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Teachers and Students Needs Analysis for the Development of Subject Specific Pedagogy (SSP) Blended Learning Based on Multiple Representations

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Abstract: This article discusses the needs analysis of the teachers and students towards the development of a multiple-representation-based blended learning Subject Specific Pedagogy (SSP) used in chemistry learning. The subjects of this study consisted of 15 chemistry teachers in Central Java and 34 high school students in class XII IPA. Primary data were obtained by providing teacher questionnaires consisting of the characteristics of reaction rates material, the use of learning media that are usually used, and students' critical thinking skills and learning using SSP blended learning based on multiple representations. While the student questionnaire consists of students' interests and learning methods in understanding chemical material, students' opinions regarding the reaction level material, and students' general critical thinking skills. The results of this need analysis show that teachers and students need integrated learning tools to support learning activities. The conclusion of this study is to develop a multiple-representation-based blended learning Subject Specific Pedagogy (SSP) to improve critical thinking skills and student learning outcomes.

Keywords: Blended learning; Critical thinking; Multiple representation; Subject specific pedagogy

Introduction

21st century learning is a concept that was formed due to the rapid development of digital technology. Digital technology has changed the way of teaching and learning (Awidi & Paynter, 2022). The effects of digital technology on teaching and learning have attracted widespread attention (Castro, 2019; Crompton & Burke, 2018). One of the main elements of 21st century learning is ICT Literacy where this can influence students' ways of thinking and learning with the validity of the information obtained.

To support learning with technology, blended learning is appropriate for the learning process. The blended learning learning strategy is considered the most practical method to adapt because it combines the advantages of synchronous and asynchronous strategies (Lapitan et al., 2021). Wardani's research (2018) also suggests that blended learning is a learning model that can increase the attractiveness of the face-to-face learning process and is very suitable for application in the 21st era. Some common blended learning models are station rotation, lab rotation, remote blended learning, flex blended learning and flipped classroom (Chowdhury, 2020).

In developing the skills needed for the 21st century, the flipped classroom is one model that can be applied (Cosculluela et al., 2021). The flipped classroom procedure is that students are instructed to carry out mandatory learning activities through online resources at home before class and then time in class is devoted to discussions, group activities, and application of concepts (Anand, 2021). Thus, in face-to-face learning, teachers and students interact more to help students solve learning problems and improve learning quality

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(Paristiowati et al., 2022). With a flipped classroom, students can build knowledge and increase their own conceptual understanding during activities. In addition, the flipped classroom model can also have a big influence on motivating interest in learning and analytical skills which are part of high-level thinking (Maemanah & Yunita, 2019).

In addition to the need for technology in learning, the need for higher abilities and skills of students in learning is also an important key to achieving learning goals in the 21st century. According to Rushiana et al. (2023) and Fuad et al. (2017), the dominant thinking skills needed in the 21st century are critical thinking skills. Critical thinking as a result of student learning is an important thing that must be developed (Thonney & Montgomery, 2019). However, students' critical thinking skills in Indonesia are still low (Muhammad et al., 2023; Saputri et al., 2018). The problems encountered show that many students cannot think critically because teachers cannot integrate critical thinking into everyday learning practices (Wijiastuti & Muchlis, 2021).

Based on research by Marpaung & Simanjuntak (2018), students' critical thinking skills can be trained by learning based on multiple representations. In chemistry, the learning process is very dependent on the teacher's strategy in selecting and combining several representations of abstract concepts (Ferreira & Lawrie, 2019). Chemical representations serve as a foundation to guide the teaching of chemical concepts. Students can form conceptual understanding well by understanding the three existing representations (Safitri et al., 2019). However, this is not easy because students are used to thinking at the macroscopic level. Students will be more interested in a lesson if the material relates to them and can do it directly with the five or macroscopic senses (Afifah et al., 2023).

Chemistry as a branch of science is not enough just to be conveyed by modifying the learning model, but it is very important to develop a variety of learning tools that can make it easier for students to understand chemical concepts according to the 2013 curriculum that will be developed. Based on the achievement data for the National Examination scores for the 2018/2019 school year, it was found that the average scores in the chemistry test for Senior High School and Islamic Senior High School levels were 50.99 and 46.73, respectively. One of the factors causing low learning outcomes is teacher-centered learning that makes students passive in learning (Minarni et al., 2022).

In supporting chemistry learning which is required to involve multiple representations, learning tools are needed such as Subject Specific pedagogy (SSP) which is the packaging of subject matter into a set of comprehensive and educational learning (Depdiknas, 2008). However, so far no blended learning SSP has been developed, while the 21st century demands itlearnersfor technology literacy (ICT literacy).

Thus, it is necessary to develop SSP blended learning, especially in chemistry learning based on multiple representations. The learning tools developed are packed with blended learning according to the needs of the 21st centurylearnersrequired ICT literacy with a combination of multiple representation bases that make it easierlearnersbuild their own knowledge so that concepts can be understood.

Method

This research is Design Based Research (DBR) development research, which is a research method used to design and develop learning components, both learning strategies, learning materials as well as products and systems. In this research what will be developed is the Subject Specific Pedagogy (SSP) learning device on the material of reaction rate.

The subjects in this study were 15 chemistry teachers in Central Java and 34 students of class XII IPA 7 at SMA Negeri 1 Karanganyar. The DBR development model is implemented through four stages. The first stage is problem analysis in the field (need assessment) so that the data from this pre-research is in the form of a questionnaire based on teacher and student responses.

Result and Discussion

At the need assessment stage, the activities carried out are determining the basic problems encountered in learning, identifying the characteristics of students, formulating learning objectives, and studying teaching materials. At this stage, data collection was obtained based on a needs analysis questionnaire given to teachers and students. The needs analysis given to teachers includes material characteristics reaction rate, the use of learning media that are commonly used, and students' critical thinking skills and learning using SSP blended learning based on multiple representations. The results of the teacher need analysis questionnaire can be seen in Table 1.

Based on the results of the teacher's questionnaire, it was found that 73% of the students were quite interested in the reaction rate material, while the other students were less interested in the material. Students find it difficult to study reaction rates, which is as much as 80% often have difficulty understanding collision theory and calculating reaction rates. While some other difficulties faced by students, namely in determining the graph of the reaction rate, understanding the catalyst, and understanding the factors that affect the rate of reaction. This is supported by Lestari's research (2020) which states that students experience difficulties in

learning reaction rate material where students have not been able to construct chemical reaction concepts that are close to real life into calculating order and reaction rates, and apply them through experiments. To overcome these difficulties, as many as 60% of teachers provide practice questions. Other efforts made by the teacher are by providing learning videos about catalysts, using guided inquiry models, and giving practicum.

Table 1. Results of the Teacher Needs Analysis Questionnaire

Question	Results	Percentage (%)
According to you, are the students interested in the reaction rate material?	Interested enough	73
In your opinion, what are the difficulties that students often face in learning the material on the rate of reaction?	Collision theory and reaction rate calculations	80
What efforts have been made to overcome these obstacles or difficulties?	Provide practice questions	60
What learning method do you often use?	Discussion, lecture	60
In your opinion, what learning model is suitable for teaching reaction rate material?	Discovery Learning, Problem Based Learning	67
What learning resources do you use in class?	Package Book	80
Do students have more interest when you present learning material using media?	Yes	100
What media do you usually use in the chemistry learning process, especially the reaction rate material?	YouTube videos and power point slides	87
Does the learning tool that you use contain and relate the level of chemical representation (macroscopic, submicroscopic, and symbolic)?	No	67
Have you ever used learning tools to train students' critical thinking skills?	No	53
What is your response regarding online learning that has been implemented due to the Covid-19 pandemic?	Less effective, students do not understand the material	100
What do you know about blended learning?	A combination of face-to-face learning with online learning	100
Have you ever made a blended learning tool based on multiple representations?	Never	67
In your opinion, is blended learning based on multiple representations necessary for high school chemistry learning?	Yes	100

The learning method that is often used by teachers is lecture and discussion, which is as much as 60% of teachers use this method. Another method used is to do demonstrations and practicum and give assignments to students. In addition to varying learning methods, teachers also vary learning models. Discovery learning and Problem Based Learning (PBL) are the learning models most often used by teachers. Other learning models such as inquiry learning models and cooperative learning. Meanwhile, as many as 80% of teachers use textbooks as learning resources in classroom learning. The use of models and learning resources that are less varied can lead to low understanding of concepts and student learning outcomes (Auliyani et al., 2023).

The use of learning media can make students more interested in understanding the material presented. According to Sumarmi (2021) learning outcomes increase if students focus during the learning process supported by learning media that has an attractive appearance. As many as 87% of teachers used YouTube videos and power point slides in the learning process and 67% of teachers stated that the learning tools used had not included and linked levels of chemical representation (macroscopic, submicroscopic, and symbolic). In addition, as many as 53% of teachers have never used learning tools to train students' critical thinking skills. The implementation of chemistry learning in many schools tends to pay less attention to the development of students' critical thinking skills. Chemistry learning is more theoretical in nature, memorizing or factual knowledge, this makes chemistry learning not in line with the goals of national education (Siahaan et al., 2021).

Online learning that has been implemented due to the Covid-19 pandemic has had both positive and negative impacts. The positive impact is that teachers are required to be literate in technology and teachers must think creatively so that students are interested in learning chemistry. While the negative impact is that all teachers state that online learning is less effective so that students do not understand the material presented. Thus, it also has an impact on student achievement.

Online learning makes interaction between teachers and students limited and the learning process is often constrained by an unstable network.

Blended learning is one of the strategies in the learning process to get the expected learning outcomes. The blended learning model combines face-to-face learning with online learning so that it can be applied because it integrates technology in the learning process. It is hoped that learning will be more effective and efficient. This learning provides convenience because learning with computers (online) does not completely eliminate learning face to face (Andriani et al., 2023). As many as 67% of teachers stated that they had never made a blended learning tool based on multiple representations. All teachers also stated that multiple representation-based blended learning tools were needed for high school chemistry learning.

As for the analysis of student needs, the questionnaire provided included students' interests and learning methods in understanding chemical material, students' opinions regarding the reaction rate material, and students' general critical thinking skills. The results of the student needs analysis questionnaire can be seen in Table 2.

Table 2. Results of Student Needs Analysis Questionnaire

Question	Results	Percentage (%)
What are the obstacles that make you not interested in learning chemistry?	The learning material is quite difficult	59
	Learning is done boring	29
How is chemistry learning done by the teacher so far?	By doing learning in the classroom	50
What learning media does the teacher use when teaching chemistry?	Power point	62
What kind of chemistry study do you want?	Connecting concepts with everyday phenomena as learning materials	44
Which way of learning chemistry do you like the most?	Using learning media with the teacher explaining	62
What learning method do you often use to study chemistry?	Exercises	47
Are you interested in the reaction rate material?	Less interested	53
Do you know the application of the concept of reaction rate in everyday life?	No	74

Based on the results of student questionnaires, it was found that students had difficulty learning chemistry, namely 59% of students stated that the learning material was quite difficult and 29% of students felt that learning was boring. Another difficulty is that students feel they do not know the benefits of learning chemistry and there is no learning media used by the teacher. As many as 50% of students stated that so far learning had been carried out in the classroom. With regard to learning media, as many as 62% of students stated that the learning media often used by teachers was in the form of power points.

Chemistry learning that students want is as much as 44% of students want learning that connects chemical concepts with everyday phenomena with 62% of students stating that learning must be supported by learning media with the teacher explaining the material presented. This is in line with research conducted by Lewar et al. (2023) which states that learning materials associated with examples of cases that are often encountered in everyday life will provide an overview for students to analyze and find a concept. Other research states that students' conceptual knowledge can be built by connecting information known in everyday life with new concepts that are known during learning (Prawita et al., 2019; Bayram & Deveci, 2022). Other students want learning that connects various concepts to solve problems, uses a variety of learning methods, and uses appropriate learning media. The learning methods used by students in studying chemistry also vary. As many as 47% of students stated that the learning method they used so far was by practicing questions. In addition, another way that is also often used is by memorizing learning material.

Regarding students' interest in the material of the reaction rate, as many as 53% of students stated that they were less interested in the material and as many as 74% of students did not know the application of the concept of the reaction rate in everyday life.

There are six components of critical thinking indicators, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2011). According to Facione, indicators of critical thinking skills can be seen in Table 3. Each component is represented by one question to measure the percentage of students' initial critical thinking achievement. The data obtained in the form of the percentage of students' initial critical thinking skills is shown in Table 4. The data shows that the percentage of student achievement is still relatively low in each domain of critical thinking.

Table 3. Critical Thinking Ability Indicator according to Facione

Critical Thinking	Competence
Interpretation	Get the implied meaning based on the phenomenon
Analysis	Can connect phenomena with concepts
Evaluation	Can rationalize the phenomena that occur
Inference	Can provide additional information
Explanation	Can provide reasons for the conclusions drawn
Self-regulation	Can prove conclusions

Table 4. Results of Student Needs Analysis Questionnaire Regarding Reaction Rate and Critical Thinking Ability

Question Indicator	Critical Thinking Indicator	Students Answered Correctly (%)	Student Answered Incorrectly (%)
Students are able to predict fast chemical reactions and slow chemical reactions in everyday life	Inference	12	88
Students are able to interpret the reaction rate graph and relate it to the concept of reaction rate	Interpretation	32	68
Students are able to draw conclusions about the effect of increasing temperature on the rate of reaction and relate it to collision theory	Explanation	32	68
Through the reaction equation, students are able to provide conclusions after the concentration factor and the surface area of the touch area are varied	Self-regulation	44	56
Students are able to analyze the factors that affect the rate of reaction based on collision theory after connecting with phenomena	Analysis	18	82
Students are able to rationalize the fastest reaction rates through pictures and relate them to factors that affect reaction rates and based on collision theory	Evaluation	15	85

Conclusion

Based on the needs analysis that has been carried out on teachers and students, it is found that it is necessary to develop blended learning Subject Specific Pedagogy (SSP) tools that connect the three levels of representation (macroscopic, submicroscopic, and symbolic). With this learning tool, it is hoped that learning can take place effectively and efficiently so that it can improve critical thinking skills and student learning outcomes.

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Author Contributions
Creating research instruments, conducting research, and writing research article reviews, Rachma Kharolinasari. Instrument validation and assisting in the data collection process, Sri Mulyani. Guiding the process of research and article writing, Elfi Susanti and Nurma Yunita Indriyanti.

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Conflicts of Interest
The authors declare no conflict of interest.

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