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Guided Inquiry Learning Model in Chemistry Education: A Systematic Review

Robiatul Adauyah[1*], Nurfina Aznam[1]

[1] Master of Chemistry, Departement of Mathematics and Educational Sciences, Yogyakarta State University, Indonesia.

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Corresponding Author:
Robiatul Adauyah
Robiatuladauyah.2022@student.uny.ac.id

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Abstract: The abstractness of chemical concepts can be understood easily through learning chemistry using guided inquiry. This article uses the Systematic Literature Review (SLR) method to review eleven articles published from 2018 to 2023. Articles were systematically obtained from the online article databases ERIC, Scopus, and Google Schloar. The purpose of the review is to provide information to teachers and researchers in the field of chemistry education about the definition of guided inquiry models, the effect of guided inquiry models on chemistry learning outcomes, and how to apply guided inquiry models/strategies in chemistry learning. The review results show that the definition of various guided inquiry models involves students into a problem and confronts students with an investigation, and directs students to solve the problem of the problem. The effects of guided inquiry models on chemistry learning outcomes include improving metacognition, concept understanding, critical thinking skills, science process skills, learning outcomes, and creative thinking skills. Various chemistry learning models have also been applied in several learning models or strategies such as Guided Inquiry, Guided Inquiry-Based on Blended Learning, Flipped Classroom Based on Guided Inquiry Learning, Guided Inquiry Model Integrated with STEM, Guided Inquiry and Task Hierarchy Analysis Model in Cooperative Learning Strategy.

Keywords: Chemistry Learning Outcomes; Guided Inquiry; Learning Models

Introduction

Education in Indonesia follows the rules of Law Number 20 of 2003 concerning the National Education system which explains that education is a plan to develop the potential and skills of students in the form of spiritual, social attitudes and intelligence that are needed in the life of the nation and state. The provision of education is aimed at preparing the next generation to play a role in the development of the Indonesian nation and state in the future. However, according to the Political and Economic Risk Consultant (PERC) survey, the quality of education in Indonesia is in 12th place out of 12 countries in Asia. This position is below Vietnam. This shows that the quality of education in Indonesia is very worrying. The causes of the low quality of education in Indonesia include problems with effectiveness, efficiency and standardization of teaching, so that the potential of students has not been developed to the maximum (Suryana, 2017).

Based on the results of several studies conducted on students, especially in learning chemistry, it shows that the activeness, participation, interest, enthusiasm, and motivation of students are lacking; learning is still teacher-centered; and learning is not fun and boring so that students consider chemistry a difficult subject (Anisa & Yuliyanto, 2017; Fakhrurrazi et al., 2017; Jusniar, 2016). In classroom learning, teachers have used a scientific learning approach because it adapts to the 2013 curriculum, but the learning process is still teacher-centered and students lack independent and active learning so that the important role of students in the learning process is low.

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Guided inquiry-based learning is a popular model in science curriculum, international research, project development, and learning (Pedaste et al., 2015). It is an effective learning strategy because it encourages students to engage in learning through problems or tasks (Hwang et al., 2015; Oliver, 2008) and lets them explore scientific phenomena (Graaf et al., 2020). The school has facilities that enable students to take part in meaningful activities (Ikpeze & Boyd, 2007)

The research on education demonstrates that directed inquiry comes in several forms and stages (Hong et al., 2018). For instance, according to some experts, guided inquiry learning proceeds through the following steps: orientation, which piques students' interest in the phenomenon; conceptualization, which helps students develop hypotheses for studies and organize suitable experimental procedures; investigation, which involves carrying out experiments and gathering and analyzing data; conclusions, which involve formulating conclusions and considering experimental findings; discussion, which conveys findings (Pedaste et al., 2015). According to She et al. (2014) and Yang et al. (2015), there are experts who contend that scientific inquiry comprises the following steps: formulating research questions; putting forth research hypotheses; identifying variables; designing experiments; carrying out experiments; collecting data and observing results; analyzing data and reporting results. According to Taylor et al. (2006), there is also another viewpoint that states that the five steps of the inquiry phase in the 5E learning paradigm are engagement, exploration, explanation, elaboration, and evaluation.

According to earlier studies, there are a number of benefits associated with guided inquiry learning. It is thought that this learning will improve students' critical thinking abilities (Thaiposri & Wannapiroon, 2015; Uum et al., 2017; Yang et al., 2015) skills in conducting scientific investigations (Hannasari et al., 2017; Yanto et al., 2019), and learning outcomes (Hwang et al., 2015; Marshall et al., 2017; Rönnebeck et al., 2016). Concept understanding (Korganci et al., 2015), critical thinking abilities (Wale & Bishaw, 2020), and student motivation (Hwang et al., 2015; Suduc et al., 2015; Wang et al., 2015). According to these research, implementing guided inquiry-based learning improves students' comprehension of science, boosts their capacity for scientific inquiry, and narrows the achievement gap between high- and low-achieving students (She et al., 2022).

Several researchers have conducted systematic literature review studies related to guided inquiry learning, including literature studies to provide an overview of the range, definitions, and operationalizations used related to scientific inquiry activities in empirical studies (Rönnebeck et al., 2016), the effect of guided inquiry learning on students' knowledge, skills, and attitudes (Zweers & Denessen, 2019), guided inquiry learning models in chemistry education (Purwandari et al., 2022), contextual teaching challenges related to inquiry-based practical work and produce a multiperspective description of these challenges (Akuma & Gaigher, 2021), and critically analyze and evaluate the advantages and disadvantages of traditional learning models, 2022), contextual teaching challenges related to inquiry-based practical work and producing a multiperspective description of these challenges (Akuma & Gaigher, 2021), and analyzing and critically evaluating the advantages and disadvantages of traditional learning models and guided inquiry (Khalaf & Zin, 2018).

According to the above explanation, there are still not many literature reviews on the use of guided inquiry learning in the field of chemistry education. This is most likely due to the fact that, despite chemistry education being a vital topic in science learning, guided inquiry-based learning is infrequently used in science learning practices globally (Ireland et al., 2014). In order to ascertain how guided inquiry learning has been implemented in the field of chemistry education, particularly with regard to its effectiveness in enhancing conceptual understanding, learning experience, critical and creative thinking skills, motivation, and self-efficacy of students in chemistry learning, we conducted a literature review.

Furthermore, it offers guidance for additional study and informs scholars in the field of chemistry education about trends and patterns in studies pertaining to guided inquiry models in chemistry learning. The following research questions served as a guide for writing this article:

What is the definition of guided inquiry model?

How does the effect of guided inquiry model on the chemistry learning outcomes?

How does the implementation of guided inquiry model on chemical learning?

Method

This article employed the Systematic Literature Review (SLR) methodology. Systematic Literature Review (SLR) is a literature review process that adheres to standard guidelines for finding and synthesizing pertinent research papers and evaluating the body of knowledge regarding the issue under study (Xiao & Watson, 2019). The online databases ERIC, Scopus, and SINTA (Indonesian Research Database) were searched to find the publications examined in this literature review. The collection of literature and analysis took

place between August 20 and November 27, 2023. The Keywords "Impact guided inquiry model in Chemistry Learning", "Chemistry Learning with Guided Inquiry Model", "The Effect of Guided Inquiry Model", and "Guided Inquiry Model" are utilized in this study. Following a keyword search, the researcher looks through the article's title to choose publications that satisfy the subsequent inclusion requirements: discuss the effects of learning using a guided inquiry model and the process of using one; the year that articles published between 2018 and 2023; papers from respectable journals that have been nationally or internationally indexed by SINTA, Eric, or Scopus.

Based on the results of the article search, there were 31 titles that met the inclusion criteria. Then the 31 articles were analyzed. The results of the analysis obtained 22 chemical learning articles using the guided inquiry model. While 9 other articles about the effectiveness of teaching materials or learning media that use guided inquiry models.

In addition, every word in 31 articles was read. Eleven publications that included the research design, research types leaning toward quantitative or mixed techniques, and integration of syntax and learning process were found based on the results of the content readings. In conclusion, the material presented in these 11 articles is appropriate for the topic at hand. Table 1 depicts the process of searching and selecting.

Table 1. The Process of Search and Selection Article

Article	Google Schloar (N= 16) ERIC (N = 3) Scopus (N = 12)
Title Selection	Relate with learning using guided inquiry and the effect of learning using guided inquiry model
Abstract Selection	Accordance with chemistry learning using guided inqury model
Content Selection	Include design of research, the type of research inclined to quasi experimental, pre-experimental design, and include syntax or learning process

Result and Discussion

Definition of the guided inquiry model for chemistry learning

Chemistry is a branch of study that aims to explain natural events by addressing the what, why, and how of changes in matter's composition, structure, and characteristics as well as its dynamics and energetics. Two inseparable aspects of chemistry are process chemistry, or scientific work, and chemistry as a result of scientific discoveries, or chemical knowledge expressed in the form of facts, concepts, rules, and theories (Priyambodo & Khaizuron, 2020).

The three levels of understanding that make up chemistry are macroscopic, sub-microscopic, and symbolic (Johnstone, 1991; Sevian & Talanquer, 2014). Chemistry is a science that investigates matter and its changes. Such atomic or molecular structure and distribution reveal macroscopic phenomena of a matter and its represented symbol from the sub-microscopic chemical features. The relationship between the three levels forces students to reflect and conduct research. Appropriate exercises are necessary from the outset of effective chemistry learning; otherwise, starting students may find it difficult (Sudria, 2006).

According to the findings of study, chemistry is viewed as a science that is not very exciting to study and is very difficult to understand. According to research backed by Marsita et al. (2010), students' lack of enthusiasm and focus during the chemistry learning process is the reason they are having trouble understanding the subject. Students feel content and become less engaged in chemistry courses because, according to Ristiyani & Bahriah (2016), the educational process in schools appears less appealing. Students who struggle to make the connection between the macroscopic and microscopic worlds, which makes it challenging for them to comprehend the principles found in chemistry.

One of the inquiry learning approaches is guided inquiry, which calls for students to carry out a number of searches, experiments, explorations, investigations, and research projects. Students can work in small groups to complete this learning, which is student-centered. Numerous researches have demonstrated the effectiveness of guided inquiry learning in fostering meaningful learning, raising students' conceptual comprehension abilities, enhancing learning outcomes, and developing their science process skills. One of the most advised teaching strategies for chemistry is the guided inquiry-based experiment or practicum.

In the guided inquiry learning paradigm, the instructor serves as a facilitator and guide to help students actively learn, with an emphasis on the students' search for and discovery of solutions to the problems that are formulated (Sanjaya, 2014). Students are required to use critical thinking to address challenges in science and daily life using this learning model. A contextual approach is used in the learning activities that include the guided inquiry learning paradigm. It is required of students to acquire knowledge and skills through fact recall and problem-solving through critical and analytical thinking processes (Sanjaya, 2014).

Learning model that involves students to find concept of a material by their own is inquiry learning model. According to Sanjaya (2014), inquiry learning is a series of learning activities that emphasize on

analytical and critical thinking process to seek and find the answer of a problem. In general, the inquiry learning process includes five steps such as formulating the problem, proposing hypotheses, gathering data, testing hypotheses, and drawing conclusions. This is in accordance with the stages in the scientific activities commonly done in the study of natural science; one of them is on the chemistry subject.

The guided inquiry learning model is effective in helping teachers motivate students to ask questions which is an important part of inquiry-based learning. This learning model also encourages students to discover concepts for themselves and makes students understand the concepts and remember them. Apart from that, the guided inquiry model can grow students' self-confidence and can improve students' cognitive learning outcomes.

The guided inquiry learning model is a learning model that can improve students' cognitive by providing opportunities for students to learn according to their learning style and being able to meet the needs of students who have above-average abilities (Hamruni, 2012). Guided inquiry learning will allow students to develop the concepts they learn. Students are also given the opportunity to exchange information with their peers in group discussion activities. This learning model also makes students more enthusiastic in learning (Sumarni et al., 2017).

For learning through invention, the inquiry learning methodology is advised. Among the many inquiry learning models, guided inquiry is one that primarily consists of five steps: application, generalization, verification, observation, and manipulation (Fay et al., 2007; Martin-Hansen, 2002; Vishnumolakala et al., 2017). For students whose inquiry skills have not yet committed or established, guided inquiry offers assistance in creating investigative questions and other phases if necessary (Banchi & Bell, 2008; Dounas-Frazer & Reinholz, 2015; Kuhlthau, 2010; Vishnumolakala et al., 2017). Important functions of inquiry or scientific talents are learning behaviors including witnessing of investigation pursuing occurrences, creating investigative queries, and designing investigative experiments.

Using student-centered, hands-on, and mind-centered activities, students can enhance their knowledge and comprehension of concepts, ideas, and courses using guided inquiry learning strategies. The instructor serves as a facilitator in these activities. The "student-scientist" model emphasizes the scientist through guided inquiry. The main goal of guided inquiry is to encourage learning through student inquiry. In a 2014 study, Cornel examined how inquiry-based laboratory exercises improved high school students' practical Chemistry performance in Australia. According to the study, students fared better during their self-directed learning experience. Ugwu (2015) also studied how Abia State Chemistry students performed when using a guided inquiry teaching approach. The outcome demonstrated that, in comparison to students taught using a traditional manner, SS1 Chemistry students who were taught using a guided inquiry instructional strategy demonstrated higher academic performance in the mean scores. According to Shidik et al. (2021), a lot of scientific teachers think it's improbable that pupils can learn in 90–120 minutes what great scientists took years to uncover. The Nigerian Junior Secondary School Integrated Science curriculum as well as the senior secondary school chemistry, biology, and physics curricula (Shidik et al., 2021), advocate guided inquiry, in which the instructor gives some assistance.

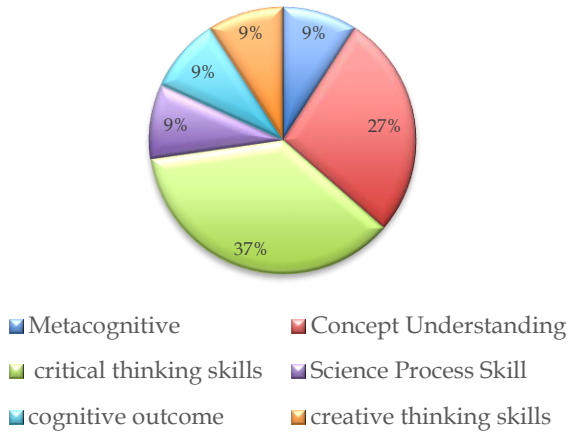

Figure 1. Summary of the influence of guided inquiry model on chemistry learning outcomes

The Influence of Guided Inquiry Model on Chemistry Learning Outcomes

The effect of guided inquiry model on chemistry learning is based on the inclusion of systematic review is metacognitive, concept understanding, critical thinking skills, science process skills, creative thinking skills, and learning outcomes in chemistry learning. The effect of various guided inquiry models on chemistry learning outcomes is summarized in Figure 1. Based on Figure 1, the biggest effect of various guided inquiry models on chemistry learning outcomes is to improve students' critical thinking skills. Statistical results from several articles show that the impact of the posttest is higher than the pretest results.

Critical thinking is a high-level thinking skill. Critical thinking is a skill that aims to understand problems in depth, be open to other people's opinions and understand the information received before making decisions both in the learning process and the daily environment. Critical thinking skills have several skills, including interpretation, inference, analysis, explanation, evaluation, and self-regulation.

Critical thinking skills are essential for students to accurately answer various academic tests and equip students with life skills so that they have decision-making skills. Students who have critical thinking skills usually tend to provide comments to refute ideas with logical analysis, provide comparisons, provide suggestions and criticisms, disagree, think broadly, or think conically and have skills in solving problems (Amri, 2015). One way to train critical thinking skills is through learning chemistry on reaction rate material. In this material students are taught to gain knowledge through data collection with literature, observation, and communication to produce reliable explanations. However, there are not many chemistry studies that are oriented towards habituation and improving critical thinking skills in reality. Reaction rate material is the most widely used material in learning chemistry with guided inquiry models based on the inclusion of material topics. Based on the inclusion literature searched through the most widely used data collection are tests, observations, and questionnaires.

Based on the results of previous research, it shows that the use of guided inquiry models can improve students' understanding of concepts. These results are consistent with research conducted which concluded that inquiry-based learning media used in the learning process can improve student learning outcomes. In addition, a study showed that learning chemistry with inquiry has an effect on improving student learning outcomes. This is reinforced by the results of research proposed which states that guided inquiry learning models can increase student activity and student learning achievement.

This means that possessing a critical thinking ability to help students understand the subject matter is essential. One essential skill in the learning process is the ability to think. Critical thinking skills include solving difficulties in science and daily life. Critical thinking abilities are one of the skill aspects that students in elementary and secondary education must have, according to Permendikbud Number 22 of 2016 about Competency Standards for Elementary and Secondary Education Graduates.

The ability to think critically serves as the foundation for solving problems. A person with critical thinking skills can evaluate a development's advantages and disadvantages. Thus, the ability to think critically is crucial for 21st-century society. Since critical thinking abilities and concept mastery are positively correlated, critical thinking can aid students in expanding their knowledge base and helping them grasp concepts.

Students can use critical thinking to improve their knowledge of the content learned. Concepts learned through critical thinking will be remembered longer because students actively participate in learning to discover concepts independently. Integrating critical thinking skills with the material taught is one way to achieve this. This suggests that a shift from teacher-centered to student-centered learning is necessary to develop critical thinking skills.

Table 2. The Influences of Guided Inquiry Model Toward the Learning Outcomes of Several Chemistry Topi

Research and Year	Topic	The influences of Guided Inquiry Model the Learning Outcomes
Affifah & Utiya (2021)	Reaction Rate	To improve the metacognitive skills of students
Auliyani et al. (2023)	Reaction Rate	To determine the Concept Understanding effect of E-scaffolding in guided inquiry learning
Lenggogeni & Mawardi (2022)	Acid-Base Solutions	To determine the effectiveness of flipped classroom based on guided inquiry learning
Giovani & Dian (2022)	Equilibrium Material	To improve student students' activities, critical thinking abilities, and responses toward implementing the guided inquiry learning model
Juniar et al. (2020)	Analytical Chemistry	To improve students' scientific process skill especially for chemistry courses
Partanen (2023)	Thermodynamics	To the traditional physical chemistry laboratory module where the equilibrium constant of acetic acid is determined conductometrically
Iryani. et al. (2021)	Chemical Bonding	To reveal the influence of using guided inquiry-based chemical bonding modules
Sudria (2006)	Solubility	To describe the effectiveness of guided inquiry-based learning material to improve students

The Implementation of Guided Inquiry model on Chemistry Learning

Students today need to participate more in the educational process. It is therefore required of the Learners to actively participate in the educational process. As a result, the role that learners play in learning—that is, by asking, answering, and reacting to questions—is used to evaluate how active learners are (Nugrahaeni et al., 2017). Teachers and educators merely serve as motivators, mentors, and facilitators; learners'

activity is also evaluated based on their efforts to learn everything on their own volition and capacity. To increase learners' activeness, learning interests, and learning results, chemistry education currently employs a variety of learning models or methodologies.

Tabel 3. The Implementation of GI Model on Several Model

Research	Learning Models/Strategies
Affifah & Utiya (2021)	Guided Inquiry-Based on Blended Learning
Auliyani et al. (2023)	Guided Inquiry Learning
Lenggogeni & Mawardi (2022)	Flipped Classroom Based on Guided Inquiry Learning
Giovani & Dian (2022)	Guided Inquiry Learning
Juniar et al. (2020)	Guided Inquiry Learning
Partanen (2023)	Guided Inquiry Learning
Iryani et al. (2021)	Guided Inquiry Learning
Sudria (2006)	Guided Inquiry Learning

In addition to utilizing different learning models or procedures, chemistry learning requires the use of diverse representations as, as previously said, guided inquiry model have a favorable impact on learners. The systematic research articles included in this review of the literature demonstrated the use of guided inquiry model on various models or learning processes in chemistry. Table 2 illustrates the application of guided inquiry model on multiple models.

The application of the guided inquiry learning model equipped with Student Worksheets (LKS) resulted in cognitive achievement of 56% in cycle I and 84% in cycle II. Meanwhile, using the cognitive improvement inquiry model averaged 83.33 and 80.22. The application of the guided inquiry learning model based on the research above shows that students' conceptual understanding of chemistry material increases so that students' chemistry learning outcomes improve.

Based on Table 2, it can be seen that the guided inquiry model is often applied to science-based chemistry learning. The low of minister education number 59 of 2014 states that the learning chemistry is a learning that emphasizes the skills of the science process (SPS). SPS is a process for performing activities related to science. SPS gives students the opportunity to discover the facts and connect the concepts, through activities or experiences. In addition, SPS is a learning approach that gives students the opportunity to discover concepts by interacting with concrete objects. SPS can also help students to provide meaningful learning experiences as they can also develop higher-order thinking.

Science process skills (SPS) are the intellectual, social, and physical skills that kids gain as a result of their fundamental abilities. Derilo (2019) asserts that in order for students to successfully finish scientific inquiries, they must possess sufficient science process skills. One of the most successful learning approaches for enhancing students' science process abilities is the guided inquiry model. The goal of inquiry learning is to quickly and immediately involve students in the scientific method (Juniar et al., 2017). According to Schelenker's research findings published in Juniar et al. (2017), inquiry-based learning with guidance can improve students' scientific comprehension while also encouraging their creative thinking and developing their information-gathering and analysis skills. More possibilities for direct learning are given to pupils through guided inquiry learning. This learning model can be a solution to enhancing science process skills and student learning outcomes with direct learning experiences since it gives students the chance to practicthe process of building scientific thinking skills (Jufri, 2013).

Based on Table 2, it can be seen that guided inquiry model are often implemented on chemistry learning-based guided inquiry learning. For example, the guided inquiry- Based on Blended Learning by Affifah & Utiya (2021); Auliyani et al. (2023); Giovani & Dian (2022); Iryani et al. (2021); (Partanen, 2023); and (Sudria, 2006) based guided inquiry learning. Flipped Classroom Based on Guided Inquiry by Learning Lenggogeni & Mawardi (2022). Guided Inquiry Model Integrated with STEM, and Guided Inquiry and Task Hierarchy Analysis Model in Cooperative Learning Strategy.

The outcomes demonstrated that using a guided inquiry learning paradigm can help students become more adept at science process skills and critical thinking. Furthermore, a number of publications clarify how the guided inquiry learning approach might help students build stronger cognitive structures. In blended learning-based guided inquiry learning activities, the guided inquiry model is also applied (Affifah & Utiya, 2021). The five steps of the guided inquiry learning process based on blended learning are as follows.

Technological advancements, learning may be done through both in-person and online learning. This is especially true for students enrolled in the guided inquiry learning paradigm. The goal of educational technology is to support, incite, and encourage students' learning process while offering resources and facilities for learning. Blended learning is one of the available online learning techniques. Blended learning has been shown to promote students' learning freedom, according to prior study. Blended learning-based learning is one that combines online and offline learning. Several online activities are online learning process

using G-meet, downloading worksheets and videos, uploading assignments, taking tests using G-classroom, and using WhatsApp groups for group discussion forums. Meanwhile, offline activities are face-to-face class activities. Blended-based learning supports student-centered learning and provides opportunities for students to develop their own abilities without leaving social interaction in the classroom so that with this system students play more active role in learning while the teacher is only a facilitator.

The first phase is the phase of confronting the problem and explaining the inquiry process. The first phase is the phase where the teacher performs apperception, provides motivation and communicates learning objectives to students using the G-meet application. The second phase is the phase of collecting data-verification of the problem situation. In the second phase, students formulate problems based on the phenomena in the student worksheets. The third phase is the phase of collecting data - conducting experiments. In this stage, students only experiment with video experiments given by the teacher and then on the worksheets and collect data from the video experiment regarding the factors that affect the reaction rate in the form of determining the hypothesis and what variables are used. The fourth phase is the phase of organizing and formulating an explanation. In this phase, students organize the experimental video data, formulate an explanation and conclude the results of the experimental video in groups using Whatsapp Group. The fifth phase is the phase of analyzing inquiry strategies and developing more effective inquiry. In this phase, the teacher guides students to work on evaluation test questions on the student worksheet. Besides that, teacher too reflects on the phenomena that have been given at the beginning of online learning, reflects on the inquiry process, gives awards, and delivers the next material.

6 syntax of the guided inquiry learning model, namely: Phase 1 is to focus students' attention and explain the inquiry process. The activity carried out in phase 1 is that the teacher starts learning by appreciating the students by linking the material with the students' prior knowledge about with the previous material. The teacher motivates students and conveys the objectives of learning. Phase 2 presents the problem of inquiry. In this phase, the teacher distributes student worksheets to students. The teacher also asks students to read and understand the phenomena presented in the student worksheet.

Phase 3 helps students formulate hypotheses to explain problems or phenomena. The teacher guides students in formulating problem formulations following the phenomena in the student worksheet, preparing problems including critical thinking skills of interpretation. Then, students develop appropriate hypotheses, including inference critical thinking skills. Then the teacher guides the students to determine experimental variables based on the phenomena in the student worksheet, defining the variables included in interpretation critical thinking skills. Phase 4 encourages students to collect data to test hypotheses. In this phase, the teacher previously asked students to read and study work procedures in solving problems in the student worksheet. Students were asked to experiment at home using tools and materials that are easy to find in their respective lives by documenting the results in videos. And students collect and organize the data that has been obtained. Then the teacher also guides students to analyze experimental data, which is included in analytical, critical thinking skills.

Phase 5 formulates explanations and conclusions. The activity in this phase is to make conclusions based on the experiments that have been carried out. Then the teacher asks the group representatives to present the analysis and findings, showing the results, including the critical thinking skills of explanation. Phase 6 reflects the problem situation and thought process. In this phase, the teacher provides a re-discussion of the learning that has been carried out.

Flipped Classroom on Guided Inquiry Learning System has 4 syntax, namely: The first stage is orientation. At the orientation stage, the teacher prepares students to start learning activities. Students looked at orientation video that consists of motivation, apperception, indicators of learning competence, learning objectives, and introductory materials designed by the teacher and uploaded into the homepage of the Edmodo. In the video, learning objectives and motivation can attract students' curiosity regarding the material to be studied (Hanson, 2005; Susanti & Hamama Pitra, 2019). At this stage, students watch the video first independently. The second stage is exploration and concept formation, while the stage is interrelated. At the exploration stage, students can explore, analyze the model, and collect information related to the model representing the concept. The process is followed by answering key questions that lead students to gain a conceptual understanding tailored to the learning objectives (Hanson, 2005).

The next stage is the application. In this stage, identifying concepts that have been obtained, students can strengthen and clarify the concepts acquired in the previous stage by working on questions in the exercises at the application stage. Students can be integrated with other concepts if the concepts applied to the practice questions are successful. The last stage is closing. In this stage, students conclude the concepts that have been found. In addition, students also provide a protest, feedback, and input. At the same time, the teacher will

confirm and deliver reinforcement related to the concepts that students have obtained.

STEM Integration via a Guided Inquiry Model. Phase 1: Beginning. The teacher assigned problems that related to everyday phenomena. One example of a STEM manifestation was the outstanding student book and worksheet. Science that served as a means of researching issues or phenomena would engage pupils in scientific inquiry. Students may be trained to one of the indicators of critical thinking skills, such as interpretation, by stating the difficulties with the phenomenon. It may raise students' motivation for learning, which would impact their ability to retain material in long-term memory and improve their grasp of concepts.

Phase 2: Choosing. This period was crucial since it introduces students to thermochemistry as the primary subject. Students debating with peers in their group to choose reliable sources of data or knowledge for developing their theory. The student handbook and other resources, such as the internet, are available to the students. Students were inspired to conduct research in order to find the answers after learning the material. Students with this condition may receive instruction in interpretation techniques, which are a sign of critical thinking abilities. When pupils relate to challenges that are still within their grasp, or what is generally referred to as the ZPD (zone of proximal development), learning occurs. Before higher mental function enters a person, level zones of higher mental function development typically occur through cooperation or conversation among the individuals.

Phase Three: Conception. The teacher gave the students instructions on how to construct a meaningful hypothesis in relation to the problem, prioritizing the hypothesis as a research question and creating a study variable by incorporating science, a STEM subject. It serves as a scientific basis for knowledge as well as a means of problem-solving and participation in decision-making. Phase 4: Collection. The students conducted an experiment by implementing all parts of STEM, such as science, technology, engineering, and math. The experiment at phase four would train one of the indicators of critical thinking, namely analysis and inference. It made the students more active in participating to gain the concept mastery. In addition, students were easy to get useful experience and also to prove the concept truth. Finding relevant information to formulate hypotheses and useful variable in training students critical thinking skills, especially for indicator of interpretation (identifying the relations between statements and questions and also concepts that would be assimilated by students in their concept structure. When students built the exoterm and endoterm reaction-related equipment, such as the ice gel product manufactured from baby diapers, simple thermos, simple calorimeter made from styrofoam, and emergency bottle lighter, science, technology, engineering, and mathematics were utilized.

Phase 5: Making a Presentation. Students applied the STEM method to analyze the research findings. Science played a part by providing the fundamental ideas needed to create the problem statement's conclusion. One breakthrough that made it easier for pupils to understand problem solutions was technology. Critical thinking techniques in analysis, inference, and explanation indicators were taught to the students. It took skill to identify and obtain the elements required to reach a logical conclusion. It was put into practice when students worked on a research project and presented their findings in front of the class. Phase Six: Evaluation. It was crucial for the instructor to give students the opportunity to practice critical thinking and concept mastery through questions in the last stage of the guided inquiry model integrated with STEM. This will help the students' comprehension of the concepts and sharpen their critical thinking abilities.

Conclusion

The conclusion in this study is that the definition of guided inquiry model refers to the syntax in chemistry learning, which is based on a systematic review of the articles taken. This model can also refer to other types of media, but this type of media integrates chemistry learning at the macroscopic, submicroscopic, and symbolic levels. Based on the results of the study, information was also obtained that the guided inquiry model has been applied to several chemical learning models such as Guided Inquiry Learning, Blended Learning-Based Guided Inquiry, Flipped Classroom-Based Guided Inquiry Learning, STEM-Integrated Guided Inquiry Model, Guided Inquiry and Task Hierarchy Analysis Model in Cooperative Learning Strategy. The results showed that the application of guided inquiry models/strategies in chemistry learning effectively improved students' critical thinking skills and concept understanding.

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Conflicts of Interest
Regarding this study, the author declares that there is no conflict of interest

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