Development of a Coordination System Design Based on Problem-Based Learning to Improve the Critical Thinking Ability of Grade XI Students

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Article Info

Abstract

The critical thinking skills of students in class XI SMAN 1 Bawang are low because of their lack of active participation. Students rely too much on the teacher, so they have difficulty mastering the coordination system material. This study aims to describe the characteristics of the diktat, analyze its feasibility, and analyze the improvement of students' critical thinking skills after using the problem-based learning and coordination system diktat. This research is a type of development research (Research and Development) with the ADDIE model. The subjects of this study were students of classes XI and XII MIPA SMAN 1 Bawang in the even semester of the 2022–2023 academic year. The sampling used the purposive sampling technique. The readability of the problem-based learning-based coordination system dictated by 18 XII grade students in the small-scale test obtained a result of 81.69% with a very feasible category. The results of this study indicate that the problem-based learning-based coordination system dictates self-directed, self-contained, adaptive, user-friendly, and attractive appearance characteristics. The results of lecturer validation of the feasibility of the diktat of 95.83%, teacher assessment of 86.67%, and student responses of 77.36% showed an average of 86.62% that the developed product was very feasible to use in learning the coordination system. Furthermore, the effectiveness of the problem-based learning-based coordination system diktat was tested by involving 107 students from three XI MIPA classes. 92.53% of students got a complete score of KKM (70). There were differences in students' critical thinking skills after the pretest and post-test. The average n-gain score obtained in the student critical thinking ability test was 0.63 with moderate criteria. The conclusion of this research is that the problem-based learning-based coordination system dictate meets the characteristics of a dictate, is very feasible to use in learning, and is effective because it can improve the critical thinking skills of grade XI students of SMAN 1 Bawang on coordination system material.

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INTRODUCTION

The rapid development of the world and information make life require quality humans. One of them has good critical thinking skills (Rahmi et al., 2021). The importance of critical thinking skills possessed by humans aims to enable humans to face various problems that occur in the present and the future (Juhji & Mansur, 2021). Education is the right place to form humans who are able to think critically. Critical thinking is a way of thinking that is acceptable to reason and reflective, centered on something that is believed and done when making decisions (Nur Afifah & Ilmiyati, 2020). Critical thinking ability can be interpreted as human thinking that always wants to know information to understand it deeply (Yustyan et al., 2015). The learning process in the classroom must actively involve students so that they are skilled at finding, analyzing, applying, evaluating, and concluding the knowledge they learn so that their critical thinking skills are trained (Changwong et al., 2018; Melati et al., 2020). Students' critical thinking skills are related to their mastery of the material. When students master the material, it has an impact on the acquisition of learning outcomes (Juhji & Mansur, 2020).

Based on the results of interviews with biology subject teachers of class XI at SMAN 1 Bawang, the problem of a lack of student activeness in learning was identified. This is indicated by the lack of independence of students to learn the material in advance. Students rely too much on the teacher to acquire knowledge. In addition, coordination system material is considered difficult for students to master, so students need to train their thinking power critically and deeply. This has an impact on the low student learning outcomes of the coordination system material, as indicated by the results of the students' daily test scores in the 2021–2022 school year, of which only 65% were complete. Therefore, to attract students' interest in understanding abstract material and train their critical thinking, product development in the form of a problem-based learning coordination system is carried out.

According to the Big Indonesian Dictionary, a diktat is a textbook made by a teacher in the form of a stencil (not printed) that contains text and images. The developed diktat contains additional coordination system material that is presented in a concise and interesting manner. The purpose of presenting the diktat is to attract students' attention to open and study it so that they can understand and master the coordination system material. In addition, the coordination system dictate to be developed contains problem-based learning worksheets. The purpose of preparing student worksheets in problem-based learning diktats is as an exercise to support the supplement of teaching materials developed as well as to train students' critical thinking skills. This is corroborated by previous research, which states that the developed diktat is feasible to use with a very good category (Khoirun et al., 2019). The provision of LKPD in problem-based learning diktats as an evaluation tool also shows an increase in students' ability to think critically, which has an impact on student learning outcomes (Pertiwi et al., 2019; Lubis et al., 2020).

RESEARCH METHODS

This research was conducted at SMAN 1 Bawang, Banjarnegara Regency, from March 1 to March 31, 2023. The research method used is development research (Research and Development) with the ADDIE model with the stages of analysis, Design, Development, Implementation, and evaluation. Sampling was carried out using the purposive sampling technique. The sample for the small-scale test conducted at the implementation stage was eighteen XII grade students, consisting of one student with the highest score, one student with the medium score, and one student with the lowest score in six XII MIPA classes. The small-scale test was conducted to determine the readability of the problem-based learning-based coordination system diktat that had been developed. The samples used for the effectiveness test of the problem-based learning-based coordination system diktat were students in classes XI MIPA 1, XI MIPA 2, and XI MIPA 3, totaling 107 students.

The data to be collected are the characteristics of problem-based learning-based coordination system diktat as a product of development, the feasibility of problem-based learning-based coordination system diktat, and the effectiveness of problem-based learning-based coordination system diktat in improving students' critical thinking skills after using the product. The research instruments used for data collection are product validation questionnaires filled in by lecturers, product assessment questionnaires filled in by biology teachers at SMAN 1 Bawang class XI, and student response questionnaires to products filled in by students. The three questionnaires were used to collect data on product feasibility and then to assess students' critical thinking skills using multiple-choice test questions. The test questions to collect data on students' critical thinking skills totaled thirty questions, each of which was based on critical thinking indicators. The results of the product feasibility assessment were analyzed using descriptive percentages, while the improvement in students' critical thinking skills was analyzed with n-gain.

RESULTS AND DISCUSSION

The results of this study include (1) the characteristics of problem-based learning-based coordination system diktat; (2) the feasibility of problem-based learning-based coordination system dictate; and (3) the effectiveness of problem-based learning-based coordination system diktat for students' critical thinking skills on coordination system material.

Characteristics of Problem-Based Learning-Based Coordination System Dictate

The stages of developing a problem-based learning-based coordination system include five stages of ADDIE, namely analysis, design, development, implementation, and evaluation (Branch, 2009). The analysis stage is to analyze the problems that occur at SMAN 1 Bawang as a research site. Then the design stage is the process of creating a product design that will be developed. Furthermore, the development stage involves the manufacture of products using the Canva application and live worksheets. After the product has been developed, an assessment is carried out by lecturers and teachers, and a product readability test is carried out by students at the implementation stage. The evaluation stage is the last stage after the product is improved and revised according to constructive suggestions. After completing the evaluation, the product is ready to be tested on a large scale in research to test its effectiveness in the learning process in the classroom. The appearance of the product home page can be observed in Figure 1.

Figure 1 Cover, foreword, and interesting facts page of problem-based learning-based coordination system dictate

The development of this product utilizes technology, in line with the statement of Permendikbud (2014) that in the 21st century, the use of technology is needed in school learning. The product developed in this study is in the form of additional textbooks, namely problem-based learning and coordination system diktat. Rizki & Martini (2018) revealed that additional textbooks are additional explanations used in learning to complement or clarify existing material. However, it is not only additional material that is developed but also participant worksheets that are needed to facilitate students participation in the learning process based on the problem-based learning model.

The existence of a problem-based learning model shows that the developed diktat has self-directed characteristics in its learning or invites students to learn independently. It can be observed when students use the problem-based learning coordination system diktat: they look at the instructions for use to make it easier, the learning objectives that must be achieved on the coordination system material, and there are worksheets that students must do. Learner worksheets on each coordination system sub-material present problems encountered in everyday life to solve or find solutions. The use of a problem-based learning model in this product directs students' way of thinking to think critically.

The sequential arrangement of product components aims to make it easier for readers to develop thinking skills while reading. In line with the findings of Rizawayani et al. (2017), who revealed that the structured presentation of the product will direct the reader's thinking power in absorbing information and knowledge from the product he reads, This shows that the developed diktat has self-contained characteristics.

The problem-based learning-based coordination system dictate also contains adaptive characteristics. Adaptive means that this development product is adapted to technology and scientific developments. This is indicated by the use of the Canva application and the Live Worksheets website in its preparation. Supported by Agustina and Fitrihidajati's research (2020), which states that adaptive teaching materials contain reference links in the form of videos and information that can be directly accessed by students to support the accuracy of the material.

The results of the linguistic feasibility assessment show that the problem-based learning-based coordination system has user-friendly characteristics. The use of communicative language, the use of clear language and not double meaning, the use of simple sentences, the use of good and correct Indonesian language, and the accuracy of the structure and arrangement of sentences make students able to understand the contents of the product developed.

The presentation of text and images in the content of the problem-based learning-based coordination system diktat is presented with a balanced composition, meaning that the amount of writing is proportional to the images presented. Supported by research by Rahmati et al. (2018), which explains why students tend to be more interested in reading that uses little writing and contains more colour images. The use of colourful images has the aim of attracting attention, clarifying material, and illustrating the facts and information conveyed (Kustandi et al., 2013). This shows that the product has attractive display characteristics.

Feasibility of Problem-Based Learning-Based Coordination System Dictates

The feasibility of the product in this study includes an assessment of the feasibility of content, presentation, language, and graphics. The results of product assessment by UNNES biology lecturers and biology teachers of SMAN 1 Bawang can be observed in table 1 and table 2.

Table 1 Lecturer validation of problem-based learning-based coordination system dictates

No	Feasibility	Score	Max.score	%
1	Content	26	28	92.85
2	Presentation	50	52	96.15
3	Language	20	20	100
4	Graphics	19	20	95
Score total			115	
Total max. score			120	
Percentage (%)			**95.83**	
Criteria			**Very feasible**	

Table 2 Teacher assessment of problem-based learning-based coordination system dictates

No	Feasibility	Score	Max.scor	%
1.	Content	25	28	89.28
2.	Presentation	45	52	90.00
3.	Language	18	20	90.00
4.	Graphics	19	20	95.00
Score total			104	
Total max. score			120	
Percentage (%)			**86.67**	
Criteria			**Very feasible**	

The purpose of conducting product assessment or validation is to assess the feasibility of the product based on expert judgment by providing values, suggestions, and input on the developed product so that it can be used in learning at school (Fransisca, 2017; Lestari et al., 2018; Wangsa et al., 2021). The assessment from lecturers and teachers shows that the problem-based learning coordination system is very feasible to use in learning. This is based on the acquisition of a percentage that is categorized as feasible if it obtains a range of 62.59% (scores 81.25%) and is said to be very feasible if it obtains a percentage of 81.25% (scores 100%). (Arikunto, 2013).

The content feasibility aspect shows that the developed product already contains additional coordination system material that is in accordance with the scope of the 2013 curriculum material. The preparation of teaching material supplements is said to be good when the content is adjusted to the needs and curriculum used (Magdalena et al., 2020). The questions presented have been linked to daily life problems, so that learning with this product is more meaningful (Purwanto et al., 2015). The presentation feasibility aspect shows the order of the coordination system sub material and the components in it are in order from the cover to the author's bio. Khafida (2021) said that the presentation of components in a product must be coherent so that readers can easily understand its contents.

The aspect of language feasibility is shown by the suitability of the content with Indonesian language rules, communicative, and the suitability of the structure and arrangement of sentences so that it makes it clear to readers in understanding it. The graphical aspect of this product shows the suitability of the image illustrations with the material, the suitability of the layout, the selection of the cover design and the design of the pages. In addition, the appearance of the images presented is relevant to the learning information needs (Paramita et al., 2018). The presentation of an attractive and colorful design can also create a sense of pleasure so that readers are motivated to continue reading it (Ilmi & Trimulyono, 2018). The feasibility of this product is also assessed from the results of student responses contained in thirteen statements. The results of student responses on average amounted to 77.36% Student assessment in terms of content feasibility shows the results that the content is in accordance with the learning objectives and is able to train students' thinking skills. The feasibility of presentation with decent criteria shows that the presentation of images, videos, and instructions for use are in accordance with the needs of students in studying the coordination system. Then the feasibility in terms of language shows decent results indicated by the use of sentences, communicative language, conformity with Indonesian language rules, and the terms presented are clear and available in the product. Likewise, the feasibility of graphics shows decent criteria where the appearance of the product, especially the cover and page design, is appropriate and balanced between text and images or videos. It can be concluded that students' responses regarding the feasibility of the product gave positive responses according to Amir & Kusuma (2018) that the response is said to be positive if the percentage reaches 75.40%.

Improvement of Students' Critical Thinking Skills

Students' critical thinking skills are obtained from the results of their work after learning a material. Evaluation tools for facilitating the improvement of students' critical thinking skills in this study are supported by LKPD's problem-based learning-based coordination system diktat. The average value obtained in the three instances of LKPD work always increased. Learning outcomes to measure students' critical thinking skills are influenced by the learning media used (Kurniawan, 2017). This increase can be seen from the comparison between the results of the pretest and post-test (Yuliani, 2020). The average value of students' critical thinking skills can be observed in Figure 2.
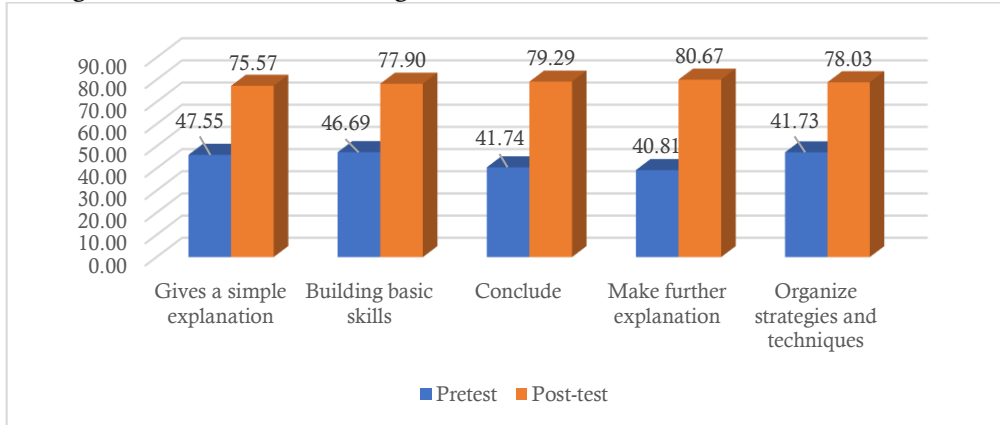

Figure 2 Critical Thinking Achievement Score of Class XI Students of SMAN 1 Bawang on Each Indicator Before and After Using Problem-Based Learning-Based Coordination System Dictate

Figure 2 shows a significant difference between the acquisition of students' pretest and post-test scores. Students' critical thinking skills after using the problem-based learning and coordination system look higher than before using the product. In line with the findings of Hidayat et al. (2016), they explained that the increase in students' critical thinking skills was obtained from the results of working on questions that were prepared on the basis of critical thinking indicators, according to Ennis. The existence of practice questions that contain critical thinking indicators is an effective way to hone students' critical thinking skills (Mukti & Istiyono, 2018).

In detail, the improvement of students' critical thinking skills after using the developed product is described for each critical thinking indicator according to Ennis (2011), including (1) giving simple explanations; (2) building basic skills; (3) organizing techniques and strategies; (4) giving further explanations; and (5) concluding. The improvement of critical thinking skills on each indicator is presented through n-gain analysis as in Table 3.

Based on Table 3, the indicator of building basic skills obtained an increase in the results of the n-gain analysis of 0.53 with a moderate category. This increase in basic skills occurs due to the contribution of student worksheets on problem-based learning and coordination system diktat, specifically on question number 1 on page 3 regarding the formulation of problems that must be analyzed. Students are trained to analyze the causes and reasons why the problems presented can occur. What factors are behind the problem? Therefore, through this problem orientation, students direct their way of thinking to provide simple explanations for addressing the problems presented through critical thinking.

Table 3. Acquisition of N-gain and Criteria on Each Indicator of Critical Thinking of Students of Class XI MIPA SMAN 1 Bawang on Coordination System Material After Using Problem-Based Learning Based Coordination System Diktat

Critical thinking skills	n-gain acquisition	criteria
Gives a simple explanation	0.53	Medium
Building basic skills	0.59	Medium
Conclude	0.64	Medium
Make further explanation	0.67	Medium
Organize strategies and techniques	0.62	Medium
Average	**0.61**	Medium

Indicators of building basic skills that get an increase in n-gain analysis results of 0.59 with a moderate category This increase occurred due to the contribution of worksheets in the problem-based learning-based coordination system diktat question number 2 on page 4 regarding temporary answers that students must answer through a basic understanding of the problems presented. Students are required to organize information that is relevant to the problem as a basis for determining whether the answer to the previous number regarding the factors behind the problem is correct or not. This process directs students' thinking so that it is organized so that the problems that occur will have consequences or impacts.

Indicators of the ability to organize techniques and strategies get an increase in the results of the n-gain analysis of 0.62 with a moderate category. This increase occurred due to the contribution of worksheets in the problem-based learning-based coordination system diktat on question number 3 on page 4 regarding the truth of the information presented along with the source that underlies its truth. In this process, students are trained to conduct investigations so that the information they get is not only obtained but also understood in depth. This emphasizes the need for students in groups to jointly pour out the results of their thoughts and searches to reach a common answer agreement. Students need to consider the truth that may cause differences between students in one group.

Furthermore, the indicator of giving further explanation got an increase in the results of the n-gain analysis of 0.67 with a moderate category. This increase occurred due to the contribution of worksheets in the problem-based learning-based coordination system diktat on question number 5 on page 5 of the hormone system worksheet. A question arises regarding how students analyze the relationship between the mechanism that occurs between normal human blood sugar levels and the blood sugar levels of diabetics when consuming food and being injected with insulin. In this process, students are required to develop the results obtained from the joint discussion into a unified answer that is used. Students provide further explanation to emphasize that the answers they determine are correct and accompanied by valid and relevant sources. Students in one group share information obtained and then jointly reach a decision as an answer to the question posed (Laeni & Shelly Efwinda, 2022).

Fitriani & Irawan (2018) explained that, in the indicator of further explanation, students need high-level critical thinking skills. This is because students are expected to be able to provide a more in-depth explanation of a problem or material studied. Therefore, in this indicator, students' ability to think critically is very important so that they can explain their answers in detail.

The last critical thinking indicator, namely concluding, received an increase in n-gain analysis results of 0.64 with moderate criteria. This increase occurred due to the contribution of worksheets on the problem-based learning-based coordination system diktat on the question of drawing conclusions, number 9, page 7. In this process, students are required to evaluate the answers that have become the result of mutual agreement by considering various valid sources. Furthermore, students draw conclusions as an answer to how far their understanding of the coordination system material has advanced. When students are able to conclude correctly on a strong basis and can be accounted for, they have directed their thinking process to think critically. This is in line with the findings of Koasih (2014), who revealed that making conclusions is done to interpret or obtain a final understanding of what happened or was observed.

Student learning completeness is used as a marker of good or bad student learning outcomes when at least 80% of the total students in a research class score above the KKM (70). The classical completeness of students can be observed in Table 4.

Table 4. Number of Class XI Students of SMAN 1 Bawang who Completed Learning on Coordination System Material After Using Problem-Based Learning Based Coordination System Dictate

Data		Student total	Complete learning	Percentage
Final results	XI MIPA 1	35	33	94.28%
	XI MIPA 2	36	32	88.89%
	XI MIPA 3	36	34	94.44%
Average students completed				**92.53%**

Table 4 shows that the classical completeness of students after using the product was 92.53%, meaning that the completeness of learning outcomes that had an impact on improving students' critical thinking skills obtained very good criteria.

CONCLUSION

Based on the research results, it shows that the diktat coordination system based on problem-based learning has the characteristics of being self-directed, self-contained, adaptive, user-friendly, and having an attractive appearance so that it is suitable for use in the learning process. Apart from that, the students' scores after using the problem-based learning coordination system diktat showed an increase in the critical thinking abilities of class XI students at SMAN 1 Bawang on the coordination system material.

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