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The Effect of E-Scaffolding in Guided Inquiry Learning on Concept Understanding in Reaction Rate Material

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Abstract: Understanding the concept of an object is needed by students, because the understanding of a concept applies in general so that students can solve more complex problems. This study aims to determine the effect of E-scaffolding in guided inquiry learning on conceptual understanding of reaction rate in class XI IPA MAN 1 Indragiri Hilir E-scaffolding is cognitive assistance in electronic form that given in the guided inquiry learning stage as a cognitive tool to support students. The quasi-experimental research method is used to see the effect of E-scaffolding in guided inquiry learning on conceptual understanding in the control class and the experimental class. The results of the two-way ANOVA hypothesis test with a significance value (0.000) <0.05 indicate that there is a difference in conceptual understanding between the control class and the experimental class. Thus, E-scaffolding can be used as a cognitive assistance for students who have difficulty doing inquiry and cannot be completed independently while in the zone of proximal development (ZPD).

Keywords: Concept Understanding; E-scaffolding; Guided Inquiry; Reaction Rate

Introduction

Education has a function as the foundation for the growth of a thinking society and a technological society which is the capital to keep up with the development of science and technology. Education as a place that contains activities to prepare human resources will go through the learning process (Suratno, 2012; Windyariani, 2019). Knowledge, skills, values/motivation that humans have are the result of an educational activity obtained from the learning process (Madleňáková & Madleňák, 2021). Changes as a result of education are changes in the components of behaviour, namely ideas and knowledge, norms and skills, values and attitudes, understanding and manifestation (Ahmadi, 2015; Desi et al., 2021).

Understanding the concept as one of the results obtained from education is a very important foundation for training students in thinking and can be applied to solve problems related to the concepts they have (Simonson, 2019). The low understanding of the concept of students in schools is largely due to learning that is more likely to be memorized and not based on experience, which is largely triggered by the teaching style of teachers who instruct students to memorize various concepts without an understanding of the concept and also the use of models and learning resources that are less varied (Annafy et al., 2021; Azis et al., 2020).

Beginner chemistry learning is an important starting point in developing concept understanding and forming a positive image of chemistry (Hariani et al., 2020). Therefore, beginner chemistry learning needs to be directed at developing concept understanding with carefully studied teaching strategies (Kirna, 2010; Muhali et al., 2021). Concept understanding is one of the cognitive processes in the cognitive process dimension according to Anderson and Krathwol Taxonomy and involves a lot of conceptual knowledge in learning. Concept understanding has complex knowledge because it involves the relationship of various elements as a system such as facts, classifications, principles and

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theories (Iskandar & Susdiani, 2018; Sweller, 2020). Concept understanding becomes meaningful when used to explain other situations, so concept understanding can also be used as a cognitive tool to make predictions, solve problems, and make hypotheses (Azizah et al., 2020).

Teaching understanding of chemical concepts is a complex problem because it involves macroscopic aspects of a phenomenon, submicroscopic and symbolic aspects (Rizal & Aini, 2023). The three aspects are always related to get a complete understanding of the chemical concepts studied so as to bring up a meaningful understanding of the concept. For example, to understand the concept of reaction rate, it is necessary to involve macroscopic aspects of the reaction rate phenomenon, for example, meat that cooks faster if the surface area is larger. Submicroscopic aspects involving compounds, molecules and atoms, as well as symbolic aspects to represent the compounds, molecules and atoms involved in the reaction rate. The existence of these representations makes it easier for students to understand chemical concepts and will enter the long-term memory to form new schemes in student cognition (Gabel, 2003).

Research conducted by Marthafera et al. (2018) revealed that the average percentage of students' concept understanding in reaction rate material was 33% with the lowest indicator in determining the reaction rate price. Factors that influence students' concept understanding are dominated by social factors consisting of teacher factors and teaching methods, tools used in learning and only a few are influenced by individual factors such as training intelligence and student motivation. The results of this analysis show that many students who do not understand the reaction rate material are caused by students who do not want to find out for themselves (Sundari et al., 2017), students prefer to depend on the explanation and media used by the teacher in class.

Preliminary studies conducted at MAN 1 Indragiri Hilir show the difficulties experienced by students in reaction rate material are in the mathematical concept of calculating the reaction rate. In addition, on the concept of collision theory, students cannot explain the effect of temperature on collisions and its relationship with kinetic energy. The difficulties experienced by these students are at the symbolic and micro representation levels. Therefore, teachers can link the concept of reaction rate with three chemical representation models so that students easily understand the concept of reaction rate. So that learning becomes meaningful, consequently the learning material must be meaningful. Through meaningful learning there is a process of linking new information to relevant concepts contained in one's cognitive structure.

According to Gabel (2003), one of the strategies that can be used to improve students' concept understanding is using inquiry strategies (Srisawasdi & Panjaburee, 2019). In the inquiry strategy students work like scientists, starting from asking questions, hypotheses, collecting data, processing data and making conclusions (Bernard et al., 2019). Although inquiry helps develop one's problem solving, critical thinking, and communication skills, students often have difficulty with inquiry (Cuccio-Schirripa & Steiner, 2000). For example, students with little experience of science enquiry may not know how to do the assigned work and understand what the process entails (Quintana & Fishman, 2006). Other studies have also shown that some secondary level education students have difficulty identifying key concepts such as dependent variables (Arnold et al., 2014), so students need instructional assistance that supports procedural knowledge and understanding during required inquiry tasks. In addition, although students are able to design and carry out investigations, they often collect insufficient or inadequate data to conduct data analyses, and state conclusions that are inconsistent with their data (Kanari & Millar, 2004).

Difficulties in guided inquiry learning can be overcome by scaffolding (van Uum et al., 2021; Wartono et al., 2019), which is instructional support in complex scientific inquiry activities. Digital-based scaffolding, hereafter referred to as E-scaffolding (Electronic scaffolding) can provide sufficient assistance and enable students to succeed in solving problems and performing complex tasks, as well as expanding the range of experiences of what they have learnt. Research studies on the use of e-scaffolding in guided inquiry learning are very relevant to be discussed, given the swift flow of changing times that use a lot of digital devices, the role of digital-based e-scaffolding to help students carry out inquiry activities needs to be explored to see its effect on students' concept understanding, especially on reaction rate material. Therefore, this study aims to determine the differences in concept understanding of students taught using guided inquiry learning with e-scaffolding and students taught with guided inquiry learning on reaction rate material.

Method

This study used a quasi-experimental posttest-only design and involved two classes, namely the experimental class and the control class (Gopalan et al., 2020; Maggin, 2022). The experimental class was treated with guided inquiry learning with e-scaffolding while the control class used guided inquiry strategy. The research was conducted in class XI IPA MAN 1 Indragiri Hilir whose academic ability was equal and controlled through Two Way ANOVA statistical test. The independent variable of the study is a learning strategy consisting of two types, namely guided inquiry learning with E-scaffolding and guided inquiry learning. The dependent variable is the understanding of chemical concepts.

Control variables are learning materials (reaction rate), duration of learning time, evaluation instruments, lesson plans and student worksheet. The research instruments used consisted of treatment instruments and measurement instruments. The treatment instruments used are the learning syllabus, Learning Implementation Plan, and student worksheet. While the measurement instrument used is a concept understanding test on reaction rate material. The instrument used has been used validity test and reliability test before the research was conducted.

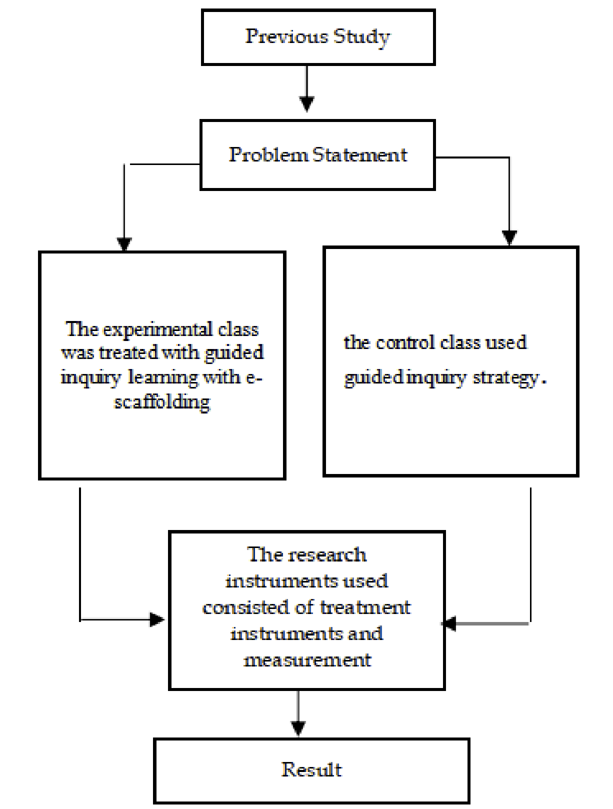

Figure 1. Research Flow and Logic

Research studies on the use of e-scaffolding in guided inquiry learning are very relevant to be discussed, given the swift flow of changing times that use a lot of digital devices, the role of digital-based e-scaffolding to help students carry out inquiry activities needs to be explored to see its effect on students' concept understanding, especially on reaction rate material. Therefore, this study aims to determine the differences in concept understanding of students taught using guided inquiry learning with e-scaffolding and students taught with guided inquiry learning on reaction rate material.

Result and Discussion

Data on the acquisition of students' concept understanding in the experimental class and control class. The average value of students' concept understanding in the class taught with E-scaffolding in guided inquiry learning is 74.11. While the class taught with guided inquiry learning alone obtained an average concept understanding score of 64.87. Hypothesis testing was carried out using the two-way anova analysis method with the help of IBM SPSS 24 for Windows with a significance level of 0.05. The results of hypothesis testing with a significance value of (0.000) <0.05 show that there is a difference in concept understanding between the experimental class and the control class.

The difference is caused by the influence of E-scaffolding used at the guided inquiry stage. E-scaffolding is a digital or electronic-based aid that can be accessed through links and barcodes as in Figure 2.

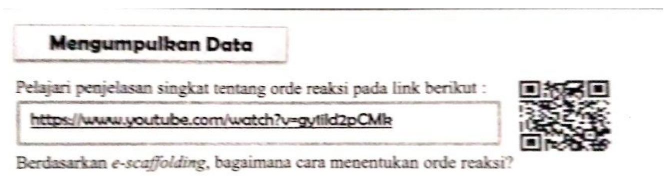

Figure 2. E-scaffolding in the form of links and barcodes

E-scaffolding is scanned through a smartphone and given to students to help solve problems that cannot be solved independently when students are in the zone of proximal development (ZPD). E-scaffolding is given at the guided inquiry learning step to overcome the difficulties that arise when completing each stage of guided inquiry difficulties that arise in guided inquiry according to Arnold et al. (2014) and Nasir et al. (2022), secondary education learners have difficulty identifying key concepts such as dependent variables as a result, the question sentence does not contain the independent variable and the control variable and the relationship between the two variables in the sentence is not correct.

In addition, according to Kanari & Millar (2004) learners often collect insufficient or inadequate data to perform data analysis, inability to use tools, inability to design experiments, and understand terms such as hypothesis, variables and data collection Castro & Morales (2017), and difficulties in finding and organizing information and face difficulties in hypothesis, testing ideas, experimenting, discussing findings.

The difficulties that arise in guided inquiry learning are assisted through the teacher as scaffolding and e-scaffolding as electronic assistance in the formulation of problems in the guided inquiry step is given e-scaffolding in the form of strategic scaffolding which helps students find ways and methods of how to make problem formulations that can be seen. The e-scaffolding provided contains instructions for making problem formulations and examples of appropriate problem formulations. After using E-scaffolding, students are expected to be able to make the right problem formulation based on influential variables at the problem identification stage. Students in the experimental class presented a clear, logical and complete problem formulation. While in the control class the formulation of the problem.

In the control class, the problem formulation only showed the influential variables without any logical relationship between the two variables. This shows that students have difficulty formulating questions due to the lack of a good understanding of the problem and proper problem formulation. Besides in the form of instructions and guidelines that can be accessed digitally, e-scaffolding is also provided in the form of simulations and concept maps that can help students gain a more meaningful understanding.

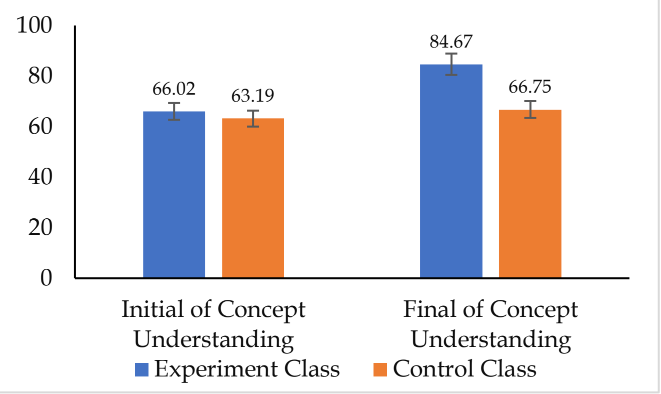

Figure 3. Level of Concept Understanding Based on Initial Ability

The provision of E-scaffolding at the guided inquiry stage has an influence on students' concept understanding. Concept understanding is then seen again based on students' initial abilities and can be seen in Figure 3. The initial ability of students in the experimental class showed significant differences in concept understanding. While in the control class, the difference in concept understanding based on initial ability is not large enough. This is due to differences in the treatment given. The existence of E-scaffolding also affects the initial ability of students. Because E-scaffolding is also used as a learning resource or cognitive source of students who contribute to shaping the initial ability. In the control class, the initial ability of students only comes from the experience of the students themselves.

According to Ladachart & Ladachart (2019) teachers should use learners' initial abilities as a cognitive source used to guide inquiry learning. Initial abilities in chemistry learning such as in LKPD 1 where the initial abilities of students about the types of chemical reactions, the concept of moles and molarity can be used as a cognitive source to form new understanding or knowledge about the definition of the reaction rate, by making connections between the initial abilities of students with new information it will transform students' understanding of the material being taught.

The initial ability of students in the experimental class showed a significant difference in concept understanding. While in the control class, the difference in concept understanding based on initial ability is not large enough. This is due to differences in the treatment given. The existence of E-scaffolding also affects the initial ability of students. Because E-scaffolding is also used as a learning resource or cognitive source of students who contribute to shaping the initial ability. Whereas in the control class, the initial ability of students only comes from the experience of the students themselves.

Conclusion

E-scaffolding applied to guided inquiry learning shows an influence on students' concept understanding. The experimental class that was treated showed a better average concept understanding than the control class that only used guided inquiry learning. In addition, when viewed from the initial ability of students, the experimental class also has a better average understanding of concepts. Thus, E-scaffolding can be used as cognitive assistance and More Knowledgable Others (MKO) intermediaries that help students pass through the Zone of Proxymal Development (ZPD) on the task being completed. This study recommends the need to study more deeply the use of E-scaffolding in other learning models and strategies to determine the extent of the influence of E-scaffolding on improving student learning outcomes.

Author Contribution

The writing of this article was done cooperatively. Each stage is done together.

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Conflicts of Interest
The authors declare no conflict of interest.

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