Volume 8, Nomor 1, June 2024
Numerical: Jurnal Matematika dan Pendidikan Matematika
http://journal.iaimnumetrolampung.ac.id/index.php/numerical
DOI:https://doi.org/10.25217/numerical.v8i1.

Development of HOTS and TPACK Based Learning Tools on Parabola Material

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Article Info
Article History:
Received: 10-06-2024
Revised: 25-06-2024
Accepted: 26-06-2024
Keywords:
Development of Learning Media,
HOTS;
TPACK

Abstract

This research aims to: 1) determine how HOTS and TPACK-based learning tools work on parabola material; 2) determine how effective they are in the parabolic equation material being developed; and 3) determine how students respond to their use. This is development research. This study employed the Thiagarajan 4-D development model—define, design, develop, and distribute. The results of the research show that: 1) it was declared valid in terms of the validity results by experts who stated that the learning tools consisted of: (1) the average validation results of the learning implementation plan (RPP) were 4.34, (2) the average validation results the average Student Worksheet is 4.24, (3) the average validation result of the HOTS ability test is 4.17; 2) The developed HOTS and TPACK based learning tools have met the specified effectiveness criteria in terms of: (1) In trial II, 90.4% (19 students) completed the learning; (2) Achievement of learning objectives has been achieved for each question item in trial II, namely question number 1 at 84.76% and question number 2 at 84.29%; (3) student responses in trial II were 94%; and (4) the learning time used does not exceed the normal learning time set by the school and 3) the increase in HOTS thinking skills, namely Trial I, was 52.4% or the 11 students who completed it had experienced an increase in Trial II to 90.4% or 19 students completed.

INTRODUCTION

The progress of the 5.0 revolution era has resulted in changes in education management. The most A dominating shift is an endeavor to modify the learning technique or strategy that is directed toward higher order thinking skills (HOTS) in order to ensure that graduates are prepared to respond to the difficulties and expectations that society places on them [1]. The Industrial Revolution 5.0 necessitates the development of a learning system that is both creative and inventive in order to enhance the level of competence possessed by graduates who possess skills relevant to the 21st century. There are a number of perspectives about the talents that are required in the 21st century. One of these perspectives is the 4C, which is an acronym that stands for Critical thinking and problem solving (C1), Creativity and innovation (C2), Communication (C3), and Collaboration (C4). Students are required to have a high degree of problem-solving skill in order to meet the requirements of this transition, which is an indirect demand for educational material [2].

Specifically, according to [3]), there are ten skills that need to be improved in order to meet the requirements of 5.0. These skills are as follows: 1) Analytical thinking and innovation; 2) Active learning and learning strategies; creativity, originality, and initiative; 3) Technology design and programming; 4) Critical thinking and analysis; 5) Complex problem solving; 6) Leadership and social influence; 7) Emotional intelligence; 8) Reasoning, problem solving, and ideation; 9) Analysis, and 10) system evaluation.

According to [4], Higher Order Thinking Skill, sometimes referred to as HOTS, is the most effective option for assisting thinkers in the concepts of ordering, comparing, and evaluating. Of course, there is an expectation for the capability of our educational graduates to meet these three components, since it is common knowledge that our educational aims are in the cognitive, emotional, and psychomotor dimensions. Not only are students need to be able to recall or comprehend information, but they must also be able to analyze, evaluate, and even create in order to be considered to have high-level thinking abilities. It is envisaged that students would be able to tackle the changing period of the industrial revolution if they possess the talents and capabilities of HOTS [5]. It is 5.0. For the purpose of producing pupils who are equipped with HOTS abilities, it is necessary to have competent educators who are prepared to deal with the Industrial Revolution 5.0. Teachers are required to have the ability to combine technology, pedagogy, and content in the form of learning tools that are based on Technology, Pedagogy, and Content Knowledge (TPACK), which were pioneered by [6]. These tools are examples of innovative solutions that have been produced in the field of education. In order to provide learning that is based on information and communication technology (ICT), TPACK is an integration of technology, materials, and pedagogy that interact with each other. Technology, pedagogy, and content (also known as knowledge material) are the three primary components that come together to form the TPACK framework, which is a framework for building new learning aids [7]. Within the context of the TPACK framework, the use of technology as a learning tool elevates pedagogy to the status of an essential component that must be taken into consideration throughout the learning process. Pedagogy is not only a task that involves the development of art in teaching or the construction of entire process and research tools in learning, but it also demands an awareness of the psychological and biological aspects of pupils. Within the framework of this pedagogical theory, there is a significant emphasis placed on the idea that a great educator is not one who is merely capable of making his pupils intelligent; rather, he is one who is effective in assisting them in discovering who they are as individuals. An educator is ultimately responsible for gaining an understanding of a student's personality, interests, and abilities.

At every level of school, students are required to study mathematics, which is one of the scientific disciplines. Mathematics is a universal science that is not only beneficial to human existence but also serves as the foundation for the development of contemporary technology [8]. It plays a significant part in a variety of distinct scientific fields and contributes to the advancement of human thought. For the purpose of mastering and developing technology in the future, it is absolutely vital to have a strong grasp and comprehension of mathematics from a young age. Students who study mathematics develop the capacity to think in a variety of ways,

Print ISSN: 2580-3573, Online ISSN: 2580-2437

including rationally, analytically, methodically, critically, innovatively, and artistically, as well as the ability to work together with others. Students are required to possess these competences in order for them to be able to acquire, manage, and make use of information in order to improve their quality of life in environments that are constantly shifting, unpredictable, and highly competitive [9]. Mathematics is a scientific discipline that has learning objectives. These learning objectives include training ways of thinking in order to understand concepts, using patterns as conjectures and making generalizations based on phenomena, using reasoning in order to solve problems, developing the ability to communicate ideas, and having an attitude of respect for usefulness. According to the [10], mathematics, having attitudes and behaviors that are in conformity with mathematical values, carrying out motor activities, and developing the capacity to utilize basic teaching aids are all activities that are included. A significant amount of attention need to be paid to the management of mathematics learning in order to accomplish the learning activities that are anticipated. Students are able to accomplish their mathematics learning goals if the quality of their mathematics education is up to par with their expectations. Research conducted by [11] suggests that the quality of learning may be evaluated based on both the process and the outcomes. When it comes to the process, learning is considered to be of high quality when students are actively interested, excited about learning, and have enough levels of self-confidence. According to the findings, learning is considered to be of high quality if it results in high quality output (students), which indicates that there is a positive change in behavior for all of the students or at least the majority of the students after the learning experience.

The completion of mathematics classes is one method that may be used to demonstrate beneficial behavioral improvements. In addition, it was discovered that the questions that were utilized in the semester MID test were not based on HOTS. This was discovered based on observations made at SMK YP Pangkalan Brandan. Only LOT-based questions, such as the one seen in the photo below, are given by the math instructor. The researchers looked through question archives and found that the majority of the queries were regarding three-dimensional materials. The students' HOTS level must be at levels C4, C5, and C6 in order for them to be able to answer this question, which is at level C2, which is complete. Tools that are based on HOTS were created by researchers for a number of reasons, one of which being the significance of students' HOTS abilities. Additional findings about the Learning Implementation Plan (RPP) that is used by educators are not founded on HOTS and TPACK. The HOTS and TPACK components have not yet been included into the learning syntax that the instructor has produced. Both a scientific methodology and the Project-Based Learning (PBL) learning paradigm are used in the process of developing the lesson plans [12]. It is of utmost importance for educators to put the TPACK method and HOTS-based learning into practice in light of the shift toward digital education that is now taking place. The development of tools that are based on HOTS and TPACK is particularly significant for researchers because of this reason. During the course of the learning process, instructors do not make use of LKPD equipment. According to the findings of interviews conducted with Mrs. Suriani, S.Pd, a mathematics teacher at SMK YPT Pangkalan Brandan, it is known that the learning process at this school continues to make use of learning resources that are boring and less fascinating. For example, the school now only utilizes textbooks and teaching materials that are given by the government. It is also acknowledged by educators that the learning tools that are now accessible are less inspirational, imaginative, and creative. As a result, learning continues to seem repetitive when standard and conventional methods are used. The capacity of the instructor to make use of technology is the primary component that contributes to this issue. Learning mathematics is made less fascinating as a result of this situation, which is the primary contributor to the lack of enthusiasm that pupils have in learning. The creation of learning tools that are based on HOTS and Technological Pedagogical Content Knowledge (TPACK) is one approach that may be taken to address the issues that have been outlined above [13].

This study is supported by the findings of interviews conducted with Mrs. Suriani, S.Pd., a mathematics teacher. The interviews revealed that instructors are not prepared to deal with the changes that will occur in the period of the Industrial Revolution 5.0, namely the increased emphasis on digital-based learning. Teachers are also lacking in their understanding of how to develop learning materials that are based on HOTS and TPACK. Therefore, the educational resources such as books and LKPD from the government are used. A lack of optimum learning and the preparation of equipment that is less appealing have an effect on the level of interest and the results of learning among students in class XI TP-1 when pandemic circumstances are present. The achievement of a decrease in learning outcomes is a significant challenge that educators must surmount [14].

Further interview results showed that in the Straight Parabola material there were 11 students, namely 52.4% of students who had completed it, and 10 students, namely 47.6% of students who had not completed it. Researchers concluded that students did not complete the parabola material. According to subject teachers, this occurs because the delivery of material is less than optimal, students are less interested in learning, lack of use of interactive media, less attractive learning tools used by teachers, and teachers do not use approaches in learning. The teacher also informed that he did not know about TPACK and HOTS. Teachers have difficulty designing media, student worksheets and TPACK and HOTS based learning outcomes tests on parabola material.

Table 1. Percentage of KKM Achievement for Odd Semester Students' Daily Assessment

No	Subject matter	Students who reach KKM	Students who do not reach the KKM	Completion Percentage
1	Parabola	11	10	52,4%

This interview was also conducted with 4 XI TP-1 students. From the results of the interview, it was found that the learning carried out at YPT Pangkalan Brandan Vocational School still uses conventional methods. In class, learning is done face to face, the only learning resources used are books in the library. When learning begins, students borrow as many books from the library as there are students present. Students experience difficulties when learning about parabola material. Requires creative and critical thinking skills in problem solving. Students are less interested in learning mathematics because they find it difficult to understand the material and questions.

In accordance with Minister of [15], the profile of vocational school graduates is to master skills and entrepreneurship program competencies both to meet the demands of the

Print ISSN: 2580-3573, Online ISSN: 2580-2437

world of work and to undertake higher education in accordance with their vocation. This graduate profile can be interpreted as saying that the mandate of vocational school education is to create or produce graduates who have special skills and are ready to enter the workforce according to market demands. It is hoped that learning mathematics will be able to create work-ready vocational school graduates so that high-level thinking skills are needed so that they can form good soft skills and hard skills in students [16].

Good mastery of the material, especially the material in this research on parabolas, namely parabolic equations. Students are expected to be able to understand problems related to parabolas so that this knowledge can be applied to problems in the world of work. HOTS-based mathematics learning will train students to be able to think at a higher level to solve everyday life problems. In the parabola material, students study the distance of an object, the point of intersection of an object, the slope of an object so that creativity, critical thinking, accuracy and high-level thinking skills are needed to solve problems. So by studying on a parabola it is hoped that it will be able to produce students who are creative, critical and think at a high level in accordance with the demands of the 21st Century and the changes of the 5.0 revolution.

As a result of the explanation of the background above, it is very important to develop learning tools based on HOTS and TPACK on parabola material so that the learning that occurs is more interesting. If learning about parabolas is interesting, it is hoped that student learning outcomes will increase. Seeing this, the author decided to conduct research "Development of HOTS and TPACK Based Learning Tools on Parabola material".

METHODS

Thiagarajan's four-dimensional development tools, which include the define, design, develop, and disseminate phases, are used in this study, which is considered to be development research. The study will focus on developing learning tools based on HOTS and TPACK that are based on Parabola content, as well as all of the essential research equipment. According to the findings of this study, 21 students from class XI TP-2 at SMK YPT Pangkalan Brandan participated in restricted trials. According to Thiagarajan and Semmel [17], this development is a reference to the development model that is referred to as the 4-D device (four D device s). This model is comprised of four phases, which are the stages of definition, planning, development, and deployment. Time restrictions prevented the fourth step of this study from being carried out; nevertheless, it is anticipated that more research will be able to be carried out in the future.

RESULTS AND DISCUSSION

This study has resulted in the creation of a HOTS and TPACK-based gadget that is based on parabolic material. It is intended for students in class XI TP-1 at SMK YPT Pangkalan Brandan. This study makes use of the four-dimensional Thiagarajan model, which consists of the processes of defining, designing, developing, and disseminating the findings [18].

Defne

The product of this research is a HOTS and TPACK-based learning device on parabola material for SMK YPT Pangkalan Brandan class XI TP-1 students. The design of this research uses the Thiagarajan 4-D model, namely the define, design, develop, and disseminate stages.

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Design

Identity, the formulation of core competencies, indicators, and learning objectives, teaching materials, the selection of learning approaches and tools and learning scenarios, the selection of learning resources, procedures, and types of research, and the appearance of lesson plan documents are all components that are included in the validation of lesson plans. In addition, the value is a reference to the validity criteria that have been established, which means that it is possible to draw the conclusion that the lesson plan that was prepared has satisfied the validity standards by having a valid category. During the process of updating the lesson plan that was prepared, criticism and ideas were gained from the validator's evaluation. These contributions were taken into account. The components of teacher activity time management that need to be addressed have to be specified and detailed in order to meet the requirements of the situation. Additionally, there are still some problems in writing and spelling, and the learning goals need to be in agreement with the teaching materials that have been prepared and the teaching materials that have been introduced. Validation of teaching materials, appropriateness of teaching materials with build needs, suitability of teaching materials based on HOTS and TPCAK, quality of teaching material content, and suitability of teaching materials with didactic requirements are all aspects that need to be taken into consideration. Validity has been shown for the findings of the validation of the created teaching material expert. In addition, the value is a reference to the validity criteria that have been established, which means that it is possible to draw the conclusion that the education materials that have been generated have satisfied the validity standards by having a valid category. During the evaluation process, the validator provided feedback in the form of errors, critiques, and recommendations, all of which were taken into account. Errors in grammar and spelling, the use of unclear terminology, colors, and problem-solving methods that are either not detailed enough or do not match the instructional materials that are being prepared are some of the things that need to be updated.

Develop

A gadget that is based on HOTS and TPACK on parabolic material has been developed as a result of this study. It is intended for use by students in the eleventh grade of SMK YPT Pangkalan Brandan. The Thiagarajan 4-D model is used in this study design. The phases that are being discussed here are the defining, creating, developing, and distributing stages. Expert validators in the realm of educational materials are responsible for evaluating several aspects.

Table 1. Recapitulation of Material Expert Validation Results

No	Appraised Object	Average Score Value	Criteria
1.	Teaching materials	4,2	Valid
2.	Lesson plan	4,1	Valid
3.	HOTS and TPACK based devices	4,3	Valid

According to the findings of the validation process conducted on the HOTS and TPACK-based learning tools that were produced, the lesson plans, teaching materials, and HOTS ability assessments were discovered to fall into the valid category. As a result of this research, it is possible to assert that the learning tools that were produced are reliable and ready to be used in educational settings in order to enhance the HOTS thinking capacities of students.

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1. Revise the lesson plan

Table 2. Revised RPP

Before	After
E. Pendekatan, Model dan Metode Pembelajaran 1. Pendekatan Pembelajaran : Pendekatan Saintifik 2. Model Pembelajaran : *Discovery Learning* **F. Media, Alat dan Bahan Pembelajaran** 1. Media Pembelajaran : LCD, Proyektor, layar proyektor dan *Power point.* 2. Alat pembelajaran : Spidol, penggaris **G. Sumber Belajar** 1. Buku siswa yang diterbitkan oleh Kemendikbud kurikulum 2013 edisi revisi 2017. 2. LAS **H. Langkah-langkah Pembelajaran** **a. Kegiatan Pendahuluan** 1. Siswa disiapkan secara fisik dan psikis untuk mengikuti proses pembelajaran melalui kegiatan berikut a. Siswa diminta berdo'a sesuai dengan kepercayaan masing-masing. b. Siswa memberikan informasitentangkehadiran. c. Siswa mendengar dan menyimak cerita yang dibacakan guru tentang tokoh matematika sebagai kegiatan literasi dan siswa akan membuat kesimpulan dari cerita tersebut.	**E. Pendekatan, Strategi/Model, dan Metode :** Pendekatan : Saintifik dan TPACK Model Pembelajaran: Problem Based Learning (PBL) Metode : Penugasan, diskusi, tanya jawab **F. Langkah-langkah Pembelajaran** **Kegiatan** | **Deskripsi Kegiatan** | **Alokasi Waktu** Kegiatan Awal | 1. Melakukan pembukaan dengan salam dan menanyakan kabar peserta didik, kemudian dilanjutkan dengan membaca doa dipandu salah satu peserta didik **(Orientasi)** 2. Guru mengabsen peserta didik. 3. Peserta didik bersama guru saling mengingatkan kesepakatan belajar agar tercipta pembelajaran yang teratur, menyenangkan, dan bermakna. 4. Guru mengaitkan materi pembelajaran dengan pengalaman peserta didik. **(Apersepsi)** • Peserta didik diminta menganalisis gambar titik titik koordinat di diagram cartesius.***(TPACK)*** • Guru memberikan pertanyaan pemantik pada powerpoint: bagaimana garis pada gambar tersebut tidak lurus ? bagaiamana pendapat kalian tentang garis perlintasan bola pada permainan sepak bola? ***(TPACK)*** • Peserta didik menjawab berdasarkan pengetahuan awalnya | 15 menit

2. Revision of Teaching Materials

Table.3 Revision of Teaching Materials

Before	After
	

It can be seen in table 3 above that there are differences between teaching materials which were previously based on TPACK, but the display on the screen of the teaching materials did not use animation and the appearance was also less attractive. The learning teaching materials after revision use animation and are video-based. In this research, students' learning completeness is reviewed from HOTS thinking abilities which are tested using a test that has been developed in the form of an essay. A description of the results of students' HOTS thinking in trial I is shown in Table 4 below:

Table 4. Description of HOTS Thinking Ability Results Trial I

Score Max	**HOTS Thinking Ability**			
	X_{min}	X_{maks}	$\bar{x}$	S
100	40,00	90,00	71,4	14,82

The findings of the posttest indicate that the average HOTS thinking ability of students is 71.4, with a standard deviation of 14.82. This information is shown in Table 4, which can be seen here. If the categorization is done according to the degree of student mastery, then the level of mastery of students' HOTS thinking skills in the posttest results of trial I may be shown in Table 5.

Table 5. Posttest Results for Mastery Level of HOTS I Thinking Abilities

No	**Value Interval**	**HOTS Thinking Ability**		**Information**
		The number of students	Percentage	
1	$0 \leq$ KKM< 55	0	0%	Not enough
2	$56 \leq$ KKM< 75	10	47,6%	Enough
3	$76 \leq$ KKM< 85	7	33,3 %	Good
4	$86 \leq$ KKM < 100	4	19,1 %	Very good

According to Table 5, the findings obtained from the posttest of students' thinking abilities using the HOTS are as follows: there were no students who got the very poor category (0%), and there were 10 students (47.6%) who received the poor category., 7 students who received the sufficient category. (33.3%), who received the good category were 4 students (19.1%). For more details, see the diagram presented in Figure 4.2 below.

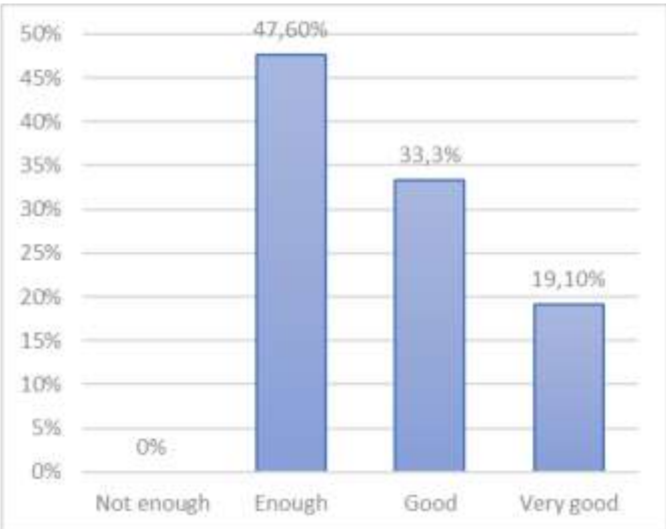

Figure 1. HOTS Thinking Ability Level Results of Posttest Trial I

As a consequence of the findings shown in Table 4 and Figure 1, it has been determined that the most prominent level of students' HOTS thinking capacity, as determined by the posttest results of trial I, is the fair category. This is followed by the good category, and the very good category is the last one. Additionally, the outcomes of the classical completion of the students' HOTS thinking abilities in trial I are shown in Table 6, which presents the findings.

Table 6. Level of Classical Completeness of HOTS Thinking Ability in Trial I

Category	***Posttest***	**Classical Completion**
	Number of Students	**Percentage**
Complete	11	52,4%
Not Completed	10	47,6%
Amount	21	100%

Following are the percentages of classical completeness criteria for students' HOTS abilities in trial I, presented in Figure 5.

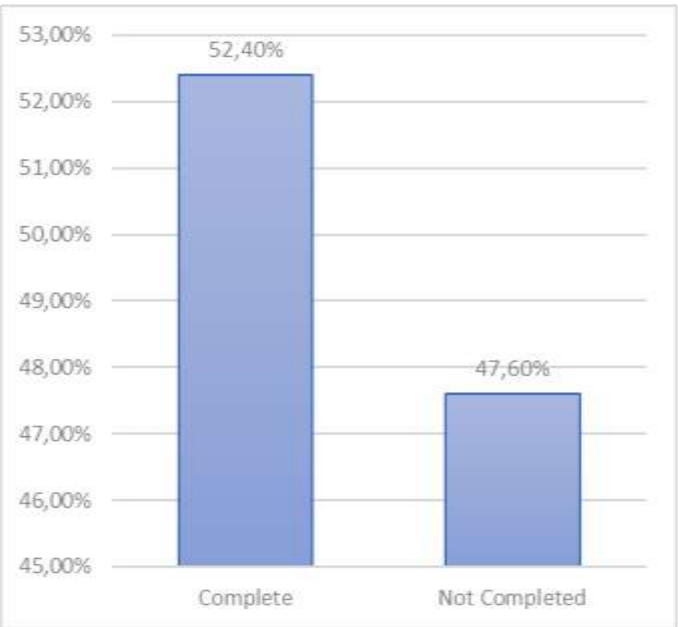

Figure 2. Percentage of Classical Completeness of Students' HOTS Thinking Ability in Trial I

Analysis of Classical Learning Completion Results HOTS Thinking Ability of Students in Trial II

In this research, the level of students' mastery was reviewed from the students' HOTS thinking abilities which were tested using a test that had been developed in the form of an essay. A description of the results of students' HOTS thinking in trial II is shown in Table 7:

Table 7. Description of HOTS Thinking Ability Results Trial II

Score	**HOTS capability**			
Max	X_{min}	X_{maks}	$\bar{x}$	S
100	60,00	94,00	80,50	9,47

Table 7 reveals that the average HOTS thinking ability of students in the posttest findings is 80.50, with a standard deviation of 9.47. This information is included in the results of the posttest. If the categorization is done according to the degree of student mastery, then the level of mastery of students' HOTS thinking skills in the posttest results of trial II may be shown in Table 8:

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Table 8. HOTS Thinking Ability Mastery Level Results of Posttest Trial II

No	**Value Interval**	**HOTS capability**		**Information**
		Number of Students	Percentage	
1	0 ≤ KKM< 55	0	0%	Kurang
2	56 ≤ KKM< 75	4	16,7%	Cukup
3	76 ≤ KKM< 85	10	54,1 %	Baik
4	86 ≤ KKM < 100	7	29,2%	Sangat Baik

According to Table 8, the findings that were obtained from the posttest of students' thinking abilities using the HOTS were as follows: there were no students who earned the very poor category (0%), four students (16.7%) achieved the adequate category, and ten students gained the good category. 54.1 percent of the pupils, or 29.2 percent, qualified for the very excellent group. Refer to the schematic that is shown in Figure 3 for more information:

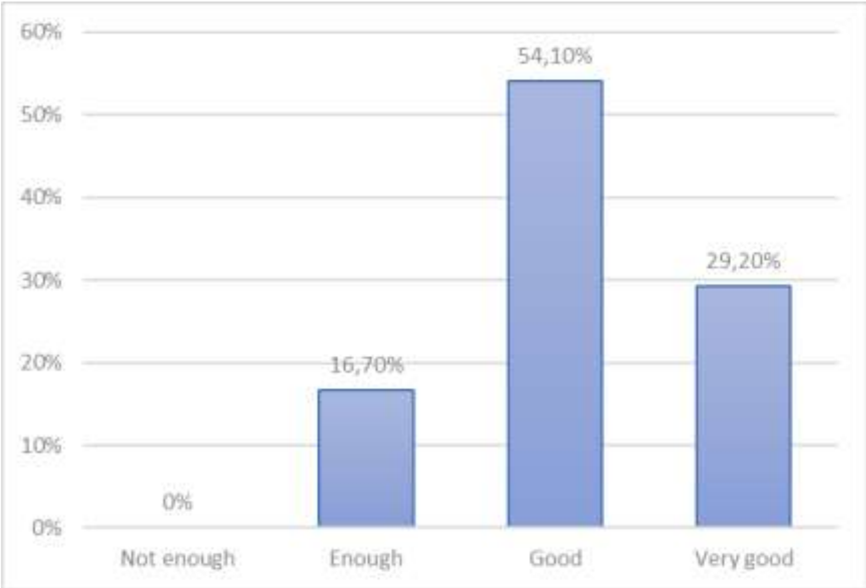

Figure 3. HOTS Thinking Ability Level Results of Posttest Trial II

Based on Table 8 and Figure 3, it is known that the most dominant level of students' HOTS thinking ability from the posttest results of trial II is the good category, followed by the sufficient category, and finally very good. Furthermore, the results of the classical completion of students' HOTS thinking abilities in trial II can be seen in Table 9:

Table 9. Level of Classical Completeness of HOTS Thinking Ability in Trial II

Category	*Posttest*	Classic Completion
	Number of Students	Percentage
Complete	17	83,3%
Not Completed	4	16,7%
Amount	21	100%

Print ISSN: 2580-3573, Online ISSN: 2580-2437

Diseminate

During the course of the trial, the final device is acquired after the requirements for validity and effectiveness have been satisfied. The next step is to carry out limited distribution, which will be done in the form of distributing the final device to the MGMP forum at SMK YPT Pangkalan Brandan. This will be marked by the submission of learning devices to the MGMP forum. The hope is that mathematics teachers who are members of the forum will be able to use the learning device in subsequent learning. Once the completed gadget has been submitted, the next most important stage is to present the findings of the development to the full population that is being studied in this particular investigation.

DISCUSSION

The validation results of the HOTS and TPACK learning tools that were constructed led to the discovery that the interactive learning tools were either declared valid or had a reasonable degree of validity. This was a consequence of the findings that were obtained from the validation process. iIt is then noted that the interactive learning device that was made is feasible, taking into account all of the criteria that apply to the validity of the interactive learning device. This is mentioned after the previous point. The results of the validation of the learning implementation plan (RPP), teaching materials, and HOTS thinking ability tests were verified or had a reasonable degree of validity. In addition, the findings of the validation were validated. It was the fact that this was the case for each and every component of the validation procedure. iTaking all of this into consideration, it is evident that the HOTS and TPACK-based learning aids that were developed in combination with lesson plans, teaching materials, and HOTS thinking capacity tests have effectively met the validity criteria. The outcomes of the validation process that was carried out by learning model experts as well as mathematics learning material experts indicate that the HOTS and TPACK-based learning aids that were generated are often unable to fulfill the learning needs for parabola content. This was shown by the fact that the validation process was carried out. In light of this, it is feasible to arrive at the conclusion that the HOTS and TPACK-based learning aids that were developed as a consequence of this research have fulfilled the standards for validity. IThat is stated by [19] measures of learning effectiveness are based on attaining learning completion if more than eighty The percentage of students who have completed it, the amount of time spent on learning is either efficient or does not exceed the amount of time spent on normal learning, and the attitudes of students to learning are positive. [20] It is claimed that the indicator of learning effectiveness is based on the attainment of learning completeness if more than eighty percent of students have finished it, the time spent in learning is efficient or does not surpass normal learning, and the students' reaction to learning is positive. these three factors are considered to be indicators of learning effectiveness. If both of these requirements are satisfied, then this is certainly the case. On the basis of the results of trials I and II, it has been shown that the learning gadgets that were constructed have been effective in terms of the accomplishment of students' HOTS thinking abilities, the active activities of students, and the positive reactions from students.

CONCLUSION

The HOTS and TPACK based learning tools that were developed were found to be valid in terms of Experts reported that the learning tools had an average validation result of 4.34 for the learning implementation plan (RPP), 4.24 for teaching materials, and 4.17 for the HOTS ability test, resulting in an overall average value of $4 \leq Va < 5$. many experts say learning techniques are viable with modest changes. The HOTS and TPACK-based learning tools met the effectiveness criteria in trial II: (1) 85.7% (18 students); (2) learning objectives were met for each question item, question 1 at 83.33% and question 2 at 83.81%; (3) student responses were 94%; and (4) the learning time used did not exceed the school's. From the studies and findings above, we may suggest: HOTS and TPACK-based learning devices have met validity, practicality, and effectiveness standards, so teachers should use them in the classroom to develop students' HOTS thinking skills, especially grade XI students. Because the researcher only uses groups that already exist in the class to form this discussion group, other researchers should pay more attention to student compatibility when dividing groups to improve group discussion.

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Print ISSN: 2580-3573, Online ISSN: 2580-2437