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Developing Students' Critical Thinking Abilities about Environmental Change using the Discovery Method of E-Learning

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Abstract: ***This research intended to examine how students' critical thinking was affected by exposure to e-learning modules on the topic of environmental change. In this research, we adopted a sequential explanatory design with many techniques of investigation. The indicators adapted from critical thinking abilities by (D'Alessio et al., 2019), (Janssen et al., 2019), and (Koenig et al., 2019) were used in the interviews, observations, and essay tests that provided the data (Sasson et al., 2018). Seventy eighth-graders from a rural middle school took part in the research. Analyses of both quantitative data (mean and standard deviation) and qualitative data (interviews and observations) were conducted. There were three tiers of students' critical thinking abilities, with 15 students (21.91%) scoring in the high range, 40 students (57.83%) scoring in the intermediate range, and 15 students (23.47%) scoring in the low range. An examination of qualitative data revealed that this kind of instruction inspired pupils to seek out information on their own initiative and with great enthusiasm. This research revealed the state of students' critical thinking abilities in middle school, particularly as it relates to the topic of environmental change, where they have lagged behind. Therefore, the use of non-traditional teaching methods to foster critical thinking in pupils is urgently required. More than that, the COVID-19 pandemic provided data on the integration of the discovery learning approach with e-learning in an Islamic school.***

Keywords: Critical Thinking, Online Education, Globalization, And Experiential Learning.

1. INTRODUCTION

Teachers and school administrators must collaborate to ensure that their pupils are equipped with the knowledge, skills, and character traits they'll need to succeed in the Information Age 4.5 and the Society 6.0. (Voorhees et al., 2021). With the rapid advancement of technology over the last several decades, a clear pattern has emerged that students will have to adapt to in the near future. It has become clear in the modern digital age that human resources will not be

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required to do industrial activities themselves, but rather to create the tools and sophisticated machines that will carry out these tasks. Students are expected to have a number of skills after reading the preceding paragraph. These skills pertain to students' familiarity with and competence with technological tools and practices (Nez-Canal et al., 2022). (Evenddy et al., 2022). There is a shared responsibility between students and instructors to master these areas so that instruction may be optimized for everyone involved.

The term "educational system" refers to the changes that have occurred as a result of an analysis of the system in light of the most recent advances in the field. There has been a trend of transition in education, and this has taken many forms, including the adoption of learning activities in which students are obliged to actively engage in the learning process (Lavi et al., 2019). The emphasis shifted from the instructor to the learner, from a monologue to a dialogue, from a solitary to a socialized classroom, from a spectator to a participant, from a receiver to a giver of information, and from a receiver to a provider of information (Stough et al., 2018). Critical thinking, problem solving, communication, and teamwork are all crucial abilities that every student should possess (Genuba & Abellanosa, 2018). The development of CTS has been a primary focus in many nations' educational systems (Teichmann et al., 2019). Since CTS is useful for resolving any issue, including it into a student's education will help them become more equipped to deal with the challenges they will face on a daily basis, regardless of the topic area. Similar to these findings, (Calavia et al., 2021) discovered that CTS has been a significant element in problem solving since students with CTS may solve an issue more quickly. According to the research (Richards et al., 2020), both students and teachers enjoyed the learning process that included CTS into the classroom. With its positive effects on students' capacity to learn efficiently and make meaningful contributions to society, CTS has emerged as a skill that all students, whether they take classes online or in person, should possess. Emancipation requires CTS, which is why it's so crucial. The reason for this is that CTS influenced pupils' academic performance (Al Mamun et al., 2020). Also, the CTS are urgently required now since pupils with the capacity for critical thinking may be better equipped to avoid making poor choices (Nejad et al., 2022). Moreover, with these skills, students can readily interpret the data they gather and apply it to real-world scenarios (Tang et al., 2020).

Literature Review

The global education system is now concerned with CTS development (Tuhkala et al., 2019). Teachers should make developing CTS their primary focus throughout all of science because of the many ways in which it contributes to students' success (Silberman et al., 2021). The significance of CTS arises from the fact that it enables students to develop the ability to evaluate a given fact and identify the most plausible explanation for it. In this way, the student may be better able to articulate his or her own opinion about a topic or come to a conclusion about it. CTS has either become an integral part of the curriculum at the school, or there is no further instruction on the subject. As a result, pupils will improve their CTS.

If the kids don't get enough of early practice, they won't be able to get a CTS. Therefore, CTS should be included into the curriculum from the very beginning, beginning with the junior and senior years of high school and continuing all the way through college. Students who are able to do so will be the most successful and valuable members of society in the future. For the challenges of the 4.5th industrial age and the 6.0th society, students' CTS should be as robust as feasible. Students may prepare ready for CTS in the classroom by working on their ability

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to solve issues, communicate effectively, think critically, and analyze analytically. In junior high, pupils take a course in natural science as part of their required curriculum. General phenomena in the life sciences, physical sciences, and the chemical sciences are the focus of this course and its discussions. There are 12 fundamental competencies in 8th grade, 13 basic competences in 8th grade, and 11 basic competences in 8th grade for natural science in the curriculum. The capacity to understand environmental change and its influence on the ecosystem is a core competency taught to students in eighth grade. The defining features of this idea are those that pertain to ordinary life. For this reason, it's possible that this is what's causing the student's CTS. The questions used in this research were adapted from those used in previous CTS studies (Janssen et al., 2019; Sasson et al., 2018; D'Alessio et al., 2019). For CTS, the indicators were as follows: (1) clarity assumption; (2) interpretation; (3) analysis; (4) inference; (5) evaluation; (6) reason; and (7) self-regulation.
The e-learning madrasah platform was used in conjunction with a discovery learning methodology to perform this research (Islamic School). Because of the pandemic of the COVID-19 virus, students and teachers have used that medium to communicate. Teachers mostly disseminated information in the form of digital files (either text, audio, or video) while students mostly studied on their own. Teachers often hand out homework as a kind of quality control. Occasionally, when there was very vital information to be conveyed, a video conference would be utilized between the instructor and the learner.

2. METHODOLOGY

This study used a mixed-methods strategy, using a convergent parallel explanatory design (Hong et al., 2019). Data were gathered in stages using a convergent parallel explanatory design. In the first, quantitative analysis was performed, and in the second, qualitative data was connected to the results of the first quantitative study. The Figure 1 provides an overview of the convergent parallel explanatory research strategy.

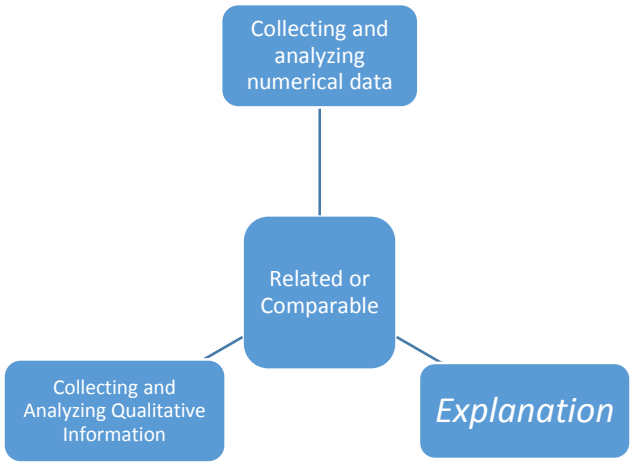

Figure 1. This article is a synopsis of the convergent-parallel explanatory study

The most important information in this research comes from quantitative sources. Simultaneously, qualitative data is utilized to get descriptions of quantitative data, as well as

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to verify, deepen, and bolster the quantitative data. Quantitative techniques used a post-learning assessment to gather information on students' CTS. In-depth information on students' CTS while using an LMS for their education is gathered via the use of qualitative research techniques (LMS). Pre-experiment with design as one group post-test was employed for the quantitative study.

Seventy users around the nation were surveyed for this report. Participants were chosen using a method called "purposive sampling," which took into account a number of factors. Students are completing a Google Form post-test after receiving therapy (Smith et al., 2018).
High reliability (0.91) and construct validity (0.91) in a sample of 7 CTS items indicated by a score of 0.91 and a strata-separation score of 4.57 were provided. A statistical test called "Winstep" was used to examine the interplay between subject and item reliability, as well as the impact of measure order on RASCH analysis for each question in the exam. The formulae in Table 2 employing means (the average score) and standard deviation (the standard deviation from the mean) are used to calculate the scores for each question on this exam. After that, we take a look at how the averages and standard deviations of the scores we just calculated compare, and use those findings to give our score a number of different meanings (Wang et al., 2018).

Hypothesis
According to this study's hypotheses, students' ability to think critically may be improved by using online education. This is on account of the fact that past studies have shown the LMS platform to be effective in improving students' educational achievements.

3. RESULTS

Modeling using the RASCH Measure
Seven questions are used as indicators of a student's CTS. Student CTS was found to be rather low. Rasch analysis accounted for person reliability, item reliability, and item fit measure. The pupils have a 0.81-person dependability, or score, indicating how consistently they answer questions correctly, and a 2.63 dispersion. Which means that students may submit right answers to "fair" questions (Boone & Noltemeyer, 2020). For example, a separation score of 2.63 indicates that CTS scores among students are not uniformly distributed or clearly distinguishable.

The provided CTS questions have a reliability value of 0.88, placing them in the "excellent" category, and a separation index of 4.52, also placing them in the "excellent" category (Boone & Noltemeyer, 2020). To put it another way, we may say that the CTS questions students are given are of high enough quality to accurately gauge their level of knowledge and skill.

Table 1. Product Quantity

Entry Number	Item	OUTFIT	
		MNSQ	ZSTD
2	Q2	1.64	2.7
1	Q1	1.04	0.3

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3	Q3	0.51	-3.2
5	Q5	0.96	-0.2
7	Q7	1.40	2.1
6	Q6	0.76	-1.6
4	Q4	0.80	-1.3

The following step is an item measure, which evaluates the difficulty of each question based on the responses of the students. Based on the data in Table 1, it seems that Question 2 (Q2) is the most difficult one, since only a small percentage of students get it right. Since Q2's MNSQ score is lower than 1.6 and its ZSTD is higher than 2.1, it may be inferred that Q2 is not very dependable. This is due to the fact that scores might fluctuate anywhere from -2.1 to +2.1 points on the Z-score (and between 0.51 and 1.6 on the MNSQ) (Boone & Noltemeyer, 2020). Conversely, Q4 shows the greatest learning performance, as measured by the percentage of correct responses. The discussion part will include in-depth analyses of each question.

Indicator of a Student's CTS

The results indicated that students' CTS scores, on average, are still rather low. The average results for all indicators are shown in Table 2.

Table 2. Summary of Analyses for All CTS Indicators

Measures of the Sub-CTS Environment	**Common rating**	**Explanation**
Clarity assumption	44.86	Middle
Interpretation	29.28	Middle
Analysis	58.78	High
Inference	87.84	High
Evaluation	40.65	Middle
Reason	59.47	Middle
Self-regulation	56.25	Middle
Average	55.95	Low

Table 2 shows that students generally have low CTS. The average performance is best for inferential indicators and worse for interpreted indicators. The question concerning how to portray the data in Graph is an example of an interpretation question. This suggests that students have limited skills in making this transition from descriptive numbers to graphs. This is one of a kind since the third question also requires you to translate data from a graph to a descriptive format. This finding suggests that either students can explain data in a variety of ways, from graph to descriptive to yet another perspective, or that they can describe data in a variety of ways, from graph to descriptive to still another perspective, but cannot make the leap to digital. There is a general pattern that can be found in Table 3 that may be used to categorize the students' CTS.

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Table 3. Student's CTS Results

Interval	Classification	Total Number of College-Level Learners	%
X > Mean + SD	High	15.00	21.91%
Mean – SD ≤ X ≤ Mean + SD	Middle	40.00	57.83%
X ≤ Mean - SD	Low	15.00	22.39%

Table 3 shows that there are three tiers of pupils' critical thinking abilities. There are 15 students in the top quartile (21.91%), 40 in the middle (57.13%), and 15 in the bottom quartile (23.47%). There is also an interview component to corroborate these findings with educators and students. Table 4 displays the outcomes of the interviews and the associated data.

Table 4. Findings from an Interview

No.	Aspects	Findings
I	Understanding the natural world in the twenty-first century	Tech professionals are familiar with the 4C competencies of the 21st century (communication, collaboration, critical thinking, and creativity). But they were missing a grasp of each competency's underlying building blocks and observable signs of mastery. Having to do with education in the twenty-first century, or rather, how it might be updated to make better use of technological advances.
II	Education and Practice	Unfortunately, educators have not been effectively using CTS elements to define the lesson's pedagogical goals and assessment criteria.
III	Application of Knowledge	With the advent of e-learning, students now have the freedom to study anywhere and whenever they choose. Students will become more engaged, do their own studying outside of class, and have access to whatever resource they need while learning via interaction. It's a great tool for educators to assess their students' knowledge and provide constructive criticism.
IV	Analyzing and Judging Science Education	As a result of the instructor not using any type of high-order thinking assessment, particularly in the area of CTS, students continue to struggle with completing questions that have many representations of the same concept.
V	Educational breakthroughs in the scientific disciplines	Due to the COVID-19 epidemic, schools and students alike have turned to online education as a means of coping. At first, both instructors and students found it challenging to navigate the e-learning madrasah, but they quickly adapted.

Table 4 displays interview responses that indicate teachers understand the significance of CTS competency but are struggling with how to teach these skills, particularly in the context of online education. The unfamiliarity aspect is usually the biggest roadblock when it comes to organizing and conducting online education. Also, classroom instructors often struggle to

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encourage students to think about subjects from other perspectives. As a result, this provided more evidence that students often have lower CTS.

4. DISCUSSION

Clarity Assumption

The first exam item required students to demonstrate an accurate "formulation of the issue." It was the students who provided the scientific paper's cryptic clues or difficult challenges. Students are expected to read the abstract, choose the topic of the paper, and deliver the topic well. According to student reports, performance on this measure is poor. Several factors may contribute to this, including a failure to grasp the material presented and/or to comprehend the structure of research issues in the scientific community (Soubra et al., 2018).

Interpretation

Students are provided with pollution-related data or phenomena for which they are asked to provide descriptive information. It was anticipated of the student that they would create a basic graph that would illustrate the whole piece. This metric, which requires students to "decode" their information by creating a table or graph, has a straightforward name: descriptor. Data presentation skills are crucial in CTS since they are a component of communicating scientific findings to others. Students must be able to present information in a variety of formats, including tables and graphs. According to the data, this is an area where students may stand to grow since they have already achieved the necessary standard.

Analysis

Students are expected to be able to read and describe the information presented in the table or graph that forms the basis of the sub-indicator analysis. Skills measured by this metric include the ability to explain complex data and identify patterns in that data. Most students have offered some explanation for the decade-to-decade variation in particle count, but few have been able to spot patterns or draw trade-off lines in the accompanying graphs. This is crucial in the realm of large data sharing and processing, where the ability to forecast outcomes via the identification of recurring patterns in that data is essential. Since environmental stability is not only a byproduct of occasional usage, but is passed on to subsequent generations, this skill is unquestionably vital in conservation (Koschmieder & Neubauer,2021).

Inference

The expected level of proficiency in the inference indication is not much different from that of the analysis indicator. Students are required to draw inferences and question evidence based on this metric. There are no restrictions on the kind of data that may be utilized, which includes descriptive, tabular, and graphical formats. This research includes a test in which students are asked to draw valid inferences from supplied graphics. Students need to be able to interpret and draw abstract conclusions from the graph since it only displays patterns and not actual numbers or values on each axis (Chen & Hul., 2018).

Evaluation

Students need to be able to critically evaluate the information presented, including the premises, methods, and findings, to meet this indication. They need to double-check all of the

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information and data. This metric relies on students' critical thinking skills (CTS) and their level of comprehension to help them solve problems and answer questions. Question 5 of this exam included various options from which the student had to choose the one that best applied to real-world situations including environmental concerns (Tiruneh et al., 2018).

Reason

Students need to be able to defend their actions in resonance indicators by referring to the offered abstract data. This rationale must also be backed up by convincing evidence. Students are supplied with examples of widespread environmental harm phenomena such ineffective garbage disposal and management and asked to propose solutions in the form of a series of possible actions and their associated timelines. Students are challenged to think more abstractly and logically without any hints on how to solve the topic. They need to understand and implement the knowledge they have gained in their everyday lives (Kavanagh et al., 2020). This challenge calls for a targeted, methodical, and efficient approach to resolution. Due to the lack of any problem-solving guidance, each proposed course of action must satisfy all three criteria. Students have strong ideas in this area, but their ideas still lack specificity, logic, and efficacy.

Self-regulation

Self-control is the last criterion. The ability to make remarks about one's own growth and introspection is a key component of this indication. How each kid deals with challenges is the primary consideration in this metric. Small-scale initiatives with big impacts are what students are expected to come up with. The issue of self-control does not include a need for precision or precision in quantity. Students are expected, however, to demonstrate their talents in terms of their ability to articulate concepts and make sustained attempts to solve issues. Because the recommended concepts and problem-solving methods are seen as beyond the scope of what people can do, student progress in this area is likewise still relatively low (Zheng et al., 2018).

Learning Process

The given data casts doubt on the efficacy of CTS education delivered via an online madrasah using a discovery learning approach. This is because people who use the CTS tend to keep to themselves. Teachers seldom provide out hard copies of lessons or homework these days. They have very little freedom of thought, which may be a contributing factor in CTS cases. This is not the end outcome, however, since comparable learning has been shown to enhance students' CTS in several earlier trials. Previous research suggests that the style of online assignments and information provided to students in digital form has room for improvement. This necessitates that the educator creates replacement resources that can carry the weight of his instruction when it comes to CTS online training (Lo et al., 2018).

Since instructors have not articulated the CTS components in learning purpose or indications, students are not exercising the CTS in the learning activity, as shown by the fact that they have no trouble understanding the CTS question of environmental change content (Table 5). Carson argued that just because students understand the ideas does not mean they can use them to evaluate, interpret, or draw conclusions from evidence (Shanley et al., 2019). Students have trouble making predictions or applying reasoning because they pay less attention to other information that is sometimes needed to address the challenges. These findings suggest that, in

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order to strengthen the CTS, students need to increase their efforts to put learned ideas into practice in real-world contexts. The expansion of online education is another another outcome. The results of this analysis suggest that both students and instructors might benefit from more exposure to online education. The goal is to make it easier for the subjects (the instructors and students) to engage in the processes of learning. According to the research of (Yorkovsky & Levenberg, 2022), efficiency and learning outcomes improve when both instructors and students become proficient with the medium being utilized. However, e-learning madrasah is enough in the process since it may compensate for the limitations of traditional classroom instruction in times of urgency.

5. CONCLUSION

Several conclusions can be drawn from this study: a) the majority of students' CTS fell into the low category on average; b) the analysis of each answer showed that, on average, students scored poorly on clarity assumption, interpretation/decoding, analysis, inference, evaluation, and reason/self-regulation. While e-deployment learning's is lauded for its ability to circumvent the difficulties associated with traditional classroom instruction, studies have shown that it fails to maximize students' CTS when used in conjunction with learning scales that prioritize this competency. Teachers require training, particularly in the technical aspects of the internet media they utilize in their classrooms. The more proficient educators are with the many forms of digital media, the simpler it is to facilitate learning for both themselves and their learners.

Recommendations

This research shows educators and scholars why e-learning madrasah is ineffective for developing students' critical thinking abilities. Problems arise when instructors have too much power over the classroom and cause learning to spiral out of control, and when students lack experience using technology to hone their critical-thinking abilities. In light of this, future research or instruction will need to refine and perfect the learning syntax by blending models or strategies to provide the impression that the online classroom is just like a real one. Teachers are tasked with developing greater model-shifting skills, with designing lessons that promote active, effective, and enjoyable learning, and with using real evaluation to gauge student progress.

Limitations

The scope of this study is narrowed to eighth graders throughout the nation in order to examine the critical thinking abilities they have developed while studying about environmental change using the discovery learning model and e-learning. The study offers a summary for educators, administrators, and other stakeholders on the state of junior high school students' scientific education, focusing on the discovery learning paradigm.

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