THE DEVELOPMENT OF STEM APPROACH-BASED LEARNING MATERIALS TO PRACTICE SCIENTIFIC PROCESS SKILLS FOR STUDENTS OF VIII MTsN 2 KEDIRI

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Abstrak

Tuntutan pembelajaran abad 21, dimana teknologi terintegrasi dalam pembelajaran sudah hal biasa. Pembelajaran dengan pendekatan STEM (*Science*, *Technology*, *Engineering* dan *Mathematic*) menjawab tuntutan pembelajaran abad 21. Tujuan penelitian ini mendeskripsikan hasil validasi perangkat pembelajaran yang dikembangkan, dari segi kepraktisan perangkat pembelajaran dintinjau dari aktivitas peserta didik selama pembelajaran, sedangkan dari segi keefektifan perangkat pembelajaran ditinjau dari hasil keterampilan proses sains peserta didik. Metode yang digunakan penelitian pengembangan 4D yang diadaptasi. Pada tahap uji coba lapangan digunakan subjek penelitian 30 peserta didik kelas 8C di MTsN kota Kediri. Teknik analisis data yang digunakan deskripstif kuantitafif dan kualitatif. Peserta didik melakukan percobaan tekanan hidrostatsis, komponen keterampilan proses yang dianalisis (1) merumuskan masalah, (2) merumuskan hipotesis, (3) mengidentifikasi variabel, (3) menginterpretasi data dan (4) menarik simpulan. Tes keterampilan proses sains berupa soal esai pada materi tekanan zat cair yang sudah sesuai indikator KPS yang sudah ditentukan. Hasil validasi perangkat pembelajaran berkategori valid dan layak digunakan sebagai refrensi guru dalam pembelajaran, hasil kepraktisan perangkat pembelajaran diperoleh aktivitas peserta didik yang tertinggi melakukan percobaan, sedangkan keefektifan perangkat pembelajaran diperoleh hasil KPS tertinggi indikator menginterpretasi.

Kata kunci: Perangkat Pembelajaran, STEM, dan Keterampilan Proses Sains

1. INTRODUCTION

The development of learning in the 21st century will never cease, where learning is an activity process to acquire knowledge, improve skills, improve behavior and shape character [1]. According to conventional scientific understanding, human interaction with nature is called experience, repeated experience can make a knowledge [2].

Science was born and developed through stages of observation, problem formulation, formulation of hypotheses, experiments, conclusions and discoveries of theories and concepts, where these stages are known as scientific methods. The basis for solving problems in science and the scientific method requires a skill known as scientific process skills [3]. The World Bank finds a comparison of access and quality about educational achievement in several countries. Most average Indonesian students can only answer memorization questions, but still find it difficult to solve problems at the level of reasoning or process skills

The researcher has observed 20 students in MTsN Kediri City, to know the Scientific process Skills (SPS) possessed on average, using instruments from Monica which have been adapted by researchers in Indonesian. The integrated scientific process skill components contained in the test, (1) identify and control variables, (2) express hypotheses, (3) operational definitions of variables, (4) design research, and (5) describe and interpret data. Results obtained by the scientific process skills of MTsN 2 Kediri City students reached an average of 58%. This shows that the SPS (Scientific Process Skills) of students is still not optimal and needs to be trained better.

In the results of the scientific process skills, it is still unable to answer the demands of skills in the 21st century, where scientific process skills are the basis of 21st century learning skills. In which technology has been integrated in learning is common, one learning that can meet 21st century learning is STEM based learning (Science, Technology, Engineering, and Mathematics). Science is the main concept in the series, science requires math as a tool in processing data, while technology and engineering applications from science. Technology, Engineering and mathematics are merged in learning Science, so learning science is not just learning concepts and theories . Organizing learning activities in STEM helps students develop scientific process skills.

One material that can be used in STEM, namely the sub-topic of liquid pressure. Liquid pressure will become interesting and increase the motivation of students to learn and understand existing concepts.

The aim of this study is to describe the results of the validity of learning materials based on the STEM approach, in terms of practicality of learning materials to describe the activities of students, while in terms of the effectiveness of STEM-based learning tools to describe the results of scientific process skills. The benefits of this research can be as a literature of learning tools in the classroom by teachers, while for students as the latest experience in learning.

2. RESEARCH METHODS

The development phase includes four stages of the 4D development model, which are define, design, development, and disseminate. The 4D model used in this study uses the model proposed by Thiagarajan, but the study was carried out to the develop stage only, for the disseminate stage was carried out [9] as in Figure 2

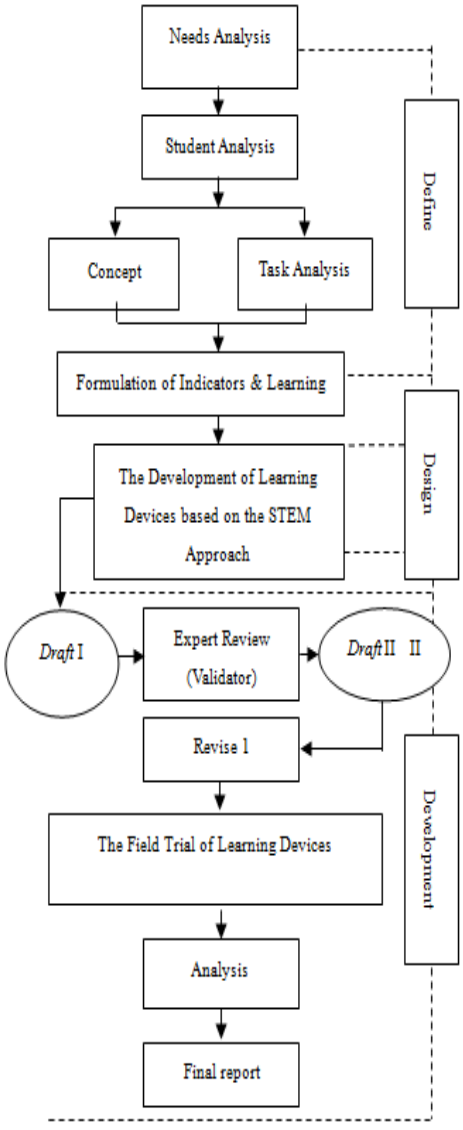

Figure 2. Research Steps for the Development of 4D Learning Devices adapted

a. The STEM Components in Hydrostatic Pressure Material

At the development stage, learning materials are developed by integrating STEM components in learning, as in Table 3

Table 3. The STEM Components in Hydrostatic Pressure Material

The Experiment	Science	Techno-logy	Enginee-ring	Mathema-tics
Hydrostatic pressure using hartl tools	The use of the hydrostatic pressure concept	The use of Hartl tool as an experi-mental tool	Designing hartl tools	Liquid pressure calcula-tion results

b. The Field Trial Phase

At the field trial stage using "One Group Pretest Posttest Design" with a sample of 30 students. The field trial scheme can be described as Table 4.

Table 4. Trial Design Results of Development Learning Materials

Pretest	Treatment	Posttest
O1	X	O2

Noted:

O_1 : SPS (Scientific Process Skills) pretest results of students before being given treatment

X : treatment using learning tools based on the STEM approach

O_2 : SPS (Scientific Process Skills) posttest results for students are given a treatment

The subjects of this research were STEM-based learning materials developed and tested on 30 MTsN 2 Kediri City students in the 2019/2020 school year.

The Analysis of the Validity Learning Materials

The analysis on the validity of learning materials uses research from a scale of 1 to 4, with categories 1 (poor), 2 (adequate), 3 (good) and 4 (very good). The results of the scores from the validators are averaged then interpreted in the form of scores as in Table 5

Table 5. The Criteria for Assessing Device Validity

The Average Score Interval	Category	Noted
$1,0 \leq SV \leq 1,59$	Invalid	Not used yet and still requires consultation
$1,60 \leq SV \leq 2,59$	Less Valid	Can be used with many revisions
$2,60 \leq SV \leq 3,59$	Valid	Can be used with a slight revision
$3,60 \leq SV \leq 4,0$	Very Valid	Can be used without revision

Noted: SV = The Average score for Device Validity Assessment

The Practical Analysis of Learning Materials based on the STEM approach

The analysis on practicality is reviewed from the activities of dominant students during learning, observing student activities using quantitative and qualitative descriptive. The data observations of students' activities during learning activities were analyzed using percentages in the form of equations as follows:

$$P = \frac{\sum R}{\sum N} x\ 100\ \%$$

Noted:

P = The Percentage of student activity

R = The Number of frequencies of observation categories
N = The Number of frequencies for all observation categories

The Analysis of the Effectiveness of Learning Materials Based on the STEM Approach

The analysis of effectiveness in terms of the results of students 'scientific process skills, analysis test data using descriptive qualitative analysis to obtain the value of students' scientific process skills (SPS) with the formula:

$$Percentage\ of\ SPS = \frac{\sum S}{\sum M} x\ 100\ \%$$

Noted:
SPS = Scientific Process Skills
S = The number of scores of obtained
M = The maximum correct score

3. FINDINGS

The Materials Validation Results and Discussion

The results of the STEM-based learning materials validation assessment from 3 validators, obtained a score as in Table 7.

Table 7. The Results of STEM-based Learning Materials Assessment

Learning Materials	Score results	Category	Noted
Syllabus	3.62	Very Valid	Can be used without revision
Lesson Plan	3.94	Very Valid	Can be used without revision
Teaching materials	3.85	Very Valid	Can be used without revision
Worksheet	3.75	Very Valid	Can be used without revision
SPS question	3.89	Very Valid	Can be used without revision
Modus		Very Valid	Can be used without revision

Based on Table 5, it can be concluded that the learning materials based on the STEM approach on liquid pressure material that aims to train students' scientific process skills can be used and are appropriate as references for other teachers to use in learning. According to the theory of learning that learning with an innovative approach and experimenting or experimenting will provide a strengthening of memory in the minds of students [12].

The Results and Discussion of Practical Learning Materials

The activities observed in learning based on the STEM Approach are presented in Table 8.

Table 8. The Student Activity Observed

Activity Code	Activity observed
Act 1	Pray based on each religion
Act 2	Answering questions proposed by the teacher in the preliminary activities
Act 3	Observing the teacher when providing initial motivation
Act 4	Listen / pay attention to teacher's explanation
Act 5	Read the teaching material of students / worsheet
Act 6	Carry out an experiment
Act 7	Take notes / write
Act 8	Ask to the teacher
Ak 9	Express opinions / communicate the results of experiments

Noted Act: Activity

The results obtained on the activities of students during STEM-based learning are illustrated in Figure 3.

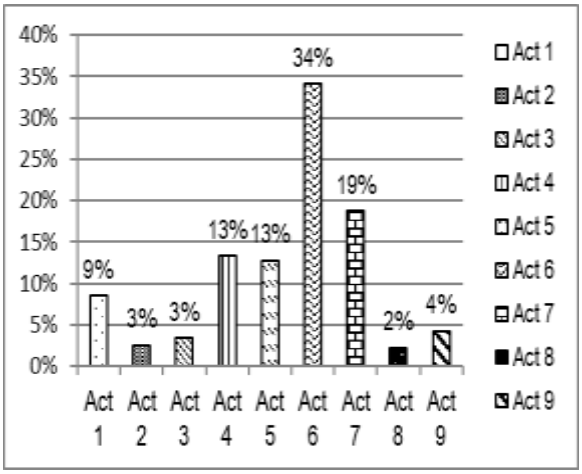

Figure 3. The Percentage of student activity

Based on Figure 3, activity 6 is conducting an experiment, in this case students conduct an experiment and design a device to investigate the effect of the depth of an object in a liquid on the amount of hydrostatic pressure received by that object. That is because the students are very enthusiastic about doing experiments, where learning by conducting experiments makes them not saturated and makes learning meaningful [14].

While activity 8 is the activity of praying according to their respective religions, in this case the activity is carried out only at the beginning and at the end of the lesson. So that, the percentage acquisition at the observed time frequency becomes the lowest.

The pretest results of the scientific process skills of MTsN 2 Kediri City students are depicted on the graph as shown in Figure 4.

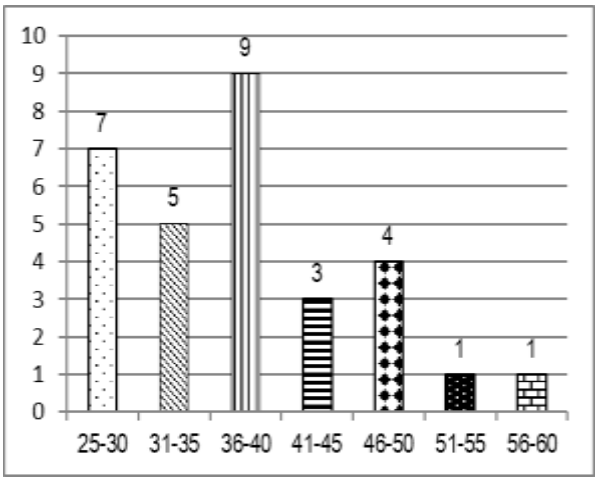

Figure 4. The Range of Pretest results graph

The pretest scientific process skills of students were tested for normality with the chi square test, obtained the results of calculations using the Kolmogorov-Smirnov test with the help of SPSS software version 25.0 with a significance level of 0.05 as Table 9

Table 9. The Calculation results for the pretest normality test

	Kolmogorov-Smirnova		
	Statistic	df	Sig.
Pretest 8-C	0.146	30	0.103

a. Lilliefors Significance Correction

Based on Table 6, Kolmogorov-Smirnov results obtained a probability value (P-value) of 0.103, a probability value greater than the significance level of 0.05, which can be concluded that H_0 is accepted. The samples taken can be said to be from normally distributed populations.

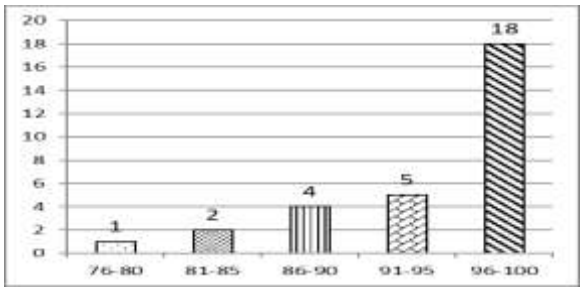

Figure 5. The Posttest Results Chart

Based on Figure 4 and Figure 5, the n-gain test is used to determine the increase from pretest to posttest, it can be seen in Table 10

Table 10. N-gain Test Results

Grade	<g>	Category
8-C	0.90	High

Based on the results of the n-gain test, it can be concluded that there was an increase in the results of the posttest and an increase in high-level scientific process skills in which STEM-based learning can have an influence on students' scientific process skills, this is also due to the STEM-based learning of students invited to experiment. In accordance with Piaget cognitive development, students of SMP / MTs are included in the Formal Operational stage which means being able to think abstractly and be able to analyze problems scientifically and then solve problems [15]. So, students can be trained in scientific process skills, but also need a real approach.

The results of the students' scientific process skills after being given learning based on the STEM approach can be seen in Figure 6.

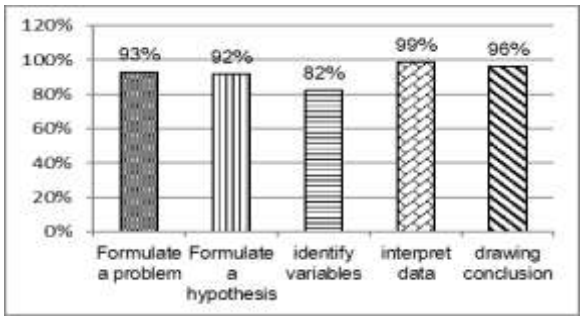

Figure 6. The Results Percentage of Students' Scientific Process Skills

Based on Figure 6, the highest component of scientific process skills is interpreting data. Where from the posttest questions in the form of essays given, almost all students can make graphics or form data into other forms. At the lowest component is formulating a hypothesis, this is because students are still difficult to predict an event if they do not know the concept of working materials or a phenomenon. So, it can be concluded that the results of students 'scientific process skills quite well, and it can be said that learning materials based on the STEM approach can train students' scientific process skills.

In related with the principle of constructivism, it can be called that better understand learning as human activities to build or create knowledge by giving meaning to knowledge in accordance with the experience. Constructivism is actually not a new idea, what is passed in the lives of students so far is a collection and coaching experience for experience. This causes someone to have knowledge and become more dynamic. According to this theory, one fundamental principle is that teachers not only provide knowledge to students, but students must also play an active role in building their own knowledge in their memory. Therefore, the coaching or training of scientific process skills that have been consciously instilled into students, will build and help hone these skills as a whole

4. CONCLUSION

Based on the results of research and discussion, it can be concluded several things about the development of learning materials based on the STEM approach on liquid pressure material. The results of the validation of the learning kit were obtained a modus in the Very Valid category, and it was appropriate to be used as a teacher's reference in classroom learning. In the practical aspect of learning materials based on the STEM approach in terms of the activities of students, the highest activity of students doing experiments reached 35%. And the aspect of the effectiveness of learning materials in terms of the results of scientific process skills, where the highest results in the data interpretation component of 99%, as well as an increase in the tests given achieve a score of 0.90 in the high category.

5. SUGGESTION

Based on the research experience of STEM-based learning development, there are a number of suggestions when conducting research on STEM, the selection of material in accordance with the STEM components is really important. So that, the components are more visible. The STEM learning is more suited to the learning of students in Vocational Schools, which can apply science according to their field of expertise.

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