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Development of Physics E-Jobsheet Integrated STEM Approach to Promote Students' 21st Century Skills

Hanana Laila Burhan[1*], Asrizal[2], Ramli[2]

[1] Magister Pendidikan Fisika, Universitas Negeri Padang, Padang, Indonesia.
[2] Pendidikan Fisika, Universitas Negeri Padang, Padang, Indonesia.

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Corresponding Author:
Hanana Laila Burhan
lailaburhan@gmail.com

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Abstract: The development of science and technology that is developing very quickly is challenge for the world of education to prepare students who are able to compete in the current era of revolution. This research aims to produce product in the form of a class XI high school physics e-jobsheet integrated with a STEM approach to improve the skills of 21st century students. The type of research used R&D research with the development model used in this study The development model used is the ADDIE development model. Data collection techniques used are observation, interview, and questionnaire methods. Based on the data that has been analyzed, three conclusions can be drawn. First, at the analysis stage, four analysts were carried out, the results of the analysis of graduate competency standards analysis of learning activities, analysis of participant characteristics, and analysis of 21st century skills. Second, the validation result is 0.76 with valid category. Third, the results of practicality by educators are 81 with very practical category, for the results of practicality by education participants are 83.53 with categories Very practical. The results of the study concluded that the integrated physics e-jobsheet STEM approach is valid and practical for use in learning.

Keywords: ADDIE model; E-Jobsheet; STEM

Introduction

Education is currently in the digital age, higt mobility, and access to information which is very important for everyone. Currently, education that is developing in the digital era 4.0 demands that learning can be adapted to the potential and talents of students. This is in line with the rapid development of science and technology in education and has become a focus for improving the quality of education in Indonesia. Application of learning and nformation technology is one of the efforts that can improve learning abilities for students (Ramdhani & Wulan, 2012). The development of science and technology has a very rapid impact on the educational environment. According to Kasali (2008) to welcome education in the 4.0 era, there are three solution steps that can be taken in the field of education. The first is a disruptive mindset. The development of science and technology has a very rapid impact on the educational environment. Which is a way of thinking that we do before acting. The second is Self-driving (Ability to Lead) is Human Resources (HR) who have integrity, able to read the situation, agile in action and able to work effectively, innovatively, and efficiently. The third is Reshape or create which is being able to defend and make good decisions. Maghfiroh et al. (2023) stated that students are expected to knowledge, attitudes, skills that students can understand a problem. Ma (2018) said the development of education is a very big challenge in this century. It is possible that in the next few years we will experience difficulties if we do not change the way we educate and teach.

The impact of change in the 4.0 era on the world of education today is in the form of many schools that are already practicing digital technology during the learning process (Irwandani et al., 2017). Education in

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the 21st century is relevant to the four pillars of life (learning to know, learning to do, learning to be and learning to live together (Zubaidah, 2016). Education that is currently taking place is expected to be able to make students have skills in the 21st century where those who have metacognitive skills, master science, can think critically and creatively, and are able to collaborate effectively (Greenstein, 2012). Students in the 21st century are currently expected to have various skills in order to be able to compete amidst the onslaught of globalization. Learners should have abilities that can fulfill them to be able to develop in the 21st century (Asrizal et al., 2017). The development of digital technology used in learning media is able to improve the abilities and skills of students. Preparing generations for the 21st century. Education in the 21st century is a challenge.

The government inaugurated a prototype curriculum in 2021, which was refined into an independent curriculum in 2022. The curriculum can determine the success of science and technology for students in development education (IPTEK) (Mariati, 2021). One of the government's efforts to prepare generations in the 21st century is by changing the curriculum (Permendikbud, 2014). Merdeka also has competence demands which include the realm of knowledge, the realm of attitude and the realm of skills. To achieve learning that is appropriate for the 21st century, teachers as human resources must also have soft skills and hard skills. According to Asbari et al. (2020), preparing generations for the 21st century. Education in the 21st century is a challenge ahrus faced.

Private (Permendikbud, 2016) state the skills that must exist in 21st century learning is not limited to the ability to read and memorize as most are implemented in schools. Education which associated with development ability characterized with the use of the STEM (Science, Technology, Engineering and Mathematic) approach in which learning is linked to the fields of science (knowledge), technology, engineering and mathematics, so that students can understand thoroughly (Hadinugrahaningsih et al., 2017). STEM is a term that can refer to teaching and approaches, namely science, technology, engineering and mathematics which is also called the cross-approach disciplines. Integration of STEM aspects can improve student learning outcomes. STEM education has referred to four fields of knowledge (science, technology, engineering, and mathematics). STEM education is in line with 21st century skills of creativity, critical thinking, collaboration, and communication (Larson & Miller, 2011).

STEM as an integrated approach investigates learning processes that have two or more subjects (Sanders, 2009). Mayasari et al. (2014) in his research concluded that the purpose of STEM-based education is for students who are able to develop their own competencies to be applied to their own conpetencies to be applied to the their current and future enviroments.STEM-based education can assist students in practicing knowledge in an effort to solve problems related to phenomena in the everyday envonment by utilizing technology that will increase their abilities and be ready to face global challenges in the future. This is evidenced by the research of Becker & Park (2011) which in STEM research can make an impact positive in learning and can increase the increase in learning outcomes in the field of science and technology. In helping the success of education based on 21st century skills, STEM learning is an integration of science, technology, engineering, and mathematicsbased learning. 21st century learning can also hone and develop students' skills in achieving learning goals (Asrizal & Darvina, 2020).

The learning process carries out the delivery of learning material from a teacher to students. The implementation of learning is expected to be able to develop participants' 21st century skills educate. The main components needed in various fields of life according to (Wijaya et al., 2016; Sugiyarti et al., 2018). The 21st century learning paradigm aims to form human resources who have the ability to think critically, creatively, communicatively, and collaboratively (Asrizal & Darvina, 2020). Freedom to learn is one of the programs of the Minister of Education and Culture who want to create happy learning conditions and a fun learning environment. Freedom to learn hopes that students can face a social change, and advances in advanced technology, so that students are able to compete with the needs of the times.

The government's effort to improve the quality of education in Indonesia is through the development of teaching materials. According to the Minister of Education and Culture No. 26 of 2016 with the government's efforts to answer challenges to improve the quality of educational facilities and infrastructure, it is mandatory to use relevant teaching materials in order to achieve the expected learning demands. The teacher who acts as a facilitator in delivering learning material and developing learning topics requires a teaching media that can improve students' abilities in carrying out learning, so that students more easily understand the subject matter. Media is an inseparable part of the teaching and learning process in order to achieve learning objectives (Arsyad, 2014). Electronic teaching materials are one of the easiest learning resources for students to use because they can be studied anywhere and at any time, they are more interactive so they can improve student learning outcomes (Sudarsana et al., 2021). One of the developments of teaching materials

that can support the learning process independently is Jobsheet. Renewal is needed in the design and development of teaching materials, one of which is applying electronic teaching materials. Electronic teaching materials are an important part of achieving learning objectives (Prasetyo, 2015). The application of electronic teaching materials is effectively used for independent learning, so students can learn even if they are not accompanied by a teacher (Mella et al., 2022).

Jobsheet is a teaching media applied by teachers that can help students during the learning process in the form of sheets of practical work procedures in which practicum objectives, theoretical basis, practicum tools and materials, work procedures and exercises are found in which students are able to learn independently without the direction and guidance of the teacher. The use of Jobsheets in learning activities functions and has very useful purposes in practicums, where Jobsheets help students when carrying out practicums according to the instructions listed in the Jobsheet. According to Noktaviyanda & Aryadi (2011) Jobsheet is a book in it work procedures, this is one of the causes learning conditions are not running effectively. Jobsheets that are used today are generally not interactive, and their shape is still like ordinary sheets in the form of hard copies.

The first step in the process of developing ejobsheet teaching materials is by conducting a needs analysis. This research activity focused on the needs of teachers and students for teaching materials to be used in the learning process. 21st century skills for students in accordance with the problems and constraints that occur in the field show that students are still not in accordance with the expected conditions. Based on observations made at SMAN 2 Padang Panjang class XI F 9, it was found that Physics learning at SMAN 2 Padang Panjang had implemented the curriculum independent. The media used in learning uses worksheets and handouts at each meeting according to the circumstances in the field and the ability of students. From the results of interviews with teachers, the LKPD used during learning already refers to the STEM approach but only emphasizes mathematical representation but has not been carried out in accordance with the steps of the STEM approach. For this reason, it is necessary to develop teaching materials in the form of e-job sheets that can support the Physics learning process, especially when carrying out practicums. The Ejobsheets that will be developed later will be interactive using the STEM approach, so that the Jobsheets are able to assist teachers during teaching and learning activities and can increase the independence of students to become independent in Physics learning.

The integration of STEM aspects can support the improvement of student learning outcomes (Pangesti, 2017). The STEM learning approach can trigger the formation of students' interest in learning and perceptions of professions related to STEM (Sulaeman et al., 2020). Use of e-jobsheets Integrated STEM will improve students' 21st century skills because it implements everyday phenomena into physics learning for students. The purpose of this research is to determine the results of preliminary study, determine the results of validity tests, and determine the results of practical tests using STEM integrated e-jobsheets.

Method

Research conducted by researchers is R&D instrument was filled in by three experts in the field of Physics Education and one staff expert in Indonesian.Data collection was made in the development research (Research and Development). Sugiono (2014) stated that the development research model is a research method used to produce products and to test the feasibility of these products. According to Arikunto (2008) development research is a series of processes of developing a new product or perfecting an existing product so that it can be used and accounted for.

The development model is carried out using the ADDIE model, namely Analysis, Design, Develop, Implementation, and Evaluation. Qualitative descriptive method is the method used in this study. Descriptive research is a form of research reference that is used to describe existing phenomena. Where in this study it provides a description of an object studied through sample data in the field and draws a conclusion that applies to the public (Sugiono, 2014). The following procedure for developing the ADDIE model can be seen in Figure 1.

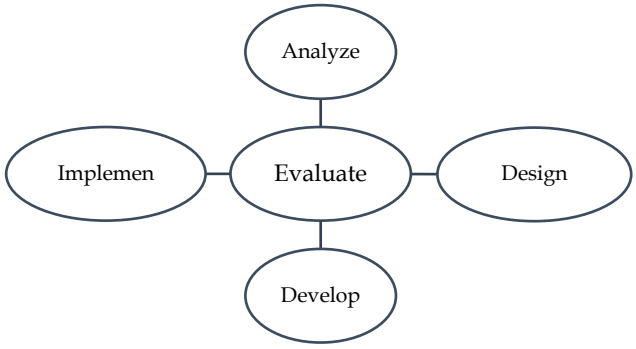

Figure 1. ADDIE development Model (Branch, 2009)

This study intends to get an overview of a situation in which the researcher will formulate the problem according to the situation in the field. The subjects in this study were students in class XI F 9 SMAN Padang Padang Panjang and conducted interviews with teachers who taught Physics. This development step uses the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The first step or phase

in making this teaching material product requires a needs analysis. The activities carried out at this stage included analyzing learning activities, analyzing student characteristics, and analyzing 21st century skills. The second step in this research was to design a STEM integrated physics e-jobsheet. The material selected in the e-jobsheet is vector. The designed e-jobsheet includes an approach learning which inside it uses STEM learning approach.

The third step in this research is the development and implementation stages. Products that have been tested for validation aim to find out what products have been developed declared valid by experts so that it is suitable for use by students in the learning process. The validation test instrument was filled inby three expers in the fileld of physics education and one staff expert in Indonesian. Data collection was made in the from of validation questionnaire. Sheet Data analysis techniques in this study used descriptive statistics to analyze the validity of the statistical analysis displayed in table form. Validity analysis using a Likert scale. Giving a value of validity using the Aiken's V formula, namely (Formula 1).

$$V = \frac{\sum s}{[n(c-1)]} \quad (1)$$

Information:
s = r – lo
lo
= The lowest validity rating score (in this case = 1)
c = The highest validity rating score (in this case = 4)
r = The number given by the validator
The validity category of the developed ejobsheet can be seen in Table 1.

Table 1. Validity Category

Value	Category
≥ 0.60	Valid
≤ 0.60	Invalid

(Source: Azwar, 2015)

The fourth step is testing the value product practicality. A product is said to be practical if educators and students can use the product easily and have benefits in learning. The practicality test of this product aims to determine if the developed product is practically used in the learning process. Data collection was made in the form of practicality questionnaire sheets. Data analysis techniques in this study used descriptive statistics in analyzing practicality. How to calculate the value of practicality is done by the Formula 2.

$$p = \frac{\text{Score Obtained}}{\text{Score max}} \times 100\% \quad (2)$$

Practicality category ofe-job sheetdeveloped, after processing the data can be determined using Table 2.

Table 2. Practicality Category

Interval (%)	Value
0 – 20	Very impractical
21 – 40	impractical
41 – 60	Less practical
61 – 80	Praktical
81 – 100	Very Practical

(Source: Riduwan, 2008)

According to Riduwan (2008) validation analysis and practicality can be obtained by dividing the score obtained by the maximum score then multiplied by one hundred percent. The validity and practicality value categories range from 0 to 20 in the bad category, 21 to 40 in the bad category, 41 to 60 in the pretty good category, 61 to 80 in the good category, 80 to 100 in the very good category.

Result and Discussion

Instruments used in the analysis stage it consists of four instruments. First, a needs analysis uses an SKL analysis sheet. Second, an analysis of learning activities uses a learning analysis sheet. Third, analysis of student characteristics using a instruments used in the analysis stage It consists of four instruments. First, a needs analysis uses an SKL analysis sheet. Second, an analysis of learning activities uses a learning analysis sheet. Third, analysis of student characteristics using a student characteristic questionnaire. Fourth, analysis of students' 21st century skills using student 21st century skills assessment sheets. Data analysis to assess the needs analysis of each indicator uses the provisions in.

Table 3. Category Needs analysis

Category	Value
Very good	$90 < N \leq 100$
Good	$75 < N \leq 90$
Enough	$60 < N \leq 75$
Not enough	≤ 60

The needs analysis carried out at this stage includes field observations, literature reviews, analysis to identify problems, and possible solutions to solve these problems stages. This analysis consists of analysis of Graduate Competency Standards, analysis of learning activities, assessment analysis, analysis of student characteristics, and material analysis. The following will provide details about each of the results of the analysis. The graduate copmpetensy standards analysis (SKL) shows that the standards of students behave in accordance with the teachings adhered to, active participation in the school

environment, good interaction in behavior and speech. Graduate copmpetensy standards analysis includes spiritual attitudes, social attitudes, knowledge, and skills. The results of the study of graduate copmpetensy standards analysis can be seen in Figure 1 below.

The results of observations on the SKL analysis at SMAN 2 Padang Panjang, show that the attitude aspects of students assessed by educators are good and the scores obtained are higher than aspects knowledge and skills in the sulfficient category. The subindicators that are of concern are that in general students are still lacking in identifying facts related to Physics phenomena, are still lacking in fully understanding Physics concepts, and are not fully able to solve problems in learning Physics. This causes students understamding of knowledge competence in learning physics to be in the less category.

Analysis activity learning covers preliminary activities (KPH), the core activities consist of applying the approach (P), using models and methods (PMM), using learning media (MP), and using learning resources (SB), as well as activities cover (KP). The results of the analysis of learning activities can be seen in Figure 2.

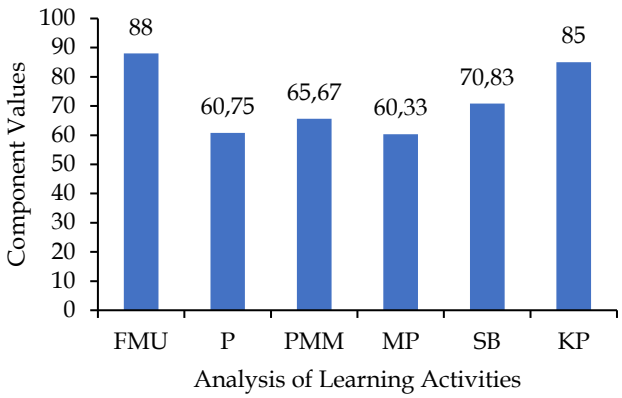

Figure 2. Result of Analysis of Learning Activities

Based on the analysis, learning activities have six components, namely: preliminary activities (KPH) with a value of 88 and closing activities (KP) with a value of 85 are already in the good category, while the application of the approach (P) obtains a value of 60.75, the use of models and methods (PMM) with a value of 65.67, learning media (MP) with a value of 60.33, learning resources (SB) with a value of 70.83, application of the approach (P) with a value of 60.75, is in the sufficient category, and the value obtained is higher in the preliminary activity (KPH). Aspects that are of concern to learning media (LM) which have a lower value than other aspects.

The results of the analysis of each component of the analysis of student characteristics are presented as follows in graphical form the results of the analysis of student characteristics in Figure 3.

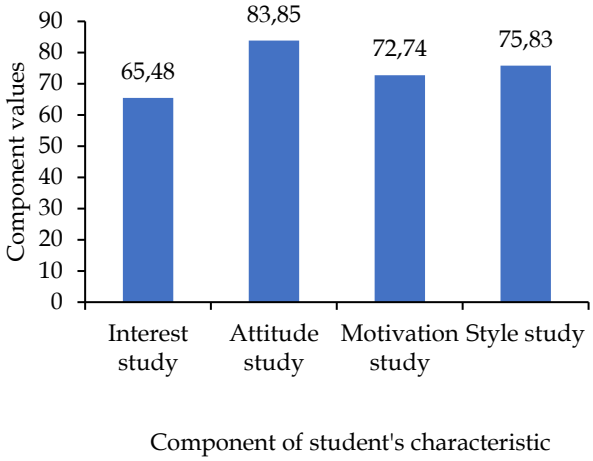

Figure 3. Results of Student Characteristics Analysis

Based on observations of 32 students, the results of students' learning interest were obtained with a value of 65.48; student learning attitude with a value of 83.85; students' learning motivation with a value of 72.74; and learning styles of students with a value of 75.83. Based on Figure 3 above, students' interest in learning needs to be increased so that the Physics learning process can take place optimally and the expected learning objectives are achieved.

Analysis of 21st century skills was carried out to see the initial condition of students' 21st century skills. Analysis of students' 21st century skills, related to students' critical thinking, creative, communization, and collaboration skills. The instrument used is in the form of an observation instrument of learning outcomes and student activities during the learning process. There are four indicators in the component parts of critical thinking in the 21st century skills, namely asking questions, looking for alternatives, answering questions, and looking for reasons. The results of the critical thinking analysis obtained an average value of 49.43. The creative skills component consists of several indicators asking lots of questions, thinking of various ways, answering with lots of answers, and giving various reasons 48.86. The communication component of the analysis.

There are four indicators for 21st century skills, namely Vocabulary, voice intonation, facial expressions, and conveying the message. The results of communication analysis obtained an average value of 58.71. The collaboration component consists of several indicators: contribution, working together, and

exchanging points of view. The results of the communication analysis with an average value of 50.03. Analysis of 21st century skills is seen in Table 4.

Table 4. Statistical Parameter Values of Students 21st Century skills

Parameter statistic	Critical thinking	Creative	Communication	Collaboration
Average	49.43	48.86	58.71	53.03
Mode	68.75	68.75	75.00	56.25
Median	50.00	43.75	50.00	56.25
The Highest Score	18.75	18.75	31.25	37.50
Lowest Value	81.25	81.25	75.00	62.50
Reach	62.50	62.50	43.75	25.00

Based on Table 1, it can be explained that the lowest scores from the analysis of 21st century skills are separately 81.25, 81.25, 75.00 and 62.50 respectively. While the highest values were 18.75, 18.75, 31.25, and 37.50 respectively. Based on the four components of the assessment on 21st century skills, students have not achieved the expected results so that this requires anrenewal in learning so that get optimal results as expected.

STEM integrated e-jobsheet description. The results of the next study are product descriptions. The product developed is an integrated STEM e-jobsheet to improve students' 21st century skills. The e-jobsheet is designed based on the writing structure of the ejobsheet. According to Aryhar (2011) and Prastowo (2012) the functions of a worksheet or jobsheet are as follows: As a teaching material that can minimize the teacher's role, but activates the role of students more. As a teaching material that makes it easier for students to understand the material provided. As a teaching material that makes it easier for students to understand the material provided. Facilitate the implementation of teaching to students. Canci & Rasyis in Abidin et al. (2014) a complete jobsheet has the following: layout and code numbers, the purpose of the work to be made, tables of tools and materials to be used, work steps to complete the work, work safety that must be considered, and evaluation of learning outcomes. The components of the jobsheet according to Trianto (2012) include experimental title, brief theory related to the material, tools and materials, experimental procedures, observational data and questions, conclusions for discussion material.

The following is the result of the e-jobsheet cover which can be seen in Figure 4.

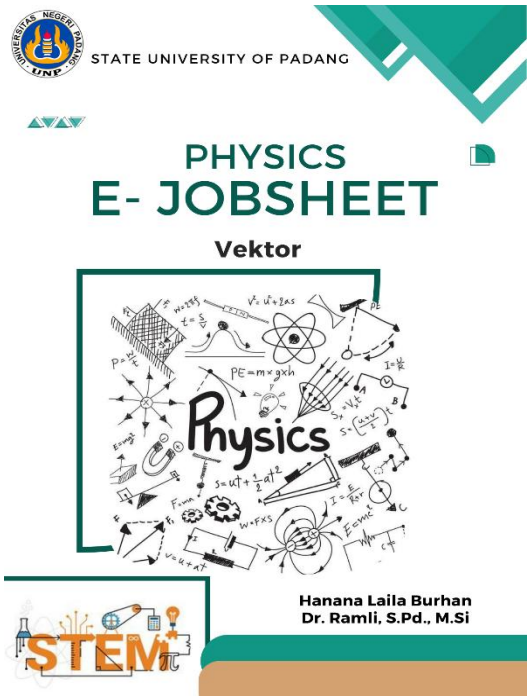

Figure 4. Cover

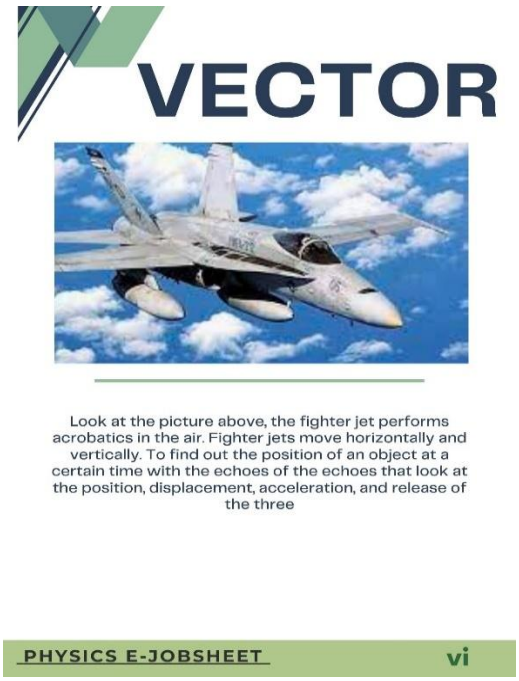

Figure 5. E-Jobsheet Presentation

At the beginning of this e-jobsheet there are covers and engineering parts in STEM activities. In the cover view of the e-jobsheet which contains the title, author, semester and class. This teaching material is provided for class XI high school students in semester 1. The appearance of the cover is made as attractive as possible by balancing the colors, providing an animation that describes the contents of the e-jobsheet. On the front page (cover) is adjusted to this linguistic indicator assesses whether the information in teaching materials

reaches students as users of teaching materials. Construct validity assesses the various components of the intervention in relation to one another. The validity of graphical indicators assesses how the appearance, type and size of writing used, layout, and illustrations or pictures related to the material, so that readers can understand and understand the material in the e-jobsheet properly. The validation results can be seen in Table 5.

Table 5. E-Jobsheet Validator Resultts

Rated aspect	Expert Validator	
	Aiken's V Score	Criteria
Content eligibity	0.71	Valid
Constuctur Feasibility	0.73	Valid
Language Eligibity	0.79	Valid
GraphicnEligibility	0.82	Valid
Average	0.76	Valid

Based on Table 5 it can be seen the average results e-jobsheet validation of 0.76 with valid criteria. Physics ejobsheet integrated STEM approach to improve students' 21st century skills that can be used in the learning proces. Integrated e-jobsheet practicality test results. STEM. The results of the research after the product has been validated, the next step is to carry out the students' practice unit to find out the practicality of the product that has been developed. This practicality can be seen from the results of the questionnaire that has been filled in by educators. The practicality instrument used has components which include: usable, Easy to use, appealing, Cost Effective, and Low Cost. Analysis of each practicality component can be seen in Table 6.

Table 6. Educator Practicality Result

Indicator	Mark (%)	Category
Usable	81.71	Very Practical
Easy to use	83.81	Very Practical
Appealing	87.27	Very Practical
Cost Effective	75.00	Practical
Low Cost	89.84	Very Practical
Average	83.53	Very Practical

Based on the results of the practicality of the students, the results of the practicality of the components Usable with a value of 81.71%, Easy to use with a value of 83.81%, Appealing, with a value of 87.27%, Cost Effective with a value of 75%, and practicality, Low Cost with a value of 89.53%. The average practicality of the physics e-jobsheet is 83.53% in the very practical category. Practicality is also carried out by educators. The practical results of educators can be seen in Table 7 below Practicality is also carried out by educators. The practical results of educators can be seen in Table 7.

Table 7. Educator Practicality

Indicator	Mark (%)	Category
Usable	90	Very Practical
Easy to use	90	Very Practical
Appealing	75	Practical
Cost Effective	75	Practical
Low Cost	75	Practical
Average	81	Very Practical

Based on results practicality educated practicality results obtained on components that can be activities are in the good category. Second, the results of the analysis of the characteristics of students are still. Appealing with a value of 87.27%, Cost Effective with a value of 75%, and practicality-saving Low Cost with a value of 89.53%. The average practicality of the physics e-jobsheet is 83.53% in the very practical category (Greenstein, 2012).

Conclusion

Research that has been done, four conclusions can be drawn. First, the results of the analysis of learning activities with an average of 83.62 are in the good category. This shows that the analysis of learning, based on the results of the analysis of students' interest in learning, it is necessary to increase it so that the physics learning process can take place optimally and the expected learning objectives are achieved. Third, the results of the analysis of 21st century skills are still low, based on the four components of the assessment on 21st century skills, students have not achieved the expected results so this requires an innovation in learning so as to get more optimal results as expected. Fourth, students who developed valid and practical for use in learning.

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Authors Contribution
Conceptualization and methodology, H.L.B.; software, validation, formal analysis, and investigation, H.L.B. and A.; data curation, H.L.B. and A.; writing—original draft preparation, H.L.B., A. and R.; writing—review and editing, R.

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Conflicts of Interest
There is no conflict of interest.

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