Effectiveness of Online Learning in Developing Critical Thinking Skills

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Abstract : The objective of this study is to ascertain whether or not the use of metacognitive strategies during online courses might lead to an improvement in the critical thinking skills of students. The research was conducted utilizing a quasi-experimental, pre- and post-test approach, and it included the participation of one hundred fifty children who were enrolled in educational programs in Balrampur, Uttar Pradesh, India. The Metadig tool was used by one group of participants in order to execute metacognitive strategies, while the other group focused only on the utilization of conventional online learning methods. Participants were assigned to one of the two groups by a random process. For the purpose of evaluating critical thinking skills, which include both substantive and dialogical features, the Critical Thinking Questionnaire was used. For the purpose of data analysis, generalized linear models were used, with pre-test scores being accounted for and Bonferroni coefficients being utilized to compensate for multiple comparisons. According to the findings, Metadig users made considerable development on both of the metrics, with the dialogical component demonstrating the greatest amount of improvement. According to the findings, the incorporation of metacognitive practices into online learning has the potential to significantly enhance the students' capacities for critical thinking, self-regulation, and reasoning.

Keywords: Online Learning, Critical Thinking Skills, Metacognitive Strategies, Self-Regulated Learning, Quasi-Experimental Design, Education Technology

INTRODUCTION

"Learning to respect and use your own brains and instincts; consequently, grappling with hard work" is what Adrienne Rich means when she states that people should "refrain from letting others do your thinking, talking, and naming for you." In other words, people should "face the challenge of hard work." In addition, Carol Wade makes the observation that individuals who have completed a course in critical thinking may be exceptionally intelligent and possess an in-depth understanding of reasoning. However, due to the fact that they fail to accept their own biases, it is possible that they may merely evolve into experienced debaters rather than critical thinkers. Elon Musk elaborates by stating that, in contrast to thinking by analogy, which consists of just imitating the activities of other people, reasoning from first principles—that is, reducing things to their most fundamental truths and then reasoning up from there—is more effective [1].

The capacity to think critically is essential because it enables one to ascertain the truth by interpreting, evaluating, and analyzing the facts and evidence that are presented to them. People who are capable of critical thinking do more than just be interested; they also connect ideas in a logical manner in order to get a more thorough understanding. This skill has many benefits, including the enhancement of decision-making through the use of logical advocacy, the resolution of problems through the consideration of a variety of solutions, the development of creativity through the identification of patterns and the linking of ideas, the contemplation of personal beliefs and biases, and the promotion of science and democracy through the use of evidence-based decision-making [2]. Students need to be able to think critically because it enables them to make better choices and find solutions to issues, it makes them more curious, and it pushes them to think "out of the box," all of which are important for creativity.

It is crucial to have the ability to think critically, which means to assess claims, study facts, and construct arguments based on solid reasoning. This ability is necessary for academic accomplishment and for continuing one's education throughout ones whole life. In light of the growing popularity of online education [3, 4], it is especially important to have a solid understanding of how these abilities are developed in digital environments. The introduction of digital technology has brought about a revolution in the field of education, leading to the rise of online learning as the most popular style of instruction. It is essential to have a solid understanding of how the use of online courses affects students' capacity for critical thinking and problem solving as more and more institutions adopt this mode of instruction.

The advent of online education has brought up both new opportunities and new challenges in terms of fostering critical thinking. Students have the ability to go through the content at their own pace, which may result in more in-depth reflection. This is because many classes do not have a time limit attached to assignments. The accessibility of a broad variety of digital resources, which may include materials that are interactive, has the potential to significantly improve the quality of the educational experience [5]. It is possible that the development of critical thinking skills might be hindered by a number of hurdles, such as a lack of face-to-face interaction, delayed feedback, and unequal access to technology.

OBJECTIVES

1. To investigate how students' critical thinking abilities are affected by online learning interventions that use metacognitive techniques.

2. To assess how students who utilize the Metadig tool and those who don't develop in the substantive and dialogical aspects of critical thinking.

RESEARCH METHODOLOGY

The objective of this study is to determine whether or not the use of metacognitive strategies by students throughout their online learning experiences leads to an improvement in their critical thinking skills. The use of a design that is analogous to an experiment will be used in order to attain this goal. The participants will be randomly assigned to either an experimental group, which will actively engage with online learning interventions designed to create metacognitive methods, or a control group, which will follow regular online learning practices without special metacognitive scaffolding. Both groups will be tested on their ability to actively participate in the online learning interventions. During the duration of the research project, both groups will continue to participate in the same activities. Through the use of a pre-test/post-test methodology, we will evaluate the critical thinking ability of the participants both before and after the intervention. The evaluation of advances that are associated with the techniques of online learning will be made possible as a result of this.

Participants

All of the participants will be students who are currently enrolled in top public and private schools located in the Balrampur region of Uttar Pradesh, India. In order to ensure that there is a diverse range of students from different educational institutions and levels of study, we will randomly invite 150 students to participate. With this sample size, which is enough for statistical analysis, it is possible to interpret the results in a meaningful way. It is expected that all ethical concerns, including informed consent, will be adhered to, and participation will be entirely voluntary. At random, two groups will be chosen from among the participants, and they are as follows:

Experimental group: Seventy-five students will participate in the metacognitive strategies-focused online learning interventions.

Control group: 75 pupils who will be provided with the usual online course material but will not be offered any further metacognitive assistance.

Instruments and Materials

The Critical Thinking Questionnaire [6] will be administered to the students as part of the research project in order to evaluate their aptitude for critical thinking. There are two distinct components that are measured by the thirty questions that comprise this survey:

1. **Substantive Dimension:** Analyzes thinking in light of facts and evidence. Contains the following skills: reading, writing, and speaking.

2. **Dialogical Dimension:** Assesses arguments in light of the viewpoints of others. Contains the following skills: reading, writing, and speaking.

When it comes to critical thinking skills, higher scores indicate more capabilities on a 4-point Likert scale, which the participants will use to respond. It is planned to deliver a pilot exam to a select number of students in order to determine whether or not the time, clarity, and face validity of the test are adequate.

Procedure

An intervention was carried out with children enrolling in famous public and private schools in the city of Balrampur, which is located in the state of Uttar Pradesh in India. Tutors reached out to students via phone calls, emails, and alerts sent out through virtual classrooms in order to provide them with information on the objectives of the study as well as the resources that are accessible to them in order to strengthen their critical thinking abilities [7]. The first training session, which lasted for two hours, took place during the first week. The students improved their ability to self-regulate their learning and gained knowledge about metacognitive strategies. In the course of the research project, we demonstrated how to make use of the Metadig tool, which is a component that is included but not required. In order to collect information, it was required that a total of one hundred fifty students complete out the Critical Thinking Questionnaire. Each of the participants was divided into two groups:

- **Experimental group:** Students who used the Metadig tool.

- **Control group:** Students who did not use the tool.

Participants who were unable to attend the live sessions were provided with the chance to see recordings of those sessions within a week of their scheduled attendance. The gathering of data for the pre-test was the first step in the intervention [8]. During weeks five and ten, students in the control group were reminded to use the tool. On the other hand, students in the experimental group used the tool on their own for the subsequent fifteen weeks. It was recommended to them that they make use of the self-assessment elements of the program in order to assist them in studying for their tests [9]. Immediately after the conclusion of the intervention, a follow-up training session of two hours was completed. Following the completion of the tool, students were given the opportunity to submit a post-test survey and report on their experience with the tool. It is possible for participants who were unable to attend the live event to access the recorded version of the survey and complete it whenever it is convenient for them during a period of seven days.

DATA ANALYSIS

Reliability: For the whole 150-student sample and for each dimension, Cronbach's alpha was computed to ensure the questionnaire's internal consistency.

Variable Preparation: For every dimension, two variables were generated: pre-test and post-test. Items 2 and 22 on the dialogical dimension, which are inverted, were recoded.

Normality Testing: To establish the proper analysis, Shapiro-Wilk tests were conducted to each dimension:

- Gaussian distributions using GLM are examples of normal distributions.

- GLM with Gamma distribution is an example of a non-normal distribution.

Model Design: To adjust for differences at baseline, we used pre-test scores as covariates, with experimental and control groups serving as independent variables, and post-test scores as dependent factors [10].

Effect Size and Significance: The formula for determining R^2 was used to calculate the proportion of variance that was explained. The Bonferroni correction was used in order to handle multiple comparisons efficiently. The marginal means plots were used to demonstrate the group effect, which was unrelated to the outcomes of the pre-test. A comprehensive investigation of the impact of the Metadig tool on the substantive and dialogical aspects of critical thinking was carried out with the help of these approaches. It was decided that a sample

size of 150 students was enough for statistical analysis [11], which is in keeping with the parameters that were already established for previous study.

Table 1. Features and fundamental abilities related to the Critical Thinking Questionnaire

Dimension	Basic Skill	Item
Sustantive	Reading	1, 11, 13, 16, 17, 18, 19, 21, 24, 25, 28, 30
	Writting	4, 9, 10, 23, 26, 29
	Oral Expression	3, 8, 14, 27
Dialogic	Reading	2*, 7, 12, 22*,
	Writting	5, 6
	Oral Expression	15, 20

Substantive Dimension

Table 2. Estimates of the Substantive Dimension Parameters (n = 150)

Names	Effect	Estimate	SE	95% Confidence Interval	z	p
(Intercept)	(Intercept)	3.165	0.049	3.069 – 3.261	64.59	<.001
UsoApp1	1 – 0	0.194	0.079	0.039 – 0.349	2.45	0.014
SustantivaPre	SustantivaPre	0.155	0.085	0.009 – 0.301	1.82	0.069

Table 3. Using UsoApp for Substantive Dimension in Post Hoc Comparisons (n = 150)

Comparison	Difference	SE	z	Pbonferroni
UsoApp 0 – 1	-0.194	0.079	-2.45	0.014

In light of the fact that the Shapiro-Wilk test revealed that the substantive dimension did not adhere to a normal distribution (p = 0.010), we decided to make use of the Generalized Linear Model with a Gamma distribution. Following the inclusion of factors that were statistically significant (group and pretest) [12], the regression model was able to explain for 23.2% of the cumulative variance. The predicted mean score of a student was 3.17 when they did not habitually use the Metadig tool, but it increased to 3.36 when they did use it, which is a 0.19 point gain [13]. When post hoc comparisons were performed, it was determined that there was a difference that was statistically significant (p = 0.014).

Dialogical Dimension

Table 4. Estimates of Dialogic Dimension Parameters (n = 150)

Names	Effect	Estimate	SE	95% Confidence Interval	z	p
(Intercept)	(Intercept)	2.910	0.044	2.825 – 2.995	66.14	<.001
UsoApp1	1 – 0	0.274	0.071	0.135 – 0.413	3.86	<.001
DialógicaPre	DialógicaPre	0.286	0.078	0.133 – 0.439	3.67	<.001

Table 5. UsoApp for Dialogic Dimension: Post Hoc Comparisons (n = 150)

Comparison	Difference	SE	z	Pbonferroni
UsoApp 0 – 1	-0.274	0.071	-3.86	<.001

Given the results of the Shapiro-Wilk test ($p = 0.035$), it was determined that the dialogical dimension did not adhere to a normal distribution. A Generalized Linear Model (GLM) with a Gamma distribution was used by the people doing the investigation. The results of the model indicated that both the group and the pretest were significant predictors ($p < 0.001$), accounting for 37.1% of the variance in the experiment. There was a difference of 0.27 points between the average score of students who did not use Metadig, which was 2.91 points, and the average score of students who used it regularly, which was 3.18 points [14]. A statistically significant difference ($p < 0.001$) was observed between the groups after analyzing the data.

RESULTS

Table 6. Findings for dimensions

Dimension	R^2	Mean G-0	Mean G-1	Difference
Substantive	0.232	3.17	3.36	0.194
Dialogic	0.371	2.92	3.18	0.274

Table 7. Findings about the many aspects of critical thinking used to control learning when reading texts

Dimension	Basic Skill	n	R^2	Pbonferroni	Mean G0	Mean G1
Substantive	Reading	150	0.078	<0.001	3.07	3.27
Substantive	Writing	150	0.059	0.003	3.17	3.34
Substantive	Oral Expression	150	0.108	<0.001	3.05	3.27
Dialogic	Reading	150	0.122	<0.001	2.82	3.13
Dialogic	Writing	150	0.141	<0.001	3.04	3.32

Dialogic	Oral Expression	150	0.100	0.003	2.94	3.17

When comparing the two dimensions, we find that the dialogical one has improved by 0.27 points, while the substantive one has only improved by 0.19 points. Metadig resulted in enhancements to all three foundational abilities: reading, writing, and expressive speech.

These findings are summarized in Tables 6 and 7 (n = 150) [15-17].

- R^2= 0.232, mean difference= 0.19, in terms of the substantive dimension.

- The diagnostic dimension has a R^2 value of 0.371 and a mean difference of 0.27.

A satisfactory result was defined as a score of 3 or above on a 4-point Likert scale. Confirming the efficacy of metacognitive tactics in boosting critical thinking, 75% of students not using Metadig reached this level and 100% of students utilizing the tool surpassed it [18].

CONCLUSION

Specifically, the findings indicate that the use of metacognitive strategies in conjunction with online learning has the potential to significantly enhance the critical thinking skills of students. On tests of substantive and dialogical critical thinking, users of Metadig did better than those who remained committed to the tried-and-true methods of online learning. The greatest significant improvement was shown in the dialogical component, which demonstrates how metacognitive processes are beneficial for activities such as critical thinking, viewing things from the perspectives of other people, and reasoning in relation to what other people have stated. Taking all of these findings into consideration, it is clear that well-planned online learning interventions have great potential for assisting students in the development of critical thinking skills, self-regulation, and autonomy while they are in the classroom.

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