Assessing secondary level students’ critical thinking skills: inspiring environmental education for achieving sustainable development goals

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Abstract. The study intends to measure secondary level students’ critical thinking skills. This study follows a survey method and is a part of a doctoral dissertation focusing on promoting critical thinking skills of environmental education for achieving sustainable development goals (SDGs). The data were collected by using the Critical Thinking Skills test on Environmental Education (CTSEE) comprises of 27 items. The participants were the 8th grade students (N=444) from 13 secondary schools that cover four administrative districts of Bangladesh. The Instrument was adopted from previous research that consists of three aspects (Conclusion, Inference, and Identifying Bias) of critical thinking skills. The result shows that the students’ critical thinking skills on environmental issues can be categorized into the poor and very poor category, and there are statistically significant differences between male and female students. The study will be used as the reference for developing students’ critical thinking skills about the surrounding environment-related problem in line with achieving the globally decided environmental sustainability as well as sustainable development goals.

1. Introduction
Critical Thinking Skills (CTS) is one of the 21st-century skills that are necessary to be achieved by the student in this era of science and technology-based society. The current curriculum of Bangladesh places more emphasis on developing students’ critical thinking skills as a part of higher-order thinking skills. The students need to acquire critical thinking skills to make a responsible and desirable decision for society. A dynamic environmental education curriculum can help the student to develop their skills to solve environmental problems around them by using critical thinking abilities. Critical thinkers can lead our beautiful world toward sustainability.

There is no specific definition of critical thinking skills in the field of education [1, 2]. Critical Thinking (CT) is a rational and thoughtful thinking process that leads to decide what to believe or do [3]. Many countries around the world are emphasizing the development of students’ critical thinking skills in their education policy [4]. Critical thinking accelerates the human ability to make logical decisions and resolve critical situations [5]. People with CT skills become a dynamic and knowledgeable citizen of the society who can handle the complicated ecological difficulties easily [5]. Therefore, CT can be defined as a thinking process that helps to make logical decisions by considering every possible
alternative, and it has been recognized as a necessary condition to become a responsible member of the challenging society [6].

Environmental Education (EE) has now become one of the inseparable parts of the school curriculum [7]. Although there is no precise definition of EE, the different researcher defines it according to their understanding and experiences. EE is the most effective technique to identify and solve environmental difficulties in society [8]. Environmental education not only increases the specific knowledge about environmental issues but also turns the conservational attitudes into human behavior [9]. Environmental education improves the environmental literacy that is essential for the individual to become confident and competent during environmental problem solving [10].

The importance of EE for ensuring environmental sustainability as well as SDGs has already been demonstrated by the international community and researchers in this field. Education related to the environment works as fuel for the movement of environmental sustainability [11]. The aim of including EE into the curriculum is to encourage learners’ attitudes towards a sustainable environment [12]. Besides, measuring the CT skills in environmental education is essential because it can demonstrate a clear picture of student ability regarding solve current environmental problems [13]. Because a critical thinker can see an environmental issue from different points of view [14]. It generates lots of notions before making the right decision [15]. Previous studies show that the secondary level students possess insufficient critical thinking skills [16]. Although there are many pieces of research, have been done already focusing on general critical thinking skills test but specific subject such as environmental education is in ignorance [17]. Therefore, the primary aim of the study is to assess the level of critical thinking skills of Bangladeshi secondary level students in environmental education.

2. Methods
2.1 Participant selection
Secondary level (8th grade) students of Bangladesh are the target population of the study. The total participant of this research is 444 students, consisting of 241 males and 203 females from 4 administrative districts of Bangladesh. The students were selected from 13 different schools by following a simple random sampling procedure.

2.2 Research Design
This research is a survey study that focuses on assessing the students' critical thinking skills about solving different types of environmental problems around them. The problems included in the questionnaire were identified based on the textbook (General Science) content and current environmental context of Bangladesh. A quantitative method was used throughout the research. The critical thinking skills of Bangladeshi secondary level students are measured through a multiple-choice type test consisting of six environmental issues. It took, on average, 40 minutes to answer all the questions. Obtained data were then analyzed to examine the level of CTS in resolving the environmental difficulties. Also, a t-test was done to see the differences between male and female students during the application of critical thinking skills in various environmental circumstances.

2.3 Data Collection Instruments
The data were collected by using the Critical Thinking Skills Test on Environmental Education (CTSEE). The test was adopted from previous research by Cheak, (1999) that was intended to measure critical thinking skills in environmental education in the US context. The questionnaires answered by the students consist of 27 multiple choice type questions divided into three parts (Conclusion, Inference, and Identifying Bias) consisting of six environmental issues in Bangladesh. The validity and reliability of the questionnaire were checked carefully before implementation and found all the items statistically valid with a Cronbach’s Alpha value of .7756 that indicates the high reliability of the test. The distribution of the test items in terms of different skills has been listed out in Table 1 below.

| Table 1. Distributions of items for the critical thinking skills test |
The value of each correct answer is "1," and an incorrect answer is "0". Therefore, a student can score a maximum of 27 and a minimum of 0. Criteria for assessing the skills level can be seen in Table 2.

| Number of Questions | Critical Thinking Skills | Description of the Skill                                                                 | No. of Problem related to the Skill |
|---------------------|--------------------------|-----------------------------------------------------------------------------------------|-----------------------------------|
| 1-9                 | Conclusion               | Choose the best conclusion based on information provided                                 | 2                                 |
| 10-18               | Inference                | Making judgment not only based on the information given but also beyond it               | 3                                 |
| 19-27               | Identifying Bias         | Identify the position based on described environmental issues                             | 1                                 |

Table 2. Criteria for assessing the students’ level of critical thinking skills

| Number of correct responses | Range of percentage | Criteria |
|-----------------------------|----------------------|----------|
| 20-27                       | 75-100               | Very Good|
| 17-19                       | 65-74                | Good     |
| 14-16                       | 55-64                | Acceptable|
| 11-13                       | 45-54                | Poor     |
| 0-10                        | 01-44                | Very Poor|

The criteria were selected based on the uniform grading system recommended by the University Grants Commission Bangladesh.

2.4 Data Analysis
Analysis of the result was done by following different statistical methods by using descriptive percentages. The gender-based analysis was done by applying t-test to measure the differences of CTS between male and female students. SPSS software was used to analyze the results.

3 Results and Discussions
3.1 Overall critical thinking skills level of secondary students
68% of the total participants found at a very poor level regarding the overall critical thinking skills in environmental education. Besides, a score of 22% of students showed the poor level of CTS. No student scored between 25 to 27. Only seven students found at a very good level that covers 2% of the total participants whereas 3% and 5% of them found in good and acceptable levels accordingly. The below figure is presenting the overall critical thinking skills level of 8th-grade students of Bangladesh concerning environmental education.
3.2 Level of the student in three different skills of critical thinking

The below figure shows the students' level of performance in three different skills (Conclusion, Inference, and Identifying Bias) of critical thinking. Students perform better in making inferences than other skills. The worst performance was resulted in identifying bias skill. More than 75% of the total participant scored in either poor or very poor level in terms of performing all three skills. Furthermore, only 1.35% of the participants were at a very good level regarding identifying bias skills.
3.3 Gender differences in overall critical thinking skills

There is a significant difference between male (N=241) and female (N=203) students regarding overall critical thinking skills that have been considered in this study. The $p$-value resulted in the t-test was .023, which is less than 0.05. Therefore, there is enough evidence to conclude that there is a difference in the overall critical thinking skills between male and female students in Bangladeshi secondary level education. The below table 3 shows the significant statistical results to support the above discussion.

| Sex          | N  | Mean  | Std. Deviation | Sig. (2 tailed) |
|--------------|----|-------|----------------|-----------------|
| Overall      | Male | 241   | 11.4066        | 3.66637         |
| Critical Thinking Skills | Female | 203   | 10.6305        | 3.46645         |

**Significant at the 0.05 level (2-tailed)**

3.4 Gender differences in specific critical thinking skills

The $P$-value of both inference and identifying bias skills considering gender issue was more than 0.05, but the value was .003< 0.05 in terms of conclusion. Therefore, no difference found in terms of inference and identifying bias skills between male and female students in the study, meaning that both males and females perform similar regarding inference making and identification of bias. On the other hand, there was a statistically significant difference recorded between male and female participants during the performance of concluding. The below table 4 shows the t-test result of the skill-specific critical thinking performance of secondary level students of Bangladesh.

| Skills       | Sex  | N   | Mean   | Std. Deviation | Sig. (2 tailed) |
|--------------|------|-----|--------|----------------|-----------------|
| Conclusion   | Male | 241 | 4.0207 | 1.76882        | .003**          |
|              | Female | 203 | 3.5320 | 1.62063        |                 |
| Inference    | Male | 241 | 4.1826 | 1.76773        | .467           |
|              | Female | 203 | 4.0640 | 1.65632        |                 |
| Identifying Bias | Male | 241 | 3.2033 | 1.84056        | .338           |
|              | Female | 203 | 3.0345 | 1.85189        |                 |

**Significant at the 0.05 level (2-tailed)**

4 Conclusion

Based on the above statistical results and discussion, it can be concluded that most of the secondary students’ critical thinking skills can be characterized by poor and very poor level in Bangladesh. Male students can perform better than female students in overall critical thinking skills, especially in drawing the conclusion. Students’ ability of critical thinking should be improved for the attainment of internationally agreed sustainable development goals.

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References

[1] Johnson R H and Hamby B 2015 *Argumentation* 4 417-430
[2] Moore T 2013 *Stud. High. Educ.* 38 506-522
[3] Ennis R H 1989 *Educ. Res.* 18 4-10
[4] Larsson K 2017 *Int. J. Educ. Res.* 84 32-42
[5] Halpern D F 2014 *Thought and knowledge: an introduction to critical thinking* (New York: Taylor & Francis) p18
[6] Marques J F 2012 *Int. J. Leadersh. Stud.* 7 87-95
[7] Awasthi M and Agarwal R 2013 *Shaikshik Parisamvad* 3 49-57
[8] Stevenson R 2007 *Environ. Educ. Res.* 13 139-153
[9] Arslan S 2012 *Soc. Behav. Sci.* 55 902-909
[10] Dada D O, Eames C and Calder N 2017 *Aust. J. Environ. Educ.* 33 201-222
[11] Uddin M R 2019 *Can. Int. J. Soc. Sci. Educ.* 20 58-80
[12] Velempini K 2017 *Afr. Educ. Rev.* 14 42-57
[13] Lin S S 2014 *Int. J. Sci. Math. Educ.* 12 1023-1046
[14] Budiarti I S and Suparmi A 2017 *Int. J. Phys.: Conf. Ser.* 909 012055
[15] Murawski L M 2014 *J. Learn. High. Educ.* 10 25-30
[16] Puspita I, Kaniawati I, and Suwarma I R 2017 *Int. J. Phys.: Conf. Ser.* 895 012100
[17] Gelerstein D, Rio R D, Nussbaum M, Chiuminatto P, and Lopez X 2016 *Think. Ski. Creat.* 20 40-49