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Developing Students' Critical Thinking Skills through Contextual Case-Based Learning: A Quasi-Experimental Study

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Abstract: Rarely was there a learning exercise that could reliably enhance critical thinking abilities in the classroom. Consequently, a different approach was required to address the issue. Contextual Case-Based Learning (CCBL) is an alternative learning activity that could be utilized as a tool to enhance the fundamental abilities required in this century. It was proposed that 21st-century learning incorporate CCBL. This study aimed to investigate the impact of the learning model in helping students develop their critical thinking skills. This study employed a posttest-only design with non-equivalent groups, utilizing a quasi-experimental approach. The total sample class is 44 pre-service biology teachers. There were 22 students in the traditional class and 22 students in the Contextual Case-Based Learning (CCBL) session. Students in the CCBL class had an average critical thinking score of 53.64, with a standard deviation of 19,160. However, in the conventional classroom, pupils' critical thinking scores averaged 36.82 with a standard deviation of 18,358. The standard deviation was 20,402, and the average for both groups was 45.23. Moreover, the learning approach factor has a p-value of less than 0.05, as determined by a two-way ANOVA. It suggests that learning strategies have a significant impact on students' ability to think critically. The p-value for the factor of students' prior critical thinking skill levels is less than 0.05. This suggests that students' earlier critical thinking abilities have a statistically significant impact of 5% on their subsequent critical thinking abilities. A p-value greater than 0.05 was found for the interaction between the model learning elements and the students' pre-existing critical thinking skills. Therefore, it follows that the two elements taken together do not affect pupils' capacity for critical thinking. Students' critical thinking skills ranged from poor to moderate, and their responses to the test's questions were generally below average.

Keywords: contextual case-based learning; critical thinking skills.

▪ INTRODUCTION

Critical thinking (CT) has become a crucial competence in 21st-century society (Santos-Meneses & Drugova, 2023). With the rise of the internet and social media, people are increasingly exposed to vast amounts of information, much of which is biased, misleading, or false. Critical thinking enables individuals to analyze, evaluate, and distinguish between trustworthy and unreliable sources. When making decisions about what to believe and do, critical thinking is contemplative and thoughtful (Ennis). There are five main concepts: realistic, thoughtful, reasonable, believe, Finding clear statements, questions, and justifications, comprehending information well by selecting trustworthy sources, being aware of the larger context and circumstances, sticking to the main idea, preserving authenticity and foundations, and searching for alternatives and mindset, thinking methodically, and in a systematic manner; adopting a stance supported by adequate facts; and looking for as much justification as you can, are some signs of critical thinking abilities. Analytical and logical thinking are other names for critical thinking (Cotton, 1991). Determining the reliability of a source, differentiating between

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what is relevant or legitimate and what is not, and separating facts from judgments, recognizing and assessing presumptions, prejudices, and viewpoints, and evaluating the data to support assertions, are some signs of critical thinking abilities.

For individuals working with previously created texts to create new ones and for groups collaborating to create an argument, critical thinking is a crucial component of the reasoning process (Brodie, 2010). Students need to be able to think critically and communicate effectively in biology to solve problems in the field of biology. The primary objective of modern teaching and learning initiatives is to help students develop their problem-solving skills (Koehler & Vilarinho-Pereira, 2021). Developing pupils' problem-solving skills is a crucial objective of biology education (Hourigan & Leavy, 2022). It is possible to clarify concepts or exchange ideas using critical thinking skills. Students will learn to accurately explain and use biological terminology when asked to articulate their concepts verbally. There are three distinct components to critical thinking skills. When students work individually in a typical learning environment, the process they need to externalize may not occur.

One of the learning models frequently used in classroom activities is the traditional one. This model starts with the instructor explaining an idea or topic. Before continuing with their practice, the teacher walks the students through the steps required to complete a task or problem. Teachers with extra concerns may further explain these steps (Chapko & Buchko, 2004). In this study, teachers actively participate in classroom activities, whereas students are passive recipients of lectures (Aziz & Hossain, 2010). When the teacher merely acts as a conduit for knowledge, the learning activities are frequently referred to as one-way learning. Students' input and feedback are useless if a teacher is the only person driving the learning process. Sometimes, the only resources provided are books and learning notes. Furthermore, insufficient student interaction occurs in the classroom, existing theories are prioritized over real-world scenarios, learning is results-oriented, learning is accomplished through memorization rather than comprehension, learning activities lack practical activities, and teacher handwriting is not a reliable indicator of the clarity of the material due to its quality (Damodharan & Rengarajan, 2007).

With traditional education, pupils become listeners rather than learners. Students must therefore learn to be more independent. The teacher exclusively teaches lessons to students. Students often struggle to perform to the best of their abilities in class due to time constraints. Students, on the other hand, need to be able to control their learning. Learning quality and its potential improve when students learn to manage their time better. Independent learners are actively involved in optimizing their learning chances and capacities (Darr & Fisher, 2004). This is understandable, considering that regulated learning entails students actively creating their learning goals and then trying to track, maintain, and monitor their motivation, awareness, and behavior, which is directed and limited by those goals, while emphasizing the surrounding context (Pintrich, 2000). Students' quality cannot improve if traditional learning methods are always used to deliver material courses. Students will always be dependent on the teacher and require assistance in determining how to raise their level of performance.

Contextual case-based learning is an alternative teaching method that may be employed. A teaching strategy known as "contextual case-based learning" requires students to actively engage in real-world or hypothetical issue situations that reflect the

experiences frequently encountered in the topic being studied (Ertmer & Russell, 1995). The Latin word "cases," which means occurrence or something that happens, is where the term “cases” originates. A contextual case's main objective is to force pupils to confront complex, unstructured situations and consider potential answers. Contextual cases were creative works that aimed to accurately describe actual circumstances. In most situations, these components are combined in the design and narrative (Morrison, 2001). The following steps outline the process of contextual case-based learning. The contextual case is presented, the group examines it, brainstorms ideas, develops learning objectives, sorts the research, presents the findings, and students reflect (Williams in Stanley, 2021).

Dorit Alt (2020) stated that one effective teaching method for enhancing students' ability to apply the skills, ideas, and knowledge they have learned in the classroom to real-world situations is contextual case-based learning. Through case-based learning, students' ability to solve unstructured situations is enhanced (Rong & Choi, 2019). For the transfer of learning in ill-structured problem solving, contextual case-based learning as a whole learning environment was beneficial (Choi & Lee, 2009). To assist educators in developing more productive, contextual, case-based learning environments, suggestions for instructional design regarding the use of failure scenarios are presented, based on discussions of the study's findings (Rong et al., 2020). Contextual case-based learning differs from problem-based learning; problem-based learning sessions often need more guidance for contextual case discussion. Students needed more time to prepare and frequently did their study as the contextual case was presented; thus, learning happened as it happened. The student needed more guidance during the contextual case discussion and initial preparation. However, with contextual case-based learning, practice is conducted in advance by both the instructor and the students, and a clear direction is provided for the debate to ensure that crucial learning elements are covered (McLean, 2016).

A case is frequently presented as a narrative with a clear framework, a significant character, specimen, or element, where a problem needs to be solved. Cases generally resemble real-life events (Kulak, 2014). Using scenarios based on real-world educational problems, case study-based instruction helps instructors to engage students in the reality of teaching (Willems et al., 2021). Students can problem-solve varied outcomes and produce potential answers from various theoretical stances. Instances are conceptualized in ways that extend beyond the conventional framework of cases, as they encompass human experiences and contain phenomena crucial to comprehending complex ideas about perspective and space (Valentine & Kopcha, 2016). In the CBL group, students demonstrated high satisfaction and problem-solving skills (Bi et al., 2019). The problem in CBL is an ill-structured or open-ended problem, which encourages more inventiveness and inspires a more extensive range of learners (Allchin, 2017). The selection of critical thinking as a cognitive domain in this study is based on the research of Nuraini Sirajudin et al., which examined the critical, creative, communicative, and collaborative thinking of students in biology education. This research was conducted over a two-year period, from 2019 to 2020. Based on this research, critical thinking is a variable that requires more attention than other elements because it is lower than other cognitive elements (Sirajudin et al., 2020, 2021).

Baeten et al. (2013) stated that compared to students who solely engaged in case-based learning, students in a gradually implemented case-based setting worked more

efficiently and with greater focus. Additionally, student participation in case-based activities scored much better on the more typical, algorithmic in-course exams (Fawcett, 2017). The majority of students felt that they learned positive attitudes throughout the course and had favorable opinions of CBL as a teaching strategy, according to the results (Watson et al., 2022). Çam and Geban (2011) stated in their research that the findings revealed a substantial difference in views regarding school subjects between the experimental and control groups, favoring the group using a case-based learning approach. According to case-based reasoning, comprehension and interpretation of a contextual case are incremental and dynamic; hence, the lessons learned from one contextual case may alter throughout a case-based curriculum and in light of new experiences (Tawfik et al., 2019).

Given that each student aspires to excel in their academic pursuits, this research is of paramount importance in identifying potential solutions to pertinent issues. According to a study, students who were instructed in set theory employing case-based learning methodologies exhibited considerably different behaviors compared to those who did not (Akanmu & Fajemidagba, 2012). The research aims to address the following questions: 1) Is there a significant difference in critical thinking skills between students taught using CCBL and those taught with traditional methods? 2) Does the initial level of students' critical thinking skills influence their final critical thinking abilities? 3) Is there an interaction effect between the learning model and the students' initial critical thinking skill levels?

▪ METHOD

Research Design and Procedures

Quasi-experimental research methodology is employed. The primary distinction between this study and actual experimental research is the grouping of participants. To reduce bias in experimental investigations, participants were recruited at random. If individual selection is thought to be difficult or impossible, quasi-experimental research is the best choice. Researchers must consider factors that affect internal and external validity when interpreting their research findings because the quasi-experimental approach does not provide complete control (Suratno et al., 2018). The total number of participants (sample class) is 44 pre-service biology teachers. There were 22 students in the traditional class and 22 students in the Contextual Case-Based Learning (CCBL) session.

The experimental and control sample classes were not created by randomly assigning individuals or study participants to the sample classes. Forty-four pre-service biology teachers from two complete classes were the study's participants in the second semester. Both classes received a pre-test during the preview meeting. Contextual case-based learning is used to teach students enrolled in the experimental class. The control class, in contrast, imparts traditional instruction to the students who served as the research subjects. With more outstanding direction, the instructor offers contextual case-based learning services (Stanley, 2021). After the learning sessions, students in both sample classes took a test to assess their critical thinking skills.

Instrument

The dependent variables in this study are critical thinking skills, while the independent variables are contextual case-based learning. In this work, a posttest-only

design with non-equivalent groups was the basis for the quasi-experimental methodology.

This design was used because researchers cannot or do not randomly assign subjects to experimental and control groups. No measurements were taken before treatment (pretest) due to time constraints. Consequently, only the experimental group received the treatment or intervention, while the control group did not. The focus is on determining whether there is a significant difference in the results (posttest) between the groups that receive treatment and those that do not. The test of critical thinking skills consists of five sections: inferences, assumptions, deductions, interpreting information, and arguments. This instrument has an average discriminatory power = 0.31 and an average level of difficulty = 0.48.

▪ RESULT AND DISSCUSSION

Contextual Case-Based Learning Activities

Research activities were conducted over seven meetings (weeks), including final tests. The first meeting lecture began with material on Environmental Problems (Case), which included the Environment and its Problems (Case), Global Environmental Problems (Case), National Environmental Problems(Case), and Local Environmental Problems (Ternate City) (Case). The final stage of this learning activity expects students to be able to explain. Provide solutions to environmental cases through collaborative work, social sensitivity, concern for the environment, and accountability for the outcomes of group projects. You should also be able to supervise and evaluate employees' completion of tasks that are assigned to them. Student learning experiences are carried out offline and online. Offline learning is conducted through lectures and research, while online learning is completed by completing Lesson Activity 1 (Online Lesson Activity 1). Student learning experiences in offline activities include solving cases on the student worksheet 1 (LKM)-1 (lecture) and researching environmental problems (contextual case) in Ternate City (Survey Research on Waste Management at Dufa Dufa Market, North Ternate City District, Ternate City). This worksheet contains contextual cases that students must solve, featuring problems in CCBL. The CCBL process begins with structured problems and progresses to complex, contextual cases or unstructured cases that deliberately do not provide all the necessary information to solve or find a solution (Duch et al., 2001).

The following learning stage involves students engaging in learning activities that enable them to explain and present solutions to conservation-related contextual cases, collaborate with others, exhibit social sensitivity and concern for the environment and society, be accountable for the outcomes of group projects, and supervise and evaluate the completion of tasks assigned to subordinates. Material that supports learning achievement is Conservation material, which includes the Definition of Conservation, the Important Role of Conservation, Conservation Objectives, and Community-Based Conservation. Offline learning activities are conducted through lecture-based learning and community service, while online learning students complete lesson activities online. The student learning experience, in the form of lectures, involves students participating in training to prepare for conservation programs and activities. Students are also given contextual case studies in the form of Student Worksheet 2 (LKM-2). The student's learning experience in community service involved conducting community service related to conservation programs in the mangrove area of Gambesi Village, South Ternate

City District, Ternate City. Students also presented problem-solving on the worksheet. Involving students directly in conservation programs is expected to increase student awareness of the mangrove case (contextual) in Ternate City. CCBL makes learning a fun experience by exploring new knowledge, increasing students' curiosity, connecting previous knowledge, and increasing participants' interest in learning. Educate.

After engaging in learning activities, students will be able to explain and demonstrate how to solve environmental health-related cases as a foundation for developing their ability to design biology lessons with an active student approach. They will also be able to collaborate, show social sensitivity, and show concern for the community and environment. Finally, they will be able to take accountability for the group work outcomes and oversee and assess the completion of tasks assigned to workers under their supervision. Material that supports learning achievement is Environmental Health material which includes Introduction, Environmental Health, Mission and Goals of Environmental Health, Sources of Drinking Water, Environmental Risk Factors, Ecological Concepts of Health, Limits of Environmental Health, Human Relations with the Environment, Environmental Health Problems, Role Environmental Health in the Community, Climate Change and Environmental Health, Healthy Water Facilities, Drinking Water Sources, Simple Drinking Water Treatment, Environmental Sanitation, and Public Places and Food Processing (TUPM). Offline learning activities are carried out through lectures and research, while online learning students complete Lesson Activity 3. The student learning experience, in the form of lectures, involves students solving contextual cases on students' worksheet 3 (LKM-3). The student learning experience through research involved surveying the community's use and response to the Rainwater Storage Installation (IPAH) in Tubo Village, North Ternate City District, Ternate City. The research activity ended with a final test of critical thinking skills.

The Impact of CCBL Toward Critical Thinking Skills

Critical thinking was studied in environmental education classes. The average and standard deviation provide a description of pupils' critical thinking abilities. Three levels of basic critical thinking skills were present, along with two therapy groups. Table 1 describes the critical thinking skills of the students.

Table 1. Description of students' critical thinking skills

Treatment	Level of PCTS	Mean	Std. Deviation	N
CCBL	High	74.29	9.759	7
	Moderate	55.00	9.258	8
	Low	31.43	3.780	7
Traditional	High	52.86	11.127	7
	Moderate	36.25	17.678	8
	Low	21.43	10.690	7

Note. PCTS = Prior Critical Thinking Skill

There were 22 students in the standard class and 22 students in the Contextual Case-Based Learning (CCBL) session. Students in the CCBL class had an average critical thinking score of 53.64, with a standard deviation of 19,160. However, in the conventional classroom, students' critical thinking scores averaged 36.82, with a standard

deviation of 18,358. The overall standard deviation was 20,402, and the average for both groups was 45.23. Since students' critical thinking skills range from 0 to 100, they can be considered moderately skilled in both traditional and CCBL classes.

According to the Kolmogorov-Smirnov test, both the CCBL and traditional courses had p-values greater than 0.05 in the normality test based on the learning strategy. The Shapiro-Wilk test shows the CCBL class has a p-value over 0.05, and the traditional class also has a p-value over 0.05. Both the CCBL and traditional classes have p-values above 0.05 according to the homogeneity of variance test. The Shapiro-Wilk test indicates that the high level has a p-value over 0.05, while the moderate level has a p-value below 0.05. Conversely, the Kolmogorov-Smirnov test shows the high level has a p-value over 0.05, and the moderate level has a p-value below 0.05, when data is normalized based on students' prior critical thinking skills. The test of homogeneity of variance finds a p-value above 0.05 among the three levels. Therefore, based on a test-based learning approach, it can be concluded that the data on students' critical thinking skills come from a normally distributed population. Additionally, considering the students' previous critical thinking skill levels, the data on students' critical thinking skills also originate from a normally distributed population.

A two-way ANOVA was employed in statistical testing to examine the relationship between students' critical thinking and their prior critical thinking skills, as well as the learning technique. The results is presented in Table 2.

Table 2. Two-way ANOVA results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13024.513[a]	5	2604.903	20.312	.000
Intercept	89571.467	1	89571.467	698.454	.000
Model	3065.256	1	3065.256	23.902	.000
Level	9661.120	2	4830.560	37.667	.000
Model * Level	252.029	2	126.015	.983	.384
Error	4873.214	38	128.242		
Total	107900.000	44			
Corrected Total	17897.727	43			
a. R Squared = .728 (Adjusted R Squared = .692)					

Table 2 presents the model (learning approach) factor with a p-value below 0.05, indicating that learning strategies significantly influence students' critical thinking ability. The p-value for students' prior critical thinking skills is also less than 0.05, implying that their initial critical thinking abilities have a statistically significant effect of 5% on later performance. In contrast, the interaction between the learning model elements and students' pre-existing skills shows a p-value greater than 0.05, suggesting that these factors combined do not significantly affect students' capacity for critical thinking.

As a means of guiding beliefs and actions, critical thinking is the active and effective process of generating, applying, analysing, synthesizing, and/or assessing knowledge derived from observation, experience, reflection, reasoning, or communication. This study can be interpreted in several ways. Researchers categorize students' critical thinking abilities as moderate. Students may feel that the information

they provide is valuable when they offer a straightforward explanation, develop fundamental skills, draw conclusions, and establish a technique.

The results also show how students' critical thinking abilities have been affected by CCBL. Other evaluations of the impact of students' prior critical thinking skills also affect their critical thinking abilities. The combination of these two factors has not affected students' critical thinking abilities. The purpose of this study is to determine whether CCBL has a greater impact on biology than conventional teaching techniques and how it affects students' critical thinking abilities. This is evident in the students' improved learning outcomes, their increased enthusiasm for biology, and their increased participation in class. Nevertheless, the results of this investigation have shown.

▪ CONCLUSION

The ability to recognize the components of a well-reasoned argument, particularly the reasons and conclusions; recognize and assess presumptions; elucidate and interpret statements and concepts; accept the validity of claims, particularly their credibility; assess various types of arguments; analyze, assess, and make decisions; analyze, assess, and generate explanations; draw conclusions; and generate arguments are all examples of the basic critical thinking skills. Using deductive reasoning to conclude data analysis and inductive reasoning to generate hypotheses are two aspects of critical thinking. Other elements include synthesizing, evaluating, and applying the knowledge learned in class and constructing an argument, evaluating assertions, using and combining data, evaluating pertinent research, and applying deductive reasoning to reach a conclusion.

Students' exploration of biology concepts is greatly aided by critical thinking [9]. To enable pupils to reflect and reason about their actions, an atmosphere that fosters critical thinking about biology can be established. Identifying the major points of the argument, assessing information sources, evaluating the evidence, and evaluating the assertions are some of the abilities that comprise critical thinking. One measure of a teacher's effectiveness in overseeing the learning activities is the improvement of students' critical thinking skills. However, pupils' critical thinking should take place in the larger social context as well as in the classroom. Students should still be able to think critically, for instance, when participating in group projects or forums. Students' talents can be developed, and their critical thinking skills can be refined through homework.

This study demonstrates how students' critical thinking abilities are influenced by their prior critical thinking skills and the elements of their learning strategies. Furthermore, the two elements do not interact. As a result, CCBL is a suitable and different approach to the topic of thinking and reaching learning objectives. Pupils in the experimental group appeared to be more adept at setting the approach, developing fundamental skills, drawing conclusions, and providing straightforward explanations. It demonstrated how Contextual Case-Based Learning might leverage biology instruction due to its beneficial impact on students' critical thinking abilities in environmental education classes.

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