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Development of Discovery Learning and Toulmin Argument Pattern (TAP) Based Learning Devices to Trains Students' Critical Thinking Skills on Global Warming Materials

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Abstract: This study aims to develop learning tools for the Discovery Learning model based on the Toulmin Argument Pattern (TAP) which are valid, practical and effective for training students' critical thinking skills on global warming. This research is a development research with the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) and is tested in SMA Negeri 1 Menganti with One Group Pre test – Posttest Design. Data collection through observation, tests and questionnaires. Data analysis techniques using descriptive quantitative analysis, qualitative and parametric statistical tests. The results of the study show that the learning tools developed are in the valid category, the learning tools developed are practical in terms of the implementation of the lesson plans and the learning activities of active students according to the stages of Discovery Learning syntax, the learning tools developed are effective in terms of from Increased critical thinking skills seen from the n-gain in the high category , there is an increase in students' critical thinking skills, there is no difference increasing critical thinking skills from one class to another. It was concluded that the discovery learning model based on Toulmin's Argument Pattern (TAP) Global Warming material developed was valid, practical, and effective.

Keywords: Critical Thinking Skills; Development of Learning Devices; Discovery Learning; Global Warming; Toulmin Argument Pattern (TAP).

Introduction

Education is a component that has a very important role in the course of human life, this is because education is a vehicle for producing superior and quality human resources in various aspects, including aspects of behavior, knowledge and skills in dealing with a problem in life. In addition, education is a process of systematic effort for individuals to develop into human beings who have responsibility, are independent, creative, knowledgeable, and have good morals, both from physical and spiritual aspects. This statement is in accordance with Law No. 20 of 2003 concerning the National Education System Chapter II Article 3 which states that national education is to cultivate capabilities and form dignified national character or attitudes and civilization, using hope that can educate the nation's life. In addition, it aims to develop the potential of students to become human beings who believe, fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and democratic and responsible. In addition, according to John Dewey, education is a process of forming or reconstructing experiences as a result of enriching an experience and increasing abilities as learning in subsequent experiences (Dwi Siswoyo, 2011). The manifestation of the educational process is that there are several aspects that must be trained for students where one of them is critical thinking skills through formal education.

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Formal education is a process in which efforts are moving forward and are innovative to improve the quality of education in schools by applying critical, creative and open thinking behaviors. Some of the things that are done as a requirement in formal education are instruments embodied in the curriculum in Indonesia, namely the 2013 curriculum. The 2013 curriculum requires students to actively participate in learning (Handayani, 2015). Furthermore, in the revised 2013 curriculum, one of the skills being trained is skills in critical thinking. Critical thinking skills are carried out with 5M including Observing, Asking, Trying, Analyzing and Communicating. In the current era where curriculum development has been experienced, namely through an independent curriculum based on 21st century skills, students are trained in several supporting skills including critical thinking and problem solving, creativity and innovation, communication and collaboration (Irvan, 2020).

According to Permendikbud No 81 A of 2013, in the activity of communicating certain matters, students are required to be able to convey observations, conclusions based on what will happen with verbal, written or other media analysis. This ability is a soft skill needed by students in 21st century learning, namely the ability to think critically in every problem. In learning the revised 2013 Curriculum, students are required to be active in the learning process. According to Ennis (2013) the main activity of higher-order thinking skills is critical thinking skills, by making decisions based on the process of analyzing existing problems. Therefore, it is hoped that in the current era education can train and prepare students to be able to master some of these skills (Isbandiyah et al, 2019). Critical thinking skills are one of the 21st century competencies which is still the focus and included in science learning (Prafitasari., 2021). Critical thinking skills are important to learn so that students are able to respond to changes quickly and effectively by using rational intellectual skills and utilizing relevant information to find solutions to problems (Utama et al, 2020).

Skills belonging to the 21st century skills are critical thinking skills, communication skills, literacy on issues and communication technology, socio-cultural skills, creativity, teamwork, and problem-solving skills (Bezanella, 2019). Several forms of learning models that develop and direct students to think critically (Hwang et al., 2015) are through problem-based learning (PBL) models (Martyn et al., 2014; Masek & Yamin, 2011), project-based learning models or Project Based Learning (Bell, 2010), discovery learning models (Putri et al., 2020; Yerimadesi et al., 2019), and blended learning models (Jou et al., 2016). In the revised and independent 2013 curriculum which focuses on 21st century learning, it provides space and opportunities for teachers to practice critical thinking skills through discovery learning models based on scientific argumentation.Critical and creative thinking skills play an important role in preparing students to become good problem solvers and able to make mature decisions and conclusions that can be held accountable academically.

The measurement of critical thinking skills carried out by TIMSS (The Trends International Mathematics and Science Study) by the IEA (International Association for the Evaluation of Educational Achievement) had low results. The 2018 TIMSS results for the science and cognitive domains (understanding, application and reasoning), students in Indonesia got 396 below the international average score of 500, meaning that students' science knowledge in Indonesia is still in the limited knowledge category and does not yet have scientific reasoning skills in compiling explanations based on evidence and arguments with critical analysis Previous research on scientific argumentation in practicing critical thinking skills conducted by Sondang (2012) states that high school students in developed countries experience difficulties in making scientific arguments, perceived difficulties in expressing scientific signs empirically and class discussions on the topic of global warming. relating to everyday life to bring up critical thinking skills in analyzing problems. The form of a learning process that requires an understanding of concepts and knowledge and is also able to practice critical thinking skills that are in line with 21st century skills is to use the discovery learning model. Discovery learning is a learning model that can build students' experiences through scientific activities.This discovery learning model is also able to improve students' critical thinking skills according to research results (Rahayu, 2020). This is because this model requires students to actively find problems based on concepts and materials, discuss, collect and process data and in the end draw conclusions (Rini Sa'diyah & Muhid 2021).

Discovery Learning is a method of understanding concepts, meanings and relationships through an intuitive process to finally arrive at conclusions. The Discovery Learning Model according to Brunner in Suherti (2017: 53) is learning that aims to acquire knowledge in a way that can train the intellectual abilities of students and stimulate their curiosity and motivate their abilities. Discovery is a learning model that regulates teaching in such a way that students gain knowledge that was previously unknown, Partly or entirely discovered by Ruseffensi himself in Suherti (2017: 53). Teaching and learning processes that require understanding of concepts and knowledge and being able to practice critical thinking skills. The ability to argue is a very important ability for the cognitive development of students (Von Aufschnaiter et al., 2008). When learning argumentation this is an important way of thinking in facilitating conceptual change and important for solving problems. Probosari (2016)

conveys that the ability to argue is something that is crucial for students to reason, interact, share learning motivation. The discovery learning model that is applied later can be supplemented with the Toulmin Argument Pattern (TAP) so that it can train students' critical thinking skills on global warming material.

Developments in the Application of Toulmin's Argument Pattern for Studying Science Discourse (Erduran et al., 2004) states that the development of the Toulmin Argument Pattern (TAP) application is very good. The ability to argue which states that there is a causal relationship is reflected in the answers of students who can answer correctly, describe the flow of logical and systematic thinking, with good and correct language (Afrizon, 2012). Researchers can well use the Toulmin Argument Pattern (TAP) argumentation model as a tool for analyzing a form of argumentation (Sibel Erduran et al, 2007). The Toulmin Argument Pattern (TAP) structural model is presented in Figure 1.

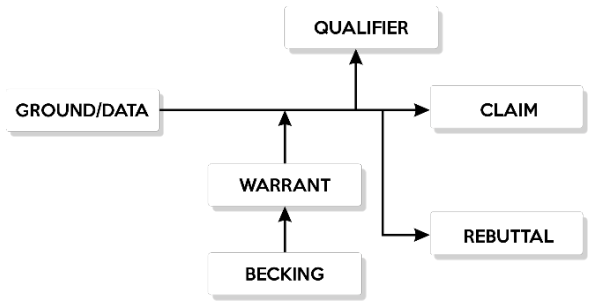

Figure 1. The structure of the Toulmin Argument Pattern (TAP)

Based on Figure 1 it shows that the structure of the sequence of arguments consists of 6 important components, namely: grounds, claims, warrants, backing, qualifiers, and rebuttals. The argument pattern consists of data that supports a claim so that it can be strengthened with a warrant, based on the backing, but can be refuted (rebuttal). It will be interconnected between data, claims, warrants, backing, and rebuttal. With this argumentation pattern, it is expected that students will lead to 6 components, namely ground, claims, warrants, backing, qualifiers, and rebuttals so that the quality of each student's argument can be measured (Devy et al, 2020) so that it is hoped that later they can practice critical thinking skills.

Glaser states that there are 12 indicators of critical thinking skills including recognizing cases, finding steps that can be used in dealing with cases in everyday life ,correcting and organizing the information needed, recognizing assumptions and unexplained values, explore and use language clearly, precisely, and uniquely, analyze data, weigh facts and test questions, identify rational relationships between problems, draw conclusions, evaluating, conclusions, rearranging belief structures originating from more mature knowledge, and generating correct judgments regarding specific matters and qualities in everyday life (Krahenbuhl, 2016). Ennis further stated that critical thinking includes several aspects, namely is providing simple explanations, building basic skills, concluding, providing further explanations, and managing strategies and tactics (Khofiyah, 2019).

Based on the results of observations and exploring learning information from physics teachers, the physics material that is deemed necessary to be carried out with learning using the discovery learning model with the Toulmin's Argument Pattern (TAP) pattern is global warming. Global warming is the occurrence of an increase in the average temperature of the atmosphere, sea and earth's land. Global warming will be followed by climate change such as increased rainfall in some parts of the world causing flooding and erosion, while other parts of the world will experience a prolonged dry season due to rising temperatures. In this study, what was studied was the understanding of global warming, causes and processes of global warming and solutions. (Singh, 2015).

Based on the explanation above, the discovery learning model was chosen with the Toulmin Argument Pattern (TAP) pattern to train students' critical thinking skills on global warming. Researchers will design and conduct research entitled Development of Toulmin Argument Pattern (TAP) Based Discovery Learning Model Learning Devices to train students' critical thinking skills on global warming material. In general, the purpose of this study was to produce learning tools based on the Toulmin Argument Pattern (TAP) to train valid, practical, and effective ways to train critical thinking skills on global warming.

Method

This research is a development research. This study developed a discovery learning model based on the Toulmin Argument Pattern (TAP) to train students' critical thinking skills on global warming. This development research refers to the ADDIE model development model (Analysis, Design, Development, Implement, Evaluation) which consists of 5 interrelated components and is systematically structured. The learning tools developed are Learning Syllabus, Learning Implementation Plan (RPP), Global Warming Handout, Student Worksheet (LKPD), and Critical Thinking Skills Assessment Instrument.The development of the ADDIE model is shown in Figure 2

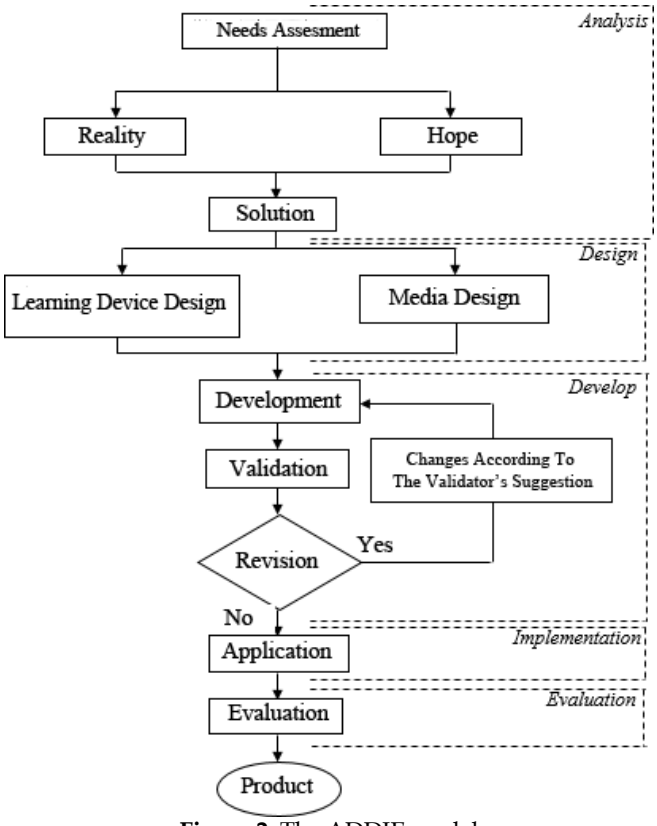

Figure 2. The ADDIE models

The research subjects from the application of the results of the development of learning tools based on the Toulmin Argument Pattern (TAP) material on global warming in the trial were class X-1 during the limited trial and classes X-1, X-2 and X-3 during the wide trial in high school Negeri 1 Changing the academic year 2022 – 2023. The limited trial involved 36 students in 1 class and the wide trial involved 108 students in 3 classes. The research design used in a limited test with a pre-experimental design approach (one group pre-test and post-test). The design of this study was used to match the results of the post-treatment with the pre-treatment, namely as follows

$$O_1 \times O_2 \quad (1)$$

Information

O_1:The pre-test was carried out before the learning treatment was carried out by the discovery learning model of the Toulmin Argument Pattern (TAP) pattern.

X :Treatment carried out in the experimental class by applying the discovery learning model of the Toulmin Argument Pattern (TAP) pattern in the learning process.

O2:The post test is carried out after learning the discovery learning model of the Toulmin Argument Pattern (TAP) pattern.

Next, the research design used in the broad test with a pre-experimental design approach (one group pre-test and post-test). The design of this study was used to match the results of the post-treatment with the pre-treatment, namely as follows

$$O_1 \times O_2$$
$$O_3 \times O_4$$
$$O_5 \times O_6 \quad (2)$$

Information

O1: The pre-test was carried out before the discovery learning model treatment was carried out by the Toulmin Argument Pattern (TAP) model which was carried out in the experimental class 1.

O2: Post-test was carried out after the treatment was carried out in experimental class 1.

O3: The pre-test was carried out before the discovery learning treatment of the Toulmin Argument Pattern (TAP) study was carried out in experimental class 2.

O4: Post-test was carried out after the treatment was carried out in the experimental class 2.

O5: The pre-test was carried out before the treatment of the discovery learning model of the Toulmin Argument Pattern (TAP) learning model was carried out in experimental class 3.

O6: Post-test was carried out after the treatment was carried out in the experimental class.

X: Treatment carried out in the experimental class by applying the Toulmin Argument Pattern (TAP).

The development of learning tools in this research consists of 5 stages in the ADDIE model development research. The choice of this model is because each step of development is directly related to revision activities and can be started from any appropriate stage in the cycle. The curriculum that applies nationally in Indonesia is goal-oriented, so the development of learning tools in this study was carried out from start to finish.

The learning tools developed include syllabus, learning implementation plans (RPP), handouts, LKPD (student worksheets), and critical thinking skills test instruments. The learning tools that have been prepared are then validated by two lecturers and one teacher which include content components, language components, and presentation components. After being validated, limited trials and extensive trials were carried out to determine the practicality and effectiveness of the learning devices made. Data collection was carried out by observation, test and questionnaire methods. Data analysis techniques using descriptive quantitative analysis, qualitative and parametric statistical tests. Implementation of learning based on the Learning Implementation Plan (RPP) made, then observed by two observers and then analyzed with the following formula.

$$Implementation\ Of\ Learning = \frac{\text{Score Obtained}}{\text{Score Maximum}}\ x\ 100\ \% \quad (3)$$

Student activity during learning is measured by observing student activity sheets. Data from observations of students' activities during learning activities were analyzed using percentages. The formula for the percentage of student activity can be presented in the form of the following equation.

$$Student\ Activity = \frac{\text{Score Obtained}}{\text{Score Maximum}}\ x\ 100\ \% \quad (4)$$

Obstacles experienced by students can be seen through the obstacle filling sheet which will be filled in by students. Based on this sheet, researchers can later find out the obstacles that occur during the learning process with the discovery learning model based on the Toulmin Argument Pattern (TAP).

The ability to think critically on Global Warming material in this study is the ability of students to solve test questions based on the Toulmin Argument Pattern (TAP). The critical thinking ability test was carried out twice, namely before teaching as a pretest value and after teaching with the Discovery Learning model based on Toulmin Argument Pattern (TAP) as a posttest value. The improvement of students' critical thinking skills can be seen from the results of the pre-test and post-test and can be measured using n-gain.

$$\langle g \rangle = \frac{\%(G)}{\%(G)_{max}} = \frac{\{\%(S_f)\} - \{\%(S_i)\}}{(100\% - \%(S_i))} \quad (5)$$

Information
(g) : Increase in student scores
(Si) : Pre-test score
(Sf) : Post-test score
These tests are classified into three categories. This normalized gain can be formulated as follows. The n - gain score is in Table 1.

Table 1. N-gain score

Value (g)	Category
$(g) > 0.7$	High
$0.3 < (g) \leq 0.7$	Medium
$(g) < 0.3$	Low

Data about student responses were obtained from student response questionnaires to learning activities, and then analyzed using descriptive qualitative. The response data obtained is used to follow up on learning activities using the discovery learning model with the TAP pattern.

Result and Discussion

The results of developing a discovery learning model based on the Toulmin Argument Pattern (TAP) to train critical thinking skills according to Rochmad (2012) to test the quality of the developed model must be based on 3 (three) indicators namely validity, practicality (practically) and effectiveness (effectiveness). so that students can understand concepts, procedures, and theories and achieve learning objectives, learning devices play an important role in the implementation of education in schools (Dewi et al, 2015).

Validity of Learning Devices

The results of the validity of the learning devices developed are stated to be valid for use in learning physics on global warming material which presented in Figure 3.

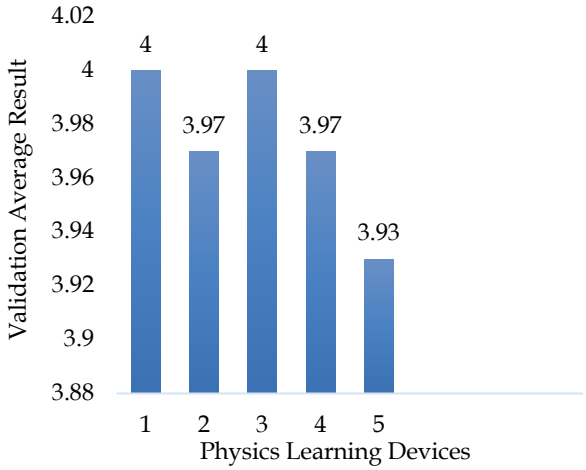

Figure 3. Learning Device Validation Results

In accordance with figure 3 above, number 1 shows the syllabus, number 2 shows the Learning Implementation Plan, number 3 shows handouts, number 4 shows student worksheets and number 5 shows the critical thinking test instrument, it can be seen the results of the validity of the syllabus learning tools, learning implementation plans, handouts, worksheets, critical thinking test instruments, obtaining an average value in the range of 3.50 - 4.00 with a very valid category. Validity is a standard to indicate the level of validity or the validity of a test, while a test can be said to be valid if it can measure what is measured. (Siregar et al, 2020). Learning tools revised based on input and suggestions from the validator after being validated to find out whether a number of aspects have been carried out based on input and suggestions from the validator (Nismalasari & Mukhlis 2016).

Based on Figure 3 it can be seen the results of the validity of the syllabus learning tools, learning

implementation plans (RPP), handouts, worksheets, critical thinking test instruments, obtaining an average value in the range of 3.50 - 4.00 with a very valid category. Validity is a standard to indicate the level of validity or the validity of a test, while a test can be said to be valid if it can measure what is measured. (Siregar et al, 2020). Learning tools revised based on input and suggestions from the validator after being validated to find out whether a number of aspects have been carried out based on input and suggestions from the validator (Nismalasari & Mukhlis 2016).

Based on Figure 3 it can be seen the results of the validity of the syllabus learning tools, learning implementation plans (RPP), handouts, worksheets, critical thinking test instruments, obtaining an average value in the range of 3.50 - 4.00 with a very valid category. Validity is a standard to indicate the level of validity or the validity of a test, while a test can be said to be valid if it can measure what is measured. (Siregar et al, 2020). Learning tools revised based on input and suggestions from the validator after being validated to find out whether a number of aspects have been carried out based on input and suggestions from the validator (Nismalasari & Mukhlis 2016).

Practicality of Learning Devices

RPP Implementation

The implementation of the learning carried out during limited trials in class X-1 and extensive trials in classes X-1, X-2 and X-3 were observed by two observers from the teacher. The results of the implementation of the RPP during limited trials and wide trials are shown in Figure 4.

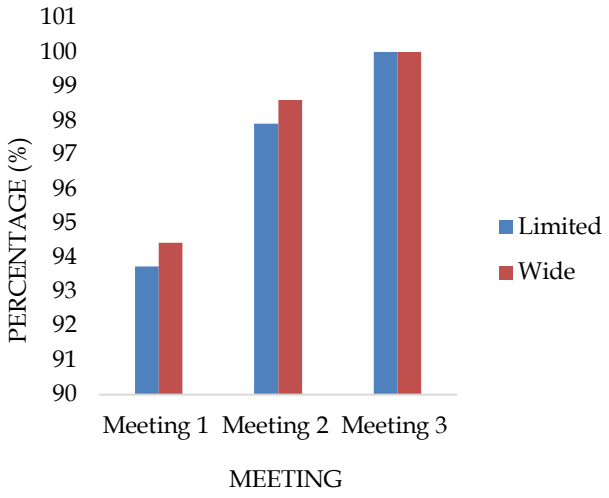

Figure 4. Percentage of Implementation of RPP

Based on Figure 4, the overall results of the implementation of the RPP were obtained during limited trials and extensive trials, where during meetings 1 to 3, an increase in the percentage of learning implementation was obtained from limited trials to extensive trials. This is in accordance with what was explained by Fatmawati (2016), that the implementation of learning is classified as very good criteria if it reaches a percentage of 90-100. Santi & Santoso (2016), further explained that learning tools can be said to be practical if the implementation of learning is at least in good criteria.

Student Activity

The activities of students in this study were observed by two observers in each class both during limited trials in class X-1 and during wide trials in classes X-1, X-2 and X-3. Some of the aspects observed include aspects of answering greetings, praying according to their respective religions, listening to teacher explanations, discussing and working together in groups (building basic skills), answering questions from teachers accompanied by giving logical reasons, asking teachers or friends, presenting the results of the discussion, asking and answering questions, making conclusions and reflecting on learning with the teacher. The percentage of activity reliability of class X-1 students during the trial was limited to the first to third meetings, which can be seen in Figure 5.

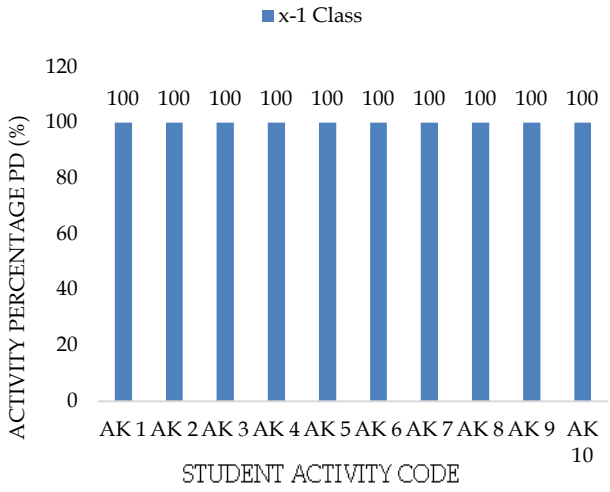

Figure 5. Limited Trial Student Activities

Based on Figure 5 regarding the activities of the students in the limited trial it can be seen that the activities of the students during the limited trial at the third meeting, namely regarding the impact material and efforts to tackle global warming, were already good and active in learning, this is because the percentage of student activities had all reached 100 % on 10 activities.

The percentage of activity of students in class X-1, X-2 and X-2 during extensive trials at the first to third meetings with the material understanding global warming and the causes of global warming, can be seen in Figure 6.

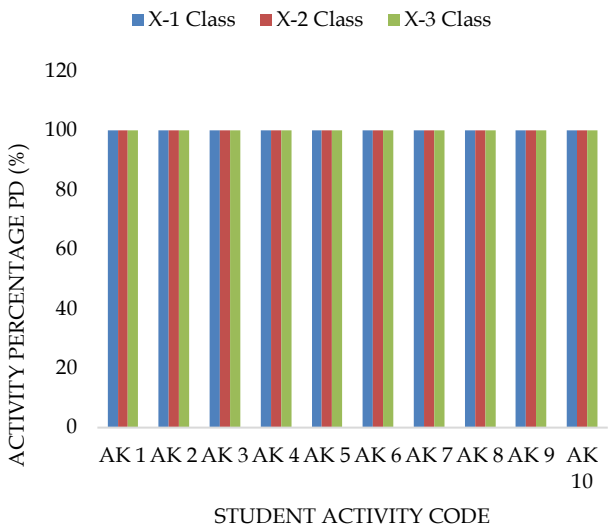

Figure 6. Extensive Trial Student Activities

Based on Figure 6 regarding the activities of students in the wide trial of classes X-1, X-2 and X-3, it can be seen that the activities of students during the wide trial were better than in the limited trial. This is because the overall percentage of student activity has reached 100% and students have enjoyed the learning they are doing. The closer to 100%, the better the learning activities of students (Fatmawati, 2016).

The Effectiveness Of Learning Devices

The effectiveness of learning tools through the implementation of extensive trials in classes X1, X2, X3 can be seen from the tests of critical thinking skills and student response questionnaires.The results of the analysis of critical thinking skills in class X-1 are presented in Figure 7.

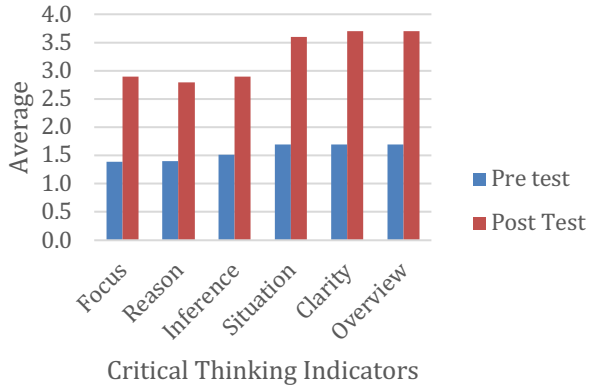

Figure 7. Average results of critical thinking skills measured during limited trials.

Based on Figure 7, the results obtained for all indicators of critical thinking skills during the pre-test were in the range of 1.0 to 2.0. Critical thinking skills tests using the Toulmin Argument Pattern (TAP) were carried out during limited trials, namely in class X-1 and wide trials, namely in classes X-1, X-2, and X-3 using critical thinking skills test instruments with the TAP pattern that has been prepared previously. The results of students' critical thinking skills tests during limited trials in class X-1. Next. Then after carrying out learning with the discovery learning model with the Toulmin Argument Pattern (TAP) pattern, students' critical thinking skills experienced an increase during the post test, namely obtaining an average score in the range of 2.5 to 4.0, so that learning is carried out using TAP patterns can improve students' critical thinking skills.

Next, the results of the analysis of critical thinking skills in class X-1 during the extensive trials according to Ennis' critical thinking indicators, namely Focus, Reason, Inference, situation, clarity and overview are presented in Figure 8.

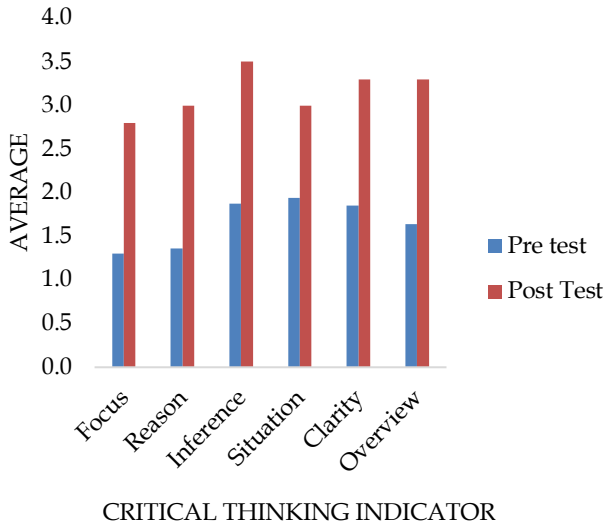

Figure 8. Analysis of critical thinking skills during the Extensive Trial

Based on Figure 8, the results obtained for all indicators of critical thinking skills during extensive trials during the pre-test were in the range of 1.0 to 2.0, then after learning was carried out using the discovery learning model with the Toulmin Argument Pattern (TAP), participants' critical thinking skills students experienced an increase during the post test, namely obtaining an average score in the range of 2.5 to 3.5, so that learning with the TAP pattern could improve students' critical thinking skills.

According to Syafitri et al. (2021), through critical thinking skills students are able to build quality thinking so as to produce good and more active learning. In addition, according to (Chifton, 2012) states that critical

thinking can improve the learning abilities and metacognitive abilities of these students in analyzing various phenomena. Learners are trained to have the ability to ask questions and reason in a variety of authentic and academic contexts

Response Questionnaire

The results of student responses were obtained from the distribution of questionnaires. The results of student responses to the limited tryout at the first to third meeting in class X-1 are in Figure 9.

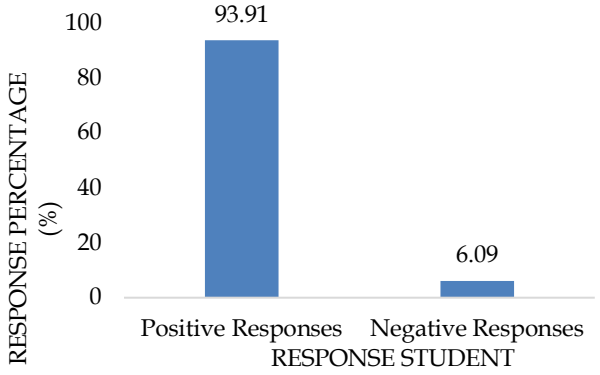

Figure 9. Percentage of Student Responses During Limited Trials

Based on Figure 9 regarding the percentage of student responses during the limited trial in class X-1, students gave an average positive response of 93.21%, while giving an average negative response of 6.09%. The results of student responses are included in the very positive response criteria because it is more than 90%. during limited trials.Next, the results of student responses during the wide trial are presented in Figure 10.

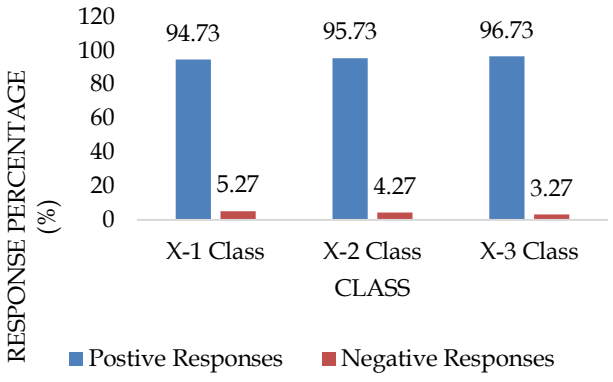

Figure 10. Percentage of Student Responses in Extensive Trials

Based on Figure 10 regarding the percentage of student responses during extensive trials in classes X-1, X-2 and X-3, students gave positive responses in the percentage range of 90 - 100% with an average of 94.73% in class X -1, 95.73% in class X-2 and 96.73% in class X-3, while giving negative responses in the range 0 - 6% with an average - average of 5.27% in class X-1, 4.27% in class X-2 and 3.27% in class X-3. The results of student responses are included in the very positive response criteria because it is more than 90%. during extensive trials

Conclusion

Based on the results of the research and discussion conducted, it can be concluded that The validity of the learning tools developed using the Toulmin Argument Pattern (TAP) discovery learning model to train students' critical thinking skills on global warming material are all declared valid with very valid criteria, the practicality of the learning tools developed using the Toulmin Argument Pattern (TAP) discovery learning model to train students' critical thinking skills on global warming material is in a very good category and the students' activities are very active, so that the learning tools developed are proven to be practical, with several obstacles that already have an alternative solution to overcome it, and the effectiveness of the developed learning tools is stated to be effective in terms of students who have been able to think critically in the high category and the percentage of student responses, in the very positive response category

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Author Contributions

Conceptualization; T. M., A. F., E. M.; methodology.; T. M., validation; A. F., formal analysis; E. M., investigation.; T. M., resources; A. F., data curation: E. M., writing—original draft preparation.; A. F., writing—review and editing: E. M., visualization: E. M. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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