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Research Article

Effect Of Direct -Problem Based Learning On Critical Thinking In IBDP Students

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ABSTRACT

Advancements in education are pivotal in enhancing a nation's global competitiveness by cultivating essential competencies, which are increasingly necessary in the rapidly evolving 21st century. The improvement of educational quality begins with the refinement of learning processes, particularly through the development of critical thinking skills among students, who must be equipped to navigate complex challenges. This study aims to develop and evaluate a direct problem-based learning model specifically designed for the Biology curriculum, with a particular focus on the topics of Conservation and Biodiversity, to enhance students' critical thinking skills.

Employing a rigorous one-group pretest-posttest design, the research was conducted with a sample of 30 high school students from Cita Hati Christian School. Comprehensive data collection methods were utilized, including both standardized tests and structured questionnaires, to assess the impact of the intervention. Data analysis was meticulously conducted using normality tests, homogeneity tests, and paired sample t-tests to ensure the reliability and validity of the findings. The results unequivocally demonstrate that the direct problem-based learning model is both feasible and effective in significantly enhancing students' critical thinking skills, as evidenced by a statistically significant improvement (p-value 0.000 < 0.05).

In conclusion, this study provides compelling evidence that the integration of direct instruction with problem-based learning within the context of biology not only enhances the acquisition of subject-specific knowledge but also fosters critical thinking skills.

Keywords: critical thinking, direct problem-based learning, educational quality.

1. Introduction

Advancements in education are pivotal in enhancing a nation's global competitiveness by cultivating essential competencies. By improving the quality of education, a nation can develop human resources with expertise across various fields, thus becoming the backbone and hope of the nation in facing challenges driven by advancements in science and technology. The Partnership for 21st Century Skills, a non-profit coalition of business and education leaders, advocates for learning approaches that address the complexities of the 21st century, including critical thinking, problem-solving, effective communication, and collaboration.

The choice of appropriate learning methods plays a significant role in determining students' learning outcomes. The teaching methods employed by educators have a considerable impact on learning outcomes, particularly those relevant to 21st-century skills. Student-centered learning emphasizes the active role of students in the learning process (Rusman, 2017). One effective form of student-centered learning that significantly impacts learning outcomes is problem-based learning (PBL) (Hmelo-Silver, 2004).

Problem-Based Learning (PBL) uses real-world problems as a context for students to develop critical thinking and problem-solving skills, as well as to acquire essential knowledge and concepts (Sudarman, 2007). According to Tan (2006), PBL emphasizes real-world challenges, high-level thinking skills, problem-solving, interdisciplinary learning, individual learning, information-seeking skills, teamwork, and communication skills. Key elements of problem-based learning include engagement, inquiry and investigation, performance, questioning to test solution accuracy, and reflection on problem-solving (Savery, 2006).

Direct instruction, on the other hand, is specifically designed to support students in learning well-structured procedural and declarative knowledge in a step-by-step manner. It involves teacher-centered methods that

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ensure student engagement (Rosenshine, 1987). Arends (2012) describes direct instruction as a teacher-centered method with five steps: setting the stage, explanation and/or demonstration, guided practice, feedback, and extended practice. This approach focuses on academic tasks and maintains active student involvement. The advantages of direct instruction include its effectiveness in teaching concepts and skills to low-achieving students, bridging the gap between theory and practice, and its applicability in both large and small classes.

Educational Research and Innovation (OECD, 2019) highlights that critical thinking will become increasingly important in the future workforce, contributing to better personal and social outcomes. In a digitalized society, where automation through artificial intelligence and robots is prevalent, skills that are less easily automated, such as critical thinking, will be more valued (Bawden, 2008). These skills are crucial for human well-being and the functioning of democratic societies.

Critical thinking is closely linked to effective learning outcomes. Paul and Elder (2006) defines critical thinking as a set of cognitive activities involving the use of the mind, learning to think critically, analytically, and evaluatively through mental processes such as attention, categorization, selection, and judgment. Critical thinkers objectively process information, build connections, analyze, evaluate, and conclude.

Preliminary studies in Grade 11 Biology at SMA Cita Hati Christian School, conducted through interviews and observations, revealed that while the school environment supports critical thinking, teachers often lack the ability to manage classroom learning effectively. Although teachers employ direct instruction and problem-based learning, student interest in Biology remains low. Teachers' understanding of the importance of enhancing critical thinking is also limited, leading to a lack of focus on these processes in the classroom. Observations and interviews with teachers indicated that the level of critical thinking in Biology classes is at 30% (Facione, 1990).

During observations and interviews, it was noted that teachers often ask students to complete tasks requiring critical thinking without providing adequate conceptual grounding. This lack of foundational understanding hampers students' ability to apply critical thinking effectively. Without a strong grasp of concepts, students struggle to connect their thinking with the content, identify relevant problems, or find innovative solutions. This situation hinders the development of critical thinking skills and reduces learning effectiveness. Therefore, teachers must ensure that students deeply understand the concepts before requiring them to use critical thinking in tasks. Providing a solid foundation helps students develop critical thinking skills and face challenges more confidently.

The ideal learning condition envisioned by the researcher involves learning driven by students' questions, where they are encouraged to solve problems with a strong conceptual foundation (Bransford, 2000). Learning should not just involve direct instruction from teachers; instead, teachers should guide students in discovering the knowledge they seek. The direct problem-based learning model combines Problem-Based Learning (PBL) and Direct Instruction (DI). By combining PBL and DI, the model aims to enhance students' critical thinking skills, leveraging the strengths of both approaches (Schmidt and Moust, 2000).

PBL provides a challenging and engaging learning environment using real-life situations as a basis for learning. In PBL, students work in groups to solve problems and develop solutions, fostering critical thinking. Direct instruction offers clear and structured guidance, helping students understand and master concepts effectively. By integrating these models into direct problem-based learning, students practice and understand concepts while strengthening their problem-solving skills. This model enables better comprehension and critical thinking as students apply learned concepts in real-world situations. Thus, the direct problem-based learning model enhances critical thinking skills through a comprehensive and holistic learning approach.

To assess the academic readiness for research design preparation, the following research questions are formulated: Is the direct problem-based learning model effective in enhancing critical thinking skills?

Based on these research questions, the objectives of this study is to assess its effectiveness of direct problem-based learning in enhancing critical thinking skills.

2. Literature Review

Direct-Problem Based Learning

Direct Instruction (DI) is specifically designed to support students' learning processes related to procedural knowledge and well-structured declarative knowledge, which can be learned step-by-step. Direct Instruction is not the same as lecturing, although lecturing and recitation (checking understanding through questions and answers) are closely related to the Direct Instruction model. The uniqueness of Direct Instruction centers on the teacher, while still ensuring student engagement (Arends, R.I., 2012). According to Rosenshine (1995), to maximize Direct Instruction, the material must be presented in an active manner. Teachers are expected to present attractive material and keep students engaged as much as possible, even though the teacher is the focal point of the instruction.

Problem-Based Learning (PBL) is a learning method that uses intelligence to tackle new challenges and complex real-life problems (Tan in Rusman, 2014). The problems in problem-based learning are those encountered in real life that occur unexpectedly. The Ministry of Education and Culture states that problem-based learning involves real, unstructured, open-ended problems to solve issues, think critically, and build new knowledge (Kebudayaan, 2013). According to Erick, Problem-Based Learning is an educational approach

where the problem is the starting point of the learning process. Problem-Based Learning is an educational approach where the problems used align with educational goals and criteria derived from everyday life issues (Erick, 2003).
The Direct-Problem Based Learning model is designed to enhance students' critical thinking skills (Hmelo-Silver, 2004). The objectives of this model are to encourage students to actively construct knowledge, collaborate and integrate knowledge through discussions, and reflect on what has been done to develop critical and creative thinking skills. The theoretical foundation of this model includes constructivist theory, Vygotsky's theory, Jean Piaget's theory, Jerome S. Bruner's theory, and behavioristic theory. The Direct-Problem Based Learning model consists of six stages (or syntax): (1) problem analysis, (2) demonstrating knowledge, (3) organizing students, (4) guiding individual and group investigations, (5) presenting results and checking student understanding, and (6) reflecting on and evaluating the learning process.

Critical Thinking

Thinking is the activity of generating various ideas and concepts that lead to conclusions oriented towards reality. The thinking process underpins many human actions and interactions. Thinking enables people to understand, interpret, model experiences, and make predictions. Therefore, the thinking process is crucial for fulfilling needs, achieving goals and desires, and creating plans or efforts to reach those objectives.
According to Kallet (2004), critical thinking involves thinking in a different manner. Most people view it as an analytical, wise, questioning, investigative, unemotional, organized, innovative, logical, methodical, non-dismissive, scrutinizing, detailed, comprehensive, out-of-the-box, scientific, and procedural process. Critical thinking encompasses how students develop and apply thinking to understand how thinking can be improved. Critical thinking focuses on deciding what to believe or do (Enis, 2011). An organization that can attract, retain, and develop the best critical thinkers has a significant and measurable competitive advantage in the business world (Facione, 2018). Critical thinking is the backbone of several crucial skills, including problem-solving, decision-making, sound judgment, and analysis.
According to Fisher (2011), indicators of critical thinking include: (1) identifying elements in reasoned cases, particularly reasons and conclusions, (2) identifying and evaluating assumptions, (3) clarifying and interpreting questions and ideas, (4) judging acceptance, especially credibility and claims, (5) evaluating arguments of various types, (6) analyzing, evaluating, and generating explanations, (7) drawing conclusions, and (8) generating arguments. Ennis (2011) also identifies indicators of critical thinking, such as providing elementary clarifications, building basic support skills, drawing inferences, making further clarifications, and employing strategies and tactics.
Therefore, the learning model designed must be capable of stimulating these critical thinking skills through active engagement. The learning process should facilitate students in developing questions that inspire knowledge search and problem-solving. Educators need to ask questions that encourage students to seek information through open discussion. Sternberg (2009) recommends that the focus on enhancing the intellectual functions of critical thinking in students can be viewed through three functions: meta-components, performance components, and knowledge management. Meta-components refer to processes that involve planning, monitoring, and self-evaluation. Performance components are the actual steps or strategies used, while knowledge management strategies refer to how individuals connect prior knowledge with new material and apply the new material.

3. Research Design

The design used is a one-group pretest-posttest design (Sugiyono, 2016), with the research subjects being grade 11 IBDP Biology students from Cita Hati Christian School. By applying the direct problem-based learning model in the classroom, data collection was carried out through the pretest and posttest and also questionnaires with a Likert scale (1-4) to collect data for students. Data analysis was conducted using independent sample t-test with a significance level of 0.05 using software SPSS Statistics and Microsoft Excel (Pallant, 2020).
Questionnaires for students responses to see critical thinking of students in this study include, (1) Consistency of the lessons plans with the Direct Problem-Based Learning, (2) Resources and materials are appropriate and effective, (3) Critical thinking element is inclusion and effective, (4) Student engagement during the introduction, (5) Providing effective guidance and support, (6) Encouragement of critical thinking, (7) Active student participation, (8) Collaboration and teamwork are happened base on the Cyntaks, (9) Application of problem solving skills, (10) Critical thinking analyze are proved, (11) Positive group dynamics and interactions, (12) Maintenance of conducive learning environment, (13) The activities in the classroom are running according to the lesson plan, (14) Relevance of activities to the learning objectives, (15) The learning environment fuels my desire to acquire more knowledge or information, (16) The learning environment are enjoyable, (17) Response if the learning model is applied to other subjects (Ennis, 2011).

4. Finding

This research comprises two phases: the model development phase and the field trial phase. During the initial development phase, the primary steps involved identifying general learning objectives, conducting a learning

analysis, analyzing student characteristics and contexts, formulating competency achievement goals, developing assessment instruments, designing learning strategies, selecting and developing instructional materials, and conducting formative evaluations.

The main field trial was conducted with a biology class consisting of 30 students, along with the teaching team, which served as the experimental group. The field trial aimed to implement the direct problem-based learning model, evaluate the quality of the learning process and outcomes, and assess the enhancement of critical thinking skills using predetermined instruments. The assessment results were used to evaluate the effectiveness of the direct problem-based learning model in fostering critical thinking skills. The pretest and posttest assessment results are presented in Table 1.

Table 1. Pre-test and post-test result critical thinking skills

Average 30 students	**Pre-test**	**Post-test**
	53,33	90,83

Next is the feasibility test, which includes validation by learning model experts and subject matter experts using a feasibility questionnaire for the model and its components, with detailed results presented in Table 2.

Tabel 2. The feasibility results of the direct problem-based learning model and components.

No	**Statement**	**Score**
1	Consistency of the lesson plan with the Direct Problem-Based Learning	97%
2	Resources and materials are appropriate and effective	97%
3	Critical thinking element is inclusion and effective	97%
4	Student engagement during the introduction	100%
5	Providing effective guidance and support	100%
6	Encouragement of critical and creative thinking	100%
7	Active student participation	100%
8	Collaboration and teamwork are happened base on the Cyntaks	95%
9	Application of problem solving skills	60%
10	Critical and creative thinking analyze are proved	97%
11	Positive group dynamics and interactions	100%
12	Maintenance of conducive learning environment	100%
13	The activities in the classroom are running according to the lesson plan	95%
14	Relevance of activities to the learning objectives	100%
15	The learning environment fuels my desire to acquire more knowledge or information	100%
16	The learning environment are enjoyable	97%
17	Response if the learning model is applied to other subjects	100%

Students responded positively to the model, as evidenced by the response statement on student interest in the learning process, with 96% of the feedback being categorized as 'very good'.

A performance assessment was employed to evaluate the effectiveness of critical thinking in the direct problem-based learning model, using parameters such as (1) achievement of learning objectives, (2) adherence to learning procedures, and (3) enhancement of critical thinking skills. The assessment revealed growth in critical and creative thinking abilities following the learning activities. An independent samples t-test was used to analyze the average differences between two data sets. The trial results demonstrated a significant difference in critical thinking scores between the traditional teaching method (as indicated by pretest scores) and the new direct problem-based learning method (as indicated by posttest scores), as shown in Table 3.

Table 3. The results of critical thinking ability using the direct problem-based learning model."

	Group	**N**	**Mean**	**Sig**
Critical Thinking	Pretest	30	53.33	.000
	Posttest	30	90.83	

Based on the significance level, which is < 0.05 (0.000 < 0.05), we reject the null hypothesis (Ho), indicating that the application of the direct problem-based learning model is statistically significant. Analysis of the mean values reveals a substantial increase in critical thinking ability, from 53.33 to 90.83. Therefore, the direct problem-based learning model significantly enhances critical thinking skills.

5. Discussion

The direct problem-based learning model has demonstrated a positive impact on enhancing critical thinking skills, as evidenced by its effectiveness in critical thinking learning. The phases specifically related to critical thinking were completed within the designated timeframe, facilitated by the use of a student workbook that stimulates thinking through guided questions (Bezanilla, Fernández-Nogueira, Poblete, & Galindo-Domínguez, 2019). This workbook enables students to understand and prepare for the steps required during activities and serves as a tool for organizing and managing the necessary information and data.

All procedural steps were implemented with a rating of 'good' quality. The alignment and execution of these steps with the characteristics of the learning design, which is contextualized within a realistic problem setting and presented holistically for problem-solving (Zancul, Sausa-Zomer, & Cauchick-Miguel, 2017), are key indicators of the learning model's effectiveness. The critical thinking stimuli, such as conducting investigations, identifying problems, formulating concepts, and drawing conclusions from gathered information, were carried out effectively. Although students initially faced challenges in formulating and drawing conclusions, the fourth phase, which involves evaluation and reflection integrated with critical thinking, transformed these challenges into opportunities for reflection and improvement. Performance assessments, evaluated using a rubric, indicated an enhancement in critical thinking skills.

The direct problem-based learning model incorporates approaches, strategies, and methods that are specifically tailored to meet the needs of critical thinking development. Through the student workbook, students engage in activities designed to develop their critical thinking skills, including conducting investigations, seeking information from various sources, utilizing instructional materials such as technology and media (e.g., the internet), synthesizing and connecting information, and formulating individual and group conclusions within a classroom community. This approach minimizes information bias in workbook completion and enables students to focus on making informed decisions (Ennis, 2011).

These activities are systematically integrated into the lesson plans, aiming to foster and enhance students' critical thinking abilities. The methodologies of investigation, formulation, conclusion, and reflection are designed with question prompts and visual diagram illustrations in the student workbook, which assist students in strategizing and formulating concepts and solutions from the information they acquire (Marzano, 2001). This approach is consistent with research findings indicating that reflective methodologies, oral and written argumentation, analysis and synthesis (across written, graphical, and audio-visual formats), and case studies are among the most effective techniques for teaching critical thinking (Bezanilla, Fernández-Nogueira, Poblete, & Galindo-Domínguez, 2019). Supported by productive questioning techniques employed by the teacher, which are also considered effective for fostering critical thinking, this model provides students with opportunities to practice and further develop their critical thinking skills.

The initial steps of collecting information and data, identifying criteria, and formulating conclusions are crucial for the successful implementation of the Direct Problem-Based Learning model in the classroom. During the learning sessions, students are encouraged to actively gather relevant information and data, identify the necessary criteria, and formulate conclusions based on their analysis. These phases lay a solid foundation for planning, setting procedures, and providing clear rationale in the design concepts they develop. Students are then guided to interpret and generalize principles and field data, ensuring that the proposed solutions align with real-world conditions. In the context of visual communication, students learn to formulate definitions, develop strategies, provide arguments, and outline further steps to ensure effective and clear messaging. Criteria selection, evaluation of alternative solutions, and actions are conducted carefully by students to ensure that each decision is based on a comprehensive analysis and yields optimal results. With this Direct Problem-Based Learning approach, the overall learning process becomes more structured, systematic, and results-oriented, preparing students to address real-world problems with effective and efficient solutions.

Student feedback indicated that the model is easily implementable, which is a positive response for its continued application. The ongoing implementation of this model is expected to provide ample opportunities for the continued development of critical thinking skills.

6. Conclussion

The results of research on the effect of direct problem based learning to critical thinking skills show that there is an influence on the students. There was an increase in the average critical thinking skills score from 53.33 to 90.83, and student responses were positive, as indicated by 96% of students finding the model easy to implement. This model can be a alternative to increase students motivation in learning activities at SMA Cita Hati.

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