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REALISTIC MATHEMATICS EDUCATION AND REACT STRATEGY IN CONTEXT MATHEMATICAL CONNECTIONS

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ABSTRACT

This study aims to describe the process of developing and producing high-quality, realistic mathematics learning devices using the REACT strategy at the junior high school level and their effectiveness in training students' mathematical connection skills. This type of research is known as development research. The learning devices developed in this study are the Mathematics Connection Ability Tests. We developed the test using the 4-D development model, which consists of four stages: define, design, develop, and disseminate. The research subjects for the trial class were 35 students of class VIII-A, and the research subjects for the implementation class were 35 students of class VIII-B. This study used descriptive analysis. The results showed that the tests developed were of excellent quality because they met the criteria of valid, practical, and effective. In addition, realistic mathematics learning with the REACT strategy effectively trains students' mathematical connection skills. This is evident in the aspects of learning quality, the appropriateness of the learning level, the use of incentives, and the amount of time allocated, all of which align with the planning outlined in the learning implementation plan. Furthermore, realistic mathematics learning and the REACT strategy effectively enhance students' mathematical connection skills.

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1. INTRODUCTION

Interrelated concepts compose mathematics subjects. Mathematical concepts not only link to other disciplines but also to real-life situations (Verschaffel et al., 2020). The 2013 curriculum's objectives for mathematics learning state that students should comprehend mathematical concepts, clarify the connections between them, and utilize concepts or algorithms in a flexible, accurate, efficient, and precise manner to solve problems. As a result, students must develop mathematical connection skills as part of their mathematical abilities. This description suggests that mathematical connection skills play a crucial role in the learning objectives of mathematics. Mathematical connection skills refer to the ability to identify, utilize, and comprehend mathematical concepts, establish connections between ideas to form a comprehensive relationship and apply mathematics to non-mathematical situations (Zengin, 2019; Hasbi et al., 2019).

Mathematical connection skills are essential to develop in the mathematics learning process. The NCTM (2000) statement supports this, suggesting that students develop a tendency to use connections in solving mathematical problems rather than viewing mathematics as a disconnected collection of separate concepts and skills (Hasbi et al., 2019). In addition, García-García & Dolores-Flores (2021) argue that mathematical connection skills are very much needed by students, especially in solving problems that require relationships between mathematical concepts and other concepts in mathematics and other disciplines or in real life. Students in various Indonesian schools still have relatively weak and moderate mathematical connection skills. This is based on several research results that state that students' mathematical connection skills are low, and students still have difficulty connecting mathematical concepts (Siregar & Surya, 2017; Haji et al., 2017; Nugraha, 2018).

The results of the PISA survey, which rank Indonesia 64th out of 72 countries with a score of 386, further support this. According to the PISA data, mathematics learning, particularly in Indonesia, focuses primarily on fundamental skills, with little attention given to the practical applications of mathematics, automatic communication, and intuitive thinking (Fenanlampir et al., 2019). The TIMSS study on geometry material in Indonesia revealed that the percentage of incorrect answers was 55.5%. The data indicates that students continue to struggle with making connections between three-dimensional and two-dimensional concepts. The low mathematical connections problem shows that students cannot make mathematical connections on their own. This aligns with Stillman et al. (2020) perspective, which asserts that students are not inherently capable of connecting mathematical concepts. This is due to its significant impact on teachers' ability to implement effective learning strategies, allowing students to demonstrate the ability to connect mathematical knowledge with other disciplines and real-world applications. Therefore, students require training in mathematical connection skills.

Based on the statement, mathematics learning in the classroom emphasizes a relationship between mathematical concepts and students' experiences in everyday life, and it is very necessary to re-apply students' knowledge to mathematical concepts in real life. Realistic mathematics education is an approach to mathematics that guides students in mathematizing everyday knowledge and applying mathematics to their daily lives (Van den Heuvel-Panhuizen & Drijvers, 2020). As a result, we can assert that mathematics education primarily cultivates students' logical reasoning abilities by enhancing their mathematical connection skills. Therefore, the realistic mathematics learning approach is right for training students' mathematical connection skills. Students should practice realistic mathematics learning, which uses contextual problems as a foundation for learning. The Netherlands pioneered the development of the realistic mathematics learning approach. According to Freudenthal's hypothesis, "mathematics is a human activity," which means mathematics is a human activity (Makonye, 2014; Appelbaum & Romero, 2023).

A learning strategy that can support learning success is required for realistic mathematics learning in the classroom. Strategy is defined as a plan that contains a series of activities designed to achieve a specific educational goal (Romiszowski, 2024). We expect the learning strategy to enhance students' mathematical connection skills by enabling them to link mathematics with everyday life, utilize their existing knowledge, discover their own conceptual understanding, and apply and transfer the acquired knowledge. The learning strategy in question that meets the standard criteria is the Relating, Experiencing, Applying, Cooperating, and Transferring (REACT) strategy (Sari, 2020).

The constructivist philosophy underpins PMR's development, making it suitable for realistic mathematics learning with REACT. This philosophy views mathematical knowledge not as pre-prepared for students, but rather as a product of their own learning. Therefore, in realistic mathematics education, students are the center of the learning process itself, while the teacher plays more of a role as a facilitator and motivator (Fredriksen, 2021). REACT is also a constructivism-based learning strategy. To put it another way, the REACT learning strategy engages students in the process of creating their own knowledge (Widada et al., 2019). Students are required to interact with their environment while building their own knowledge.

Crawford (2001) mentioned five aspects, namely relating, experiencing, applying, cooperating, and transferring. Students must relate the subject matter to their prior knowledge or connect it to their daily lives. Students learn directly from the process of exploring, discovering, and creating. Students apply concepts to real and relevant problems (Crawford & Witte, 1999). Cooperating entails learning through interaction, exchanging, and reacting to fellow students. Transferring refers to the process of applying knowledge to unfamiliar contexts or conditions outside of the classroom.

When students can relate images, real objects, and everyday life situations into mathematical ideas and symbols, they can develop their mathematical connection skills. The related aspect of the REACT strategy dictates that students use images, videos, and real objects as a medium to generate problems that mirror their everyday experiences (Nurhayati et al., 2021). They then translate these mathematical ideas into mathematical symbols. In the collaborative and transfer aspect, students exchange statements from each other's viewpoints, forming a connection through oral delivery (Sari & Rosjanuardi, 2018). In the experiential and application aspect, students directly apply concepts based on their individual thoughts, thereby training the indicators of mathematical connections. This includes developing the ability to formulate definitions, compile arguments, and express their thoughts in their own language against a mathematical description.

One of the mathematics materials taught in junior high school's grade VIII focuses on flat-sided geometric shapes, particularly prisms. The curriculum incorporates this material, which bears a strong connection to daily life. Therefore, we anticipate that by incorporating realistic mathematics learning and the REACT strategy into this material, students will become more engaged in class and develop confidence in communicating concepts related to prisms from everyday life. Aisah & Yulianti's (2016) research reveals that students encounter four learning difficulties, specifically in comprehending the concepts of volume and surface area of prisms. These difficulties include: (1) students struggle to determine the base of a prism; (2) they struggle to calculate the surface area of a prism; (3) they struggle to calculate the volume of a prism; and (4) they struggle to establish connections with other mathematical concepts.

Based on the description above, the author considers it necessary to develop a test with realistic mathematics learning and a REACT strategy to train students' mathematical connection skills in prism material. Additionally, the learning plan includes media preparation, learning resources, assessment tools, and learning scenarios. Thus, it is important to develop a good-quality test that can facilitate students to study mathematics in depth. Therefore, an appropriate test is needed. We achieve suitability by creating a realistic mathematics test using the REACT strategy. Therefore, we have set the following specific objectives for this study:

1. Describe the process of developing a realistic mathematics test with the REACT strategy on prism material.
2. Describe the results of developing a realistic mathematics test using the REACT strategy on high-quality prism material.
3. Describe the effectiveness of realistic mathematics learning with the REACT strategy to train junior high school students' mathematical connection skills on prism material.

2. METHOD

This research falls under the category of development research, as it involves developing a realistic mathematics learning device using the REACT strategy on prism material. The Mathematical Connection Ability Test is the learning tool in question. Thiagarajan et al. developed the 4-D model, which consists of four stages: defining, designing, developing, and disseminating (Simanjuntak et al., 2019). Instruments and data collection methods for developing learning devices consist of validation sheets, observation sheets (teacher activities in managing learning and student activities), student response questionnaires, and mathematical connection ability test sheets. We analyzed the data collected and used the findings to evaluate the learning devices we had developed. We conducted two types of data analysis: the validation of learning devices and the analysis of mathematical connection ability tests. The study focused on the practicality of the learning device, specifically analyzing the data from teacher activity observations to manage learning, as well as the data from student activity observations. The learning device effectiveness analysis includes data on student response, learning completion, and mathematical connection ability.

When each aspect of the question receives a positive response from 80% or more of the students, it is considered a positive response. In this study, there are two categories of learning completion, namely individually and classically. Classical learning completion is when the learning outcomes are classically complete and 80% of all students in the class have achieved the KKM score. We obtained results from TKKM's mathematical connection ability data, which served as both a pretest and a posttest. We used the N-Gain formula to evaluate the effectiveness of the REACT strategy in training mathematical connection skills. However, before conducting the analysis using the N-Gain formula, a statistical test using a correlated t-examination was required. We conducted a right-hand test using a correlated T-examination. If at least 75% of students who participate in the learning achieve an N-Gain of less than 0.3, then realistic mathematics learning using the REACT strategy is considered effective in training students' mathematical connection abilities. Figure 1 below schematically depicts the learning device's development.

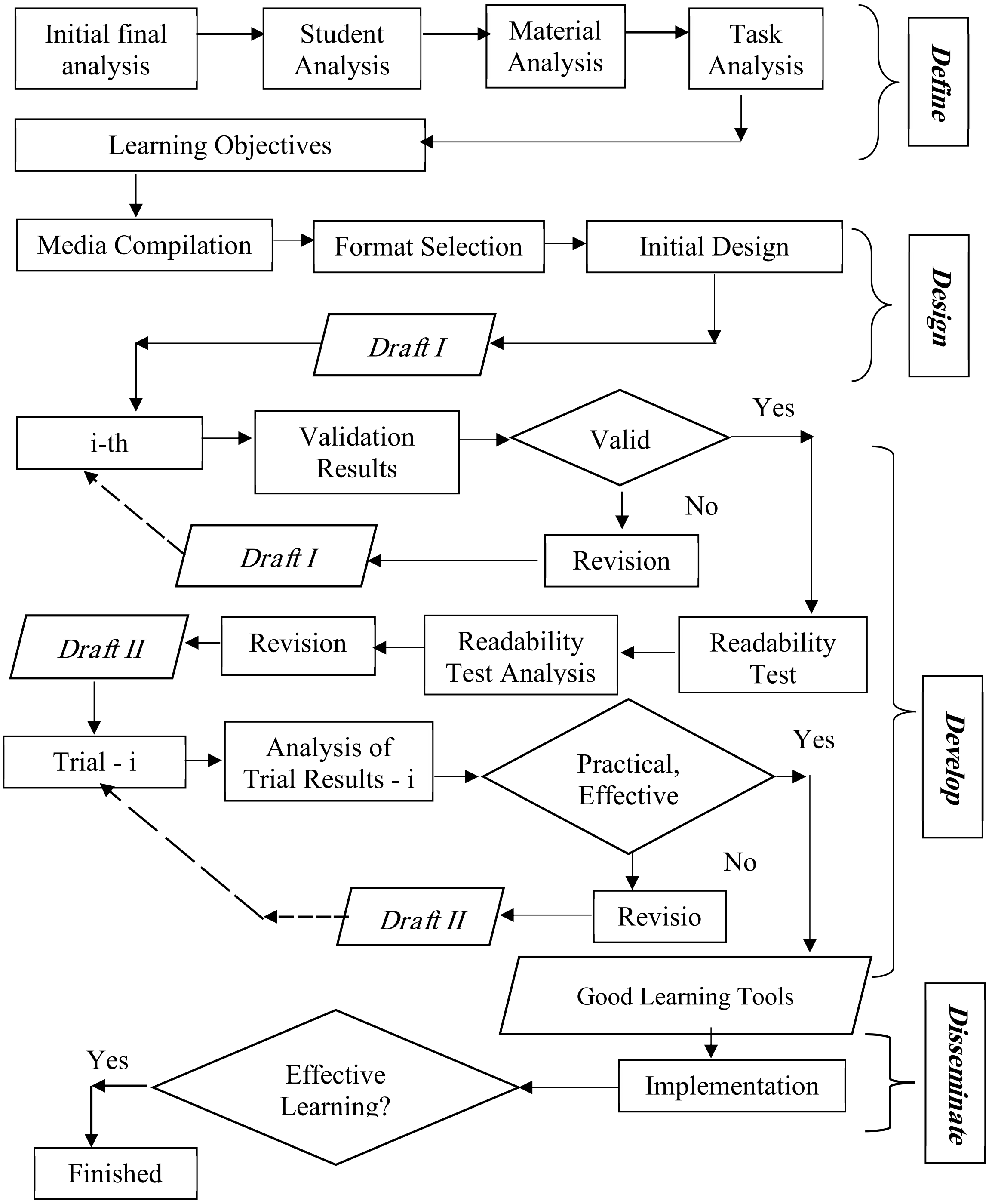

Figure 1. 4-D Learning Development Model

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3. RESULTS AND DISCUSSION

Results

The results of this study consist of the learning device development process, data from the learning device trial, and data from the learning device implementation.

Description of the Learning Device Development Process and Results

The study's goals are to make a realistic math learning tool using the valid, useful, and effective REACT strategy and to find out if realistic math learning using the REACT strategy can help junior high school students improve their mathematical connection skills on prism material. This study employs the four-D model for device development, which comprises four stages: the definition stage, the design stage, the development stage, and the dissemination stage. The Mathematics Connection Ability Test (TKKM) was developed as the learning device for this study. We describe the stages of developing the learning device as follows:

Description of the Define Stage

The initial and final analysis yielded the following insights. At State Junior High School 2 Candi Sidoarjo, some learning issues exist. These include a teacher-centered approach to learning, low student participation, a lack of connection between past and present learning, and a habit of pupils memorizing formulas and solving routine problems.

We conducted a student analysis to determine the characteristics and conditions of students in class VIII of State Junior High School 2 Candi Sidoarjo. The study's trial and implementation subjects were students in class VIII. The study analyzed the characteristics of the students, specifically their cognitive background, academic ability, and skills. We obtained this information from partner teachers and the school.

This study will discuss the prism material analysis scheme presented in Table 1 below.

Table 1. Analysis of Prism Material

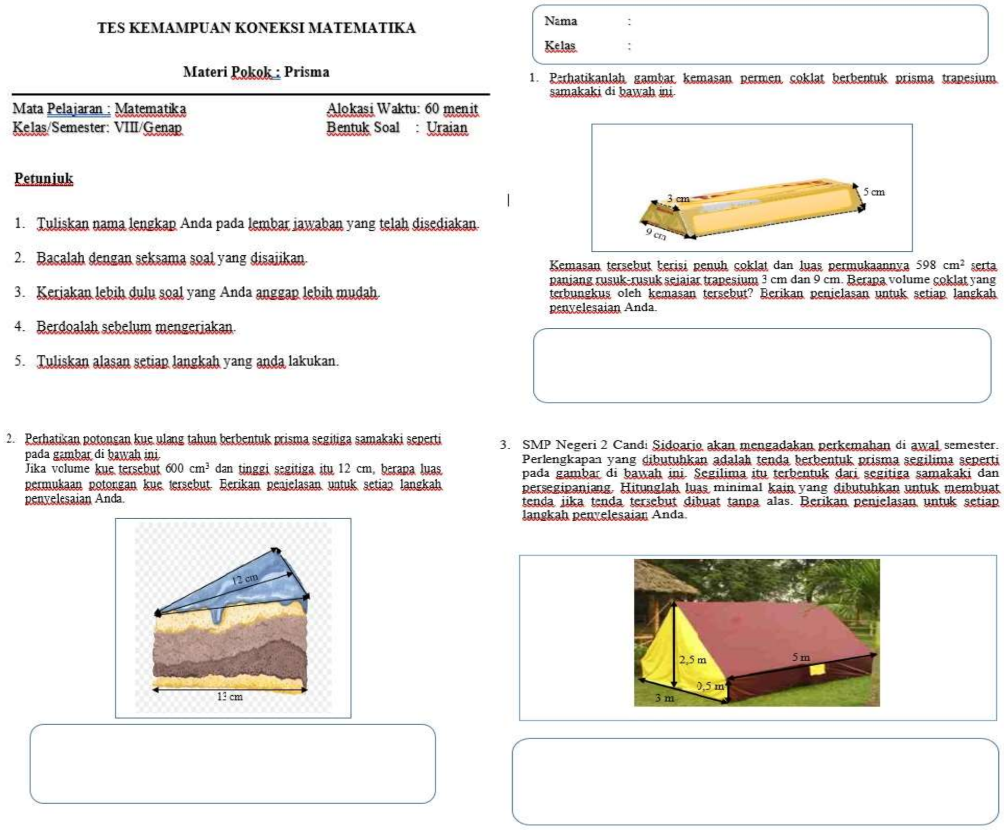
No	Type	Description
1	Fact	➢ Definition of Prism ➢ Definition of surface area of prism ➢ Definition of volume of prism ➢ Prism model ➢ Symbols
2	Concept	➢ Surface area of a prism ➢ Volume of a prism
3	Principle	➢ The formula for the surface area of a prism Lp = (2 × base area) + (Circumference of the base of the prism × height of the prism) ➢ Prism volume formula Vp = base area × height
4	Procedure	➢ Calculating the surface area of a prism ➢ Calculating the volume of a prism ➢ Solving problems in everyday life related to the surface area of a prism.

No	Type	Description
		➢ Solving problems in everyday life related to the volume of a prism.

Furthermore, students' task analysis results include calculating a prism's surface area and volume, as well as solving everyday problems related to these quantities. Meanwhile, the results of the material analysis and task analysis are: Students can find the formula for a prism's surface area. Students can find the formula for a prism's volume. Students can calculate the surface area of a prism. Students can calculate the volume of a prism. Students can solve contextual problems related to the surface area of a prism, and Students can solve contextual problems related to the volume of a prism.

Design Stage Description

Based on the analysis results from the define phase, the next stage of the learning device involves compiling a criterion reference assessment, selecting media and formats, and creating an initial learning design. Furthermore, the preparation of the TKKM relies on the findings from the learning objective specification analysis. The developed form of the test is descriptive and consists of four questions. We used 60 minutes to complete all these questions. In this study, we conducted a test to train students' mathematical connection skills. The preparation for the test includes designing the grid, compiling test items, making answer keys, and scoring guidelines. Test items, answer keys, and scoring guidelines are all part of the preparation process. Figure 2 displays the initial design of the TKKM.


TES KEMAMPUAN KONEKSI MATEMATIKA

Materi Pokok : Prisma

Mata Pelajaran : Matematika — Alokasi Waktu: 60 menit
Kelas/Semester: VIII/Genap — Bentuk Soal : Uraian

Petunjuk

1. Tuliskan nama lengkap Anda pada lembar jawaban yang telah disediakan.
2. Bacalah dengan seksama soal yang disajikan.
3. Kerjakan lebih dulu soal yang Anda anggap lebih mudah.
4. Berdoalah sebelum mengerjakan.
5. Tuliskan alasan setiap langkah yang anda lakukan.

Nama :
Kelas :

1. Perhatikanlah gambar kemasan permen coklat berbentuk prisma trapesium samakaki di bawah ini.

Kemasan tersebut berisi penuh coklat dan luas permukaannya 598 cm^2 serta panjang rusuk-rusuk sejajar trapesium 3 cm dan 9 cm. Berapa volume coklat yang terbungkus oleh kemasan tersebut? Berikan penjelasan untuk setiap langkah penyelesaian Anda.

2. Perhatikan potongan kue ulang tahun berbentuk prisma segitiga samakaki seperti pada gambar di bawah ini.
Jika volume kue tersebut 600 cm^3 dan tinggi segitiga itu 12 cm, berapa luas permukaan potongan kue tersebut. Berikan penjelasan untuk setiap langkah penyelesaian Anda.

3. SMP Negeri 2 Candi Sidoarjo akan mengadakan perkemahan di awal semester. Perlengkapan yang dibutuhkan adalah tenda berbentuk prisma segilima seperti pada gambar di bawah ini. Segilima itu terbentuk dari segitiga samakaki dan persegipanjang. Hitunglah luas minimal kain yang dibutuhkan untuk membuat tenda jika tenda tersebut dibuat tanpa alas. Berikan penjelasan untuk setiap langkah penyelesaian Anda.

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Figure 2. Initial design of the TKKM

Development Stage Description

The validators who validated the developed learning device (Draft I) consisted of three people: two doctoral students majoring in mathematics who were also lecturers, and one mathematics teacher from Junior High School 2 Candi, Sidoarjo. The validaters results showed that each indicator's average assessment for all aspects fell into the valid category, allowing for its use with minor revisions. Before testing the draft in the field, we conducted a readability test. The readability test results on the TKKM also showed that students could read and understand the intent of the questions. Students demonstrated the ability to record their knowledge, understand the questions posed, and solve them. This demonstrates that students are capable of reading and comprehending the instructions on the TKKM sheet, indicating that the researcher did not alter its contents. The partner teacher's readability test revealed that the learning device was easily readable and understood. We carried out the next stage, known as the trial, over two meetings, culminating in the provision of TKKM at the third meeting. In the trial of the realistic mathematics learning device with the REACT strategy, the researcher involved a partner teacher and two observers. The researcher personally observed student activities in one predetermined group. Meanwhile, one observer monitors the partner teachers' learning management activities.

The results of the assessment of teacher activities in managing learning show that the average score of each assessment aspect in learning meets criteria 3 and 4. This value is based on the criteria that teacher activities in managing learning have met good criteria (≥ 3) so that Draft II does not need to be revised. The observations of student activities during learning result in a time tolerance of less than 10%, which aligns with the established ideal time span. Consequently, the student activities satisfy the active criteria, obviating the need for revision in Draft II. Furthermore, Table 2 below describes the results of the student response questionnaire.

Table 2. Student Response Questionnaire Results

No	Aspects responded to	Student Response		Percentage (%)	
		Yes	No	Yes	No
Do you feel happy with the following learning components?					
1	Subject matter being studied	30	5	85.7	14.3
2	Student Worksheets (LKS)	31	4	88.6	11.4
3	Learning atmosphere in the classroom	32	3	91.4	9.6
4	Teacher's teaching methods	30	5	85.7	14.3
Are you interested in taking math lessons like this again?		31	4	88.6	11.4
Can you clearly understand the language used in:					
1	Student Worksheet (LKS)	32	3	91.4	9.6
2	Mathematics Connection Ability Test (TKKM)	32	3	91.4	9.6
Do the displays (text, illustrations/images, and image layout) in the following devices appeal to you?					
1	Student Worksheet (LKS)	33	2	94.3	6.7
2	Mathematics Connection Ability Test (TKKM)	31	4	88.6	11.4

Based on the established criteria, Table 2 above concludes that student responses meet positive criteria because they are above 80% for each aspect.

We process the TKKM data, which takes the form of learning outcomes and mathematical connection abilities, to evaluate the validity, reliability, and sensitivity of the test items. Table 3 presents the results of calculating the validity of each test item using the product moment formula.

Table 3. Results of the Validity Analysis of Question Items

Question Number	1	2	3	4
r_{xy}	0,613	0,717	0,566	0,616
Interpretation	High	High	Medium	High

Each question item's validity level falls between medium and high. We believe that each question item is both valid and practical for use. The test reliability calculation yielded a question reliability coefficient of 0.650. We conclude that the mathematical connection ability test exhibits high test reliability, signifying the validity and feasibility of the questions. Table 4 presents the results of the sensitivity calculation for each question item.

Table 4. Results of Item Sensitivity Analysis

Question Number	1	2	3	4
Sensitivitas (S)	0,497	0,545	0,662	0,788

Question Number	1	2	3	4
Information	Sensitive	Sensitive	Sensitive	Sensitive

If a test item's sensitivity index is less than 0.30, it is considered sensitive. Table 4 above demonstrates that each test item has a sensitivity level of less than 0.30, indicating that it is sensitive to learning and suitable for use without revision.

The results of the data analysis revealed that 85.7% of students achieved completeness. Therefore, we can conclude that the students in the trial class achieved learning completeness through classical methods. The t-test correlated right-hand test results also showed that a certain percentage of students met the requirements: at least 75% got an N-Gain of at least 0.3, with 62.85% getting an N-Gain of at least 0.7 and 37.15% getting an N-Gain of at least 0.3. Therefore, we can conclude that using the REACT strategy in realistic mathematics learning can enhance students' mathematical connection skills.

4. CONCLUSION

Following the data analysis and examination of the research findings previously outlined, along with the research inquiries, numerous conclusions were derived as follows: The four-D development model (Define, Design, Develop, and Disseminate) is used in the process of developing realistic mathematics learning devices using the REACT strategy for prism material in Class VIII of Junior High School. The process of developing learning devices begins with the definition stage. The results of the analysis at that stage are used to design learning devices at the design stage. The design results at that stage produce Draft I, which is then validated by three expert validators. After being validated by the validator, the researcher revised the learning device according to the validator's suggestions, which resulted in Draft II. After all learning devices meet the valid criteria, a readability test is carried out on the TKKM. The next step involves development, where the researcher conducts a trial of the learning device in the trial class. The data obtained in the trial class was analyzed to determine whether the developed learning device had met the criteria for excellent quality. Using the REACT strategy for prism material and the 4-D development model to make realistic math learning devices led to learning gadgets (TKKM) that met the standards for high-quality devices. Based on the descriptive analysis done in the implementation class, it was also decided that using the REACT strategy to teach Prism material through realistic math learning worked well. This is evidenced by the fulfillment of the requirements for learning effectiveness.

This study suggests that the developed learning devices can serve as an alternative for teachers who are implementing realistic mathematics learning tools using the REACT technique for prism concepts in grade VIII junior high school, with the aim of enhancing students' mathematical connection skills. Realistic mathematics education with the REACT technique for prism content serves as an excellent pedagogical alternative for junior high school teachers to engage students. Researchers can advance research by performing trials in several schools with distinct features, demonstrating the broad applicability of the new technologies.

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