Practice of Online Course Using Diamond Mandala Matrix at A Japanese University Designed Based on ICE Approach and Its Results from Text Data Analysis

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Abstract

We will show the practice of a course on the fundamentals of space and universe (79 students) of a Japanese university and its results of a textual analysis applied to text data input by students into the Diamond Mandala Matrix (dDMM) in the spring semester of 2022. The course was designed based on the ICE approach in a flipped classroom for proactive and deep learning to have enough time for group work, presentations, and discussions in real-time online classes. Students will organize their thoughts into a dDMM across multiple themes during the preparatory, group work, and re-view phases. In the approach, the learning process is divided into I, C, or E, which can be identified based on verbs used in a sentence. We defined that increasing the proportion of C and E in the students' sentences of the dDMM is an indicator of proactive and deep learning in our study. From a chi-square test applied to sentences, input by students into dDMM, the in-crease in C was observed, which is a positive result in terms of the realization of proactive and deep learning. We plan to test the effectiveness of the generative AI-added function to dDMM applications.

1. Introduction

In this paper, we will show the practice and results of its analysis of a course on fundamentals of space and universe (79 students) in the spring semester of 2022 at a Japanese university designed as a flipped classroom based on the ICE approach [1]. In the course, students used the digital Diamond Mandala Matrix (dDMM; Fig. 1) application [2] and we analyzed the text data input by the students in the dDMM application with KH Coder [3,4,5]. The course is officially in an on-demand format as instructed by the university, but real-time online classes were combined for those who wished to take the class. The analysis was conducted on the students who participated in the real-time online classes. Flipped classroom is an educational method developed mainly in primary and secondary education in the United States since the late 2000s, and refers to a format in which students prepare for class by acquiring knowledge before participating in class. Currently, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan is promoting proactive and deep learning in high schools, so in a few years, students with that education will enter universities. We must use in-class time for discussion and group work for proactive and deep learning. So, flipped classrooms are necessary. In addition, dDMM is an effective tool for organizing thoughts [1]. Therefore, our study is important on higher education.

We have been researching to develop methods and effective tools for designing courses that lead students to proactive and deep learning using the results of text analysis on student submissions on the ICE approach. The ICE Approach is a framework to proceed and trace the learning process. In the approach, the learning process is divided as I (ideas), C (connections), and E (extensions), and learning proceeds according to

this learning cycle (from I to C through E).

In the course, class time is not used for imparting knowledge, but for presentations and discussions to realize proactive and deep learning, and a flipped classroom format is used, where students get knowledge from contents prepared by the lecturer before the real-time online classes and organized their thoughts in dDMM application. Students participate in the class present their own thoughts and discuss, after that they put them together as a group through group work. It is expected that the percentage of C and E in the sentences input into dDMM application will increase as they learn.

As the course was officially conducted in an on-demand format according to university policy, it was up to the students to decide whether or not they would participate in the real-time online class as an option. However, students who did not participate in the real-time online class were also able to view the video recording of the real-time online class so that they could grasp the presentations and discussions.
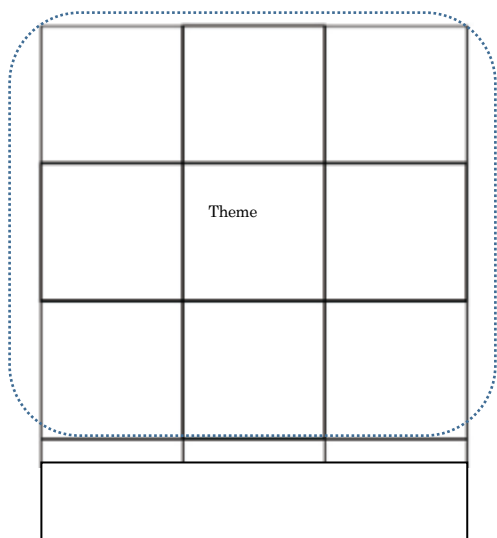
Figure 1 Diamond Mandala Matrix
Students enter their thoughts on the central theme specified by the teacher in short sentences in the eight surrounding cells (dotted line box). In the description field at the bottom (single dotted line box), they enter their thoughts as sentences using the short sentences entered in the upper cells. The contents of the sentences in these cells are the object of analysis.

2. Tools and course design

The following tools were used for the purposes described in the Introduction.

1. Digital Diamond Mandala Matrix (dDMM) applications. Details are shown below.
2. Zoom Meeting; It was used to conduct real-time online classes.
3. KH Coder; It was used for textual analysis of the students' submissions (data input into dDMM). As preliminary processing, typographical errors were corrected and vocabulary was standardized.

We have been developing the dDMM application as a tool for deploying thoughts and aggregating and integrating the opinions of members through cooperative learning in group work, etc. In the classes, dDMM was used for organizing to summarize thoughts in groups for presentations and discussions. Unlike presentations using applications such as Microsoft PowerPoint, the dDMM allows presenters to show their whole thoughts on a single screen, so dDMM is suitable for presentations and discussions. The image is that of a concept map with a vocabulary limited to eight words (the central concept is specified by the lecturer as the theme) (dotted line box in Fig. 1), with an additional column of sentences explaining it (the subject of analysis in this paper) (single dotted line box in Fig. 1). In past cases, the dDMM application has been useful in terms of sharing each other's thoughts and broadening horizons [2].

We designed the course working flow as follows (Fig. 2).

1. (1st week) As a record of the first stage of thoughts, the students will summarize their thoughts on the theme 'What is the universe for you?' in a dDMM.
2. (Weeks 2 to 15) Before participating in the real-time online classes, students study the content prepared by the lecturer (pdf and video of approximately 90 minutes) and prepare themselves for the classes by

researching the theme by the lecturer and summarizing their thoughts in a dDMM as 'pre-learning'.

3. (Weeks 2 to 15) During the real-time online class, students present their own thoughts and the thoughts they have put together as a group for the dDMM through group work and discuss them based on these thoughts.

4. (Weeks 2 to 15) Based on the presentations and discussions in the real-time online classes, the students organize their thoughts on the same themes as those tackled in the 'pre-learning' into a dDMM application as 'post-learning'.

5. (Last week) Students organize their thoughts on the same theme as 1st week, 'What is the universe for you?', in a dDMM. The purpose of this is to reflect on students' own learning by comparing it with the dDMM of 1st week when they create a Learning Portfolio.

6. (Last week), students summarize what they have learned in the dDMM. This is not the subject of analysis in this paper.

7. (After last week) At the end of all the course, the students prepare a Portfolio as a summary of their learning. They reflect on what they have learned, and summarize how their thinking have changed or not changed

and the reasons for this. To support their explanations as evidence, they were asked to use the dDMM created in their 'pre-learning' and 'post-learning'.

The themes set by the lecturer for weeks 2 to 15 were in the following order.

1. What is the Sun for you?
2. How to live on the Moon?
3. How to live on Mars?
4. How to select an exoplanet to live in?
5. How to effectively utilize stellar energy?
6. Our relationship with the Big Bang
7. Our relationship with nucleosynthesis in the universe

3. Results and Analysis

In the ICE approach, it is assumed that whether a description corresponds to I, C, or E is determined by the verb. For this reason, the sentences written in dDMM (single-dotted box in Fig. 1) were analyzed by KH Coder. Based on the correspondence analysis diagram (Fig. 3) created from the results of analyzing the sentences in the dDMM for the theme "What is the universe for you?" in the 1st week and the last week, the following descriptions were identified to I, C, E, respectively.

1. Description including vocabulary characteristics of the 1st week
   i. identified as I. 'Listen to the universe'.
   ii. identified as I. "Listening to new perspectives"
   iii. Expanding was not identified to be C or E due to its use in facts, e.g. 'The universe is expanding.'

2. Descriptions containing vocabulary characteristics of last week.
   i. Identified as I. "I got to know the principles of the universe."
   ii. Identified as I, "I also learned that the universe is still getting bigger."
   iii. Identified as C: "It also led to a wider reminder."
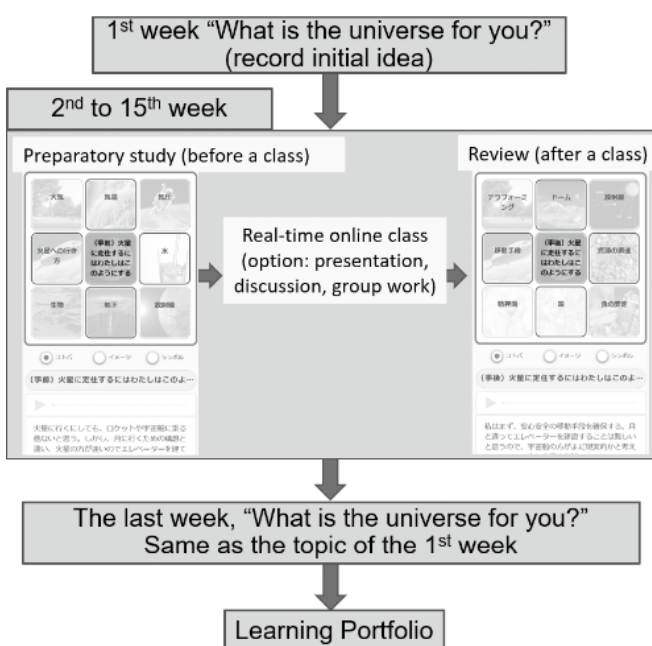   iv. Identified as C: "I realize that it leads to a

Figure 2 Working Flow of the Course

better understanding of nature."

v. Identified as C: "A lot of changes will happen to us."

vi. Identified as E: "I now see space as a step into the future."

We defined that increasing the proportion of C and E to I in the students' sentences of the dDMM is an indicator of proactive and deep learning in our study. Thus, the following rules were also established for cross-tabulation (Fig. 4). Then, we performed a chi-square test on the verbs used in sentences.

1. If 'know/hear/receive/understand/learn' is expressed, it is considered I.

2. If 'connected' is shown, it is considered 'C'.

3. If 'change/research' is shown, consider it as E.

From the results of the chi-square test, we can say that the verbs identified as I and C are significantly more frequent last week than after 1st week at a significance level of 5%. In particular, the increase in C is a positive result in terms of the realization of proactive and deep
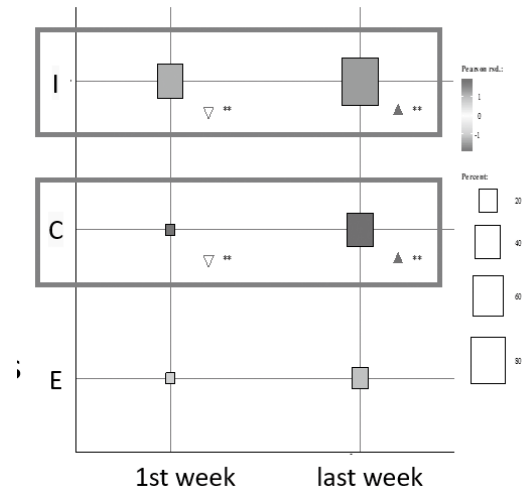

Figure 4 Diagram based on cross-tabulation
Size of rectangular '□' : frequency of occurrence
Color: percentage obtained from cross-tabulation.
**: significant at 5% level of significance by chi-square test
Judgments of I and C are significantly different between '1st week' and 'last week'.

learning. It is possible that the reason for the increase in I is due to a change in the students to be more specific about what they have learned, but further analysis is needed.

4. Future work

The function of the generative AI (Chat GPT, BARD) was implemented as a function of Digital Mandala. This aims to utilize other viewpoints generated by the generative AI as reference information. In the future, this function will be used in classes to verify its effectiveness. In addition, as the classes analyzed in this paper have returned to a face-to-face format from spring 2023, we plan to com-pare the practical results in those classes with the results presented in this paper.

5. Summary

This paper presents the results of a textual analysis of the Diamond Mandala Matrix (dDMM) input by the students in a course of the fundamentals of space and universe (79 students) combining the on-demand format of a Japanese
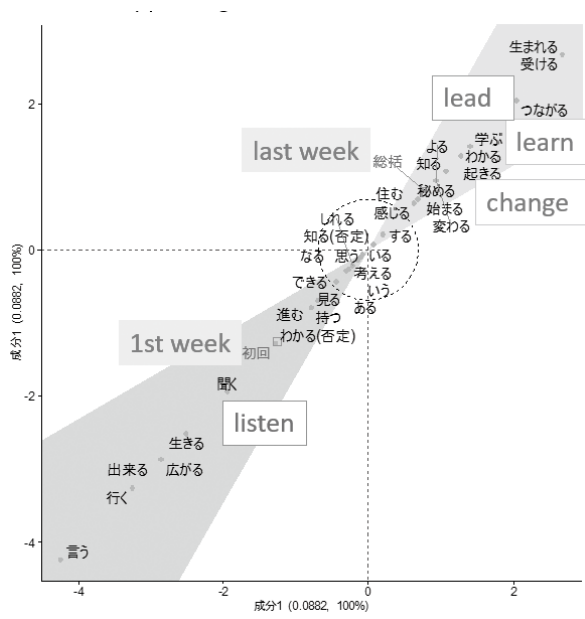

Figure 3 Correspondence analysis chart of verbs in the sentence description field of dDMM

The verbs that appeared four or more times were compiled for each sentence. The verbs on the side of '1st week' from the center (verbs in the blue area in the bottom left) indicate those with a higher proportion of occurrences in '1st week' than in 'last week'. The verbs in the orange-colored area on the upper right-side show, conversely, the verbs that have a higher proportion of occurrences in the 'last week' than in the '1st week'.

university with a free participation real-time online format, offered in the spring semester of 2022. The course was designed based on the ICE approach in a flipped classroom for proactive and deep learning by increasing the proportion of C and E in the students' sentences of the dDMM, so that the real-time online classes were used for group work, discussion, and presentations. dDMM was used for students to organize their own thoughts: pre-learning by studying pdfs and videos prepared by the teacher, group work and presentations in the real-time online class, and post-learning by students as a review. An analysis of sentences of the dDMM, in which students wrote about the theme 'What is the universe for you?' in weeks 1 and 15, showed that the number of students who used verbs that corresponded to I and C increased significantly last week, based on the ap-plication of a chi-square test. The increase in C, in particular, is a positive result in terms of the realization of proactive and deep learning.

In the future, we will test the effectiveness of the generative AI (Chat GPT, BARD) as a new function added to dDMM application and compare the practical results of the face-to-face classes from Spring 2023 with the results shown in this paper.

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