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Development of STEM-Based Student Worksheets on Virus Material to Improve Student Science Literacy

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Abstract: This study aims to design and produce Student Activity Sheets based on Science Technology Engineering and Mathematics (STEM) on Virus material. The research design used is a type of research and development. The subjects in this study were Material Experts, Media Experts, Instrument Experts, Biology teachers and students of class X-IPA-2 MAS-AL-Washliyah 12 Perbaungan. Data collection was carried out with instruments in the form of material expert validation assessment sheets, media experts, teacher assessment instrument experts and student responses. Data analysis used quantitative and qualitative descriptive analysis. The design of STEM-based student worksheets is carried out using the 4D development model because in this model each stage is revised until a better student worksheet product is obtained. The results showed that the design of STEM-based student worksheets based on the assessment of material experts obtained an average percentage of 98.2 % with very valid criteria, the assessment of media experts obtained an average percentage of 84 % with very valid criteria, and the assessment of instrument experts obtained an average percentage 100 % with very valid criteria. The results of using student worksheets based on the STEM approach designed to foster scientific literacy skills obtained an average score of 8.6.3 % with a total of 19 students who completed. STEM-based student worksheets on Virus material that have been designed to obtain the assessment criteria of "Very Practical " and have fulfilled the requirements for effective use in improving scientific literacy skills and are suitable for use in the Biology learning process on virus material

Keywords: Scientific literacy; STEM; Student worksheets; 4D

Introduction

The 2013 curriculum has become a model for how the Indonesian education system has developed over the past few years. Minister of Education and Culture Regulation Number 20 of 2016 stipulates that educational institutions must be able to develop the four C skills of critical thinking, communication, creative thinking, and collaboration in the context of implementing the 2013 curriculum (Ananda et al., 2022). It is only natural that Indonesia must adjust its educational policies and curricula to face these global challenges because it is part of the global environment (Sajidan et al., 2019).

In the industrial era 4.0, the learning process in educational units is carried out systematically to produce human resources (HR) who are competent and able to think creatively, master their fields of knowledge optimally, and apply those in the world of work cannot be carried out. Apart from the process of preparing a golden generation of Indonesia who is qualified and able to compete. Hanover (2011) able to motivate students to participate actively and provide sufficient space for ideas, creativity, and independence in accordance with the interests, talents, and psychological and physical development of students (Harahap et al., 2018). Presenting material, learning climate, learning media and assets, as well as instructors as learning subjects are the four main factors that influence student achievement. Due to lack of facilities, difficulties in disseminating learning resources, lack of reading materials, extensive subject matter, and limited time,

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students experience a class environment that is barren, boring, and binding (Simatupang et al., 2020).

One of the learning resources that can help students in learning is Student Worksheets. According to Aldila et al. (2017), Student worksheets are teaching materials in the form of sheets that contain instructions for using theory and practice based, steps for completing assignments, and steps -work steps. Using student worksheets can help students learn on their own and make material easier to understand. With the help of Student Worksheets on Virus Biology material, students are expected to be able to discover and develop biological concepts about virus material (Herlina, 2017). This will help them form an effective interaction with the teacher and increase student activity that enhances scientific literacy skills because student worksheets are an important learning tool (Putra et al., 2018).

STEM is a learning approach that connects four fields, namely science, technology, engineering and mathematics into a holistic whole (Yunipiyanto et al., 2020). The goals of STEM in the world of education are in line with the demands of 21st century education, namely that students have scientific and technological literacy skills that can be seen from reading, writing, observing, performing science skills, and being able to develop the competencies they already have to apply them in dealing with problems in everyday life, days related to STEM science fields (Suprobowati et al., 2018). Along with the development of the times where the demands of the 21st century that education must be linked to science, technology, engineering and mathematics, it is very necessary to worksheets for students based on STEM so that education is not left behind (Aldila et al., 2017).

Improved Skills Scientific literacy is the ability to understand the characteristics of science in the contemporary world, apply scientific knowledge, identify problems, describe scientific phenomena, draw conclusions based on evidence, and be willing to consider and engage with scientific concepts. and ideas. Students' understanding of the importance of science and technology for their daily life is one aspect (Widiyanti et al., 2020). To make evidence-based decisions, they must be able to evaluate scientific data and information using the scientific method. So it is known that students lack scientific literacy skills, such as not being able to conduct an effective literature search, understand and interpret basic material, understand the elements of research design, and be able to draw learning outcomes (Khairiyah, 2019).

Scientific literacy is one of the important skills that students need to have (Prastowo, 2021). Logical education is used to adapt, deal with ordinary problems, understand and describe logical oddities using logical proofs. The terms "scientific knowledge" and "using that knowledge to identify questions", "acquiring new knowledge", "explaining scientific phenomena", and "drawing conclusions" are used to describe a person's scientific knowledge in scientific literacy in the International Student Assessment Program (PISA). According to the words of the OECD PISA, science process skills, conceptual knowledge, and scientific attitudes are components of scientific literacy. So it tends to be considered that logical abilities are very important for students to dominate because they are able to understand climate and peculiarities because logical proofs depend heavily on innovation and logical turns of events (Agustina, 2017).

Based on the results of observations that I made at SMA/MA school seeing the problems that exist, the researcher will conduct research with the research title: "Development of Stem-Based Student Worksheets on Virus Material to Improve Students' Science Literacy Skills in SMA/MA". The need for the development of Stem-Based Student Worksheets so that students become active regarding STEM-based Biology learning, and with STEM-based Student Worksheets students are able to master aspects (Anggraini et al., 2020).

Method

The development model which is also known as research and development (R&D) is the model used in this research. Innovative work strategy (Research and development) is an exploratory technique used to create certain items. By validating products to be used in educational settings, research models and this development is used to develop a product (Sugiyono, 2018). This research and development model utilizes an educational research and development strategy known as 4D Design (Define, Design, Development, and Disseminate) (Emzir, 2019).

This development research method was chosen by the researcher because it produces a certain product that has been tested for its effectiveness (Syaukani, 2018). The researcher also decided to use the 4D design because it was programmed with a planned sequence of activities to try to solve specific learning problems with the needs and characteristics of students (Sugiyono, 2018). The procedure for developing STEM-based biology student worksheets refers to the 4D development model (Trianto, 2018) which can be explained as follows:

Stage Definition (define)

Action which done on study this is analysis. Stage analysis is something collection information through process analysis need and analysis situation. Analysis done with gather information about device learning what which need for developed, in study this device which developed is sheet work participant educate.

Which where student worksheets they must notice material tree which discussed, notice experience student learning, paying attention to suitability of core competencies, basic competencies, and learning objectives Which will achieved as well as must notice writing and drafting student worksheets good and right.

Collection information done with observation And interview towards biology teachers for class X-IPA at MAS-Al-Washiyah 12 Perbaungan, student worksheets _ used in the classroom X -IPA still own a number of lack, that is student worksheets Which used is still in the form of student worksheets from the government characteristic theoretical, and lack of practical activities so that it causes students to be less active because lack of direct practical activities carried out by students, poor design used still not enough interesting, student worksheets also not yet load condition and component which should there is in in drafting student worksheets as well not yet concerning STEM learning, so it is necessary to develop student worksheets with STEM approach.

Stage Design (design)

Kindly line big steps drafting LKPD Biology Senior High School class X based science, technology, engineering, and Mathematics (STEM) that is (Silvia et al., 2020): (a) Determine title student based worksheets material Which listed on curriculum 2013 as well as combine title based approach STEM; (b) Determine Design Student worksheets. The steps to be carried out in writing student worksheet designs that is: according to Ministry of National Education Student worksheets Which Good must have structure in the form of, (1) Instructions for learning, where the instructions contain steps for Teacher And student in use student worksheets; (2) Competence Which will achieved contains core competencies, basic competencies and required indicators achieved and associated with the STEM approach; (3) Supporting information, where Student worksheets they must own information addition Which can be equipped material teach so that student the more easy For master knowledge obtained; (4) Work step, where inside the student worksheet contains procedural steps for carrying out certain activities what students have to do with regard to practice; (5) Exercise, where Student worksheets must own task or question exercise Which associated with STEM approach and shown to students to practice skills students after studying teaching materials the (Sari et al., 2019).

Stage Development (Develop)

On stage development done development design student worksheets for produce student worksheets, which have gone through the feasibility and effectiveness tests. Testability ndone by expert material and expert media whereas test effectiveness based on teacher's response and students.

Stage Deployment (Disseminate)

At this stage includes teaching materials that have been tested in groups small in class, the teaching materials are ready to be tested in groups big to produce. The dissemination was carried out in one class containing 19 students.

Product Trials

Once made, learning activities test teaching materials. The purpose of this trial is to find out whether this teaching material can help students learn. Small-scale product trials were conducted to assess the quality of the products being developed and to find out how students responded. The trial was attended by 19 students at MAS-AL-Washliyah 12 Perbaungan.

Trial Design

This study started with determine criteria evaluation, stage next is the planning and implementation stages. Next stage product assessment, assessment is carried out by material experts, design experts. Biology teacher and students will respond to the developed student worksheets (Sugiyono, 2019). The research design used in this study consisted of 4 stages. Process development student worksheets consists from stages definition (define), stage design (design), development stage (develop), and the deployment stage (disseminate).

Trial Subjects

A subject matter expert biology lecturer, a media expert biology lecturer, a biology teacher at MAS-Al-Washliyah 12 Perbaungan, and 19 students of class X-IPA at MAS-Al-Washliyah 12 Perbaungan were the subjects of this study. The purpose of this research is to make student worksheets that are adapted to the STEM approach and aim to increase students' scientific literacy.

Data Type

Quantitative and qualitative data are two types of information that can be obtained from validation results in the framework of compiling STEM-based student worksheets . Descriptive statistical analysis was used for data analysis. Quantitative descriptive data shows whether the student worksheets used meet the valid, useful, and efficient quality criteria. While the validator's criticisms, suggestions, and responses provide qualitative descriptive data, later revisions to the student worksheet products that are being developed will be based on criticism, suggestions, and validators.

Research Methods and Instruments

Instrument is tool which used researcher for help collect data so that the research becomes systematic. Instruments that used researchers are: Interview, is method for gather a data form information which we need from someone teacher. Sheet validation, is collection dat a with method give assessment of the product to be developed and given to expert material and expert media for validate product which already there is. Questionnaire, a series of questions that will be answered by other people who are willing to provide responses (respondents) as requested user. The test, in the form of questions in essay form, was given by individual or group for done, answered or responded in form written as well as deeds.

Data Analysis Methods and Techniques

The data obtained in this study are quantitative and qualitative data. Quantitative data obtained in the form of assessment scores by material experts, media experts, teacher responses and student responses. Meanwhile, the qualitative data obtained was in the form of responses and suggestions given by the validator regarding the "Student worksheets with the STEM approach on Virus material" that have been developed. Data analysis in this study was descriptive and the data obtained was in the form of a checklist summarized in the form of a Likert scale table for material experts, media experts and teachers. As for students using the Guttman scale.

Analysis validity based results from para expert validation. Data This validity was obtained from the assessment by material expert lecturers and expert lecturers media. Practicality analysis step in analyze questionnaire response student with data acquisition in the form of a checklist which is summarized in the Guttman table with answer options Yes or No. The answer "Yes" is given a score of 1 and the answer "No" is given a score of 0.

Analysis this effectiveness is based on on achievement student in finish test results Study. Testing effectiveness product which developed by giving posttest and pretest to the participants educate on moment test field.

Results and Discussion

This research was conducted in 2 meetings, the first meeting was Monday, February 13, 2023, Tuesday February 14, 2023. Before the STEM-based student worksheet products on the virus material itself were tested on students, the student worksheets were validated by an expert validator. So that after the developed student worksheets are valid/fit for use then the school testing process is carried out to obtain assessment results from teachers in the biology study field and find out the effectiveness of student worksheets in fostering students' scientific literacy skills.

Define stage consists of 4 analyzes including initial needs analysis, student analysis, task analysis and concept analysis. Initial needs analysis is carried out by observing and analyzing what kind of development will be carried out according to needs. Student analysis is carried out by interviewing students regarding Student Worksheets that will be developed with the aim of knowing and gathering information about student activity. Task analysis was carried out by interviewing students. Concept analysis is carried out according to the needs as teaching materials.

Design Stage, planning is carried out for the media to be used, such as planning development Learner participant worksheets. Compile objective learning general that is achievement core compensation and basic compensation as well objective special that is, to increase scientific literacy skills. Choose format Student worksheets with study student worksheets which has there is. Choose material Virus based the STEM will arranged in Student worksheets. Compile design Student worksheets STEM as material teach for SMA/MA. Design t- form it contains covers front, body, and back cover.

Develop stage, namely the development of Student Worksheets used in research as teaching materials by validating Student Worksheets. The validation test was carried out to find out how valid the Student Worksheets were made by the researcher. Validation was carried out with 3 validators including, material validation, media validation and instrument validation.

Table 1. Results of Validation by Validator Media

Aspect	Score Obtained	Maximum Score	Percentage	Category
Component presentation	25	28	89.2%	Very valid
cover design	15	16	93.75%	Very valid
Content design	21	24	87.5%	Very valid
STEM components	13	16	81.25%	Very valid
Number of Scores obtained				74
Maximum Score				88
Percentage				84%
Category				Very valid

Media expert validation, this validation is carried out by an expert validator. Based on the results obtained by averaging the entire validation results from the media validator, it shows the "Very Valid" category with an

average of 84%. As for the notes and input from the media validator, namely improvements to STEM activities, writing and layout of covers as well as improvements to the format of titles and subtitles. The following table validates the results of the media validator (Riduwan, 2019).

Material expert validation, this validation is carried out by an expert validator. Based on the results obtained by averaging the validation results from material experts, it shows the "Very Valid" category with an average of 98.2%. With this category it is feasible to use in learning with improvements such as more material being reproduced and the selection of images must be more precise. The following is a table of validation results by the material validator.

Table 2. Results of Validation by the Material Validator

Aspect	Score obtained	Maximum Score	Percentage	Category
Feasibility of presentation of the material	32	32	100%	Very valid
STEM components	16	16	100%	Very valid
language use	7	8	87.5%	Very valid
Number of Scores obtained				55
Maximum Score				56
Percentage				98.2%
Category				Very valid

Table 3. Validation Results by Instrument Validator

Aspect	Score obtained	Maximum Score	Percentage	Category
Clarity	12	12	100%	Very valid
Content accuracy	4	4	100%	Very valid
Relevance	8	8	100%	Very valid
Content validity	4	4	100%	Very valid
No biases	4	4	100%	Very valid
Language accuracy	12	12	100%	Very valid
Number of Scores obtained				44
Maximum Score				44
Percentage				100%
Category				Very valid

Instrument validation, this validation was carried out by Ms. Mira Wahyuni, M.Pd. based on the results obtained by averaging the overall validation results from instrument experts showing the "Very Valid" category with a percentage of 100%. The results of the instrument validator can be seen in table 3.

After validating the student worksheets (LKPD) used, then conducting a practicality test on student worksheets by giving questionnaires to respondents such as teachers and students about the use of student worksheets as learning teaching materials will be used.

Teacher Response

The teacher who received the student worksheets and the Biology teacher's response questionnaire was Mr Abdul Kadir Jailani, S.Pd from MAS AL-Washliyah 12 Perbaungan. The results of the student worksheets responses from the Biology teacher are as follows.

Table 4. Teacher Response Results

Aspect	Score obtained	Maximum Score	Percentage	Category
Interesting LKPD cover	1	1	100%	Very practical
Suitability of the subject matter with KI and KD	1	1	100%	Very practical
There is a STEM-based LKPD	15	15	100%	Very practical
Number of Scores obtained				17
Maximum Score				17
Percentage				100%
Category				Very practical

Based on Table 4 regarding the results of the biology teacher's responses, it can be seen that Student Worksheets in the cover aspect of interesting student worksheets obtain a percentage of 100%, then in the aspect of suitability of the subject matter with core competencies and basic competencies obtain a percentage of 100%, in the aspect of existence STEM-based student worksheets get a percentage of 100%. Then the overall percentage of the results of the teacher's response is 100% in the very practical category.

Student Response

Student response questionnaires were filled in by 19 students for practical tests of Student Worksheets used. This questionnaire explains the Student Worksheets that will be used for the research to be carried out. The results of the responses from 19 students were as follows (Sukmana, 2017).

Table 5. Student Response Results

Student	Score Obtained
Respondent 1	6
Respondent 2	10
Respondent 3	7
Respondent 4	7
Respondent 5	7
Respondent 6	10
Respondent 7	10
Respondent 8	8
Respondent 9	8
Respondent 10	9
Respondent 11	10
Respondent 12	10
Respondent 13	10
Respondent 14	10
Respondent 15	10
Respondent 16	7
Respondent 17	10
Respondent 18	8
Respondents 1 9	7
Amount	164
Average	86. 3%
Category	Very practical

Table 6. N-Gain Results

Student	Pretest	Posttest	N-gain Score
Respondent 1	30	60	0.42
Respondent 2	40	60	0.33
Respondent 3	30	70	0.57
Respondent 4	30	50	0.28
Respondent 5	30	70	0.57
Respondent 6	20	70	0.62
Respondent 7	35	60	0.38
Respondent 8	30	70	0.57
Respondent 9	45	50	0.09
Respondent 10	40	60	0.33
Respondent 11	30	70	0.57
Respondent 12	40	60	0.33
Respondent 13	40	40	0
Respondent 14	50	50	0
Respondent 15	40	60	0.33
Respondent 16	40	60	0.33
Respondent 17	40	60	0.33
Respondent 18	30	70	0.57
Response 19	30	50	0.28
Amount			6.9
Average			0.36
Category			Currently

From table 5, it can be seen that the results of student responses to the Student Worksheet used from 19 students got a score of 164 out of a maximum score of 190 with an overall percentage result of 86.3% in the very practical category. The results obtained indicate that the student worksheets used are very practical to use in learning activities.

Dissemination stage is carried out by distributing or giving Student Worksheets to students and seeing the results of the effectiveness of Student Worksheets on students. Next, test the effectiveness of Student Worksheets to improve students' scientific literacy skills by conducting direct trials on students who are at MAS-Al-Washliyah 12 Perbaungan. The results of its effectiveness are as in the following table.

Based on table 6, it can be seen that the N-gain results that have been carried out at MAS Al-Washliyah 12 Perbaugan get a total score of 6.9 which is then averaged to 0.36 in the moderate category. The results of the pretest and posttest values that have been tried in this study obtained an average pretest score of 35. 2 and the average posttest score is 60 which shows that it has increased by 70% from the pretest to the posttest score.

Based on the results of the analysis, it can be seen that the Student Worksheets are stated to be very valid from media experts at 84%, then very feasible from material experts with a percentage of 98. 2% and very valid from instrument experts with a percentage of 100%. The Student Worksheets are also practical in accordance with the results of the practicality test carried out by teachers and students with respective scores of 100% and 86.3% in the very practical category. Student Worksheets also effective with an N-gain value of 0.36 in the moderate category. This is in accordance with research conducted by Choirun et al. (2020) which states that student worksheets are considered effective in increasing scientific literacy with an average N-gain of 0.8 in the high category.

Conclusion

Based on the results of the analysis that has been done, it can be concluded that the student worksheet is very valid with a percentage value of 84% from media experts, 98.2% from material experts in the very valid category and 100% from instrument experts in the very valid category. Student worksheets are also practical according to the practicality test with a percentage value of 100% from school teachers in the Very practical category and 86.3% of student responses in the very practical category, not only valid and practical student worksheets used are also effective with an average value of 0.36 in the moderate category and have increased from pretest scores to posttest scores of 70%.

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