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The Implementation of the Guided Inquiry Model in Basic Chemistry Courses

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Abstract

The study aimed to provide an overview of the application of the model in Basic Chemistry learning and its impact on student abilities. The researchers employed a descriptive qualitative method, focusing on the Guided Inquiry Model applied in Basic Chemistry courses. The primary data source was documentation, administering the data collection technique in the form of documentation analysis involving photos of the Guided Inquiry Model activities. The findings revealed two key points: Firstly, there was an improvement in students' knowledge and insights about basic chemistry, such as recognizing that the purification of substances could effectively separate naphthalene from its contaminants. Secondly, the implementation of the Guided Inquiry Model in Basic Chemistry courses involved four stages. The process began with problem orientation, framed by the question: "When naphthalene is contaminated, how can it be separated from its pollutants?" The subsequent stage involved formulating a hypothesis through discussions, culminating in an agreed-upon alternative hypothesis: "The practice of purifying substances can successfully separate naphthalene from its contaminants." In the exploratory stage, students engaged in practical purification activities guided by the practicum guidebook and lecturer instructions. The final stage encompassed formulating generalizations, concluding that purifying substances through sublimation could effectively separate naphthalene from pollutants. As a recommendation, this study suggested that lecturers adopt the Guided Inquiry Model because it could enhance students' understanding of the materials covered in Basic Chemistry courses.

Keywords: basic chemistry; guided inquiry model; substance purification

Abstrak

Penelitian bertujuan untuk memberikan gambaran penerapan model dalam pembelajaran Kimia Dasar dan dampaknya terhadap kemampuan mahasiswa. Peneliti menggunakan metode deskriptif kualitatif dengan fokus pada Model Inkuiri Terbimbing yang diterapkan pada mata kuliah Kimia Dasar. Sumber data primer adalah dokumentasi, teknik pengumpulan datanya berupa analisis dokumentasi dengan melibatkan foto-foto kegiatan Model Inkuiri Terbimbing. Temuan ini mengungkapkan dua hal penting: Pertama, adanya peningkatan pengetahuan dan wawasan mahasiswa tentang kimia dasar, seperti menyadari bahwa pemurnian suatu zat dapat secara efektif memisahkan naftalena dari kontaminannya. Kedua, penerapan Model Inkuiri Terbimbing pada mata kuliah Kimia Dasar melalui empat tahapan. Prosesnya dimulai dengan orientasi masalah, yang dibingkai dengan pertanyaan: "Ketika naftalena terkontaminasi, bagaimana naftalena dapat dipisahkan dari polutannya?" Tahap selanjutnya melibatkan perumusan hipotesis melalui diskusi, yang berpuncak pada hipotesis alternatif yang disepakati: "Praktik pemurnian zat dapat berhasil memisahkan naftalena dari kontaminannya." Pada tahap eksplorasi, mahasiswa melakukan kegiatan penyucian praktikum dengan berpedoman pada buku panduan praktikum dan petunjuk dosen. Tahap terakhir mencakup perumusan generalisasi, menyimpulkan bahwa pemurnian zat melalui sublimasi dapat secara efektif memisahkan naftalena dari polutan. Sebagai rekomendasi, penelitian ini menyarankan agar dosen mengadopsi Model Inkuiri Terbimbing karena dapat meningkatkan pemahaman mahasiswa terhadap materi yang dibahas pada mata kuliah Kimia Dasar.

Keywords: kimia dasar; model inkuiri terbimbing; pemurnian zat

Introduction

Basic chemistry serves as the foundational cornerstone for courses within the Chemistry Education study program. It covers a range of essential topics, including matter and its transformations, atomic structure, the periodic table of elements, fundamental chemical laws, chemical bonding, chemical compound nomenclature, various types of chemical reactions, oxidation numbers, chemical reaction equations, and stoichiometry (Asmaningrum & Kamariah, 2018; Emda, 2014; Haryono, 2019; Sulastri & Rahmayani, 2017). Each subject subsequently becomes an individual focus within the Chemistry Education study program's curriculum.

Astuti (2020) defines basic chemistry as a collection of fundamental theories that enrich students' scientific knowledge, enabling them to grasp the core principles of chemistry as a foundation for more advanced courses. Basic chemistry classes are typically offered to early-semester students in the Chemistry Education study program. They are mandatory due to their pivotal role in providing students with the essential knowledge for succeeding in subsequent courses. The primary objective of these basic chemistry courses is to ensure that students can effectively engage in practical experiments related to basic chemistry concepts and demonstrate a comprehensive understanding of them.

Practical exercises are crucial for chemistry education as some relevant concepts can be abstract and often pose challenges in the learning process (Khulliyah & Fadhlan, 2019; Prasetya et al., 2019). Chemistry falls under the realm of natural sciences. Maisarah (2023) highlights that natural sciences involve abstract concepts, necessitating effective learning strategies and resources. Additionally, research by Prasetya et.al (2023) revealed that students expressed a desire for more frequent chemistry practical sessions.

To optimize the learning experience, practical-based activities should be designed with learning models that align with learning objectives, such as the Guided Inquiry Model. Studies have consistently demonstrated that learning through implementing the Guided Inquiry Model proves more effective than other methods, primarily due to its practical-oriented approach. Notable research by Lazonder & Harmsen (2016) showcased the positive impact of the Guided Inquiry Model on student performance and engagement in active learning. Similarly, Moon (2017) revealed that Guided Inquiry learning significantly influenced learning outcomes, argumentation skills, and chemical reasoning abilities. Given these findings, Guided Inquiry learning is recommended for application across natural and science-based disciplines.

In the present study, the Guided Inquiry Model was employed within the framework of Basic Chemistry courses. The researchers delved into a comprehensive breakdown of the Guided Inquiry Model, elucidating students' specific actions at each sequential stage and the skill sets honed during these stages. This research endeavor aimed to contribute to the theoretical understanding of the Guided Inquiry Model's practical implementation and to furnish empirical evidence supporting its suitability in practice-oriented domains like Basic Chemistry courses. Furthermore, this investigation emphasized the potential impact of the Guided Inquiry Model on students' proficiencies when integrated into their learning journey.

Method

The research in this article incorporated a descriptive qualitative method. Descriptive research is a methodology that aims to objectively depict the object or subject under investigation, striving to present facts systematically and characteristically (Azwar, 2010; Maisarah et al., 2022; Zellatifanny & Mudjiyanto, 2018). The focus of this study was the implementation of the Guided Inquiry Model in Basic Chemistry courses. The researchers provided a detailed account of the Guided Inquiry Model's activities within Basic Chemistry courses. The primary data source utilized for this research consisted of relevant documents.

Hence, it became evident that the employed data collection technique was documentation. It involved researching and analyzing various documents acquired from research sites relevant to the study's subject (Evanirosa et al., 2022). In this context, the documentation comprised personal photos captured during Basic Chemistry practical sessions at Universitas Samudra's laboratory. The documents scrutinized in this study encompassed photos depicting the activities associated with the Guided Inquiry Model implementation in Basic Chemistry courses.

The study was conducted at Universitas Samudra's laboratory, focusing on students in the first year of the Chemistry Education study program. The total number of subjects involved in this study was twelve students. The data analysis technique employed was the Miles and Huberman analysis method, including the following steps: data collection, data reduction, data presentation, and conclusion drawing (Maisarah, 2023; Miles & Huberman, 1994).

Result and Discussion

This study employed a descriptive method incorporating a qualitative approach. This method was used to explain and analyze research results. Its primary objective was to provide a detailed and in-depth description

Guided Inquiry activities stimulated student curiosity, encouraging them to devise solutions for given problems. This process was intended to ignite their interest in various issues and challenges, fostering a sense of environmental responsibility. By applying scientific concepts acquired in their learning journey, students could effectively address everyday problems. The Guided Inquiry Model encompassed six key learning steps: orientation, problem formulation, hypothesis development, data collection, hypothesis testing, and conclusion formulation (Nurdiansyah & Fahyuni, 2016; Winanto & Makahube, 2016). In addition, Puspitasari et al. (2019) elaborated on the five steps within the Guided Inquiry Model in their research, covering posing questions or problems, formulating hypotheses, collecting data, analyzing data, and drawing conclusions. The Guided Inquiry Model featured distinct learning steps, ultimately comprising four core activities: orientation, hypothesis formulation, exploration or validation, and generalization development.

Within the Basic Chemistry practicum context, students embarked on their practical journey by immersing themselves in problem-oriented tasks related to fundamental chemical applications, including material purification, chemical reactions, oxidation-reduction reactions, and chemical bonding. However, this article primarily focused on the material purification aspect of the practicum. The description of the Basic Chemistry practicum, centered explicitly on substance purification, utilized the Guided Inquiry Model, as illustrated in the following Figure 1.

Figure 1 depicts the problem orientation activity. The lecturer's role in this stage was to guide students in orienting themselves to the problem, review the provided practicum manual, and present questions or challenges related to the purification of the substance to be practiced. As the lecturer, CP presented a question or problem: "If the naphthalene is contaminated, how would you separate it from its pollutants?" Based on the issues raised by the lecturer, students engaged in

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discussions. During this activity, it was evident that students were enthusiastic about solving the problems. They explored practicum activities relevant to the problem online and reviewed the practicum in person. The problem orientation activity concluded with the formulation of an agreement regarding problem-solving, achieved by conducting substance purification experiments. The second inquiry activity involved formulating a hypothesis, as illustrated in the following Figure 2.

Figure 1.
Students being Guided by Lecturers During Problem Orientation

Figure 2.
Hypothesis Formulation Activity

Figure 2 illustrates the process of formulating a hypothesis. In this phase, students collaborated in groups to discuss hypotheses that would subsequently be tested through practicum activities. The lecturer assumed the role of monitoring the group discussions and providing guidance in formulating these hypotheses. A hypothesis is a preliminary statement or proposition with limited substantiation, requiring further validation or confirmation (Anuraga et al., 2021; Ryando, 2021). In this study, a hypothesis served as a provisional response to the question posed by the lecturer. In the realm of research, this preliminary hypothesis is termed the alternative hypothesis (ha). It represents a proposition that is open for acceptance or serves as a temporary solution. Following thorough discussion within student groups and under the guidance of the lecturer, an alternative hypothesis (ha) was established for verification: "The process of substance purification can effectively separate naphthalene from its pollutants." Subsequent to the formulation of the alternative hypothesis (ha), the appropriate null hypothesis (h0) was also constructed: "The process of purifying substances cannot effectively separate naphthalene from its pollutants." The lecturer then directed students to undertake exploratory activities or practical substance purification to substantiate the hypotheses. This exploration phase signified the third step in the Guided Inquiry Model. The specific exploratory activities executed by students are displayed in the following Figure 3.

Figure 3.
Exploration Activities Regarding Substance Purification

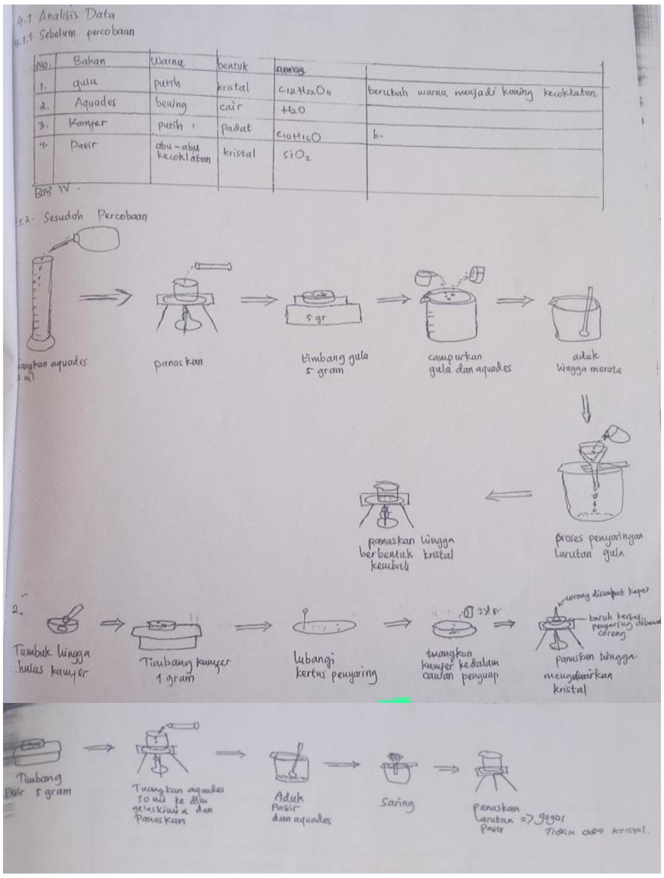

In practicum activities, students were directed to determine the appropriate substance separation technique for a given problem, one of which was sublimation. It was carried out to separate substances with differences, with the principle based on a mixture of substances in which one of the components could sublimate. It involved a change of state from solid to gas. In this practicum, naphthalene was separated from its pollutants, namely sand. Additionally, students were asked to document the phase change reaction of the compound. The core activity of Guided Inquiry encouraged learners' independence in constructing conceptual knowledge during learning. It also aimed to enhance autonomous learning skills, as depicted in Figure 3.

Students collaborated within their groups to solve problems during the data collection process. Simultaneously, the teacher monitored the investigative work to ensure alignment with the specified learning objectives. Students documented their procedural steps after conducting literature study throughout the experimental process. It resulted in distinct writing styles for each group's work procedures and individual justifications for each step. Guided Inquiry empowered students to seek learning experiences, leading to meaningful learning outcomes.

Throughout the practicum, all pupils wore laboratory attire and handled solutions carefully, as they knew the associated chemical hazards. They effectively allocated tasks within their groups and diligently cleaned all utilized tools. They also properly disposed of materials in designated bins instead of directly pouring chemical solutions into the sink, which could cause pipe corrosion. The students' explanations served as evidence of their meaningful learning. Meanwhile, lecturers played a pivotal role in raising learner awareness of relevant scientific issues and contemporary problems. Ardiansyah et al. (2016) note that students' interest in Basic Chemistry concepts directly correlates with their comprehension of the material.

The ability to explain issues or problems scientifically necessitates students to master multiple skills, such as recalling and applying scientific knowledge and identifying and utilizing various models and representations to substantiate predictions or hypotheses appropriately. Latukau (2016) conducted research using Guided Inquiry coupled with a scientific literacy approach, successfully enhancing learners' critical thinking abilities. Students were prompted to pose questions throughout the investigation while exploring knowledge concepts. This approach enabled them to formulate clear hypotheses and expound upon the potential societal implications of scientific knowledge. During the data collection phase, students employed a variety of information and literature to aid in problem-solving. When presenting and elaborating on investigation results, they showcased their problem-solving results and addressed analytical questions related to the real-life application of those concepts. Engaging in data/information search activities linked to problem-solving helped learners develop science process skills. Rahmi et al. (2014) carried out a study employing Guided Inquiry-based Learning and Teaching Activity Sheets (LKPD), designed to foster student independence in learning and subsequently yield science process advancements. Students leveraged the information stored within their cognitive structures to acquire new essential knowledge.

Figure 4.
Formulation of Generalizations



Lecturers allowed students to submit their processed data results and guided them in creating experimental reports. The reports in question generalized that purifying substances through sublimation could effectively separate naphthalene from pollutants. This overarching conclusion was derived from exploring phenomena and science-based practical work. Consequently, it could be inferred that grasping Basic Chemistry was achievable through hands-on activities like employing the Guided Inquiry Model. Moog (Price et al., 2021) proposes that students employ data to investigate phenomena and develop scientific concepts in the Guided Inquiry Model of learning involving experimental methods, which can boost students' confidence in acquiring information (Iswatun et al., 2017). Moreover, integrating Guided Inquiry-based laboratory activities is crucial for enhancing learning outcomes (Ural, 2016).

Conclusion

The research findings revealed the following key points: (1) There was a notable enhancement in students' knowledge and insights regarding Basic Chemistry, particularly in comprehending that substance purification could effectively separate naphthalene from its pollutants. (2) The implementation of the Guided Inquiry Model in Basic Chemistry involved a structured approach encompassing four distinct stages: problem orientation, hypothesis formulation, exploration, and generalization. The problem orientation phase commenced with the question: "If naphthalene is contaminated, how can it be separated from its pollutants?" The process of formulating a hypothesis involved collaborative discussions, culminating in the agreement upon the alternative hypothesis (ha) to be tested: "The practice of purifying substances can successfully separate naphthalene from its pollutants." During the exploratory phase, students engaged in substance purification practices based on practicum manuals and lecturer guidance. The culmination of these activities was the formulation of generalizations, establishing that the technique of sublimation-based substance purification could effectively separate naphthalene from pollutants. Therefore, this study strongly advocated incorporating the Guided Inquiry Model by lecturers, as each stage significantly contributed to learners' comprehension of the content within Basic Chemistry courses.

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