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The Empowerment of Critical and Creative Thinking (CCT) Skills through Inquiry Social Complexity (ISC)-based Student Worksheets

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Abstract: - It is widely accepted that in the twenty-first century, educational processes place a greater emphasis on students' cognitive understanding than on rote learning. Thus, twenty-first-century students must possess fundamental skills, one of which is the capacity for critical and creative thinking. However, empirical evidence suggests that they lack so-called critical and creative thinking (CCT) skills. As a result, educators must concentrate their efforts on preparing students for future success. Thus, the purpose of this study was to find out the effect of an inquiry social complexity (ISC)-based student worksheet that would empower students' critical and creative thinking (CCT) skills to the point where they would be expected to participate actively in learning activities and achieve the best results. This study employed a one-group pretest-posttest design with numerical data (quantitative). The results indicated that the average of pre-test, post-test, and n-gain was 0.77 ± 0.06 (High), indicating that the implementation of the ISC-based student worksheet had a positive and significant effect on students' CCT skills, as demonstrated by the Sig. value (2-tailed) of 0.000, which was < 0.005 .

Key-Words: - Critical and Creative Thinking (CCT) Skills, Student Worksheets, Inquiry Social Complexity (ISC), Learning Model, Experimental Research, Learning Activities

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1 Introduction

It is widely accepted that educational process in the twenty-first century places a premium on students' cognitive understanding rather than rote learning [1]. Students must acquire knowledge quickly and gain direct experience [2;3], as direct experience enables students to gain a greater understanding [4;5]. Thus, students in the twenty-first century must possess fundamental skills, one of which is the ability to think critically and creatively [3]. Nevertheless, empirical evidence from the literature indicates that they lack the so-called critical and creative thinking (CCT) abilities. As a result, educators must focus their efforts on preparing students to be more competitive in the future.

To accomplish this, one possible strategy is to employ an innovative learning model since it is intimately connected with the goal of enlightenment, as evidenced by a behavioral image or educated participant's coefficients. In this regard, the adoption of an innovative learning model may facilitate the coexistence required of educated participants in the twenty-first century. One of them is the inquiry-based model of learning [6;7].

The inquiry model was created with students who already possess a readiness mindset when it comes to learning [8;9]. As a result, students with low academic abilities will struggle to think critically and articulate relationships between concepts, both in writing and orally. To address these shortcomings, one possibility is to combine the inquiry learning model with elements of social complexity. This is possible because an individual's personality can be developed through observation of others' behavior [10;11]. Social complexity facilitates what is known as collaboration-elaboration, a process of sharing between individuals [12;13].

Therefore, this current study is significant because it demonstrates to teachers and prospective teachers that the paradigm of needs-based learning must result in the development of learning models. Its objective is to enhance both the quality and quantity of education. A student worksheet utilizing inquiry-based social complexity (ISC) to empower students' CCT skills is critical in this endeavor. This ISC-based student worksheet can assist students in comprehending learning and achieving desired

learning outcomes in accordance with the teacher-designed learning objectives.

In other words, combining the inquiry learning model with social complexity is critical for mitigating the model's shortcomings and ensuring that all students participate actively in learning activities and achieve their maximum academic potential as a result of their enhanced CCT skills. Therefore, this study sought to empower students' CCT skills through the use of an ISC-based student worksheet.

2 Literature Review

2.1 Critical and Creative (CCT) Thinking Skills

Higher Order Thinking Skills (HOTS) include critical and creative thinking abilities [35;36;37;38]. High-level skills have been shown to be critical indicators of future success, particularly in the twenty-first century. Critical and creative thinking abilities are critical for students' success in school because they enable them to comprehend complex information [39;40].

These thinking abilities are supported by a variety of substances. Nonetheless, implementation surveys are integrated into all aspects of learning

and education—classroom instruction, advisory services, and public services—from a practical standpoint. That is, when someone has extraordinary ideas and ideas, starting with daily observation and critical analysis of an object, results in a clever conclusion as a result of customization.

According to [14], critical thinking abilities are comprised of six components, abbreviated as FRISCO. These components include Focus, Reason, Inference, Situation, Clarity, and Overview. Critical thinking is reflective decision-making wisdom in problem-solving about what to believe and how to act intellectual processes [15;16;17;18] an active discipline that is skilled at conceptualizing, applying, studying, and evaluating information gathered from, or generated by, investigation, experience, reflection, reasoning, or communication, and that serves as a guide to beliefs and actions [16;19] According to the various perspectives above, indicators of creative thinking and critical thinking skills are obtained as a conceptual construct for creative thinking and critical thinking skills that are divided into six dimensions: problem sensitivity, analysis, inferences, elaboration, evaluation, and novelty, as shown in Table 1.

Table 1. Creative and Critical Thinking (CCT) Skills

Aspect	Description	Indicator
<i>Problem sensitivity</i>	The ability to identify and generate novel ideas in response to problems and situations encountered.	<ul style="list-style-type: none"> Producing novel ideas or concepts in response to the questions he/she faces (Fluency) Predicting how a problem will appear from various perspectives (Flexibility).
<i>Analysis</i>	The ability to discern truth between questions and concepts as well as data in order to make sound judgments based on accurate information.	<ul style="list-style-type: none"> Identifying information that is supported by evidence based on existing data (Interpretation) Connecting the rationales for and against fact-based decisions (Reason)
<i>Inferences</i>	The ability to explain the relationship between data and applicable theory, as well as the capacity to defend opinions in order for others to accept them.	<ul style="list-style-type: none"> Defining the terms used (Clarity) Communicating effectively with others requires a high level of understanding (Insight)
<i>Elaboration</i>	The ability to describe something precisely and in detail in such a way that others can understand it.	<ul style="list-style-type: none"> Creating something that will help him/her or others understand him/her better (Generating) Considering a question from a different angle or compare it to others to ensure comprehension (Redefinition)
<i>Evaluation</i>	The ability to evaluate the credibility of a question or experience that describes, from a person's perspective, knowledge, situations,	<ul style="list-style-type: none"> Recognizing and comprehending their own thought processes in order to comprehend their capabilities (Self-regulated) Conducting a thorough review of the

	decisions, and beliefs, and to evaluate the logical strength of the resolution relationship in actual or other forms of representation.	decisions made (Overview)
Novelty	The ability to create or overcome something in a novel but beneficial manner.	<ul style="list-style-type: none"> Producing or completing something in a unique and different manner from how it is normally done because it is rarely used by the majority of people (Originally)

2.2 Student Worksheet

According to the Ministry of National Education, a student worksheet contains questions or tasks for students to complete, as well as instructions and work steps for solving problems through theory and practice. According to [20], a student worksheet is a document that contains tasks that students must complete, assisting them in integrating their physical and mental activities throughout the learning process. According to [41], a student worksheet is classified into five types based on its objectives: 1) a student worksheet assists students in locating a concept; 2) a student worksheet assists students in applying and integrating the various concepts they must locate; and 3) a student worksheet serves as a learning guide; 4) a student worksheet serves as reinforcement; 5) a student worksheet serves as a reference guide.

According to the definition above, a student worksheet contains information, explanations, and directions from teachers to students to investigate or break down a subject in the form of a practical experiment in which learning occurs.

2.3 Inquiry Social Complexity (ISC)

The Inquiry Social Complexity (ISC) learning model is based on the idea of adding an element of social complexity to increase the level of learning in

the inquiry model. This enables students to enhance their cognitive abilities [21;22]. Figure 1 contains the model syntax, illustrating the sequence of using the ISC model in learning from the beginning to the end.

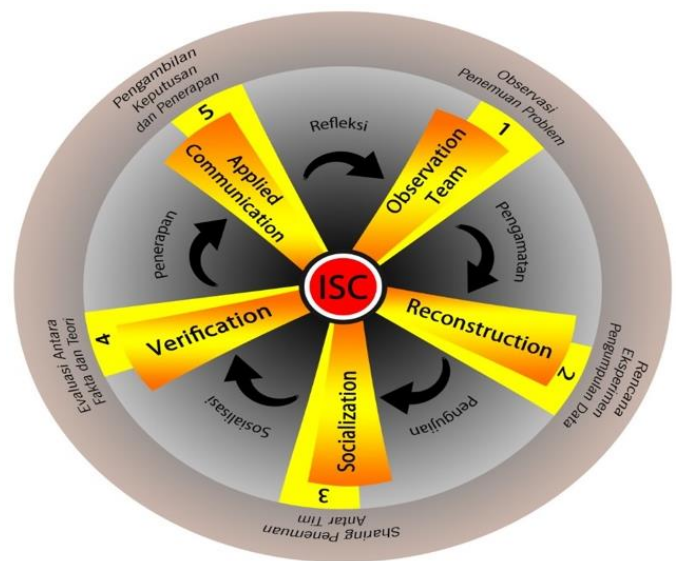


Fig. 1: Inquiry Social Inquiry (ISC) Model

Then, for each syntax, Table 2 illustrates the model of student learning activities.

Table 2. Learning Activities in Each Syntax

No	Syntax	Learning Activities
1	Observation Team	Students work in small group teams to observe phenomena presented by the teacher via videos or demonstrations and to pose pertinent questions about the issues that will be investigated and studied during the learning process.
2	Reconstruction	Each team's members proposed ideas and gathered data in both qualitative and quantitative formats. Data collection occurs through the compilation of practical tools and materials used by students in their group debut.
3	Socialization	Students in their groups share their perspectives on the data collected between groups, and each student is assigned a role in order to participate fully in the group.
4	Verification	Students in small groups exchange ideas about the data collected, and each student plays a critical role in effectively participating in groups.
5	Applied Communication	Students and team members present the outcomes of their discussions orally or in writing and discuss how they can apply them in daily life.

According to Table 2, the ISC model's steps are extremely coherent, which enables CCT to be more effective, because students' abilities are influenced by their ability to solve problems and share information with others [23]. With a collaborative social system between individuals at each stage of learning, the ISC conceptual model can maximize overall student learning outcomes. This is consistent with the opinion stated by [42] that while the inquiry-based learning model was successfully implemented at Illinois State University, a literature review revealed that the model had weaknesses. These weaknesses, according to [5], can be mitigated by allowing students' understanding and knowledge to allow them to express their learning outcomes in understanding social experiences and the power of cognitive processes.

According to the literature review above, teachers can use the ISC-based student worksheet to guide and empower students' CCT skills by guiding and providing opportunities for students.

3 Method

3.1 Research Flowchart

This research was conducted in a public secondary school in Metro city, Lampung, Indonesia, with a sample size of 30 students. This study, which adopted an experimental design, took place between April and September of 2021. [27] defines experimental research as objective, systematic, and controlled research conducted in order to predict or control phenomena. Then, [25] stated that experimental research could be defined as a method for determining the effect of certain treatments on others under controlled conditions.

This study employed a One-Group Pretest-Posttest Pre-Experimental Design, which examined whether or not there was an improvement in critical and creative thinking skills prior to and following a controlled condition. As defined by [46], experimental research is a method for determining the effect of specific behavior on other objects under controlled conditions. The following diagram illustrates the detailed implementation of the research steps.

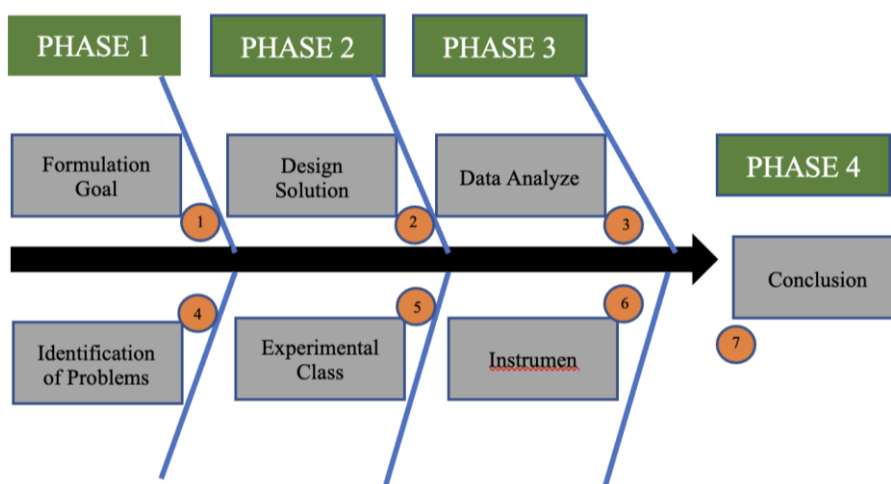


Fig. 2: Research Flowchart

3.2 Data Collection

The following data collection instruments were used:

1. Observation

Observation is a technique that was adopted in this study. [26] asserts that observation is intrinsically linked to human behavior, work processes, and natural phenomena.

2. Test

This instrument was used to collect data on student learning outcomes in the cognitive

domain, administered at the start of the learning process, before students received the material (pre-test), and at the end of the learning process, after students received the material (post-test). Due to the numerical nature of the data and its statistical processing, the test is quantitative in nature [43].

3. Questionnaire

According to [26], a questionnaire is a data collection technique that concludes with the

respondent responding to a series of written statements or questions.

3.3 Data Analysis and Hypothesis Testing

1. Qualitative Analysis

In quantitative analysis, the results of observations made during the learning process were elaborated [44]. We conducted observations throughout the process, focusing on the values reflected in students' attitudes and personalities.

2. Quantitative Analysis

10 It was generated quantitatively using students' pre-test and post-test scores. It was tested differently following the normality test of the data. 14 If the data were normally distributed, a t-test was used; however, if the data were abnormally distributed, the Chi-Square test was used [45].

4 Results and Discussion

Table 3 contains the results of statistical tests.

21 Table 3. Statistical Test Results Data (pre-test, Post-test, and N-Gain)

Score	$\bar{X} \pm Sd$	Normality Test	Independent Sample t-test
Pre-test	43.79 ± 2.53	Sig. 0.062 > 0.05	Sig. (2-tailed) 0.000 < 0.005
Post-test	86.74 ± 3.25	Sig. 0.823 > 0.05	
N-Gain	0.77 ± 0.06 (High)		

29 The Kolmogorov-Smirnov test was used to determine whether or not the research sample was normally distributed based on the research findings. The result of the normality test, Sig > 0.05 with a value of 0.154 on the pretest and 0.814 on the posttest, led to the decision. This means that the research sample was drawn from a normal population. The hypothesis was then tested using the Independent Sample t-test, which was used to see if there was a positive and significant impact on students' critical and creative thinking skills after the implementation of the ISC-based student worksheet. Table 3 shows that the value of Sig. (2-tailed) is 0.00, which is <0.005, indicating that there is a significant increase in CCT skills between before and after treatment using an ISC-based student worksheet. The result of the N-gain test is 0.77, which is in the high category. This demonstrates that the ISC-based student worksheet has a significant impact on the CCT skills of students after treatment.

This increase in CCT skills occurs as a result of the application of ISC-based student worksheets, which transforms students into a center of learning, where an educator guides students in planning and developing procedures of inquiry to infer alongside group members. In so doing, during the learning process, students understand the steps necessary to solve a problem and can explain or justify one solution. Students solve problems by consulting information sources in the form of literature. When students present and develop the results of their investigations, they convey the results of trial and error and respond to analytical questions about applying concepts in real life, thereby developing

students' thinking skills. Solving environmental or social problems exposes an individual to a variety of scientific, social, and moral perspectives [27]. As a result, connections between what they learn and their environmental problems must be made [28].

Additionally, students are taught how to collaborate with their peers to solve problems during the learning process through the inclusion of full and active student participation. Students are developing their ability to think systematically, critically, and logically. This is due to the fact that 10 the inquiry-based learning model is coupled with social complexity. Through this model, students have a chance to communicate the relationships between concepts, develop problem-solving abilities, and exchange written and oral information with their peers. According to [29], the inquiry learning model is a method of instructing students on how to think. To summarize, inquiry learning is the process by which students work systematically, critically, logically, and analytically to uncover an object or problem through a variety of sources in order to obtain a solution to a problem. Students can develop their thinking skills through interaction, from investigating an issue to understanding assumptions, formulating and selecting relevant hypotheses, and drawing conclusions. This way, students can take a more proactive role in conversations and discussions, assessing their knowledge and providing opportunities for students to form a concept from what they have. This is consistent with [30], who states that in order to develop students' thinking skills through interaction, it is necessary to deviate from psychology in order for all students to adapt to collaborating with peers 5 in the process of knowledge development. The

average N-Gain for each aspect of CCT skills is shown in Table 4.

Table 4. Average N-Gain for Each Aspect of CCT Skills

Aspect	Average N-Gain
Problem	0.76 (High)
Analysis	0.81 (High)
Making	0.70 (High)
Inferences	0.81 (High)
Evaluation	0.72 (High)
Average	0.76 (High)

According to Table 4, the highest value of N-Gain was 0.81 in the analysis and inferences aspects and the lowest 0.70 in the making aspect. While the average for all aspects of CCT skills is 0.76.

The high average value of N-Gain across all domains of CCT skills is due to students' use of the ISC-based student worksheet. Students collaborate with group members and rely on sources of information in the form of literature to solve problems and respond to each question. When presenting and developing the investigation's findings, students collaborate with their group members to communicate the outcomes of problem solving and to respond to analytical questions about the application of concepts in real life. With each learning process, students can enhance their ability to think critically and connect these facts to form a concept of knowledge. Tyler, as cited in [31], discovered that inquiry-based learning enables students to develop problem-solving skills that can help them improve their critical thinking abilities. Additionally, according to [32], the inquiry-based learning model's application of social interaction within and between groups can boost students' abilities to improve direct results. Additionally, active student participation in inquiry-based learning can boost information's resilience in long-term memory, resulting in increased mastery of concepts [33]

The highest aspect is the analytical aspect, which demonstrates that students' analytical ability and intellectual level are adequate when using ISC-based student worksheets. In this case, learning through the inquiry model helps students develop their analytical skills and requires them to connect investigations to scientific knowledge, which requires students to use scientific reasoning and think critically when developing a concept. This

finding corroborates previous research by LM Sartorelli and R. Swartz, cited in [31], which concluded that the inquiry learning model can enhance analysis and develop observing/observing skills, thereby enhancing students' critical thinking abilities.

The making aspect of CCT skills is ranked lowest when compared to the other CCT skills aspects. Students often struggle with describing something in a way that others can understand. This is because the students experienced a shift in their learning from the traditional method to the application of the ISC-based student worksheet. Learning in this manner is a new strategy for them. To overcome this, we encouraged students to practice describing something. In this case, we asked them to share mind maps with one another through discussions about creative ways to describe concepts in greater detail so that they can be understood by others and to guide students in discovering deeper meaning within the concepts they already possessed. This is consistent with [34], who asserts that the presence of an educator during the learning process can help students achieve better learning outcomes.

5 Conclusion

According to the findings and discussion, learning through the Observation Team, Reconstruction, Socialization, Verification, and Applied Communication activities engages students physically and mentally. It has been demonstrated to improve students' CCT skills in student-centered learning. Students' CCT skills must be continued to be honed through use of the ISC-based student worksheet.

Finally, this research is beneficial in the learning process because it establishes a new model and method for the use of inquiry and serves as a substitute for the inquiry model in order to mitigate the inquiry model's shortcomings. It can be used with all students, but is particularly effective with passive students, because it involves developing one's personality through observation of others' behavior and the process of knowledge sharing between individuals.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Supriyadi conceived the idea, designed the research, and wrote the initial draught of the manuscript. Ika Wulandari Utamining Tias conducted field research, aided in the preparation of the draught, and conducted the statistical analysis. Amina Izzatika conducted the review of literature, collected and analysed the data. Ryzal Perdana assisted with computations, corrected the earlier draught of the manuscript, and supervised the overall research process.

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