Literature Study: Relationship between Inquiry Model and Ability to Understand Mathematical Concept and Students' Learning Independence

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Abstract

The application of the inquiry learning model is often related to students' ability to understand mathematical concepts and self regulated in mathematical learning. This is one of the reasons why the relationship between the inquiry learning model and the ability to understand mathematical concepts and self regulated in mathematical learning is interesting to discuss again. Studies regarding the relationship between the inquiry learning model and the ability to understand mathematical concepts and independent mathematical learning have been carried out since the 1960s until now. With the large amount of literature regarding the inquiry learning model on the ability to understand concepts and self regulated in mathematical learning, this article aims to map existing studies on the relationship between the inquiry learning model and the ability to understand concepts and self regulated in mathematical learning. This article is a study that uses a literature study approach. Literature such as books, articles and journals were collected online, namely with the help of the "publish or perish 8" tool using the Google Scholar category as a search in 2018 to 2023 using two keywords, namely "Inquiry Learning Model on the Ability to Understand Mathematical Concepts" and "Learning Model Inquiry into Mathematical learning self regulated", then connected with Mendeley 1.19.8 as the reference management found. This study found that there is a relationship between the inquiry learning model and students' mathematical problem solving abilities and students' Mathematical learning self regulated. There are 31 articles discussing the inquiry learning model on mathematical problem solving abilities and 27 articles discussing the inquiry learning model on learning independence. In the end, this study came to the conclusion that there is a relationship between the inquiry learning model and the ability to understand concepts and independent mathematical learning.

INTRODUCTION

The relationship between inquiry learning and the ability to understand concepts and learning independence is an interesting thing to discuss again in a student-centered teaching and learning process (Amir et al., 2023; Julaeha, 2019). Inquiry learning is a model that can activate the ability to understand concepts and students' mathematical learning independence (Ainni & Khayroiyah, 2023; Dalimunthe, 2021; Eliza & Susilawati, 2019; Handayani, 2018; Murnaka & Dewi, 2018; Ramadhan, 2022; Yanda et al., 2019).

Besides that, the inquiry learning model has a relationship with independent mathematical learning. This is proven by several literatures that discuss this matter. Ramadhan, (2022) development module guided inquiry to increase learning independence and understanding of social arithmetic concepts. Azhari et al., (2021) study on the implementation of inquiry methods in mathematics to increase learning independence and mathematical communication skills of high school students. Julaeha, (2019) wrote that the inquiry method in mathematics lessons increases students' learning independence and mathematical communication skills.

Sianipar et al., (2023) initial study: the impact of using guided inquiry-based teaching materials on student learning independence. Amir et al., (2023) study recommends an inquiry learning model that is used as an effort to increase student learning independence. Furthermore, study stated that students' independence was increased through the use of the guided inquiry learning model in learning mathematics on KPK and FPB material. Devi, (2023) study regarding students' ability to understand concepts using the WEE learning model assisted by an inquiry approach and viewed from learning independence. Furthermore, Eliza & Susilawati, (2019) in their study wrote about the ability to understand mathematical concepts and independent learning of students using the inquiry learning model.

The various studies above have been actualized by various researchers and academics through their studies to review the relationship between inquiry learning models and the ability to understand concepts and independent mathematical learning. Studies regarding the relationship between the inquiry learning model and the ability to understand concepts and independence in mathematical learning are literature that is used as an effort to show and emphasize the relationship between the inquiry learning model and the ability to understand concepts and independence in mathematical learning.

Studies from 2018 to 2023 show that the inquiry learning model has a relationship with understanding mathematical concepts and independent mathematical learning. Based on Scopus data, previous research used several keywords that refer to research on inquiry learning models *such as inquiry modeling, inquiry-based, discover learning, and learning systems*. Then it is also based on authors from various countries in the world as seen in the picture below:
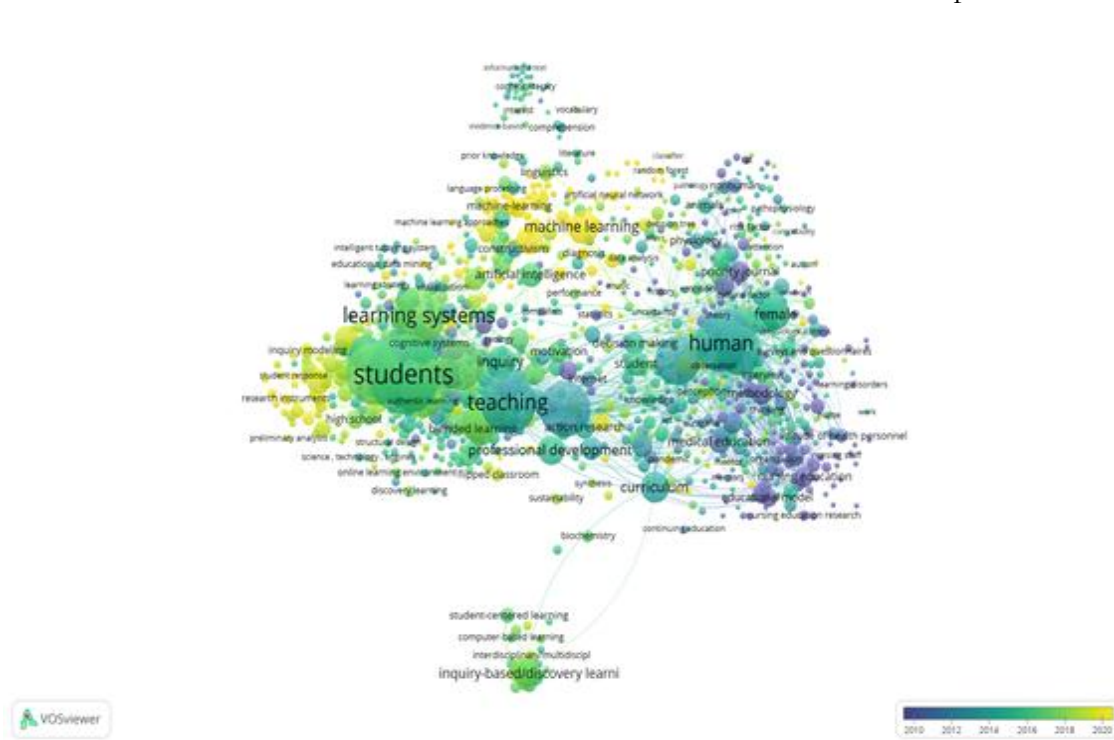

Fig 1. VOS Viewer analysis of the study being researched based on keyword search
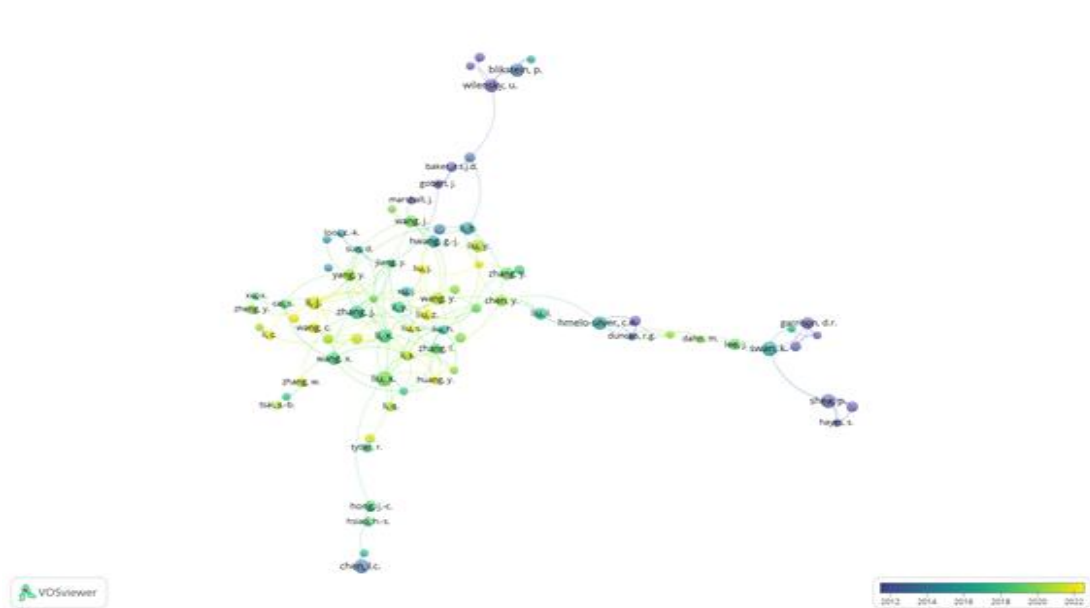
Fig 2. VOS Viewer analysis of the research studied based on author search

From visualization of inquiry literature via VosViewer The above shows that many of the inquiries studied include learning systems, students, teaching, humans, motivation, student respondents, and so on. If we look at student problems, based on the results of the Scopus database research, it was found that research using the keyword inquiry learning model on understanding ability the concept, and independence of mathematical learning have not been discovered. Therefore, this research aims to analyze the relationship between inquiry learning models and the ability to understand concepts and independent mathematical learning. It needs to be appointed as a scientific study to enrich the literature.

METHODS

This article is research using qualitative methods with a content analysis approach. The tool used is a document sourced from 58 articles that are relevant to the relationship of the inquiry learning model to the ability to understand concepts and independent mathematical learning. Data analysis techniques, first; procurement of literature data collected using online search engines, namely with assistance *tools "publish or perish 8"* by searching from 2018 to 2023 using two keywords, namely "Inquiry Learning Model on the Ability to Understand Mathematical Concepts" and "Inquiry Learning Model on Mathematical Learning Independence" then managing and reducing the collected literature using the form of creating a database. Second; Determining the unit from the 100 pieces of literature searched that discussed the inquiry learning model on the ability to understand mathematical concepts, 31 articles were the same as the keywords and 100 pieces of literature for the study of the inquiry learning model on independent learning, there were 27 articles used in this study. Third; recording, namely reading and marking the collected literature. Fourth; identify studies of the relationship between inquiry learning models on the ability to understand concepts and independent mathematical learning and then draw conclusions which are presented in the discussion section of this article.

RESULT AND DISCUSSION

From the literature facts found are spread in various book manuscripts, articles, and journals regarding studies of the relationship between the inquiry learning model and the ability to understand concepts and learning independence. This article argues that so far inquiry studies have had a relationship with problem-solving abilities and mathematical disposition. So, on that basis, in general, this study aims to complement existing studies regarding the relationship between the inquiry learning model and the ability to understand concepts and learning independence. Specifically, this study aims to conduct an analytical

study of this literature. Two questions arise from the arguments built in this article, first; How does the inquiry learning model relate to problem-solving abilities? second; How does the inquiry learning model relate to learning independence? These two questions are each used as sub-discussions in this article.

The inquiry learning model emphasizes the process of searching and finding. Study material is not provided directly. The student's role in this strategy is to search and find the learning material themselves, while the teacher acts as a facilitator and guide for students to learn. The inquiry learning model is a series of learning activities that emphasize the process of thinking critically and analytically to search for and find answers to a problem in question and involves students in formulating questions that lead to carrying out investigations to build new knowledge and meaning, as well as encouraging students to actively involved in the teaching and learning process. With inquiry learning, students are directed to be active and creative in looking for answers to every problem and finding solutions or concepts with students' thoughts and observations. The steps in the inquiry approach are, posing a problem, proposing allegations, collecting data, testing conjectures, and formulating conclusions. So, to facilitate these inquiry steps in this learning, students should be encouraged to understand how they understand the problem, and then think about how they can provide or make a temporary assumption about a symptom or situation. Then students collect data and carry out observations and investigations to provide answers to the allegations that have been formulated.

Likewise, the inquiry learning model is a series of learning activities that emphasize the process of thinking critically and analytically to search for and find answers to a question in question (Abdurrahman et al., 2019). The inquiry learning model is a series of learning activities that emphasize the critical thinking process; namely a series of learning activities that emphasize critical thinking processes and an analytical method to search and find answers to questions. The thinking process itself usually takes place through a question-and-answer session between the teacher and students, because this inquiry model is a fun learning model (Fitri & Aprilianingsih, 2021).

Several things are the main characteristics of the inquiry learning model, namely as follows: (1) the inquiry model emphasizes maximum activity to search and discover, meaning that the inquiry model places students as learning subjects. (2) all activities carried out by students are directed at seeking and finding their answers to something in question (3) the aim of using the inquiry learning model is to develop the ability to think systematically, logically, and critically, or develop intellectual abilities as part of the mental process. Inquiry learning does not only require students to master the subject matter but also how students can develop the potential that exists within them. Some of the advantages of using the inquiry learning model are: first, students learn important things that are easy to do, students are encouraged to do it, not just sit, be quiet, and listen. Second, the themes studied are unlimited and can come from anywhere. Third, students learn by mobilizing all the potential they have, from creativity to imagination. Fourth, students have the opportunity to make discoveries through various observations and experiments (Azmi, 2022).

The Relationship between the Inquiry Learning Model and the Ability to Understand Concepts

Understanding is a process that can explain various things, by providing pictures, and examples with more in-depth explanations and can provide more creative explanations. Meanwhile, the concept exists in thoughts, ideas, or feelings. Therefore, if students can complete a calculation by applying formulas strategically, by applying symbols to present a concept, and can change one form to another, then the student can be said to have the ability to understand concepts (Ciptaningtyas, 2018). Understanding concepts is mastery of several learning materials, where students do not just know and know but can re-express concepts in a form that is easier to understand and can apply them (Damayanti & Anando, 2021).

Students are said to understand if apart from being able to express it again, they can also use it in different situations (Depitasari et al., 2021). Understanding concepts is the ability to change information in the form of material or material that has been studied into another meaningful form, then explain a situation or an action, identify and define and give examples outside the material being discussed, express something in one's language or certain symbols, presenting concepts in the form of mathematical representations, as well as applying concepts or algorithms to solving problems regarding something that has stuck in the mind (Dorier & Maass, 2020).

One of the most basic mathematical abilities possessed by students is the ability to understand concepts (Azmi, 2022). A concept is interpreted as an abstraction that represents a class of objects, events, activities, or relationships that have the same attributes, is abstract, represents a situation or event, and is obtained from the facts, events, and experiences that have been studied. Abstraction (Dwijayanti, 2019). A concept is also something that is depicted in the mind, a thought, idea, or an understanding, embedded in a person's heart and mind as an idea or understanding (Febriana, 2018). So a concept is an abstraction that is depicted in the mind which represents one class of objects or relationships that have the same attributes. Understanding a concept means: 1) mastering something with the mind and understanding the meaning of what is conveyed so that students can understand a situation (Gunur et al., 2019), 2) competence that demonstrated by students in understanding a concept and students can represent a concept again in another form (Hadi et al., 2018), 3) the ability to explain a situation with different words and be able to interpret or draw conclusions from tables, data, graphs and so on" (Hariani et al., 2020).

The definition of conceptual understanding explains that a person's understanding can be measured if they can explain a situation in different words and can draw conclusions from what they have learned. Understanding is not just memorizing, because if you only memorize what you have learned, then one day you will forget. In other words, understanding a material or concept is a prerequisite for mastering the next material or concept. Therefore, understanding concepts in mathematics is very fundamental to learning. Hulu et al., (2023) states that the ability to understand concepts is not only limited to remembering and applying formulas but also linking one concept to another.

Learning mathematics has so far been considered difficult and meaningless. This is because students only accept the concepts given by their teachers without thinking about where these concepts come from (Hunter & Hunter, 2017) stated that even though generally students are exposed to mathematical ideas from an early age. Students have a learning experience, so students can develop basic mathematical concepts from an early age. Mathematical concepts start from simple concepts. Even though it is simple, understanding concepts is very important for learning mathematics because mathematical concepts are related to each other. Therefore, it is necessary to be careful in presenting mathematical concepts. Jannah & Rohmah, (2019) also stated that mastery of mathematics is necessary. Mathematical concepts must be understood properly and correctly from an early age. This is because concepts are a series of causes and effects. A concept is structured based on previous concepts and will become the basis for subsequent concepts so that a wrong understanding of a concept will result in a wrong understanding of subsequent concepts.

Based on the Regulation of the Director General of Basic Education Number 506/C/Kep/PP/204 dated 11 November 2004 concerning report cards, it is explained that the indicators for students understanding mathematical concepts are restating a concept, classifying objects according to certain properties following the concept, giving examples and non-examples of a concept, presenting a concept in various forms of mathematical representation, developing necessary or sufficient conditions for a concept, using and exploiting and selecting certain procedures or operations, applying concepts or algorithms to problem-solving (Johnson et al., 2020).

The inquiry learning model is related to students' understanding of mathematical concepts. This is proven by several literatures that discuss this matter. Juwita, (2019) the relationship between the inquiry learning model and the ability to understand concepts explains that theoretically inquiry learning already contains things that support students' knowledge in understanding mathematical concepts. Kalogeropoulos et al., (2021) in its study emphasizes that the development of the guided inquiry module is to increase learning independence and understanding of social arithmetic concepts. The study by Kurniasih et al., (2023) also states that GeoGebra-assisted inquiry can help students' ability to understand mathematical concepts and can help in developing students' independent learning characteristics. Kurniawati, (2019) study explains that laboratory-based guided inquiry can increase students' understanding of science concepts as proven by student learning outcomes.

Laursen & Rasmussen, (2019) study showed that students' ability to understand mathematical concepts increased after using the guided inquiry learning method. A study by Lotter et al., (2018) states that there is an influence of the inquiry learning model on problem-solving abilities. Dalimunthe, (2021) in their study wrote that the use of the inquiry learning model can improve the ability to understand concepts. Sabela et al., (2022) study states that the guided inquiry learning model is quite effective in increasing understanding of mathematical concepts. Nurwahid & Shodikin, (2021) confirmed that students' ability to understand mathematical concepts who were taught using the inquiry learning model was better. Azmi, (2022) also wrote about students' ability to understand mathematical concepts by applying the inquiry learning model. Gunur et al., (2019) study showed good concept understanding abilities after following the guided inquiry learning model. Ummaeroh et al., (2019) study shows that inquiry using worksheets affects the ability to understand mathematical concepts. Romadon & Mahmudi, (2019) in their study strengthens the inquiry approach in terms of mathematical concepts understanding, and finds out which approach is more effective than learning with guided inquiry. Fitri & Aprilianingsih, (2021) study aims to determine the effect of implementing the guided inquiry learning model on students' ability to understand mathematical concepts.

A study by Depitasari et al., (2021) describes students' ability to understand concepts in flat-sided geometric material after learning using LKPD with an inquiry model as better than conventional learning. Juwita, (2019) shows that there is an increase in the ability to understand concepts after implementing inquiry learning. A study by Sari et al., (2019) shows that students' ability to understand mathematical concepts taught using the Inquiry learning model is better than conventional learning. Jannah & Rohmah, (2019) study shows that the guided inquiry learning model is more effective in understanding mathematical concepts. Tresnawati, (2019) wrote that there were differences in the ability to understand mathematical concepts in students who received guided inquiry learning models and direct learning models. Siswantoro & Sananwetan, (2020) increased students' ability to ask questions and understand mathematical concepts by implementing inquiry-based active learning at a higher level. Rais et al., (2020) study shows that students' understanding of concepts through the guided inquiry learning model has a high level of mathematical difficulty. Furthermore, wrote that understanding the concept of subsets of sub-subjects using the inquiry learning model is better than direct learning.

The study by Rusmiati & Ihsan, (2018) on the application of the Alberta model of inquiry method to improve students' understanding of mathematical concepts. Mustika et al., (2021) study the influence of the guided inquiry learning model on students' conceptual understanding abilities. A study by Rohmana, (2021) shows that in conveying mathematical concepts taught using the inquiry learning model assisted by Magic Cube media towards understanding concepts. Dwijayanti, (2019) study shows that the inquiry learning model has a positive effect on the ability to understand concepts and procedural fluency. Paramita et al., (2021) study on scientific inquiry, with a STEM approach, has a more significant influence on increasing understanding of concepts. Furthermore, Hariani et al., (2020)

wrote about the influence of implementing the guided inquiry learning model assisted by e-modules on students' conceptual understanding. Samosir, (2018) study found that the inquiry learning model was assisted by concept map media on students' ability to understand concepts. Furthermore, Anjarwati, (2021) wrote that the development of edu agatrix with a guided inquiry approach to improve understanding of concepts in class XI students. Then Hulu et al., (2023) wrote that the inquiry learning model increased students' understanding of mathematical concepts, most recently Mahmud et al., (2018) studied that learning activities and understanding of set concepts increased using the inquiry method.

The Relationship of the Inquiry Learning Model to Mathematical Learning Independence

Learning independence is developing students' learning processes to determine goals, learning matters and experiences, and learning assessments (Navisya, 2022). Independent learning can also be concluded as activities that bring about changes in behavior through observing, reading, imitating, trying for yourself, listening, and following directions as a result of experience and interaction with the environment used with the ability to control, regulate thoughts and feelings, and one's actions freely. and not depend on other people. Therefore, learning independence is very important in the learning process. In learning mathematics, students are required to be active and creative to achieve the learning objectives. Learning independence is the freedom to take the initiative, overcome obstacles, do something appropriately, persistently in business, and do everything yourself without the help of other people (Amir et al., 2023), active learning activities that are driven by the intention or motive to master a competency to overcome a problem and are built with the knowledge or competency that they already have (Nurwahid & Shodikin, 2021). A form of learning that provides opportunities for learners to determine goals, sources and learning activities according to their own needs (Purwoko et al., 2019). Independent learning is an activity or learning activities carried out by students of their own accord without help from other people to achieve a competency or goal (Sari, 2020). From this opinion it can be concluded that independent learning is a learning activity that emphasizes the activeness of a learner accompanied by the encouragement of intentions that arise within oneself to achieve a competency or goal. This means that independent learning is a form of learning that provides students with the opportunity to determine learning goals, resources, and activities according to their own needs.

In addition to the explanation above, learning independence frees students to use learning styles, develop what students have, explore their interests, and develop their abilities to use the intelligence they like (Rahayu et al., 2020). Learning independence is the freedom to take the initiative, overcome obstacles, do something correctly, be persistent in business, and do everything yourself without the help of others, active learning activities that are driven by the intention or motive to master something competency to overcome a problem and is built with the knowledge or competencies that they already have (Rais et al., 2020), a form of learning that provides opportunities for learners to determine learning goals, sources and activities according to their own needs (Rohmana, 2021). Independent learning is not individual learning, but learning that requires a student's independence to learn. Independent learning is an effort to develop freedom for students to obtain information and knowledge that is not controlled by other people. Independence requires responsibility, those who are independent are those who are responsible, take the initiative, have courage, and can accept risks and can become learners themselves. So the indicators of independence in learning are having confidence in oneself, having learning activities that are self-directed, having a sense of responsibility, have their initiative (Rusmiati & Ihsan, 2018).

The inquiry learning model has a relationship with independent mathematical learning. This is proven by several literatures that discuss this matter. Ramadhan, (2022) developed of a guided inquiry module to increase learning independence and understanding of social arithmetic concepts. Furthermore, Sabela et al., (2022) examine the effect of

implementing the inquiry model on the independent mathematics learning of fifth-grade students at SDN 10 Mataram. Azhari et al., (2021) study on the implementation of inquiry methods in mathematics to increase learning independence and mathematical communication skills of high school students. Samosir, (2018) wrote that the inquiry method in mathematics lessons is to increase students' independent mathematical learning. Anggraeni et al., (2018) study on the application of the think pair and share learning model through an inquiry approach in terms of learning independence on mathematics learning achievement. Saputra et al., (2020) study on mathematical communication and independent learning of students who received Peer Instruction with a Structured Inquiry (PISI) learning model. Study by Rahayu et al., (2020) on the differences between open inquiry and guided inquiry learning models based on independent learning and high-level thinking.

Furthermore, Navisya, (2022) wrote that the STEM-based inquiry learning model can increase learning independence. Kurniasih et al., (2023) TPACK-based thematic learning using a guided inquiry approach through LKPD to increase learning independence and science learning outcomes. Initial study: the impact of using guided inquiry-based teaching materials on student learning independence. Study uses the guided inquiry learning model to increase students' independence in learning mathematics on KPK and FPB material. study examined the influence of the Lectora-assisted inquiry learning model on the

This article shows the literature regarding the relationship of the inquiry learning model to the ability to understand concepts and learning independence. Publications have gaps in discussing indicators of ability to understand concepts and learning independence. In this study, it was found that there were 31 articles discussing the relationship between the inquiry learning model and the ability to understand concepts, especially the article whose title was "The inquiry learning model on the ability to understand concepts". These articles were identified starting from 2018 with 5 articles, 10 articles in 2019, 4 articles in 2020, 7 articles in 2021, 3 articles in 2022, and 2 articles in 2023. Apart from that, 27 articles discuss the relationship between the inquiry learning model and learning independence, especially the article with the title "Inquiry Learning Model towards Learning Independence). These articles were identified starting from 2018 with 3 articles, 2019 with 5 articles, 2020 with 7 articles, 2021 with 5 articles, 2022 with 3 articles, and 2023 with 4 articles. This is what is meant by the gap presented in the paragraph above, that currently studies on inquiry learning models are dominated by students' ability to understand mathematical concepts compared to studies of independent learning. So this study extends these findings that until now in 2023 the focus of inquiry studies is more dominated by the ability to understand concepts.

CONCLUSION

There has also been a tendency that when the relationship between the inquiry learning model and the ability to understand mathematical concepts is discussed, what emerges is an increase in students' ability to understand mathematical concepts and when the relationship between the inquiry model and mathematical learning independence is discussed, what emerges is an increase in students' mathematical learning independence. Both of them have literature and studies that are worth doing to complete the literature study of inquiry learning models on the ability to understand concepts and independent mathematical learning.

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