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Development of Exploratory Learning Mode Matrix Teaching Materials Based on Geogebra Classroom

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Abstract: ***The purpose of the study was to determine the feasibility, practicality and effectiveness of mathematics learning tools, especially the Matrix material with the Geogebra Classroom - based Discovery Learning learning model in class XI of the Nursing expertise program at SMK Negeri 1 Tondano. There are 24 students in the class. The focus of the research is developing learning tools which include Learning Implementation Plans (LIP), Student Worksheets (SW), Learning Outcomes Tests (LOT), and Matrix Teaching Materials with the Geogebra Classroom - based Discovery Learning learning model. . The development model used is a mathematical didactic research design. Generic Research Design Model which explicitly describes an integrated cycle of research activities, designs and outputs that interact directly and indirectly with practice. The results of this study indicate that the products developed, namely LIP, SW, LOT, Teaching Materials to teach mathematics, especially Matrix material with the Geogebra Classroom platform meet the valid, practical and effective criteria.***

Keywords: Teaching Materials, Matrix, Discovery Learning, Geogebra Classroom

1. Preliminary

The Covid - 19 (Corona Virus Disease 2019) pandemic in Indonesia has attacked since March 2020, affecting all fields, including the education sector. The government through the Ministry of Education and Culture immediately responded by taking several policies in the field of education. The Minister of Education and Culture issued Circular No.4 of 2020 regarding the implementation of education policies in the emergency period of the spread of Covid - 19, where the learning system changes from elementary to tertiary levels to an online learning system. The main emphasis of the circular letter is that all learning is no longer done face - to - face in class, but has been done online since the circular was issued (Kemendikbud, 2020). The impact of this policy encourages every educational institution to carry out learning from home by utilizing technology, namely carrying out online learning. Online learning is able to deliver various teaching materials to students without time and distance limits through internet access (Sahara 2017). Online learning provides access to learning between students and teachers when separated by time, distance or both (Aicha, 2014). In learning mathematics, some materials require the help of teaching aids so that it is easier for students to understand the concepts being studied. In this case, teachers can demonstrate teaching aids through online meeting applications or share demonstration videos via YouTube. However, this method has weaknesses, among which students cannot interact directly with teaching aids. Sometimes students only become "passive spectators" who only watch explanations and demonstrations from the teacher. One of the platforms that can be used so that students are actively involved in learning activities is the Geogebra Classroom. In Lestari's research (2018) the development of mathematics teaching materials using Geogebra showed that students at SMP Negeri 6 Serang City who used teaching materials by utilizing the Geogebra program experienced an increase in conceptual understanding compared to students before using the teaching materials. The teacher as the main factor that causes students to understand or not on the material being taught, needs to apply varied methods so that students are actively involved in learning. One solution is the use of interactive teaching materials (Supriani and Oktaviyanthi 2014). The use of interactive teaching materials, especially in integrating mathematics software, can make it easier for students to understand concepts (Oktaviyanthi and Herman, 2016). In addition, technology - assisted mathematics learning can help students to be more involved in connecting the school world with the real world (Oktaviyanthi, et al, 2017). In Hayati's research, et al (2020) showed that the application of Geogebra to Matrix material could increase students' enthusiasm and interest in learning.

Another factor that affects learning conditions is the problem of using learning models. In relation to the learning model, it was argued that the teacher - dominated learning model could hinder the activeness of students in understanding concepts (Bani 2011). Students should be directed to process knowledge, find, and develop their own mathematical concepts so that students' thinking skills can develop (Dwi Putra et al.2018).

Table 1: Syntax of Discovery Learning Learning Model and Teacher's Role

Phase	Teacher's Role
Phase I *Stimulation*	The teacher directs students to read, learn to find concepts that will be studied seriously and thoroughly.
Phase II *Problem statemen*	The teacher encourages students to ask questions related to the concept material that has been studied, other students are given the opportunity to respond. The teacher also confirms the students' responses.
Phase III *Data collection*	The teacher helps direct each student in the group to understand the problem presented.
Phase IV *Data processing*	The teacher directs students individually to solve questions about the material presented as an evaluation of students' knowledge abilities.
Phase V *Verification*	The teacher directs students in groups to solve the questions/problems presented in the Student Activity Sheet (LKPD).
Phase VI *Generalization*	The teacher asks each student in the group to present the conclusions about the concept of the material presented.

(Kemendikbud 2014a)

Learning with such characteristics is in accordance with the learning of the Discovery Learning model. The use of the discovery learning model can increase the interest and activeness of students in learning and also create learning in which this learning model emphasizes the discovery of concepts or principles that were previously unknown. This learning model helps students to learn actively and provides opportunities for students as a problem solver, a scientist, a historian or a mathematician. In this learning model, students are required to carry out various activities to collect information, compare, categorize, analyze, integrate, organize materials and make conclusions. Discovery learning and Geogebra have been widely combined to improve the mathematical abilities of mathematics learners, including to improve mathematical understanding (Shadaan and Kwan Eu n. d.), problem solving abilities and attitudes towards mathematics (Murni, Sariyasa, and Ardana 2017), and mathematical thinking skills (Widyastuti and Hamidah 2017). According to (Kemendikbud 2014a), each learning model has its own sequence of work steps (syntax). The syntax of the Discovery Learning model is (1) Giving stimulation (Stimulation), (2) Statement/problem identification (Problem Statement), (3) Data collection (Data Collection), (4) Verification and (5) Drawing conclusions/ generalization (Generalization). Table 1 describes the teacher's role in learning the Discovery Learning model.

2. Research Procedure

The research used is the type of research design development type of mathematics dikdactic Research Design Generic Model (McKenney and Reeves, 2012) which explicitly describes an integrated cycle of research activities, designs and outputs that interact directly and indirectly with practice. (**Figure** 1)

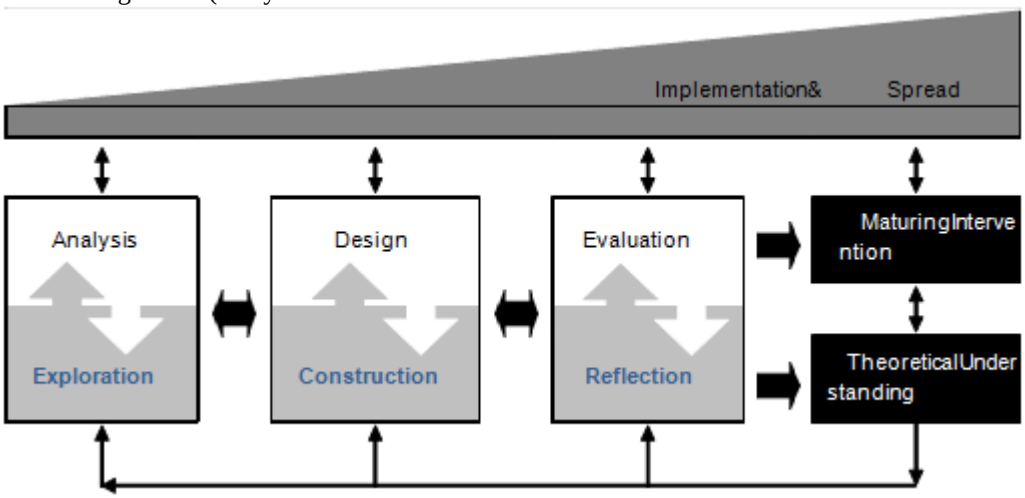


Figure 1: Generic model for conducting educational design research

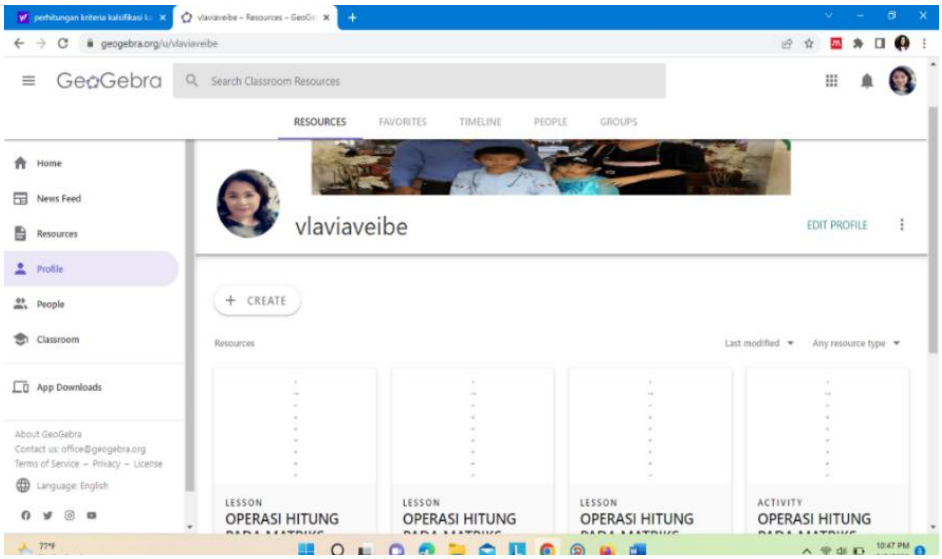
The Generic Research Design Model only shows the core elements of a flexible process featuring three main stages, which take place in interaction with practice and produce multiple outputs of knowledge and intervention (Spector et al.2014). In this model there are three concepts that are distinguished from each form: (1) Square: Three phases of research and development activities, (2) Rectangles: The two main outputs of design research, and (3) Triangle: Interaction with practice is shown to increase from time to time. There are 5 (five) stages of activities in the Generic Model of Research Design, namely (1) Analysis – Exploration, (2) Design – Construction, (3) Evaluation – Reflection, (4) Maturation of Theoretical Interventions, and (5) Implementation/Dissemination (Deployment).

The products produced go through stages 1 and 2, then in stage 3 an evaluation is carried out to measure the achievement of valid, practical and effective criteria. In stage 4, revisions or improvements are made to the developed media products according to the results of trials and the considerations of the supervisor. After the revision is complete, a re - test is carried out. This process will continue to repeat if the product has not shown a good level of feasibility. However, if the trial process results show good

feasibility results, media testing will be stopped and a hypothetical model is found that is suitable for use in the learning process. Intervention is mature with the completion of each design research cycle. Stage 5 is actually inclusive in this stage of development. The implementation phase of this model is carried out starting from the analysis, design, evaluation and theoretical interpretation stages. In other words, every time you perform the steps in this model, the results will be implemented immediately.

3. Results and Discussion

After passing stage 1 of the Generic Research Design development model, the following results were obtained: (1) Material Planning, namely (a) Conducting a review of learning materials guided by Competency Standards, Basic Competencies and indicators in the class XI SMK syllabus, reading books sources related to the selected material, namely the matrix, (b) Reviewing the material of learning models in accordance with the 2013 curriculum, and focusing on the Discovery Learning model, (c) Reviewing material on media, applied applications and various techniques for preparing teaching materials as basic in choosing the form and design of matrix teaching materials with the Geogebra Classroom - based Discovery Learning mode,



Graph 2: Tampilan Akun Guru di *Geogebra Classroom*

(d) Reviewing the results of interviews from teachers and students, regarding the use of digital media and applications in the learning process, with data that teachers are still focused on using the teacher's WhatsApp media, zoom meetings or Google Meets in learning or delivering information, while using math applications specifically for mathematics subjects have never been applied in learning; (2) Media Planning, (3) Introduction to students about the Geogebra Classroom application.

After passing phase 2 of the Generic Research Design development model, the following results were obtained: (1) Product development, namely (a) The teacher created a Geogebra classroom account, so that he got a classroom link which was distributed to trial participants. The appearance of the teacher account in the geogebra classroom is shown in Figure 2; (b) Learning Tools for RPP, LKPD, THB and Geogebra Classroom Based Teaching Materials have been designed and are ready to be tested. In Figure 3, a display of student activities is presented when working on the LKPD in the Geogebra Classroom.

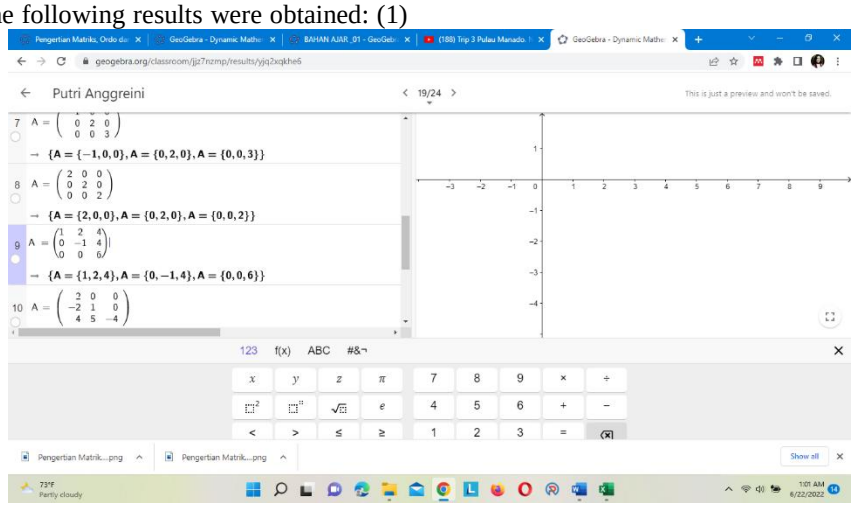


Figure 3: Display of student activities when working on LKPD

In Figure 4, two examples of the display of these teaching materials are given through the geogebra classroom with the link and group code.

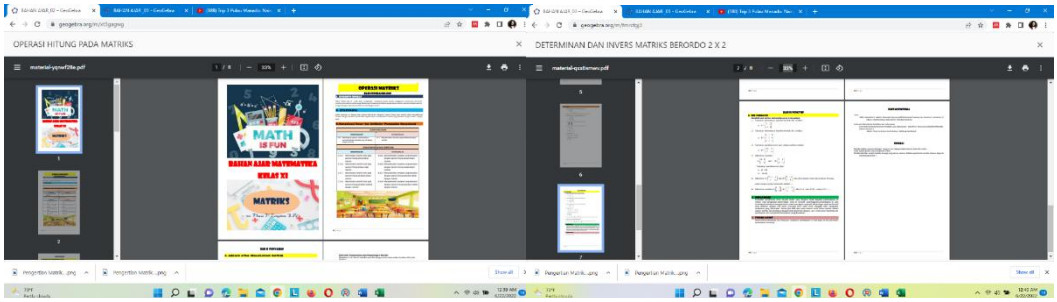


Figure 4: Display of Teaching Materials_02 Matrix with Geogebra Classroom

After passing stage 3 of the Generic Research Design development model, the following results were obtained: (1) A valid device after two validation processes; (2) A practical and effective device after going through two rounds of field trials, each round of learning is carried out in 4 meetings. Furthermore, in Table 2, a description of the validation results in the second round is given.

Table 2: Results of Validation of Learning Implementation Plans

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Format RPP	4, 90	Sangat Valid
Bagian II. Isi yang disajikan	4, 74	Sangat Valid
Bagian III. Bahasa dan Tulisan	5	Sangat Valid
Bagian IV. Alokasi Waktu	5	Sangat Valid
Rataan Total	4.91	Sangat Valid
Persentase (%)	0, 98	Sangat Tinggi

Aiken's Formula Validation category average percentage of RPP Validation value obtained V = 0.98 = 98% is in the range of 0.80 < V <1.00 with a very high predicate. Based on these results, the lesson plans that have been developed by researchers are declared valid and can be used with revisions based on suggestions in the comments column.

The results of the assessment from the LKPD validator team which includes the LKPD format, LKPD content, language and concept accuracy, there are several parts that need to be improved. In making improvements to the LKPD, it is presented in the following table:

Table 3: Results of Validation of Online Student Activity Sheets

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Format	4, 90	Sangat Valid
Bagian II. Isi	4, 80	Sangat Valid
Bagian III. Bahasa	4, 80	Sangat Valid
Bagian IV. Keakuratan konsep	4, 90	Sangat Valid
Rataan Total	4.85	Sangat Valid
Persentase (%)	0, 97	Sangat Tinggi

Aiken's Formula Validation category average percentage of online LKPD Validation scores obtained V = 0.97 = 97% in the range of 0.80 < V <1.00 with a very high predicate. Based on these results, the Online LKPD that has been developed by the researcher is declared valid and can be used. The results of the validation of the Learning Outcomes Test (THB) both formative (quiz) and summative (daily test) which include THB Content, THB Construction, and Language, are presented in Table 4 below.

Table 4: Validation Results of Learning Outcomes Test (THB) Online

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Isi	4, 80	Sangat Valid
Bagian II. Konstruksi	4, 67	Sangat Valid
Bagian III. Bahasa	4, 93	Sangat Valid
Rataan Total	4.80	Sangat Valid
Persentase (%)	0, 96	Sangat Tinggi

Aiken's Formula Validation category average percentage of online THB Validation scores obtained V = 0.96 = 96% is in the range 0.80 < V <1.00 with a very high predicate. Based on these results, the THB that has been developed by researchers is declared valid and can be used. The results of the assessment from the material expert validator team for Matrix Teaching Materials which include format, content, language, and concept accuracy, are presented in Table 5 below.

Table 5: Results of Material Expert Validation (Matrix Teaching Materials)

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Format	4, 90	Sangat Valid
Bagian II. Isi	4, 76	Sangat Valid
Bagian III. Bahasa	4, 85	Sangat Valid
Bagian IV. Keakuratan Konsep	4, 80	Sangat Valid
Rataan Total	4.83	Sangat Valid
Persentase (%)	0, 97	Sangat Tinggi

Aiken's Formula Validation category average percentage value of Matrix Teaching Material Validation obtained V = 0.97 = 97% in the range 0.80 < V <1.00 with a very high predicate. Based on these results, the matrix teaching materials that have been developed by researchers are declared valid and can be used. The results of the assessment from the validator team of geogebra classroom media experts which include the appropriateness of the display, the appropriateness of presentation and the language, are presented in Table 6 below.

Table 6: Media Expert Validation Results (Geogebra classroom)

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Tampilan Media	4, 85	Sangat Valid
Bagian II. Tampilan Bahan Ajar	4, 67	Sangat Valid
Bagian III. Bahasa	4, 87	Sangat Valid
Bagian IV. Aksesibilitas	4, 83	Sangat Valid
Rataan Total	4.80	Sangat Valid
Persentase (%)	0, 96	Sangat Tinggi

Aiken's Formula Validation category average percentage of the Geogebra classroom validation value obtained V = 0.96 = 96% in the range 0.80 < V <1.00 with a very high predicate. Based on these results, the geogebra classroom media that has been developed by researchers is declared valid and can be used with revisions based on suggestions in the comments column. The results of the assessment from the validator team for the instrument for observing the implementation of learning devices which include format, content and language, are presented in table 7 below.

Table 7: Results of Validation of Implementation Observation Instruments Learning Media

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Format	4, 90	Sangat Valid
Bagian II. Isi	4, 80	Sangat Valid
Bagian III. Bahasa	5, 00	Sangat Valid
Rataan Total	4.90	Sangat Valid
Persentase (%)	0, 98	Sangat Tinggi

The Aiken's Formula Validation category average percentage value of the Instrument Validation Observation of the Implementation of Learning Devices obtained V = 0.98 = 98% is in the range of 0.80 < V <1.00 with a very high predicate. Based on these results, the Observation Instrument for the Implementation of Learning Devices that has been developed by researchers is declared valid and can be used. The results of the assessment from the validator team for the questionnaire instrument for student responses to learning tools which include format, content and language, are presented in table 8 below.

Table 8: Results of Validation of Student Response Questionnaire Instruments against Learning Devices

Aspek Penilaian	Rataan Tiap Aspek	Keterangan
Bagian I. Format	5, 00	Sangat Valid
Bagian II. Isi	4, 80	Sangat Valid
Bagian III. Bahasa	4, 90	Sangat Valid
Rataan Total	4.90	Sangat Valid
Persentase (%)	0, 98	Sangat Tinggi

Aiken's Formula Validation category the average percentage of the total value of the Student Response Questionnaire Instrument Validation on the Implementation of Learning obtained V = 0.98 = 98% in the range of 0.80 < V <1.00 with a very high predicate. Based on these results, the Student Response Questionnaire Instrument on the Implementation of Learning that has been developed by the researcher is declared valid and can be used.

To measure the practicality of learning devices, data from observations of the implementation of learning devices were used in the second trial. The analysis of the results of the observation of the implementation of learning is shown in Table 9

Table 2: Results of Observation of Learning Implementation

No	Aspek Penilaian	Nilai Rata - rata Setiap Aspek
1	Bagian I. Pendahuluan	5.00
2	Bagian II. Membuka Pelajaran	4.92
3	Bagian III. Kegiatan Inti:	
	a. Syntaks	4.38
	b. Penguasaan Materi Pelajaran	4.92
	c. Pendekatan/Strategi Pembelajaran	4.64
	d. Pemanfaatan Sumber Belajar/Media Pembelajaran	4.75
	e. Pembelajaran yang Memicu dan Memelihara Keterlibatan Peserta didik	5.00
	f. Penilaian Proses dan Hasil Belajar	4.63
	g. Penggunaan Bahasa	5.00
4	Bagian IV. Penutup	5.00
	Rata - Rata Aspek Penilaian	4.92
	Persentase	98.38

Observational data obtained the total average value for 3 meetings, namely 4.92 and with the criteria quoted from Nurdin (2007) in Ilyas (2015), the results of these observations are in very high criteria. This criterion indicates that the level of teacher's ability to process learning is very high. So that it can be concluded, the learning device developed by the researcher, namely the development of matrix teaching materials with Geogebra Classroom - based Discovery Learning meets the practical criteria. To measure the effectiveness of learning tools, the data from the questionnaire analysis of student responses to the implementation of learning and the completeness of student learning outcomes are used. Table 10 shows the data analysis of student responses to learning and the tools used.

Table 10: Percentage of Student Responses to Learning Components

Aspek perasaan yang direspon	Senang (%)	Tidak Senang (%)
Materi pelajaran	91.67	8.33
LKPD	83.33	16.67
Suasana Belajar di Kelas	91.67	8.33
Cara Guru mengajar	91.67	8.33
Media *Geogebra classroom*	91.67	8.33
Rata - rata	**90.00**	**10.00**
Aspek pendapat yang direspon	**Baru**	**Tidak Baru**
Materi pelajaran	87.50	12.50
LKPD	87.50	12.50
Suasana Belajar di Kelas	91.67	8.33
Cara Belajar	91.67	8.33
Media *Geogebra classroom*	91.67	8.33
Rata - rata	**90.00**	**10.00**
Aspek minat yang direspon	**Berminat**	**Tidak Berminat**
Persentasi Respons (Minat) Siswa	100%	0%
Aspek pendapat yang direspon	**Menarik**	**Tidak Menarik**
Bahasa yang digunakan dalam LKPD dan THB	91.67	8.33
Penampilan (tulisan, gambar, letak gambar) yang terdapat pada LKPD dan THB	91.67	8.33

The Learning Outcomes Test Instrument (THB) used to collect data on student learning outcomes is a valid instrument. The validity of the THB is indicated by the results of the assessment by the validators (see Table 4) and empirical assessments such as the analysis of learning outcomes data captured in the test in the first trial. The instrument was then used to measure the effectiveness of the learning tools developed by comparing the data on the learning outcomes of two groups of students, namely group A and group B. Group A were students who studied matrix with learning using the developed tools, while group B was a group of students who studied with conventional device. Based on the data in the Group Statistic output table, it is known that the number of data on class A learning outcomes is 24 people and the number of data on Class B learning outcomes is 24 people. The average value (mean) of student learning outcomes for Class A is 74.58 and the average value of student learning outcomes for class B is 67.08. Thus, statistically descriptive, it can be concluded that there is a difference in the average student learning outcomes between class A and class B. Based on the independent sample test output in the Equal Variances Assumed section, it is known that the value of sig (2 tailed) is 0.017 < 0.05, it can be concluded that there is a significant difference between the average learning outcomes for class A and the average learning outcomes for class B

4. Conclusions and Suggestions

Based on the results of the research and discussion, the conclusions obtained from this study are as follows: (1) Development of learning tools which include lesson plans, LKPD, THB, Matrix Teaching Materials, Geogebra Classroom Media obtains an average validation value with a very high predicate, so that it meets Valid criteria; (2) Based on the student's response to learning with the developed device, a positive response was obtained and was in strong criteria, so it was concluded that the developed learning device had a positive response. The learning outcomes test showed a significant difference in the average learning outcomes of the two classes, so it was concluded that the learning tools that had been developed met the criteria of Effective; (3) Criteria for the Practicality of Learning Devices developed, seen from the level of teacher ability taken through observational data on the implementation of learning which was assessed by the observer, obtained a score with very high criteria. So it can be concluded that the development of mathematics learning tools, especially the Matrix material with the Gepgebra Classroom - based Discovery Learning model, meets the practical criteria; (4) The results of the development of mathematics learning tools, especially Matrix material with a discovery learning model based on the Geogebra Classroom include Learning Implementation Plans (RPP), Student Activity Sheets (LKPD), Learning Outcomes Tests (THB), Matrix Teaching Materials with GeoGebra Classroom Media which have categories good because it meets the criteria of Valid, Practical and Effective. For teachers and further researchers, it can be suggested that: (1) facilitate students in understanding mathematical concepts as a new learning experience in improving learning outcomes in either face - to - face learning (PTM) or distance learning (PJJ); (2) provide alternative online mathematics learning tools for teachers to improve, develop and improve the quality of mathematics learning; (3) make a positive contribution in teaching and learning process activities, so that schools are more creative and innovative in developing mathematics learning tools to improve the quality of education.

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