HOTS-oriented Learning Model and Mathematical Reasoning Ability

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Abstract

Related primary research implementation of the HOTS-oriented learning model for increase students’ mathematical reasoning ability has many done. Researches the need identified, analyzed development, and pulled conclusion in general so that could utilized as a suggestion for progress researcher and practitioner in the field of math education. This study aim for see research trend with identify and classify whole results related research with application of the HOTS-oriented learning model for increase students’ mathematical reasoning ability in Indonesia on 2017-2022 period. This study use method Systematic Literature Review (SLR). There is 29 article related to be analysed in this study. The results of this SLR show implementation of HOTS-oriented learning model to students’ mathematical reasoning ability. The most publications occurred in 2018 which used the DL/IL learning model and were most frequently applied to students at the SMP/MTs level on the island of Java. The research trend uses quantitative methods and teaches material on flat sided spaces. This results could becomes consideration for researcher to do research and for internal teachers doing classroom learning.

Keywords: HOTS-oriented Learning Model, Mathematical Reasoning, Systematic Literature Review
1. INTRODUCTION

Talking about learning mathematics, mathematical reasoning ability is one of the important things that must be possessed by students. Mathematical literacy skills tested in PISA include mathematical reasoning abilities (OECD, 2019). According to Kartono & Shora (2020), mathematical reasoning abilities are important to grow so that students are able to understand mathematical concepts well. In addition, according to (Novianda et al., 2021), reasoning in finding patterns and procedures used in mathematics will assist students in developing a deeper understanding of mathematics.

Mathematical reasoning ability can improved one of them with activity encompassing learning complex or non-routine (Demir et al., 2022). According to Lakin & Kell (2019), reasoning abilities are not static, they can be developed through experience and made easier to do through practice. Furthermore, according to Kaplar et al. (2022) that reasoning ability mathematics level could studied and Skills complex math could developed. From these several opinions, it can be concluded that mathematical reasoning abilities can be developed through learning complex or non-routine mathematics.

Furthermore, (NCTM, 2000) suggests that reasoning has a certain standard where the standard includes: recognizing reasoning as a fundamental aspect of mathematics, making and investigating mathematical conjectures, developing and evaluating mathematical arguments, selecting and using various types of reasoning. To find out the mathematical reasoning abilities possessed by students, it can be measured by indicators of mathematical reasoning abilities. Reasoning ability indicators are as follows.

a. draw logical conclusions
b. provide an explanation of the model, facts, properties, relationships or patterns
c. estimating the answer and the solution process
d. use relationship patterns to analyze situations, or make analogies, generalize, and construct conjectures
e. put forward the opposite example
f. following the rules of inference, checking the validity of arguments, proving and constructing valid arguments
g. compile direct proof, indirect proof, and proof using mathematical induction.

Besides see ability cognitive, learning mathematics very important so that Becomes the right collaboration in learning. With Support moment this that is approach scientific, learning could directed with method student center. this could interpreted that in communicate Theory lesson needed practice High Order Thinking Skills (HOTS). kindly general application of HOTS measure ability on realm analyze (C4), evaluate (C5), and create (C6) (Siregar & Nasution, 2019). Based on Thing , we need an oriented learning model on implementation of HOTS. Implementation The 2013 curriculum is appropriate Permendikbud Number 22 of 2016 concerning The Process Standard uses learning models including :

a. Discovery / Inquiry Learning (DL/IL)
b. Problem-based Learning (PBL)
c. Project-based Learning (PjBL)

A number of studies have analyzed the increase in mathematical reasoning abilities by applying these three learning models in learning mathematics. Each of these studies is still individual in nature, revealing students' mathematical reasoning abilities after applying these models. On the other hand, there is a need to see progress by identifying, classifying and analyzing these various studies. This can be done with a Systematic Literature Review (SLR).
This study aims to see the results of research related to the analysis of students' mathematical reasoning abilities through the application of the HOTS-oriented learning model in terms of various aspects, namely: 1) Year of publication; 2) Journal index level; 3) Category of research subject education; 4) The research method used; and 5) research location. Through several research results that have been extracted, some formulations of the problems that arise in this study include the following.

1. How is the students' mathematical reasoning abilities through the application of the HOTS-oriented learning model in terms of the year of publication?
2. How is the students' mathematical reasoning abilities through the application of the HOTS-oriented learning model in terms of the educational level of sample?
3. How is the students' mathematical reasoning abilities through the application of the HOTS-oriented learning model in terms of learning materials?
4. How is the students' mathematical reasoning abilities through the application of the HOTS-oriented learning model in terms of the research methods used?
5. How is students' mathematical reasoning abilities through the application of the HOTS-oriented learning model in terms of research location/demography?

2. METHOD

This study aims to determine the diversity of students' mathematical reasoning abilities in Indonesia. This research was conducted by identifying, reviewing, evaluating and interpreting published articles. The research instrument used was an observation sheet related to the inclusion criteria based on the year of research and the level of research using the Systematic Literature Review (SLR) method.

Systematic Literature Review (SLR) method is a research method that synthesizes various research results to present a more comprehensive and balanced fact. All research results with similar topics can be identified, evaluated and interpreted using the SLR (Calderón & Ruiz, 2015). Destination use SLR method is for find and synthesize study in a manner comprehensive with refers on question specific, and managed procedures with good, transparent, and could replicated on every step in the process (Juandi, 2021)

a. Literature Search

Search process literature studies conducted with access google scholar database. Search conducted on database use keyword “mathematical reasoning ability”, "Discovery Learning", "Inquiry Learning", "Problem-based Learning", "Project-based Learning".

b. Inclusion Criteria

Literature that has collected filtered return based on criteria inclusion and exclusion. Determination criteria inclusion and exclusion conducted for determine appropriateness literature to be used in SLR research or no (Fitriani & Prahmana, 2021). Compliant article criteria inclusion will included in step research. Table 1 describe criteria inclusion and exclusions used in this study.

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<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
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<tbody>
<tr>
<td>Discovery/Inquiry Learning, Problem Based Learning or Project Based Learning learning</td>
<td>Interventions other than the application of the Discovery/Inquiry Learning learning</td>
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Table 1. Inclusion and Exclusion Criteria
Inclusion Criteria | Exclusion Criteria
--- | ---
models with the observed results being mathematical reasoning abilities. | model, Problem Based Learning or Project Based Learning with the observed results are mathematical reasoning abilities.
Publication in journals/proceedings in 2017-2022 | Publication of journals/proceedings before 2017 and after 2022
The primary research subjects were students of SD/MI, SMP/MTs, SMA/SMK/MA. | Primary research subjects are students at tertiary institutions
Research locations in Indonesia | Research locations other than in Indonesia

c. Population and Sample

The population in this study is all research on mathematical reasoning abilities that use the HOTS-oriented learning model and are published in journals. Based on a search using a search engine, found a sample of 35 articles consisting of 29 articles to be analyzed.

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**Figure 1. PRISMA Diagram**

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d. Data Analysis

Articles declared to have met all inclusion criteria were then analyzed further. Each article is identified and classified based on five study characteristics, namely year of publication, level of...
education, teaching materials, research methods and research location/demography. Analysis of the year of publication was carried out by grouping articles of year. The characteristics of the study level were analyzed by classifying the research subjects in each article into SD/MI, SMP/MTs, SMA/SMK/MA levels. An analysis of the characteristics of the teaching materials was carried out by grouping the mathematical materials used in research in each article. Furthermore, an analysis of the research methods used in each article is divided into categories of quantitative, qualitative, mixed, development and PTK research. Then an analysis was also carried out on research locations based on regions in Indonesia. Then analysis also done to results study every article so that could concluded how HOTS oriented learning model effect to ability reasoning mathematical student. The results of the analysis of each study characteristic are interpreted and written in the form of reports to answer research questions.

3. RESULT AND DISCUSSION

From the results of a literature search, 29 articles were found that could be included in the analysis stage. Judging from the year of publication of articles about the three HOTS-oriented learning models and mathematical reasoning abilities, the years 2017-2022 presented in Figure 2. found that most articles were dominated by research using the DL/IL model in 2018 as many as 6 articles out of the number of articles using DL/IL model of 14 articles. In contrast to those using the PBL and PjBL models which totaled 3 and 0 of 29 articles respectively. The data for the year of publication of the article which is summarized in the figure shows interest in research with topics among the three HOTS-oriented learning models in order to increase student competency in the form of mathematical reasoning abilities which have increased and decreased.

![Figure 2. Total of Articles by Year of publication](image)

The HOTS-oriented learning model is applied to students at various levels of education as an effort to improve mathematical reasoning abilities. The number of articles at each level is presented in Figure 3. In the last 5 years it was found that the implementation of the HOTS-oriented learning model was dominated by efforts to improve students' mathematical reasoning abilities at the SMP/MTS level, namely 16 articles out of 29 articles. Furthermore, 11 articles examined this topic for SMA/SMK/MA students and only 2 articles for SD/MI students.
Learning materials are things that need to be considered in implementing a learning model. In the 29 articles analyzed, learning materials were found to be quite diverse, but several articles did not mention the material being taught. The learning materials for each article are presented in Figure 4.

Based on the analysis carried out, the material for flat side shapes is mostly taught in the implementation of research. Other types of learning materials used include social arithmetic, curved sides, lines and angles, geometry and measurement, matrices, probability, multiplication, exponential inequalities, PLSV and PtLSV, linear programming, quadrilaterals, SPLTV, Pythagorean Theorem, and Trigonometry. Meanwhile, articles that do not include what material is taught during the research process are categorized as others material.
Article classification was also carried out based on the research method used. Article grouping is divided into 4 categories, namely qualitative, quantitative, mixed, development and PTK research. The distribution of articles for each category of research methods is presented in Figure 5.

Figure 5. Total of Articles Based on Research Methods

From 2017 to 2022, research on the topic of HOTS-oriented learning models and mathematical reasoning abilities is dominated by quantitative research. Of the 29 articles analyzed, there were 20 research articles that used quantitative methods from all HOTS-oriented learning models. 1 article each using qualitative, mixed and development research, and 6 research articles using the PTK method. This means that the research trend in 5 years is in quantitative research.

Based on 29 articles with various research methods as well as various research areas presented in Figure 6.

Figure 6. Total of Articles Based on Research Location/Demography

Based on the demographics of Indonesia’s territory, there are 3 out of 9 islands, namely Kalimantan, Maluku and the Eastern Islands, where there are no research results on the topic of mathematical reasoning abilities using HOTS-oriented learning models. Figure 5 provides information that based on demographics, the highest number of publications occurred in Java with 10 articles from 2017 to 2022 using the PBL model. This is the hope of other demographers who are still doing a little research.
on the topic of using the HOTS learning model on mathematical reasoning abilities to be further improved and published.

Based on 29 articles with various research methods, it also shows research results that vary from one to another. The implementation of the HOTS-oriented learning model does not always have the same effect on students' mathematical reasoning abilities. However, the results of the study were dominated by the success of the DL/IL model in improving students' reasoning abilities in learning mathematics.

Several quantitative research articles reveal that the application of the DL/IL model can have a better effect on increasing mathematical reasoning abilities than other learning (Badjeber, 2017; Hermawan & Hidayat, 2018; Mahrifah & Samosir, 2019; Mukhlis & Manullang, 2019; Nurmala et al., 2018; Rahman et al., 2019; Riyadi et al., 1907; Roesdiana, 2017; Syahputri & Manullang, 2017). However, in the results of Yuni et al. (2018) gave no better effect on increasing mathematical reasoning abilities.

Results in a mixed study using the DL/IL model revealed an increase ability reasoning mathematical on class with learning models discovery learning more tall from on class normal (Santana et al., 2022). Furthermore, for PTK research using the DL/IL model, it shows that students' mathematical reasoning abilities increased from cycle I to cycle II (Jabar & Lestari, 2018; Parida et al., 2020; Tukaryanto et al., 2018).

Then, several quantitative research articles revealed that the application of the PBL model can have a better effect on improving mathematical reasoning abilities than other learning (Bedilius Gunur & Apolonia Hendrice Ramda, 2020; Fatimah et al., 2017; Julia, 2019; Khaeroh et al., 2020; Komala et al., 2020; Munawaroh et al., 2018; Rhofiqah & Thaariq, 2019; Sugandi & Bernard, 2020; Wiyanti and Leonard, 2016).

The results of qualitative research using the PBL model reveal that all indicators of reasoning ability can be fulfilled in PBL if all PBL phases are carried out properly (Afif et al., 2016; Astiati, 2020). Furthermore, for development research with the PBL model it is effective in increasing students' mathematical reasoning abilities by 82.76% (Palobo & Nur'aini, 2018). PTK research using the PBL IL model shows that students' mathematical reasoning abilities increase from cycle I to cycle II (Abidah et al., 2021; Fitriana, 2019; Kurniawati, 2018).

4. CONCLUSION

There are 29 research articles that use the HOTS-oriented learning model as a treatment for students who aim to improve mathematical reasoning abilities in the 2017-2022 period which are identified and classified based on the year of publication, level of education, learning materials, research methods and research locations/demography.

The most publications occurred in 2018 which used the DL/IL learning model and were most frequently applied to students at the SMP/MTs level on the island of Java. The research trend uses quantitative methods and teaches material on flat side shapes. In general, based on the results of his research, it shows that the HOTS-oriented learning model in mathematics learning is able to have a positive impact on increasing students' mathematical reasoning abilities when compared to other
learning models. A series of steps from one of the HOTS-oriented learning models, namely the PBL model, can help students hone their mathematical reasoning abilities for each indicator used.

The results of this SLR can be considered by researchers and practitioners in the field of mathematics education in conducting research and learning activities in class. For further research, it is necessary to analyze all articles in a more comprehensive manner using meta-analysis or meta-synthesis methods so that the results obtained are more in-depth.

References


