# CRITICAL THINKING BASED FLEXIBLE STUDENT-CENTERED LEARNING MODEL

## - AN EFFORT BY ISEE

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*Abstract*— **ISEE is an NPO in India dedicated to conducting critical thinking based educational workshops. In this work, we have given an insight into a student-centered learning model developed to foster the ability of the students to think dynamically, contemplate and deliver arguments and responses to subject-oriented hypotheses in a time-based competitive environment.**

**Keywords—critical thinking; student-centered; hypothesis**

## I. INTRODUCTION

Ikasle Socio-Educational Entity, also abbreviated as ISEE, is a non-profit organization that conceptualizes innovative techniques to improve critical thinking of students through workshops and forums. With a philosophy built on trans-disciplinary and student-centered learning, we aim to develop a strong network of creative, critical and responsible citizens.

Critical Thinking (CT) is an art of controlling one's mind from prejudiced, distorted, irrational thoughts and thus help one make good decisions based on a quantitative and qualitative study of the subject. This, in practice, can be made possible by continuously testing the students through time-bound research, reasoning sessions and cross-questioning segments.

In this work, we implemented a student-centered learning model for 5 days on a traditional classroom schedule, which was segregated into three segments. The first two segments were two days long while the third segment was on the final day. On the first day of each of the first two segments, based on the subject subtopic, the students were challenged with hypotheses which were to be proved/disproved by them in a time-bound research activity. While on the second day of each of the first two segments, cross-team challenges and presentations based on their conclusions/findings pertaining to the solved hypotheses were held. The third segment was a rapid questionnaire segment testing the speed, perspective and reliability of the thoughts. The results were quantified to better understand the effectiveness of the model.

## II. RESEARCH/LEARNING OUTCOMES

- To be able to make students think from multiple perspectives and tutor them to put forth authentic arguments.
- To improve the ability of students to quickly study, assess and deliver fool-proof responses when challenged.
- To monitor and assess the skill retention of students.
- To demonstrate efficient student engagement and overall classroom satisfaction.

## III. RESEARCH BACKGROUND AND SETUP

ISEE organized and conducted a 5-day workshop on the theme "Engineering Education and Environment" at an educational institute in India. This college-level workshop witnessed an enrollment of 60 students from various educational backgrounds.

The theme was categorized into three subjects, each with two subtopics:

i. Global Climate Change (M1)
   - Global Warming: Skepticism and denial (S1)
   - Consumerism and causes (S4)
ii. Sustainable Development (M2)
   - Renewable and clean energy (S2)
   - Disaster Management (S5)
iii. Pure water and Sanitation (M3)
   - Quality and Hygiene (S3)
   - Child health and disease control (S6)

The workshop was categorized into three segments. The first two segments are similar, except that they involved different subtopics in the same subjects. The segments are:

- Segment 1 (Day 1 and Day 2): Each subject is scheduled for 2 hours/day with subtopics S1, S2, and S3.

- Segment 2 (Day 3 and Day 4): Each subject is scheduled for 2 hours/day with subtopics S4, S5, and S6.

- Segment 3 (Day 5): Viva-voce

Two mentors are allotted for each subject whose responsibility is not to teach but to guide the students with tasks; to collect, record and analyze data. Also, to make assessments and record the development as well as retention of the skills. Students are assessed as teams of two.

## IV. RESEARCH DESIGN

The assessment of student development is done by the mentors using the data collected throughout the workshop.

**1. Assessment method for Segments 1 and 2:**

The table I is an exclusive rubric used by the mentors to provide points to the teams based on the following criteria:

i. Time taken to complete the task
ii. Quality of submission.

In this rubric, points A1, A2, and A3 corresponds to the quality of the submission, while points B1, B2, B3, and B4 corresponds to the duration taken to complete the task.

TABLE I.    POINT RUBRIC FOR SEGMENTS 1 & 2

| Criteria for quality | Points | Time Taken to Complete the task (minutes) | | | |
| --- | --- | --- | --- | --- | --- |
| | | < 25 | 26-50 | 51-75 | 76-105 |
| | | B1=100 | B2=70 | B3=40 | B4=10 |
| Arguments are well-defined. Covers a wide range of perspectives. | A1=100 | 100 | 85 | 70 | 55 |
| Arguments are almost well-defined. Gives a good account of different perspectives. | A2=70 | 85 | 70 | 55 | 40 |
| Arguments are inconsistent and lacking perspective. | A3=10 | 55 | 40 | 25 | 10 |

For example, if the team completes all its tasks within 25 minutes and the arguments presented are well defined, then the team gets 100 points. Whereas, if the same quality work takes say 45 minutes, then the team gets 85 points.

Subject mentors assess the performance of teams in both their subject subtopics. The tasks on day 1 are assessed based on time of completion, while the quality of work is judged at the end of the 2-day segment. This is similarly done for segment 2 as well. The data for each team is the aggregate score of the three subjects.

**2. Assessment method for Segment 3:**

The segment three has two sessions. Table II is used by the mentors to assess and record the attained team points for the viva-voce. The data recorded is the mean score from the two subsequent sessions based on quality.

TABLE II.    POINT RUBRIC FOR SEGMENT 3

| Criteria for quality | Session 1 | Session 2 |
| --- | --- | --- |
| Arguments are well-defined and well-presented | 100 | 100 |
| Arguments are almost well-defined. Vulnerable to counter-arguments | 60 | 60 |
| Arguments are inconsistent and lacking credibility | 30 | 30 |

In case if in session 1, the team makes high-quality arguments (100 points) but in session 2, only manages inconsistent arguments (30 points), they would be given a mean score of 55.

**3. Skill Retention**

In order to prove/disprove challenging subject hypotheses, skills pertaining to researching, analyzing, obtaining inference and handling complex scenarios and contradictions, is necessary. These skills are only built through regular practice and dedication. The model was put into practice for 5 days, where a new skill was inducted into the study process. It requires constant practice to ensure retention. Thus, the 5-day workshop was complimented with ISEE's CT challenge on a weekly basis through a mobile application. In this, students can choose from a list of subject topics which then directs them to a set of hypotheses. Students should type in their arguments inside the provided text box along with references within the time provided for the task. Mentors will be assessing and providing points based on the rubric in Table I. The progress of each user will be monitored and this is one way of assessing their skill retention.

## 4. Classroom engagement and satisfaction

It is highly paramount for any new study technique to ensure classroom engagement and overall study satisfaction from a student perspective. Throughout the 5-day period, feedback sessions were held, and for study purpose, were quantified using the Likert scale.

TABLE III. FEEDBACK: ENGAGEMENT AND SATISFACTION

| | Feedback Questionnaire |
|---|---|
| A | The learning experience was highly enriching and I was able to comprehend and interpret information much better. |
| B | I felt completely engaged; my classroom participation has improved. |
| C | I am very satisfied with the style of education and I cannot wait to experience more such activities. |

The data was monitored to understand the satisfaction and engagement levels of the participating students.

## V. RESEARCH METHODOLOGY AND IMPLEMENTATION

### 1. Formation and Schedule:

Table IV represents the schedule of the workshop. Firstly, teams were formed with two students each.

TABLE IV. WORKSHOP SCHEDULE

| | Days | M1 | M2 | M3 |
|---|---|---|---|---|
| Segment 1 | 1 | S1: Hypotheses | S2: Hypotheses | S3: Hypotheses |
| | 2 | S1: Discussion | S2: Discussion | S3: Discussion |
| Segment 2 | 3 | S4: Hypotheses | S5: Hypotheses | S6: Hypotheses |
| | 4 | S4: Discussion | S5: Discussion | S6: Discussion |
| Segment 3 | 5 | Viva-Voce | | |

Segment 1 and segment 2 were of two days each. Both the days of segment 1 were split into three periods: M1, M2, and M3, of two hours each, where subtopics S1, S2, and S3 happened respectively. Similarly, in segment 2, the subtopics S4, S5 and S6 took place during their respective periods. Two mentors are allotted to each subject. All the 30 teams must participate in all the subject activities throughout the workshop.

## 2. Schedule Breakdown:

### 2.1 Hypotheses Analysis

As mentioned earlier, the first day of either of the first two segments is for hypotheses analysis. An example of a hypothesis analysis is illustrated below:

Example 1:
Hypothesis: When Greenland was actually green, the temperatures were a lot warmer. So, warming doesn't indicate danger.

Argument 1 - The Greenland ice sheet has existed for at least 400,000 years. There may have been regions of Greenland that were warmer than today but this was not a global phenomenon. The average global temperatures then were lower than today.
Points and comments – The argument is almost well-defined and the facts are correct. No proper explanation pertaining to the argument has been presented. The team may get A2 = 70 points. (Table I)

Argument 2 – A part of Greenland probably was somewhat warmer during the Medieval Period which was characterized by high solar activity, low volcanic activity, and varying ocean circulation patterns. These factors explain the warmth at that time. However, they do not explain recent warming. The recent warming can be attributed to most human activities and the rate of warming is evident with increasing number of natural calamities. This is fatal to life on earth.
Points and comments – The argument is well-defined and the facts are correct. An interesting perspective is provided on why past assumptions cannot be accepted in the present. The team may get A1 = 100 points. (Table I).

### 2.2 Inter-team discussion

This section of the workshop provides a platform for an inter-team discussion/debate. The teams share their findings, opinions, and perspectives with the other teams either in a face-off or in an open discussion. The quality of the content, clarity of thought, credibility of the source and presentation etiquettes are carefully assessed by the mentors. In fact, this section happens to carry 50% weightage in each of the two segments.

### 2.3 Viva-Voce

The final segment of the workshop is where the mentors of all the subjects participate in the interrogatory panel. Each team is questioned by the mentors across all the subjects focused on the last two segments in an arbitrary manner. The questions can be about subject content, the source of information or the mentors can even choose to give a case scenario to check how well the teams adapt to difficult

situations and also how quickly and convincingly they are able to respond. The mentors closely monitor the performance of the teams and make use of Table II to assess and provide the necessary points.

## VI. MULTIFACETED NATURE OF THE MODEL

The learning process involved in this style of education can be adopted by most educational institutes. Some of the advantages of the model are:

- It can accommodate slow, moderate and quick learners, all in the same system with equal importance. This is done by adjusting the time taken to solve hypotheses and also the limiting/ exceeding the number of hypotheses to be solved.

- This method is not only applicable for most university majors, but also for students in middle, high, and secondary school education. The content of the hypotheses and the intensity of the sessions will vary according to the level of study.

- If each of the team member handles the sessions with a discipline-specific approach, that is, interpreting the situation from a subject-oriented perspective, then, the research outcome is multi-disciplinary. On the other hand, if the approach is holistic, that is, a single coagulated perspective leads a team in solving hypotheses, then, the research outcome is trans-disciplinary.

- Critical thinking skills can be built through relentless practice and by doing so, builds the capacity of students. Having been exposed to such a competitive environment, students can handle stressful situations better in their future career. Also, they shall be able to produce work of better quality and impact in their jobs. The techniques and skills practiced in this model can help them become more competent as well as knowledgeable.

## VII. DRAWBACKS
- To introduce this workshop model into any educational program requires a minimum of one week which might affect the program structure of the institution.
- It is difficult to drive people towards the online CT challenge and also the monitoring of skill retention requires high dedication by the mentors.
- Mentors are not masters of any of the subjects taught. They had to prepare for their task only before the workshop. Certain scores might have been influenced by the performance of the mentors.
- Since the assessment was done for a team, individual progress is assumed to be close to that of the team.

## VIII. RESULTS AND DISCUSSION

### 1. Class Performance

In the due course of the workshop, the points were recorded and the result showed improvement among the participants. Fig 1 represents the performance of all the participating 30 teams in segments 1 and 2. The score in each segment is a summation of all the individual subject scores achieved by the teams.
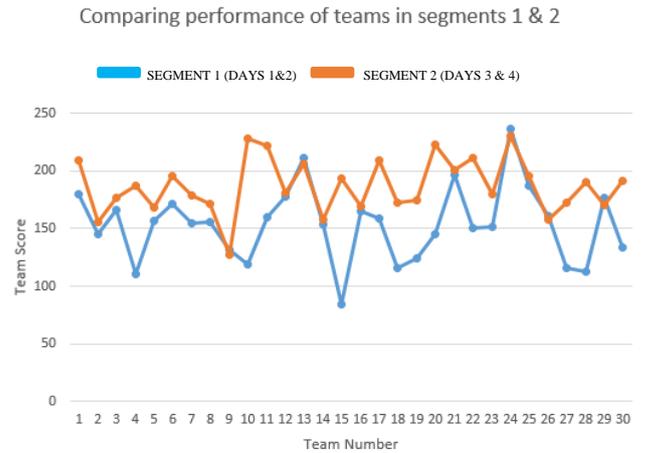


Fig. I    PERFORMANCE CHART

The class average improved by a significant 21.56% in segment 2. The majority of the teams had put forth better and more diverse arguments in much lesser time than they had in segment 1. This demonstrates student thought process of better quality.

The team with lowest total score across 3 subjects at the end of segment 1 were able to increase their score by 43 points. This shows that a competitive environment encourages learning to adapt by observing other teams and also becoming more fluent with the learning approach.

TABLE V.    SUBJECT-WISE IMPROVEMENT

|  | M1 (points) | M2 (points) | M3 (points) |
|---|---|---|---|
| Average improvement of class from segment 1 to 2 | 13.17 | 7.4 | 14.33 |
| Improvement of the lowest scoring team in segment 1 | 39 (S1:20, S4:59) | 19 (S2:21, S5:40) | 37 (S3:20, S6:57) |
| Maximum improvement by any team | 67 (S1:21, S4:88) | 45 (S2:22, S5:67) | 59 (S3:24, S6:83) |

Promising developments were being witnessed with low scoring teams of segment 1 adapting much quicker than expected. Average class improvement across all the subjects is a significant 34.9 points from segment 1 to segment 2.

**2. Satisfaction levels**

Students believed that learning in such an environment was more effective and beneficial than the traditional methods. Table depicts the satisfaction levels of the teams at the end of the 5-day workshop. Table III was used as the feedback questionnaire and the responses were quantified using the Likert scale. (Max.: 5 for Strongly Agree, Min.:1 for Strongly Disagree)

TABLE VI.     FEEDBACK RESULT

|      | Mean (After Segment 1) | Mean (After Segment 2) | Mean (After Segment 3) |
|------|------------------------|------------------------|------------------------|
| A    | 3.84                   | 4.02                   | 4.11                   |
| B    | 4.19                   | 4.15                   | 4.37                   |
| C    | 4.56                   | 4.43                   | 4.82                   |
| Mean | 4.196                  | 4.20                   | 4.433                  |

The engagement levels on an average increased as the workshop progressed. Initially, students found it difficult to interpret and comprehend information. This assessment is based on a relatively low 3.84 rating for 'A' at the end of segment 1. The high ratings for 'C' suggests that students found the learning method satisfying and enticing.

## IX.     CONCLUSION

From the above discussion, we can conclude that:

i.    Students were able to produce better and more convincing arguments. They were able to emphasize different perspectives and facts.

ii.   Students showed improvement by consuming lesser time to research, analyze, infer and put forth authentic arguments.

iii.  The model demostrated positive student engagement and classroom satisfaction.

## X.     REFERENCES

[1] Baker, Paul J. "Learning Sociology and Assessing Critical Thinking" *Teaching Sociology*. 8.3 (April 1981): 325-63

[2] Brouwer, Peter. "Hold on a Minute Here: What Happened to Critical Thinking in the Information Age?" *Journal of Educational Technology Systems* 25 (1996-97): 189-197.

[3] Carpenter, C. Blaine, and James C. Doig. "Assessing Critical Thinking Across the Curriculum." *Assessing Students' Learning. New Directions for Teaching and Learning* no. 34. Ed. J.H. McMillan. San Francisco: Jossey-Bass, 1988.

[4] Carr, Kathryn S. "How Can We Teach Critical Thinking?" *Childhood Education* 65 (1988): 69-73.

[5] Nelson, Craig E. Fostering Critical Thinking and Mature Valuing Across the Curriculum: Comments & Conversation" Work in progress.

[6] Lisa Gueldenzoph Snyder Mark J. Snyder. "Teaching Critical Thinking and Problem-Solving Skills", The Delta Pi Epsilon Journal, Volume L, No. 2, Spring/Summer, 2008.