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DEVELOPMENT OF TEACHING MATERIALS USING A SCIENTIFIC AND CONTEXTUAL APPROACH TO IMPROVE MATHEMATIC CONNECTION ABILITY

Pamila Malinda[1], Euis Eti Rohaeti[2], Asep Ikin Sugandi[3]

[1]Master of Mathematics Education IKIP Siliwangi, Jl. Terusan Jendral Sudirman Cimahi, Jawa Barat, Indonesia.
pamilamalinda31@gmail.com

[2]Master of Mathematics Education IKIP Siliwangi, Jl. Terusan Jendral Sudirman Cimahi, Jawa Barat, Indonesia.
e2rht@ikipsiliwangi.ac.id

[3]Master of Mathematics Education IKIP Siliwangi, Jl. Terusan Jendral Sudirman Cimahi, Jawa Barat, Indonesia.
asepikinsugandi@gmail.com

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ABSTRACT

For students learning mathematics, mastery of concepts is important, one of which relates one concept to another. One of the abilities that students must have is the ability to connect mathematically, but it turns out that the facts in the field are still relatively low. In order to improve the learning process, a combination of scientific and contextual approaches can be used by developing teaching materials. This study aims to develop teaching materials using a combination of scientific and contextual approaches to improve the mathematical connection skills of junior high school students, the method used is Research and Development (R&D) ADDIE model. The results obtained from the limited and wider trial validity are valid and feasible to be used at the product testing stage, at the limited trial stage the practicality of lesson plans and worksheets by teachers is in the practical category and at the wider trial stage it is in the very practical category, the practicality of Student Worksheets by students at the limited trial stage and more broadly is in the practical category, The effectiveness was in the quite effective category in the limited trial stage, and it was in the effective category in the wider trial stage, then the implementation in the limited trial stage obtained a percentage of 81.2% and in the wider trial stage a percentage of 89.7% was obtained and for increasing mathematical connection ability, the N-Gain was 0.58 which was included in the medium category.

Corresponding Author:

Pamila Malinda,
Master of Mathematics Education,
Siliwangi Institute of Teacher Training and Education,
Jl. Terusan Jend. Sudirman, Cimahi, Indonesia
Email: pamilamalinda31@gmail.com

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Mathematics is one of the branches of science that is important to learn, this statement is in accordance with Rahmawati, Priatna & Nurjanah (2018) which states that mathematics is very important to learn because it is widely used as a source of knowledge. Every learning has

a goal to be achieved, as well as learning mathematics. Likewise with mathematics learning, as according Wandini (2019) mathematics learning is a process of teacher activities with students in mathematics subjects that includes the teacher's efforts to create an atmosphere and development of students' abilities, potential, interests, talents, and needs in mathematics is very diverse so that there is an optimal interactio.

Understanding concepts is a very important foundation in learning mathematics, according to Hartati, Abdullah & Haji (2017), because mastering concepts will help or facilitate students in learning mathematics. With a good understanding of concepts, students will have a good foundation to achieve other basic abilities. In linking one concept to another and applying mathematical concepts to everyday life, of course, students need to have a mathematical ability, one of which is the ability to connect mathematically. Mathematical connection ability according to Hadin, Pauji & Arifin (2018) is a mathematical ability that connects one math topic with other math topics (between math topics) and outside math. According to Nurafini & Pujiastuti (2019) mathematical connection ability is a link between ideas or mathematical concepts, mathematics with other fields or mathematics with everyday life problems.

Regarding mathematical connection ability according to the research results of Sari, Mutmainah & Setiawan (2019) the average percentage of students' mathematical connection abilities is still relatively low. This is due to the fact that there are many errors related to arithmetic operations, so the prerequisites for the next material must be mastered in order to support further learning. So that mathematical connection skills can be improved in the learning process, a combination of scientific and contextual approaches can be used to improve mathematical connection skills in the learning process, the scientific approach, according to Nashihah (2020) scientific learning approach that emphasizes students on the need for collaboration and cooperation. However, based on the results of research Sutiarso (2020) the implementation of mathematics learning with a scientific approach is relatively low (26,1%), requiring the use of other approaches to assist the mathematics learning process and the development of the learning tools used.

One approach that can be used is the contextual approach, according to Sagala (2009) the contextual approach is a learning concept that links the material being taught with students' real-world situations and encourages students to make connections between their knowledge and its application in everyday life. With a scientific approach from the results of Anwar, Pujiastuti & Mutaqin (2019) research, it was found that the increase in mathematical connection abilities who received contextual learning was higher than students who received ordinary learning. If a scientific approach is combined with a contextual approach, the learning process will assist students in understanding and solving the problems presented. In order to apply the two approaches in the learning process, learning tools are needed. Learning tools, according to Minggele (2019) are effective and efficient equipment for learning activities that can also optimize interactions between students and students and teachers during the learning process. According to Yupinus, Ichsan, and Ardiawan (2020) improving learning quality can be done by creating learning tools that refer to learning models or approaches so that the learning process can be adapted to the characteristics and social environment of students.

Set of learning according to Nasution and Oktaviani (2020) the series of learning tools can take the form of a Learning Implementation Plan, learners Worksheets, or Student Worksheets where the learning implementation plan is a unit lesson plan that will be implemented by the teacher in learning activities in class, or student worksheets are sheets containing assignments that must be done. The learning process is expected to be more

effective and efficient if the teacher's learning tools use a learning approach, one of which is a combination of scientific and contextual approaches, It can also be adapted to the characteristics and social environment of students, results research Karmila (2018) found that using a combination of scientific and contextual approaches, the development of learning tools such as lesson plans, student worksheets, and attitude assessment sheets was practical and effective for use. Then Nopiyanti (2017) revealed that the five steps of the scientific approach when aligned with the seven steps of the contextual approach students can learn on their own to be more meaningful and learn to relate what is known to what is around them, and from the results of his research reveal that through a scientific and contextual approach has a role important in developing scientific attitudes and meaningful learning to cultivate the seeds of student scientific literacy.

METHOD

This research Research and Development (R&D) which aims to develop teaching materials so that algebraic form materials can improve mathematical connection abilities. The development model that will be used is the ADDIE model. Broadly speaking, the stages of research with the ADDIE Model according to Mulyatiningsih and Nuryanto (2014) include analysis by conducting a preliminary study in the form of collecting data through interviews with two teachers from SMPN 9 Cimahi and SMPN 2 Pagaden to identify potential problems, then the Design stage in the form of preparing Learning Implementation Plan and learners Worksheets on algebraic form material with a combination of scientific and contextual approaches, at the Development stage validation of the Learning Implementation Plan and learners Worksheets at the limited and broad trial stage, the Implementation stage the learning process is carried out with teaching materials that have been made in the limited, broad and product trial phase to see the practicality, effectiveness, implementation, teacher and student responses, the last stage is the Evaluation stage to make the final to the Learning Implementation Plan and learners Worksheets.

Interview sheets to identify potential issues, implementation observation sheets, Learning Implementation Plan and learners Worksheets validation questionnaires, teacher and student response questionnaires, and five mathematical connection ability test questions were used in this study. At the analysis stage, the research subjects were two teachers the trial's subject was limited to 10 students from SMPN 2 Pagaden the wider trial's subject was 60 students from SMPN 5 Klari, SMPN 1 Ibun, and SMP Pasundan 3 and the Produk test's subject was 38 students from SMPN 7 Cimahi. The research was conducted over the course of eight meetings. The procedure for validating the Learning Implementation Plan and learners Worksheets the total score that has been obtained is then converted into qualitative data with five criteria according to Rusnilawati (2016) as shown in the Table. 1

Table 1. Criteria for Conversion of Quantitative Data to Qualitative Data

Score	Score Interval	Category
A	$X > \bar{X}_i + 1{,}8\ sb_i$	Very Good
B	$\bar{X}_i + 0{,}6\ sb_i < X \leq \bar{X}_i + 1{,}8\ sb_i$	Well
C	$\bar{X}_i - 0{,}6\ sb_i < X \leq \bar{X}_i + 0{,}6\ sb_i$	Enough
D	$\bar{X}_i - 1{,}8\ sb_i < X \leq \bar{X}_i - 0{,}6\ sb_i$	Not Enough
E	$X \leq \bar{X}_i - 1{,}8\ sb_i$	Very Less

Table 2 shows the Likert scale scoring table that was used to assess the validity of the lesson plans and worksheets.

Table 2. Validation Criteria for lesson plans and worksheets

No	Interval		Category
	Learning Implementation Plan	**Student Worksheets**	
1	X > 491,4	X > 327,6	Very Good
2	397,8 < X ≤ 491,4	265,2 < X ≤ 327,6	Well
3	304,2 < X ≤ 397,8	202,8 < X ≤ 265,2	Enough
4	210,6 < X ≤ 304,2	140,4< X ≤ 202,8	Not Enough
5	X ≤ 210,6	X ≤ 140,4	Very Less

Description X = Actual Score

After receiving value data from both teachers and students, the analysis is continued by first determining the percentage value of practicality of lesson plans and worksheets using the formula proposed by Sugandi, Sofyan and Maesaroh (2021):

$$P = \frac{f}{N} \text{ x } 100\%$$

Description:
P = Percentage value of practicality
f = Score
N = Maximum score
The practical results of the lesson plans and worksheets that have been obtained are interpreted according to the following categories

Table 3. Practicality Interpretation of Learning Implementation Plan and Student Worksheets

Interval	Category
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Practical enough
21% - 40%	Not Practical
0% - 20%	Very Impractical

After obtaining data on the value of students mathematical connection abilities, the analysis is continued by first determining the percentage value of effectiveness using the formula proposed by Sugandi, Sofyan and Maesaroh (2021) :

$$E = \frac{f}{N} \text{ x } 100\%$$

Description:
E = Effectiveness percentage value
f = Number of students who meet the KKM score
N = Total Number of Students
The effectiveness of the lesson plans and worksheets obtained is classified into the following categories.

TabLE 4. Effectiveness Interpretation

Interval	Category
81% - 100%	Very effective
61% - 80%	effective
41% - 60%	Effective enough
21% - 40%	Ineffective
0% - 20%	Very Ineffective

After obtaining the implementation value data, the analysis is continued by first determining the implementation percentage value at each meeting to use the Sugandi, Sofyan and Maesaroh (2021) formula:

$$A = \frac{f}{N} \times 100\%$$

Description:
A = Percentage value of implementation
f = Score (Number of Yes answers)
N = Maximum score (Sum of all statements)
Then look for the average percentage of implementation of all meetings conducted with the formula:

$$B = \frac{f}{N} \times 100\%$$

Description:
B = Value of implementation percentage
f = Total percentage of implementation in all meetings
N = Number of meetings

RESULTS AND DISCUSSION

Results

The results are described in accordance with the stages of the research method used, the following are the result:

1. Analysis Stage

Two mathematics teachers were interviewed during in the analysis stage to identify possible problems. Interviews were conducted in order to determine the difficulties students face and the material that is difficult for students to comprehend. The results of the interviews showed that children struggle mightily with algebraic material questions. According to Yani and Panjaitan (2021) the percentage of students who cannot understand and have learning difficulties is still relatively high. Two mathematics teachers were interviewed during in the analysis stage to identify possible problems. Then, in terms of the teaching materials used and their effects, it was found that during the learning of the teaching materials used by teachers and students, namely the mathematics textbooks provided by the school, some students were assisted by the textbooks provided, while others still have difficulties.

Teachers frequently use a scientific approach during the learning process; while not all students can understand the material provided, this approach is adapted to the textbook held by students. In aspects of combining the two approaches and distance learning, teachers only combine the two approaches in the learning process on rare occasions, teachers teach usually use WhatsApp, Google classroom, occasionally use zoom. Due to the lack of direct interaction between teachers and students, students' character in their own learning is less active. This is also in line with Yani and Panjaitan (2021) who claim that the learning process in the current pandemic situation makes students inactive in the mathematics learning process,

so tasks given are mostly late in collecting. Sulistyo and Alyani (2021) found that students had difficulty collecting assignments given, so they were late in collecting. The identification of potential problems with the learning tools that will be developed is based on the results of above analysis in the form of interviews.

2. Planning Stage

Planning the teaching materials that will be developed based on the results of the needs interview at the analysis stage, namely Learning Implementation Plan and Student Worksheets in algebraic form materials, as well as compiling implementation observation sheets, Learning Implementation Plan and Student Worksheets validation questionnaires, teacher and student response questionnaires, and five test questions mathematical connection ability. The following is an overview of the worksheets that have been made.

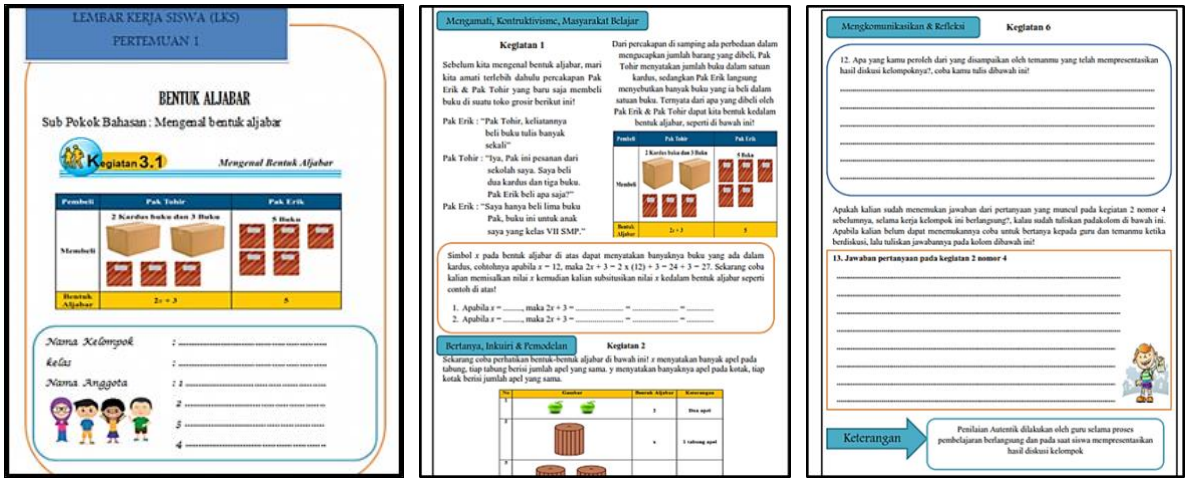

Figure 1. Initial Learning Implementation Plan Design

3. Development Stage

After all of the instruments have been created, the validity of the lesson plans and worksheets is tested during the development stage. The validity is tested twice: first before the limited trial by three experts (lecturers and teachers) and again before the wider trial by three teachers.Then validation was carried out on eight Learning Implementation Plan and Student Worksheetsthat had been made, this validation was taken based on data in the form of the total score of the three validators, along with the results of Learning Implementation Plan validation at the limited and wider trial stage.

Table 5. Learning Implementation Plan Validation Results at the Limited Trial Stage

No	Meeting	Total Score	Category
1	The First Meeting	483	Valid
2	Second Meeting	489	Valid
3	Third Meeting	492	Very Valid
4	Fourth Meeting	487	Valid
5	Fifth Meeting	485	Valid

6	Sixth Meeting	488	Valid
7	Seventh Meeting	482	Valid
8	Eighth Meeting	485	Valid

The results of the Learning Implementation Plan validation during the trial stage which were limited to the eight Learning Implementation Plan that were validated, were very valid for the Learning Implementation Plan third meeting and valid for the rest of the meetings. The eight lesson plans that will be used are valid because they meet the observed aspects in terms of subject identity, formulation aspects, indicators, learning objectives, and aspects of learning materials, but there are still some a little improvements to be made, namely the placement of learning objectives and inverse competency indicators which should be competency indicators first then goals.

Table 6. Results of Validation of Learning Implementation Plans at the Wider Trial Stage

No	Meeting	Total Score	Category
1	The First Meeting	487	Valid
2	Second Meeting	491	Valid
3	Third Meeting	494	Very Valid
4	Fourth Meeting	495	Very Valid
5	Fifth Meeting	493	Very Valid
6	Sixth Meeting	496	Very Valid
7	Seventh Meeting	494	Very Valid
8	Eighth Meeting	490	Very Valid

Similarly, most of the Learning Implementation Plans received very valid validation in the wider trial stage, which is consistent with Kasmirah (2021) findings that the validity of Learning Implementation Plans created in algebraic forms is quite valid. As a result, the Learning Implementation Plans is suitable for usage at the product test stage no revair have been made at this level.

Table 7. Student Worksheets Validation Results at the Limited Trial Stage

No	Meeting	Total Score	Category
1	The First Meeting	314	Valid
2	Second Meeting	323	Valid
3	Third Meeting	319	Valid
4	Fourth Meeting	316	Valid
5	Fifth Meeting	317	Valid
6	Sixth Meeting	315	Valid
7	Seventh Meeting	315	Valid
8	Eighth Meeting	313	Valid

Student Worksheets validation at the trial stage was limited to valid categories, the eight Student Worksheets to be used were valid because they had met the observed aspects in the form of aspects of material suitability, suitability of student abilities, suitability of approaches, conformity of construction requirements, and aspects of conformity with technical requirements. At this stage, there is an improvement in the Student Worksheets validation,

namely the continuity of the material needs to be completed and also the working instructions on the Student Worksheets do not require children to complete it.

Table 8. Student Worksheets Validation Results at the Wider Trial Phase

No	Meeting	Total Score	Category
1	The First Meeting	317	Valid
2	Second Meeting	323	Valid
3	Third Meeting	325	Valid
4	Fourth Meeting	328	Very Valid
5	Fifth Meeting	327	Valid
6	Sixth Meeting	332	Very Valid
7	Seventh Meeting	329	Very Valid
8	Eighth Meeting	330	Very Valid

The results of the Student Worksheets validation at the wider trial stage were four Student Worksheets in the valid category and there were four Student Worksheets in the very valid category, thus for the Student Worksheets feasible to be used at the product testing stage, validation at this stage did not make any improvements.

After going through expert validation and validation by the teacher in a limited and wider trial, the following is a description of the final Student Worksheets results that will be used in the product test in the experimental class, the following is a description of the Student Worksheets that has been validated.

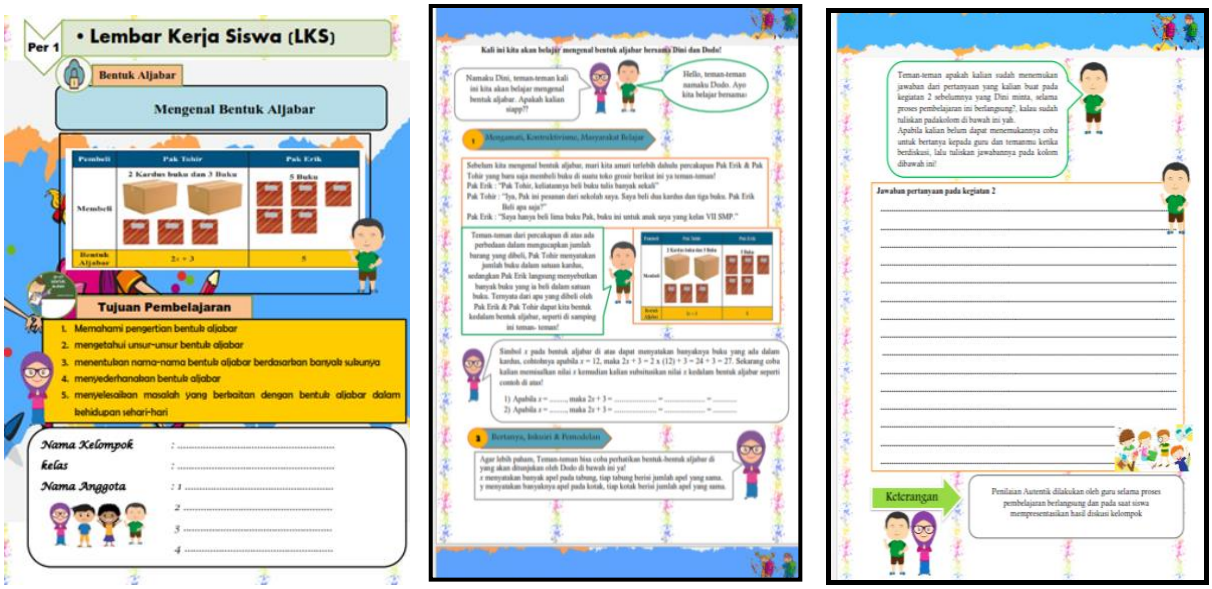

Figure 2. Final Design of Student Worksheets

4. Implementation Stage

The researchers then filled out an observation sheet on the implementation of the eight meetings that were conducted in both limited and broader trials, in order to measure how well the learning process was executed. At each stage, the results of practicality, effectiveness, and implementation will be presented.

The teacher's response questionnaire to see the practicality of the material, lesson plans, and worksheets, and the student response questionnaires to see the practicality seen from the ease, helpfulness, and usefulness were used to obtain the results of practicality at the limited and wider trial stage by teachers and students.

Table 9. Practicality Results at the Limited Trial Stage by the Teacher

No	Meeting	Practicality Presentation	Category	average percentage	Category
1	The First Meeting	79	Practical	77	Praktis
2	Second Meeting	77	Practical		
3	Third Meeting	76	Practical		
4	Fourth Meeting	79	Practical		
5	Fifth Meeting	76	Practical		
6	Sixth Meeting	77	Practical		
7	Seventh Meeting	78	Practical		
8	Eighth Meeting	76	Practical		

Because there are still things that need to be improved both in the material, lesson plans, and worksheets, the results of practicality by teachers at the limited trial stage obtained a percentage of 77% in the practical category.

Table 10. Practicality Results at the Limited Trial Stage by Students

Total Number of Responses	Practicality Presentation	Category
706	74	Practical

Student are only given practicality once, once all of the meetings using the eight Student Worksheets have been completed. Practicality is judged on the basis of convenience, helpfulness, and usefulness. The percentage of practicality at the limited trial stage was 74% in the practical category, which students said was already practical for use in the learning process at the wider trial stage.

Table 11. Practicality Results at the Wider Trial Stage by the Teacher

No	Meeting	Practicality Presentation	Category	average percentage	Category
1	The First Meeting	82	Very practical	87	Very practical
2	Second Meeting	85	Very practical		
3	Third Meeting	87	Very practical		
4	Fourth Meeting	88	Very practical		
5	Fifth Meeting	88	Very practical		
6	Sixth Meeting	89	Very practical		
7	Seventh Meeting	89	Very practical		
8	Eighth Meeting	89	Very practical		

The results of practicality by teachers at the wider trial stage obtained a percentage of 87% in the very practical category, this is because the Learning Implementation Plan and Student Worksheets materials are considered practical to be used at the product test stage.

Table 12. Practicality Results at the Wider Trial Stage by Students

Total Number of Responses	Practicality Presentation	Category
4283	74	Practical

Practicality by students at the pilot stage is wider in the practical category with a percentage of 74%, thus that the worksheets used at the pilot stage are more practical to be used in the learning process at the product test stage.

Furthermore, in addition to research to find out the validity and practicality, also want to see the effectiveness of the lesson plans and worksheets that have been made on students' mathematical connection abilities. Following are the practicality results, there is a limited trial stage and a product test.

Table 13. Results of Effectiveness in the Limited Trial Stage

Number of Students Reaching KKM	Effectiveness Percentage	Category
5	50	Effective Enough

In the limited trial stage, ten students were given five questions about the ability of mathematical connections to see the effectiveness of the Learning Implementation Plan and Student Worksheets after completing the learning process using the eight Learning Implementation Plan and Student Worksheets that had been created. There are five students who get the value above KKM , resulting in a percentage of effectiveness of 50%, which falls under the category of quite effective.

Table 14. Results of Effectiveness in the Wider Trial Phase

Number of Students Reaching KKM	Effectiveness Percentage	Category
45	75	Effective

There were sixty students in the wider trial phase, forty-five of them scored above the KKM, resulting in a percentage of effectiveness of 75% in the effective category. The implementation at the limited and wider trial stages, as well as the results of the implementation at each stage, were collected via the implementation observation sheet, which was modified to the measures made in the Learning Implementation Plan at each meeting.

Table 15. Implementation Results at the Limited Trial Stage

No	Meeting	Percentage of Implementation	Average Percentage
1	First Meeting	73,5	81,2
2	Second Meeting	75,8	
3	Third Meeting	84,8	
4	Fourth Meeting	75,8	
5	Fifth Meeting	87,9	
6	Sixth Meeting	87,1	
7	SeventhMeeting	83,9	
8	Eighth Meeting	80,6	

Obtained an average percentage of 81.2%, during the limited trial stage of the learning process of the eight meetings, students still had difficulties in the questioning activity step, and then in the step of presenting the results of the discussion, it was still not implemented in several meetings, that was due to a lack of estimating the learning time. Because in an impossible situation, the collection of completed worksheets at school was not carried out, so the activity was replaced as students taking photos of the completed worksheets and then sending them via WhatsApp or Google Classroom.

Table 16. Implementation Results at the Wider Trial Phase

No	Meeting	Percentage of Implementation	Average Percentage
1	First Meeting	82,4	89,7
2	Second Meeting	84,8	
3	Third Meeting	87,9	
4	Fourth Meeting	87,9	
5	Fifth Meeting	90,9	
6	Sixth Meeting	93,5	
7	SeventhMeeting	93,5	
8	Eighth Meeting	96,8	

In the wider trial stage, the percentage of learning implementation in the eight meetings obtained an average percentage of 89.7, at this stage the steps in each lesson have started to be implemented because there has been an evaluation of learning activities at the limited trial stage. But at the first meeting there were still steps that had not been implemented, such as responding to the results of the percentage of other groups, teacher and student activities making conclusions from the learning activities that had been carried out because at the first meeting they were still adjusting the learning process, for the next meeting it could be carried out properly.

The N-Gain or results of increasing students' mathematical connection abilities using a combination of scientific and contextual approaches were tested on students who received learning using a combination of scientific and contextual approaches during the product test stage. At this stage, thirty-eight students were working on five questions about mathematical connection skills that were given before and after the learning process, or pretest and posttest.The following are the average, percentage, and standard deviation results of increasing students' mathematical connection abilities.

Table 17. Results of Increasing Students' Mathematical Connection Ability

Seen from	Pretest	Posttest	N-Gain	Category
$\bar{x}$	21,32	38,11	0,58	Medium
%	43	76		
S	2,31	3,80		

Based on the results of the N-Gain or the increase obtained, which is 0.58, it belongs to the medium category, which means that the increase in students' mathematical connection

abilities before and after learning is given by using a combination of scientific and contextual approaches in the medium category.

5. Evaluation Stage

The results of the final evaluation of the learning device, the results of the final evaluation of the teaching materials in the form of lesson plans and worksheets based on field notes and also on the implementation observation sheet, the results of the final evaluation of the learning device, the results of the final evaluation of the learning device, in the questioning step in the learning process researchers must motivate students more so that students can reveal what is not understood during the learning process, then in several meetings there are some students who cannot follow the learning process on zoom so it must be maximized again and class groups on WhatsApp must be utilized more so that students who cannot follow zoom can understand the material presented and finally on the implementation observation sheet for students' steps to collect The worksheets that he has done at school need to be considered because of the current situation so that the collection of worksheets can be done by taking photos of the worksheets that have been done and then collecting them via WhatsApp or Google classroom

Discussions

Based on the results of data analysis obtained for the validation of lesson plans and worksheets, the results were in the valid category at the limited trial stage, and at the wider trial stage, the average at each meeting obtained very valid results, it in line with findings of Putra et al (2017) who state that the results of the validation of the Learning Implementation Plan and learners Worksheets material in the algebraic form developed in the very valid category make it feasible to use. Then, for practicality by teachers and students, a practical category was obtained at the limited trial stage, while a very practical category was obtained at the wider trial stage, and a Practicality category was obtained by students in the practical category, that was in accordance with the results of Maarif (2021) research that the material teaching on algebraic form material obtains Practicality results in the very practical category to use. It obtained a fairly effective category for effectiveness at the limited trial stage, effective category from the effectiveness results at the wider trial stage, in line with the results of the effectiveness of teaching materials obtained by Loli et al (2018) who obtained a very effective category in their research, this is obtained because the scores obtained by most students have reached the KKM score.

The implementation of the learning process on the algebraic form material on average obtained a high percentage in the research results, with a percentage of 81.2% in the limited trial stage and 89.7% in the wider trial stage, according to Helnia et al (2020) the implementation of learning in algebraic form material resulted in a more than 70% success rate.In addition to the development of teaching materials that are judged on their validity, practicability, effectiveness, and implementation, students who use teaching materials that combine scientific and contextual approaches have an increase in their ability to mathematical connections. According to Gaol and Nainggolen (2021) by combining a contextual approachcan improve students' mathematics connection abilities.

CONCLUSION

Based on the results of the study, it can be concluded that. The development of teaching materials in the form of lesson plans and worksheets in algebraic form using a combination of scientific and contextual approaches at the validation stage was tested limited and more

broadly was valid and feasible to be used at the product test stage, the practicality of lesson plans and worksheets by teachers at the limited trial stage was in the practical category by 77% and in the wider trial stage in the very practical category by 87%, the practicality of student worksheets at the limited and wider trial stage is in the practical category by 74%. According to the results of the effectiveness at the limited trial stage, that were 50% in the fairly effective category and 75% in the effective category in the wider trial stage, the implementation in the limited trial stage did receive a percentage of 81.2% and in the wider trial stage did receive a percentage of 89.7%. The N-Gain of 0.58 is included in the medium category to increase students' mathematical connection abilities before and after learning, which means that the increase in students' mathematical connection abilities before and after learning is given by using a combination of scientific and contextual approaches in the medium category. The researchers suggested that in order to develop students' mathematical connection skills, teachers or other researchers develop teaching materials by combining scientific approaches with other approaches in the learning process.

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