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Inferentialism-Based Mathematics Learning Model To Improve Students' Mathematical Reasoning Abilities

Rick Hunter Simanungkalit [1] *, Renita Br Perangin Angin [2], Dian Mayasari [3], Junarti [4], Hasriani Ishak [5], Ewin Handoco Saragih [6]

[12]FKIP Univ. HKBP Nommensen Pematangsiantar, Indonesia
[3]FKIP Universitas Musamus Merauke, Indonesia
[4]IKIP PGRI Bojonegoro, Indonesia
[5]FKIP Universitas Khairun, Indonesia
[6]FTPSDP Univ. HKBP Nommensen Pematangsiantar, Indonesia
Email; rick.simanungkalit@uhnp.ac.id

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Abstract

The purpose of this study is to develop a valid, practical, and effective inferentialism-based learning model so that it is suitable for improving the mathematical reasoning abilities of junior high school students. The inferentialism-based learning model has a syntax consisting of 6 (six) phases, namely: 1) Apperception, 2) Responsive to Reasoning, 3) Space of Reasoning, 4) Scorekeeping, 5) Deduce, and 6) Closing. This development research uses a development model design adapted from Borg & Gall which consists of 3 (three) stages, namely: 1) Preliminary stage, 2) Design stage, and 3) Testing stage. The results of the study show: 1) The inferentialism-based learning model is valid, reviewed from a) content validity meets the needs and current knowledge, b) the developed learning tools are categorized as valid and can be used; 2) The inferentialism-based learning model is practical, reviewed from the implementation of the model in limited trials and extensive trials and 3) The inferentialism-based learning model is effective, reviewed from: a) its influence on students' mathematical reasoning abilities, and b) students' responses to the learning tools and learning processes that have been carried out are categorized as good.

Keywords: *Learning Model , Mathematics , Inferentialism in Students' Mathematical Reasoning*

INTRODUCTION

The National Council of Teachers of Mathematics outlines that in implementing mathematics learning, teachers must pay attention to five mathematical abilities, namely reasoning, connections, communication, problem solving, and representation. One ability that teachers must pay attention to in mathematics learning is mathematical reasoning ability (Douven, Elqayam, & Hasshim, 2025). Mathematical reasoning is important to learn because mathematics is shaped by human thinking about ideas, processes, and reasoning (Irawan & Purwasih, 2024). This is also reinforced by the existence of the Pancasila student profile as stipulated in the Regulation of the Minister of Education and Culture number 22 of 2020, where one of the dimensions of the Pancasila student profile is critical reasoning.

Sumarmo (2013) stated that mathematical reasoning ability is the foundation in constructing mathematical knowledge. Reasoning and mathematical ability cannot be separated from each other because solving mathematical problems requires reasoning ability while reasoning ability can be trained by learning mathematics (Simanungkalit & Suyitno, 2022). Isnani, et al. (2020) stated that reasoning is one of the disciplines that underlie mathematics, and Wahyudin (Simanungkalit, Suyitno, Isnarto, & Dwijanto, 2022) previously reported that mathematical reasoning is a very important ability in the mathematics learning process, because mathematics is a science that is acquired through reasoning.

In some literature, mathematical reasoning ability is referred to as mathematical reasoning. According to Kusumawardani et al. (2018), mathematical reasoning is a requirement for students to be able to foster creativity and thought patterns during the learning process. Fauziah et al. (Silaban, 2020) stated that mathematical reasoning is necessary to construct a correct mathematical argument. From the several descriptions above, it can be concluded that mathematical reasoning ability is one of the important abilities and must be possessed by students in learning mathematics.

Considering the importance of mathematical reasoning ability, various efforts have been made by teachers, educational practitioners, and experts to improve students' mathematical reasoning ability. Fauziyah, et al. (Berutu, Muhammad, & Herizal, 2021) and Dewi & Harahap (2016) explain that attention and in-depth research are needed on mathematical reasoning ability. The current reality shows that students' mathematical reasoning ability is still in the low category compared to other mathematical abilities. Several research studies show that students' mathematical reasoning ability is still low, such as: Wardono & Mariani (2014) revealed that Indonesian students' abilities related to reasoning, analysis, and communication are still relatively low. Healy (Miftahuddin & Arofah, 2020) stated that students often encounter difficulties in reasoning, rationalization, and generalization. Estanto, et al. (2022) in their study explained that initial studies in several research schools showed that students' mathematical reasoning abilities were still low. Furthermore, Minarti (Ronaldy et al., 2022) also explained that one of the mathematical activities considered difficult by students is mathematical reasoning.

The results of a preliminary study conducted by researchers in 5 junior high schools in Pematangsiantar, namely SMP N 2, SMP N 7, SMP N 12, SMP Sw. Cinta Rakyat 3, and SMP Sw. Methodist Pematangsiantar showed that students' mathematical reasoning abilities were still low. Researchers tried to provide a mathematical reasoning ability test. The results were still far from expectations, only 9% of students were able to solve the problem. The results of the analysis of students' answers concluded that: (1) students were quite able to remember what was known or sort repeated examples but were unable to analyze the relationship between properties (2) Students were unable to generalize cases, patterns or properties using mathematical symbols and applying rules and (3) students were not yet accustomed to justifying using logical arguments or verifying that generalizations apply to all cases (Muhammad, Septian, & Sofa, 2018).

This shows that when students are faced with reasoning problems, they are overwhelmed in solving them. Routine presentation of problems, which are derived from repeated examples, results in students not being accustomed to constructing their own knowledge in forming mathematical reasoning concepts.

The low mathematical reasoning ability greatly influences the achievement of students' learning outcomes in general, resulting in students' dislike of mathematics lessons (Rani, Manurung, & Siregar, 2023) . This is evident from the list of daily test results at SMP Negeri 12 Pematangsiantar related to the material of linear equations and inequalities of one variable, the results show that only around 12% of students pass the minimum competency criteria.

Several factors have been identified as the cause of low mathematical reasoning ability of students such as learning applied in schools has not empowered the potential of students optimally (Hernaeny, Afina, & Nusantari, 2019) , also learning that is dominated by the expansion approach, namely learning activities that are centered on the teacher (Kusumawardani, et. al (2018)). Based on that, to improve students' mathematical reasoning ability, it is necessary to develop a good and appropriate learning model. The key to the effectiveness of the learning model is to train students to become reliable learners (more powerful learners). Meanwhile, conducting research on learning models that equip students with learning skills is very important as part of the teacher's job as an educator to improve students' intelligence as learners (Putri, Achmad Hidayatullah, & Shoffan Shoffa, 2020).

Ruben et al. (2017) and Simanungkalit et al. (2020) reported that in the last decade, the use of constructivist learning has increased drastically, as seen from the number of annual publications that use words starting with constructivist. Student-centered constructivism with a self-directed approach is considered useful in fostering

21st-century competencies such as autonomous learning, independent thinking, and innovation (Hernawan & Setiawan, 2021)..

The basic principle of constructivism is that students do not receive knowledge directly; instead, students construct their own knowledge by managing relationships related to their knowledge connections and connecting them with the resources they need (Zainal, 2020). Cooperative learning models, inquiry learning models, jigsaw models, cooperative scripting models, and group investment models are some examples of constructivism-based learning models that are often used in mathematics learning.

Research (Nur Syamsu, Rahmawati, & Suyitno, 2019) revealed that the interest of researchers and teachers in constructivist learning has increased significantly. Constructivist learning claims that knowledge is actively constructed so that it has become one of the main research paradigms in mathematics education. As a result, constructivist learning has become a widely accepted theoretical framework in mathematics education and learning.

This improvement is in stark contrast to criticism of its philosophical foundations and educational consequences. Many researchers argue that constructivist learning still has weaknesses in several steps. This criticism has been expressed by several educational experts (Phillips (1995), Osborne (Fitri, Liana, & Tambunan, 2023) . There are at least 3 (three) substantial problems with constructivism, namely (1) the absence of a satisfactory resolution of the social-individual dichotomy, (2) it is still threatened by relativism, and (3) the unclear characterization of constructivism regarding what construction is.

In addition to the 3 problems above, the main problem in constructivism is the lack of potential connection between the knowledge built by students with acceptable mathematical knowledge, which can then be called misunderstanding in mathematics. Furthermore, the problem can even be worse, not only students fail to build mathematically acceptable mathematical knowledge but they can also build different understandings or knowledge (Oktaviana & Aini, 2021).

To address the problems of constructivism, inferentialism was introduced as a new theoretical framework as well as research by Taylor, et al. (2017). Inferentialism provides an alternative characterization of constructivism regarding social-individual interactions that focuses on the role of reasoning in learning (Hasanah & Hakim, 2022).

Inferentialism comes from two English words: inferential (in Indonesian called inferensial) and ism. Inferential in the Big Indonesian Dictionary means "can be concluded," while the suffix -ism can come from Greek (ismos) or Latin (ismus) or Old French (isme), which denotes an understanding, teaching, or belief.

Inferentialism is a theory that explains the formation of concepts and the establishment of knowledge claims in terms of conclusions. The process of forming concepts and establishing knowledge claims (conclusions) is carried out in a context of intersubjective practice, where there are activities of giving and asking for reasons to acknowledge, connect, and challenge each other's commitments (Brandom (1994), Noorloos et al (2017). Simply put, it can be said that inferentialism is a new theory in mathematics education that emphasizes the way in which individuals construct their knowledge while participating in social practices in making mathematical conclusions. With this inferentialism, individuals (students) simultaneously carry out learning activities in both cognitive and social aspects together which are inseparable from each other (Andriyani, Setiawan, & Wawan, 2024).

There are three main concepts of inferentialism, namely (1) responsiveness to reasoning, (2) space of reasoning, and (3) scorekeeping. Learning with an inferentialism-based model provides a perspective that students acquire knowledge (cognitive) and participate (social) simultaneously and cannot be separated from cognitive and social activities in the learning process. In theory, this inferentialism concept can be said to be very suitable for improving mathematical reasoning abilities, because inferentialism itself focuses on mathematical reasoning in terms of drawing conclusions. Previously, Simanungkalit, RH, Suyitno, H., Isnarto, Dwijanto. (2022) in their research explained that there was an increase in students' mathematical reasoning in the moderate category using inferentialism-based learning tools.

Researchers have studied several constructivist learning models, namely inquiry and cooperative learning. These two models are the most frequently used to improve or develop students' mathematical reasoning skills. The advantages of inquiry and cooperative learning models include students becoming more active in thinking about mathematical concepts, developing the ability to respond to individual knowledge levels, and involving students in classroom planning and management (Mulyawati, 2022)

Several studies have shown that the aforementioned learning models provide a balanced emphasis on the development of cognitive, affective, and psychomotor aspects. Sanjaya revealed that another benefit of the aforementioned learning model is strengthening and increasing self-confidence due to its student-centered nature and limited teacher role.

These models also have limitations in improving mathematical reasoning skills. Group-directed learning makes it difficult for teachers to monitor and assist students in all groups, and in group discussions, problem topics tend to broaden, thus not fitting into the planned time (Manik, R & Surya, E. 2020). The main limitation of the above model is that students are not focused on specific decision-making, only limited to drawing conclusions from data analysis results.

Based on the advantages and limitations of the learning models described above, the researcher wishes to develop a learning model that can address the limitations of constructivism and improve students' mathematical reasoning abilities. The learning model developed in this study is an inferentialism-based learning model. The syntax of the inferentialism-based learning model in this study is apperception, responsiveness to reasoning, space of reasoning, scorekeeping, deduce, and closing.

Apperception is the phase where the teacher motivates students and conditions the class to be ready to learn. In this first phase, the teacher also creates cognitive conflict by providing problems in the form of Student Worksheets (LKPD) related to the material being studied. Responsive to reasoning means being responsive in mathematical reasoning. In this phase, the teacher directs and facilitates students to analyze and interpret data using available cognitive and social learning resources to construct answers or solutions. Space of Reasoning, which means space or opportunity to reason. Activities in this phase are students developing their understanding in the game of giving and asking for reasons. By giving and asking for reasons, students will acknowledge, refute, relate to, or make claims to previous knowledge claims. Ayele (2017) suggests that students have a greater opportunity to develop their reasoning skills if given the opportunity to speak and express their ideas with peers (Marfu'ah, Zaenuri, Masrukan, & Walid, 2022).

The next phase is the scorekeeping phase. Activities in this phase involve analyzing and assessing the validity of arguments, opinions, or objections presented by students in the reasoning and reasoning activities. Another syntax that differentiates it from constructivist learning (inquiry and cooperative learning models) is the deducing stage.

Drawing conclusions (deduction) in this model is different from drawing conclusions from data analysis results (conclusion). Drawing conclusions (deduction) is something important in mathematics. Rosnawati, R. (2009) stated that drawing conclusions is one of the stages of activities that teachers must train students in mathematics learning to make higher-order thinking more effective, and students do not automatically have this skill. The Ministry of National Education (2003) also explained that one of the goals of mathematics learning in schools is to train how to think and reason in drawing conclusions. Carlsen, M. (Sari, Yenni, & Raditya, 2017)stated that drawing conclusions is a process in mathematical reasoning.

The final syntax in the developed model is the closing phase. The teacher closes the lesson and assigns mathematical reasoning tasks to determine the level of students' reasoning regarding the material that has been taught, to see whether students are concentrating and providing correct responses and actively engaging in cognitive tasks. Assessment of students' knowledge, reasoning, or competencies in the current context can encourage students to carry out further in-depth study (Fajorah & Dasna in Hadi, L. (2015).

With the syntax developed in the inferentialism-based learning model, the inferentialism-based learning model can be an alternative choice in mathematics learning to develop students' mathematical reasoning abilities.

METHOD

This research is classified as research and development (R&D). Research and development is a research method used to produce a specific product and test the feasibility of the resulting product. The resulting product must have the following feasibility criteria: valid, practical, and effective (Nieven & Plomp, 2013). This research aims to produce a valid, practical, and effective Inferentialism-Based Learning Model so that it is suitable for use to improve students' mathematical reasoning abilities. The products of this research are an inferentialism-based learning model (model book), as well as learning tools using an inferentialism-based learning model which include: Syllabus, Lesson Plan (RPP), Student Textbook (BAS), Student Activity Sheet (LKPD), and a mathematical reasoning ability test (Ramdan, Veralita, Rohaeti, & Purwasih, 2018).

This research and development refers to the R and D (research and development) research method of Borg & Gall, 1983. It includes 10 steps, namely: (1) Research and information collecting (preliminary study); (2) Planning (planning research); (3) Development of the preliminary form of the product (product development); (4) Preliminary field testing (validity test); (5) Main product revision (revise the results of the validity test); (6) Main field testing (limited product trial); (7) Operational product revision (revise the results of the limited trial); (8) Operational field testing (extensive test); (9) Final product revision (final revision of the results of the extensive test); and (10) Dissemination and implementation

During the limited trial, researchers conducted evaluations and reflections through observations of the learning process using the developed model, student progress, and any obstacles or difficulties encountered by teachers and students. The evaluation results were used as a basis for revisions to improve and complete the draft model. During the limited trial, refinements to the draft focused on developing and refining the product material and its feasibility in a practical context.

This research is divided into two stages: the first stage is the development of an inferentialism-based learning model and tools, and the second stage is the implementation of an inferentialism-based learning model that is deemed feasible based on the trial results. The developed learning model and tools include a model book, syllabus, Learning Implementation Plan (RPP), Student Textbook (BAS), Student Worksheets (LKPD), and a mathematical reasoning ability test, which are validated through: (a) expert review, and (b) instrument trials. This is done to assess the feasibility of the developed learning model and tools (Romlah, Nugraha, & Setiawan, 2019).

To answer the problem formulation, data analysis was conducted. This study used descriptive statistical analysis. Descriptive statistics are used to describe data as it is in percentage form and to explain data or events with qualitative explanatory sentences. Meanwhile, n-gain analysis was used to determine whether the average increase in mathematical reasoning was in the high, medium, or low category.

RESULTS AND DISCUSSION

The model development design refers to the Borg & Gall (1983) development model which has been explained in Chapter III.

(1) Research and information collecting (preliminary study)

The preliminary study in this research was conducted by means of literature study and field study of the research location. From the preliminary study, it was concluded that: (1) students' mathematical reasoning ability is low, (2) the learning model that is often used by teachers to improve students' mathematical reasoning ability is the constructivist learning model (types of inquiry and cooperative learning models), (3) from the literature review, there are problems or limitations of constructivist models, (4) the methods used by teachers in the field have not fully optimized the potential of students, and (5) teachers have difficulty developing alternative learning models in developing students' mathematical reasoning ability.

(2) Planning (planning research) (Puspaningrum, Syahputra, & Surya, 2021).

Through an in-depth analysis of the preliminary study, a breakthrough in mathematics learning is planned. The breakthrough proposed in this research is the development of an inferentialism-based learning model. Furthermore, supporting tools for the inferentialism-based learning model will be developed.

(3) Development of the preliminary form of the product (product development)

The products developed in this research are a model book and learning tools using an inferentialism-based learning model. The prototype design used a qualitative research approach. The results of the prototype model development and supporting tools are presented in Table below.

Table 1. Prototype: Inferentialism-Based Learning Model and Learning Tools to Improve Students' Mathematical Reasoning Abilities

No	**Component**	**Short Description**
1	*Inferentialism* -Based Learning Model Book	- Introduction - Model Description - Model Implementation - Assessment and Evaluation
2	Syllabus	Material on Linear Equations and Inequalities in One Variable
3	Lesson Implementation Plan (RPP)	- Finding the concept of a linear equation in one variable - Solving linear equation problems in one variable - Discovering the concept of linear inequality in one variable - Solving linear inequality problems with one variable
4	Student Textbook (BAS)	- Linear equations and inequalities in one variable
5	Student Worksheet (LKPD)	- Finding the concept of a linear equation in one variable - Solving linear equation problems in one variable - Discovering the concept of linear inequality in one variable - Solving linear inequality problems with one variable
6	Students' Mathematical Reasoning Ability Test	- 3 (three) essay test questions - Topic: Linear equations and inequalities in one variable
7	Student Response Questionnaire	- Student responses to components of the inferentialism-based learning model - Student response to learning methods - Student responses to mathematical reasoning questions - Student response to learning atmosphere -

After the prototype of the inferentialism-based learning model and the supporting learning tools for the inferentialism-based learning model were developed, the quality of the model and tools was assessed. The resulting product must meet the eligibility criteria, namely: validity, practicality, and effectiveness (Nieveen & Plomp, 2013). Based on the research problem formulation that has been described, the following describes the results obtained from the validity, practicality, and effectiveness of the development of the inferentialism-based learning model to improve students' mathematical reasoning abilities.

Effectiveness of Inferentialism-Based Learning Model

Model effectiveness was conducted to determine the impact of its implementation on the desired outcomes. This effectiveness was obtained from the results of mathematical reasoning ability tests and student response questionnaires through the application of an inferentialism-based learning model in a trial (research) class.

Table 2. Material Completion in the Large Trial Class

Mark	Widespread Trial SMP N. 2 Number of Students	%	Amount (%)	SMP SW. CR 3 Number of Students	%	Amount (%)
C-	1	3.33		1	3,125	
C	5	16.7	20	4	12.5	18.75
C+	0	0		1	3,125	
B-	11	36.7		6	18.75	
B	10	33.3		10	31.25	
B+	2	6.67	80	3	9,375	81.25
A-	1	3.33		6	18.75	
A	0	0		1	3,125	

Next, the final product was distributed or disseminated to see the consistency of the effectiveness of *the inferentialism- based learning model* . Dissemination was carried out in 3 (three) junior high schools in Pematangsiantar, namely SMP Negeri 7 with 31 students, SMP Negeri 12 with 31 students, and SMP Sw. Methodist Pematangsiantar with 29 students. The results of the dissemination of the *inferentialism -based learning model* can be seen in Table 4.21 or the appendix .

Table 3. Results of Students' Mathematical Reasoning Abilities in Dissemination

Student	Class A				Class B				Class C			
	Pre	Post	N-Gain	Note	Pre	Post	N-Gain	Note	Pr	Po	N-Gain	Note
S -1	39	61	0.36	S	0	39	0.39	S	0	33	0.33	S
S - 2	14	67	0.61	S	3	61	0.60	S	0	61	0.61	S
S -3	28	64	0.5	S	0	33	0.33	S	8	61	0.58	S
S -4	22	61	0.5	S	31	67	0.52	S	14	67	0.61	S
S -5	31	72	0.6	S	3	61	0.60	S	0	61	0.61	S
S -6	50	75	0.5	S	3	61	0.60	S	0	36	0.36	S
S -7	0	31	0.31	S	8	61	0.58	S	8	67	0.64	S
S -8	14	44	0.35	S	22	70	0.61	S	17	61	0.53	S
S -9	22	83	0.79	T	3	61	0.60	S	6	61	0.59	S
S -10	19	64	0.55	S	22	61	0.50	S	28	61	0.46	S
S -11	19	61	0.52	S	3	61	0.60	S	0	61	0.61	S
S -12	25	92	0.89	T	17	61	0.53	S	0	33	0.33	S
S -13	0	33	0.33	S	0	70	0.69	S	8	83	0.82	S
S -14	3	89	0.89	T	0	72	0.72	T	11	78	0.75	T
S -15	6	39	0.35	S	33	61	0.42	S	3	61	0.6	S
S -16	36	61	0.39	S	11	61	0.56	S	3	61	0.6	S
S -17	8	69	0.67	S	6	67	0.65	S	0	61	0.61	S
S -18	31	69	0.56	S	31	67	0.52	S	11	69	0.66	S
S -19	28	72	0.62	S	6	64	0.62	S	3	61	0.6	S
S -20	8	39	0.33	S	0	33	0.33	S	3	39	0.37	S
S -21	47	97	0.95	T	11	61	0.56	S	28	83	0.77	T
S -22	19	61	0.52	S	8	64	0.61	S	6	61	0.59	S
S -23	11	61	0.56	S	3	61	0.6	S	6	61	0.59	S
S -24	28	64	0.5	S	6	64	0.62	S	11	61	0.56	S
S -25	11	64	0.59	S	0	50	0.5	S	0	33	0.33	S
S -26	8	78	0.76	T	17	83	0.8	S	8	69	0.67	S
S -27	33	61	0.42	S	14	78	0.74	T	6	61	0.59	S
S -28	39	97	0.95	T	0	33	0.33	S	11	72	0.69	S
S -29	19	83	0.79	T	0	53	0.53	S	28	61	0.46	S
S -30	19	67	0.59	S	0	64	0.64	S				
S -31	8	50	0.45	S	11	70	0.66	S				
Jlh	647	2031	-		269	1873			225	1742		

Student	Class A				Class B				Class C			
	Pre	Post	N-Gain	Note	Pre	Post	N-Gain	Note	Pr	Po	N-Gain	Note
Average	**21**	**65.5**	**0.57**	**S**	**8.7**	**60.4**	**0.57**	**S**	**7.8**	**60.1**	**0.56**	**S**

***Inferentialism* -Based Learning Models**

the inferentialism- based learning model is seen from the aspect of assessing students' mathematical reasoning abilities after being given learning as well as students' opinions/responses to the *inferentialism- based learning model* . In principle, the effectiveness of the model is through the application of the developed learning model can achieve the expected results, in this case is an increase in students' mathematical reasoning abilities. The results of the effectiveness of *the inferentialism-based learning model* are described as follows.

1. Students' Mathematical Reasoning Ability

From Table 4.15 and Table 4.17, the results of the mathematical reasoning abilities of the limited and extensive trial classes can be seen the difference in the pretest and posttest results. In the pretest, most students were not yet able to analyze problems by interpreting the available data (

Furthermore, the student was able to earn a daily allowance of Rp. 2,500, which he always saved. In finding the number of days needed to buy a math comic book, the student was also able to generalize patterns using mathematical symbols in similar cases. This enabled the student to obtain a complete and detailed answer. Indicators of justification were also evident in the student's answer, as each step of the solution used clear reasons or conclusions.

In Figure 4.11, students can analyze the problem by considering the relationships between properties or characteristics. The problem explains that Adi has **finished** reading 16 books. Students can analyze this clue to obtain the equation: Adi **has not** read yet means y – 16 (assuming y is the number of books).

The inferentialism- based learning model, which involves giving and asking for reasons, impacts students' ability to generate reasons or evidence for each solution. This is evident in the majority of student answers, which include reasons or supporting evidence for each sub-answer.

Based on the data in Table 4.15, in the limited trial, the increase (*n-gain*) in mathematical reasoning ability was in the medium to high category, namely 0.33 – 0.87 (Dachi et al., 2023).In Table 4.17, in the extensive trial, the increase (*n-gain*) in mathematical reasoning ability was also in the medium to high category, namely 0.31

– 0.95. This shows that *the inferentialism -based learning model is able to improve students' mathematical reasoning ability with a medium to high n-gain* category .

The results of the mathematical reasoning ability test of students in the dissemination class were then analyzed to see the increase in N-gain scores for each indicator. The results showed that for class A (SMP N. 7 Pematangsiantar) the *generalizing indicator* obtained the highest increase with a gain of 0.65 (moderate category), then the *analyzing indicator* with a gain of 0.58 (moderate category) and the gain value for the *justifying indicator* was 0.47 (Ariyanto, Aditya, & Dwijayanti, 2019).

The results of the analysis for class B (SMP SW. Methodist) obtained the results that the *generalizing indicator* also obtained the highest increase with a gain of 0.64 (medium category), then the *analyzing indicator* with a gain of 0.58 (medium category) and the gain value for the *justifying indicator* of 0.50. Furthermore, the results of the analysis for class C (SMP N. 12) obtained results that were not much different that the *generalizing indicator* obtained the highest increase with a gain of 0.66 (medium category), then the *analyzing indicator* with a gain of 0.54 (medium category) and the gain value for the *justifying indicator* of 0.51.

From the analysis of the indicators of students' mathematical reasoning ability above, it is clear that the justification indicator achieved the lowest improvement in all dissemination classes. This occurs because students were previously unfamiliar with providing or using irrefutable logical arguments in mathematics lessons. This requires special attention in mathematics instruction or further research to improve students' mathematical reasoning abilities.

Student Response Questionnaire

Data on student responses contained in Table 4.19 and Table 4.20 in the limited trial and extensive trial can be seen that student responses to the learning model and learning implementation during the limited trial and extensive trial were positive with very strong and strong categories. This means that students support, feel happy, and are interested in learning by using the tools resulting from the development of the *inferentialism- based learning model* to improve students' mathematical reasoning abilities.

Students' responses to the ease of answering mathematical reasoning questions were predominantly in the very difficult and extremely difficult categories. Interviews with the model teacher and several students revealed that students were unfamiliar with, or had never even attempted, questions related to the mathematical reasoning questions.

The seventh-grade junior high school students who were the subjects of this study came from different elementary schools. According to their statements, mathematical reasoning problems had never been presented to them since elementary school, especially since they had been learning online for over two years (starting in the even semester of fourth grade) *due* to the COVID-19 pandemic. This mathematical reasoning problem was completely new to them.

Based on the description above, it can be concluded that the *inferentialism- based learning model* has proven effective in improving mathematical reasoning skills. This can be seen from the increase in students' mathematical reasoning skills after implementing the model and the students' positive responses to the model. *Inferentialism -based learning tools* have also been shown to improve mathematical reasoning (Tama, Rinaldi, & Andriani, 2018).. By implementing an *inferentialism- based learning model* , students have the potential to master mathematical reasoning well and develop positive character traits. Learning using this model makes learning easier, as evidenced by the students' very positive responses to the learning process.

The results of the completion of the material on linear equations and inequalities with one variable classically for the limited trial, extensive trial, and dissemination classes were all at ≥ 80% completion. From Table 4.16, Table 4.18, and Table 4.22, it can be seen that all research classes were categorized as classically complete.

CONCLUSION

The conclusion of this research is that the inferentialism-based learning model developed meets the criteria of validity, practicality, and effectiveness, making it suitable for improving students' mathematical reasoning abilities. This conclusion is based on the research findings below.

1. The inferentialism-based learning model developed meets the criteria for content validity, and is supported by learning tools including syllabus, lesson plans, BAS, LKPD, mathematical reasoning ability tests and valid student response questionnaires.
2. The inferentialism-based learning model developed meets the criteria of practicality, because the model components (syntax, social system, reaction principle, support system, instructional and accompanying impact) can be implemented in the learning class through limited trials, extensive trials and good dissemination, and there are no significant technical constraints on the material on linear equations and inequalities of one variable.
3. The inferentialism-based learning model that was developed meets the criteria for effectiveness, because its application in limited trials, extensive trials and dissemination has an impact on: (1) increasing students' mathematical reasoning abilities for the indicators of analyzing, generalizing and justifying, and (2) positive responses given by students to the inferentialism-based learning model and tools and the learning process that has been implemented on the material of linear equations and inequalities of one variable.

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