in the pretty good category. This shows that students' critical thinking skills and creative thinking skills are still low. Second, the validity of ethnophysics-integrated AR assisted digital teaching materials with an average value of 84.1 is in the valid category. Valid digital teaching materials can be interpreted as teaching materials that have been tested for validity by experts and can proceed to the practicality test stage for students. Third, the practicality value of the use of ethnophysics-integrated digital AR teaching materials with an average score of 93 is in the very practical category. Practical teaching materials are teaching materials that have benefits and make it easy for students to get them. The implication of the results of this study is that teachers must provide learning motivation, guide, and direct students in constructing or building student skills through digital teaching materials with AR integrated ethnophysics to improve students' 21st century skills.

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Author Contributions
All authors have contributed with their respective tasks which are equally important for the completion of the writing of this paper. Febrian Virijai contributed in collecting data in the field, compiling paper drafts, processing data, and analyzing. Asrizal contributed as a guide for the implementation of research up to the paper's authorship, idea designer, and review of paper drafts.

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Conflicts of Interest
In making the paper, the authors found no conflicts. The research implementation ran smoothly according to procedures with legal permits. Research implementation does not interfere with conducive learning in class because the research material is in accordance with the curriculum used in schools.

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