

Characteristics Promoted in Order to Develop Student's Critical Thinking Disposition in Online Discussions During a Fully Online Course

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Abstract: Online discussion boards were organised to develop the critical thinking disposition of students and their attitude toward disaster mitigation during a fully online course. In order to promote participation in the discussions, an incentive was provided to all discussants. Assessment of the effectiveness of the lecturer's invitation to join the discussion was conducted to extract which participants posted once, and the learning activity and characteristics of these students was evaluated. In the results, the levels of participation in online discussions affected some factor scores for personality and learning performance. Also, the causal relationships of the development of literacy of critical thinking disposition were analysed, and the factor of participation level in online discussions was examined.

Keywords: Critical Thinking, Online Discussion, Student's Characteristics, Science And Technology Literacy, Learning Style

1. Introduction

Critical thinking disposition (CTD) and the ability to think critically may contribute to appropriate decision making during emergencies such as natural disasters or social unrest. Training procedures and levels of competence have been discussed (Rychen and Salganik, 2003; Kikuchi 2018). Learning progress in the development of CTD ability using online discussion forums during courses has been studied in previous research (Ekahitanond, 2013; Trehan et al., 2017) The authors also have been analysing the contribution of online discussion activity to measuring CTD ability levels (Nakayama et al. 2021, 2022a, 2022b). In regards to the effectiveness of online discussions (Kusumi and Tanaka, 2008; Leh et al., 2012), registered students were encouraged to join the sessions. As the characteristics of online discussion participants and non-participants were significantly different, simple invitations to join may not contribute to successful development of participant's abilities. However, the effectiveness that is expected from students who join has not yet been confirmed. As this effectiveness may differ according to the characteristics of participants, a detailed analysis will be required.

In this paper, characteristics of students according to degree of participation in online discussions boards are analysed. The following topics will be addressed:

- (1) The contribution of student's characteristics to frequency of participation in online discussion boards was examined by comparing individual factor scores of the metrics surveyed.
- (2) Effectiveness of student's characteristics and the contribution of frequency of participation in online discussion boards toward individual learning performance were evaluated. Also, causal regression of student's characteristics related to learning performance was analysed.

In order to analyse the relationships, the latest survey data from a Japanese university class was introduced.

2. Method

The development of critical thinking disposition was observed during a regularly scheduled on-demand style fully online course at a university in Japan (Nakayama et al., 2021).

2.1 Learning settings

The course was entitled The Psychology of Natural Disaster Mitigation and Prevention, and consisted of 15 sessions. Learning performance of participants was evaluated using several activities, such as weekly confirmation tests and report assignments.

The course has been fully online since 2020. The lecturer recorded videos of his lectures in advance, and the video clips for each session were delivered using an LMS. The main learning assessments during the course were online tests, and report and comment essay writing. The report essay was the main task and was used to evaluate their understanding of critical thinking ability for their final grade.

The participant's essay reports were evaluated by the course lecturer using a rubric which was presented to participants in advance, in order to assess students fairly. The targeted essay assignment was an overall assessment task.

The number of registered students was above 450. The valid number of report essay submissions was 440.

In order to encourage better understanding of the subject matter, all participants were invited to participate in online discussions. Online discussion boards were available throughout the course, and participants could obtain additional marks which contributed to their final mark.

This opportunity represented a significant incentive for students.

2.2 Survey metrics

In order to extract the characteristics of participants in the class, the following inventories were surveyed during the course. Most metrics were measured continuously (Nakayama et al. 2021, 2022b), and some were introduced for the current research purpose.

2.2.1 Personality (Big5)

Scores of participant's personalities were measured using a shortened version of the Big5 inventories, which consists of 10 question items (Kawamoto et al. 2015). The factors which were extracted were Extroversion (P1), Conscientiousness (P2), Neuroticism (P3), Openness (P4), and Agreeableness (P5). The factor scores of the Big5 use 7-point scales (1-7).

2.2.2 Literacy of science and technology (LST)

Kawamoto et al (2013) developed an inventory of science and technology literacy which is based on a survey of scientific literacy. It consists of 10 questions, from which four factors were extracted from the answers: Life-centered (LST-1), Sciencephile (people who are interested in science and technology) (LST-2), Logic-oriented (LST-3), and Authoritarian (LST-4). The LSTs were scored using a 4-point scale (1-4). Four clusters of LSTs were also defined in order to compare behavioural attitudes toward Social science issues using the four dimensional factor scores (Kawamoto et al. 2013).

2.2.3 Critical thinking disposition (CTD)

Hirayama and Kusumi (2004) developed a Japanese inventory of behaviour exhibited during development of critical thinking. Four factors from the inventory were extracted: Awareness of logical thinking (CTD-1), Inquiry-mindedness (Inquisitiveness) (CTD-2), Objectiveness (Objectivity) (CTD-3), and Evidence-based judgment (CTD-4). These CTDs were scored using a 5-point scale (1-5). These metrics were surveyed twice across the course during the first and the second halves. The differential scores between the two surveys are also used in the following analysis, and the sum of the four factor scores is referred as the meta metric of CTD.

2.2.4 Disaster-prevention consciousness (DPC)

These inventories were developed to measure attitude toward disaster-prevention consciousness, and consisted of 20 question items using a 6-point Likert scale (1-6) (Ozeki et al. 2017). The total score is defined as the summation of scores for the 5 aspects (imagination for disaster situations, a sense of crisis about disasters, directivity to others, interest in disaster, anxiety), with the minimum score being 20 and the maximum score being 120. This metric was also surveyed twice during the course, and the two scores were compared.

2.2.5 Weekly test scores (WTS)

The lecturer recorded videos of his lectures in advance, and the video clips for each session were delivered using the university LMS (a Moodle learning management system). All communications such as assignment submissions, online tests, essay report reviews and follow-up surveys were conducted using the LMS. Learning performance was evaluated using online tests such as short written tests which asked about course session topics (WTS).

2.2.6 Essay Report and Comments

All participants were asked to present two types of essays, such as a report essay or a comment essay about a talk given by an invited lecturer (Nakayama et al. 2022a). An essay report task was assigned in order to evaluate student's in class performance, and was to be marked as part of their overall final grade assessment. Another comment task was to summarise their comprehension of the guest lecturer's oral presentation, which consisted of providing information about current communication resources used in natural disaster mitigation. These essays were submitted via the LMS platform, and the lecturer's assessment scores were feedback returned to individual contributors via the LMS system.

Though the length of the essays and styles of presentation differed between individuals, these features were compared and the differences between extracted texts compared as a group.

3. Results

3.1 Levels of participation in online discussions

Unfortunately, the number of online discussants was limited despite of the efforts of the lecturer. In a sense, participation is an indication of individual learning motivation and activity throughout the course. The results show that 127 out of 440 students participated in the discussions. This means that 29 percent of the registered participants joined the online discussions.

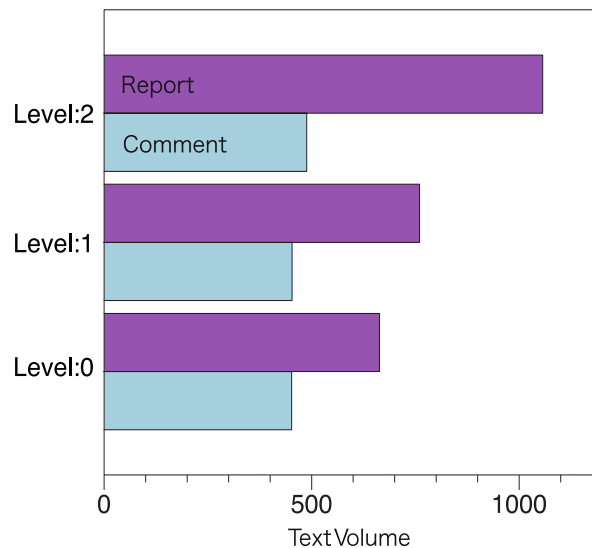


Figure 1. Mean essay volume submitted by students (Report essay and Comment essay) in three levels of online discussion participation

Of those, 64 students posted only once. The remaining 63 students posted an average 3.8 times. Therefore, their motivation for joining may be different from the two other groups. The former group (who posted once) might have joined in order to receive additional marks. The messages sent during the online discussions were analysed, and the lengths of the messages posted by the two groups were comparable. Therefore, it does not seem easy to classify discussant behaviour using only submitted texts. Since the posting frequency was so varied, participants were classified into levels 0, 1 or 2, representing no postings, 1 posting, or frequent postings, respectively.

As an index of learning activity, essay writing may represent in this course. In regards to this hypothesis, the length of report and comment essay texts of participants in the three levels are compared. The results are summarised in Figure 1. There are significant differences in the lengths of report essays submitted by students in levels 0 and 2 ($p < 0.01$), but no significant differences for levels 0 and 1. Regarding comment essays, there are no significant differences between the three levels.

This result suggests that student's attitude toward participation in online discussions may influence their learning activity.

3.2 Characteristics of online discussants

The above result suggests that student's characteristics may influence their participation in online activity such as discussion boards.

Means of factor scores of the surveyed metrics for the three levels of participation are compared. The results are summarised in Table 1. Some of factor scores increase as the level of participation in online discussion increases, such as from level:0 to level:2. One-way ANOVA tests are applied to the scores of survey items. F-values in bold represent significant differences in the three levels, such as Conscientiousness, Openness, and DPC1. Also, knowledge learning performance, known as WTS, and the scores of reports and comment type essay assignments deviated significantly with the level of participation in online discussions. The results confirm that paying attention to online discussion board activity affects a participant's proactive learning.

Table 1. Comparison of factor scores by degree of online discussion participation

Student's characteristics	level:0	level:1	level:2	F-value
PS1: Extroversion	3.77	3.88	4.24	<i>1.76</i>
PS2: Conscientiousness	3.15	3.50	3.58	3.56
PS3: Neuroticism	4.55	4.74	4.72	<i>0.67</i>
PS4: Openness	3.84	3.53	4.24	4.06
PS5: Agreeableness	2.83	2.92	2.97	<i>0.51</i>
KG1: Life-centered	3.57	3.61	3.76	<i>1.25</i>
KG2: Sciencephile	3.65	3.66	3.38	<i>0.31</i>
KG3: Logic-oriented	3.31	3.30	3.33	<i>0.03</i>
KG4: Authoritarian	3.16	3.33	3.22	<i>1.41</i>
CTD1: Critical Thinking Disposition-1st survey	14.3	14.3	14.2	<i>0.03</i>
CTD2: Critical Thinking Disposition-2nd survey	14.1	13.9	23.8	<i>0.41</i>
DPC1: Disaster-prevention Consciousness-1st survey	79.2	83.2	83.3	7.67
DPC2: Disaster-prevention Consciousness-2nd survey	80.8	82.7	83.4	<i>2.24</i>
WTS: Weekly Test Score	746.0	835.9	820.6	8.09
Report essay score	76.4	77.6	81.4	13.2
Comment essay score	82.3	82.7	83.9	3.86

Table 2. Correlation coefficients between factor scores and DPC1(Disaster-prevention Consciousness)

	Overall	level:0	level:1	level:2
PS1: Extroversion	0.28	0.18	0.38	0.49
PS2: Conscientiousness	-	-	-	-
PS3: Neuroticism	-	-	-	-
PS4: Openness	0.15	-	-	0.27
PS5: Agreeableness	-0.20	-0.27	-	-
LST1: Life-centered	0.44	0.46	0.41	0.36
LST2: Sciencephile	-	-	-	0.32
LST3: Logic-oriented	0.22	0.17	-	0.37
LST4: Authoritarian	-	-	-	-

3.3 Contribution of student's characteristics toward attitude

Since some scores for student's characteristics may affect their participation in online discussions, the contribution of attitude toward disaster-prevention consciousness (DPC) is evaluated. Simple correlation coefficients of personality (PS1-PS5) and literacy of S&T (LST1-LST4) with DPC1 are summarised and compared with participation levels in online discussions in Table 2. Here, only significant coefficients are displayed. In PS1: Extroversion, the coefficients increase with the level of participation, while the coefficients of LST1 (Life-centered) stay at the same level of correlation across the three levels of participation, however. Their relationships are summarised in Figures 2 and 3. In Figure 2, the slopes of DPC1 for PS1 increase with the level of participation in online discussions, but the slopes of DPC1 for LST1 shift upward with the level of participation.

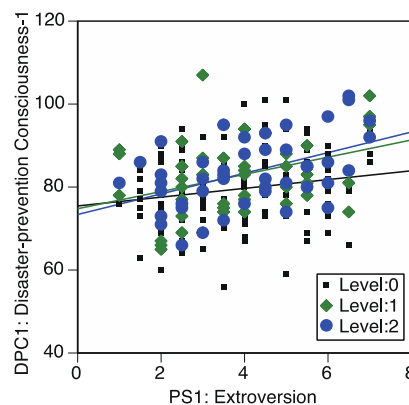


Figure 2. Scattergram of Factor scores of Extroversion and Disaster-prevention Consciousness

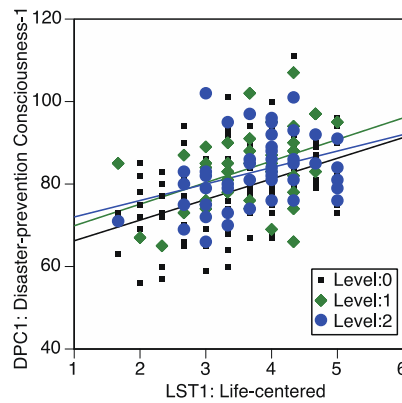


Figure 3. Scattergram of Factor scores of Life-centered and Disaster-prevention Consciousness

These results show the selective contribution of student's characteristics toward targeted learning performance.

3.4 Causal relationship

The relationships between student's characteristics and performance may differ with the type of learning activity during the course. The changes in contributions to the relationships can be extracted using path analysis between the scores of survey items. Similar analysis of online participants and non-online participants was conducted (Nakayama et al. 2022). The degree of participation is introduced into three levels using the same procedure as with the previous model. Therefore, a structural equation modelling technique was applied and the results evaluated using a causal relationship between them (Nakayama et al. 2021, 2022).

The causal relationships were evaluated using indices of the fitness of the model (the GFI: Goodness of Fit index, AGFI: Adjusted GFI and RMSEA: Root Mean Square Error of Approximation) (Toyoda, 2007). The contributions of some factor scores were checked to optimise the model.

As a result, a possible causal path was extracted, as shown in Figure 4. The model was significant in regards to the evaluation indices (GFI=0.82, AGFI=0.75, RMSEA=0.044). In this survey, as a DPC metric has been introduced recently, it cannot be implemented in the model. Though there are significant correlation relationships between DPC and CTD scores, their contribution value may be different. Since three participation level groups were introduced, path coefficients between the levels were not tested. Also, the path coefficients of participation level:1 (who posted once on the discussion board) should be examined to determine whether these participant's attitudes are similar to or independent of those of other participation levels. Most coefficients for participants are similar to those for non-participants (level:0) or multiple-time participants (level:2), though some coefficients are independent of these relationships. For example, the coefficient of level:1 for path to "report essay assessment" drops in comparison with other groups.

Further analysis will be a subject of our further study.

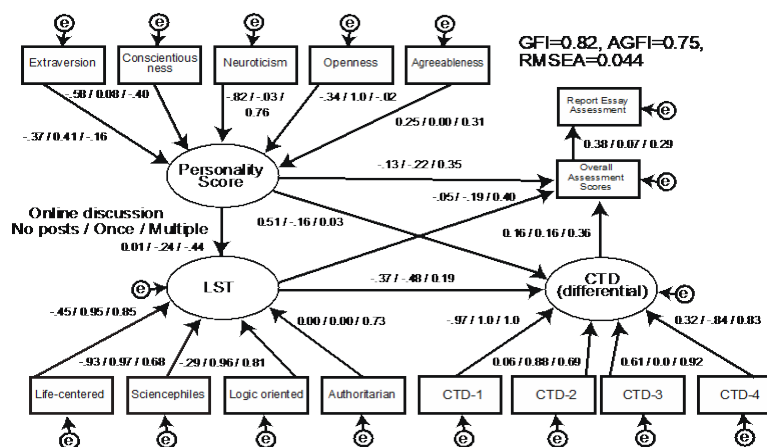


Figure 4. Causal relationship between student characteristics (Personality and Literacy of Science and Technology) and development of critical thinking disposition with levels of participation for discussions.

4. Summary and discussion

This paper presents the contribution of student's characteristics toward degree of participation in online discussion boards and evaluates learning performance during a fully online course using surveyed metrics. Student's characteristics and learning performance were measured during a course which aimed to develop a better attitude toward effective natural disaster prevention and mitigation. An online discussion board was organised by the lecturer, and student's degree of participation was sorted into three levels. The effectiveness of the level of participation in online discussions was evaluated using factor scores of the student's characteristics.

First, some characteristics of students, such as personality traits related to consciousness and openness contributed to their degree of participation in online discussions. Also, scores of disaster-prevention consciousness (DPC) also increased with the level of participation. Learning performance also advanced with the level. Targeted abilities such as DPC also correlated with the scores for characteristics of some students.

Second, the ability and attitude of the participants who were invited to join online discussions (level:1) were examined using a causal relationship analysis. In regards to specific causal path coefficients, only a few irregular values were observed. It may be necessary to continuously invite participants to join the online discussions throughout the course as a means of ensuring sufficient levels of participation.

A detailed analysis of this will be the subject of our further study.

Acknowledgement

This research was partially supported by the Japan Society for the Promotion of Science (JSPS), Grant-in-Aid for Scientific Research (KAKEN, 21K18494: 2021-2023).

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