The impact of multimodal approach on the efficacy of artificial intelligence online course from the social constructivism perspective

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ABSTRACT – Various courses have now adopted online learning which highlights the benefit of temporal and spatial freedom. In this study, a multimodal approach was applied in delivering an online Artificial Intelligence course. This study investigates the impact of the implementation on the efficacy of the online course from the social constructivism perspective. The quality of the delivery was assessed using the Constructivist Online Learning Environment Survey (COLLES). From the result, the highest-rated criterion was tutor support with a mean of 4.4 ± 0.6 while the two lowest-rated criteria were interactivity (3.6 ± 1.1) and peer support (3.6 ± 1.0).

1. INTRODUCTION

Online learning is no longer an uncommon concept in today's world. The fundamental notion of online learning that promises temporal and spatial flexibility as well as education without borders has seen it become a popular concept in delivering knowledge in the 21st century. With the advancement of technology, online learning does not only support traditional teaching methods but also disrupted the normal ways of obtaining education where more and more distance education and online learning degrees are being offered by universities. In order to reap the full benefits of online learning, proper planning and implementation are needed. This includes designing an environment that is interactive, engaging and promotes strong tutor as well as peer support [1]. An online course should also be designed with the social constructivism theory in mind. Social constructivism is an approach where learners construct their understanding of the subject through social interaction and active participation [2]. Such an approach encourages collaboration between students with knowledge being constructed and curated together, with the tutor as a facilitator.

As students learn in different styles, it is important that the content and activities provided cater to each preference to ensure engagement and participation in learning. A multimodal teaching approach, integrated with current learning technologies allows for students with different learning preferences to stay engaged and interested throughout the course [3]. This study investigates the impact of using a multimodal approach on the efficacy of an online artificial intelligence course from the social constructivism perspective.

2. METHODOLOGY

This study was conducted based on the online implementation of an artificial intelligence course in a public university in Malaysia. The study was conducted for 14 weeks where a survey was performed before concluding the course.

2.1 Multimodal Approach

An online course can be delivered through synchronous, asynchronous, or hybrid methods. In this course, lectures are delivered using a hybrid method where some are delivered synchronously while the rest, asynchronously. The course has a Microsoft Team page and a WhatsApp group to aid communication and conduct synchronous activities. The course also uses a Learning Management System (LMS) which stores learning materials and serve as a platform for asynchronous activities.

The content was delivered using various modalities catering to different aspects of the VARK (visual, auditory, reading / writing, and kinaesthetic) model. Students who are visual learners learn through seeing. Therefore, they need to be provided with pictures, graphs, illustrations, and videos to help them better understand the learning materials. In this course, several e-contents that suits the students with visual learning style were provided. For example, a 12 slides lecture presentation were converted into a 2-minute animation video. Important topics in lectures were also converted into posters to grab the students' attention as shown in Figure 1. Relevant comics were also curated so that it is easier for the students to understand by using examples.

Figure 1 Posters that highlight important subtopics.

Students who are auditory learners learn best through hearing. This type of students benefits the most in the traditional lecture setting as hearing helps them

remember. Therefore, even in the online delivery setting, synchronous lectures are still performed. To cater to students who are reading / writing learners, lecture slides and eBooks were also provided to them. Figure 2 shows an interactive eBook on the AI application topic. Students were also given the chance to become the curator and constructor of their own knowledge through self-directed learning activities such as discussions of case studies, glossary development, debates, as well as poster exhibitions. Various learning technologies were also used to support the activities. For example, students use Padlet[1] as a collaborative space, Flipgrid[2] to voice out their opinions, and Mentimeter[3] to cast votes and test their understanding using a quiz.

Since artificial intelligence is not a simple subject to learn as it requires technical understanding, students often appreciate hands-on activities. This is especially for kinaesthetic learners as they learn best by doing and experiencing. For example, asking the students to play a game called Quick, Draw![4] allows them to have hands-on experience on artificial neural network. Google's Teachable Machine[5] was also used to allow students to experience how machine learning performs classification. Figure 3 shows a screenshot of Teachable Machine for hands-on classification experience.

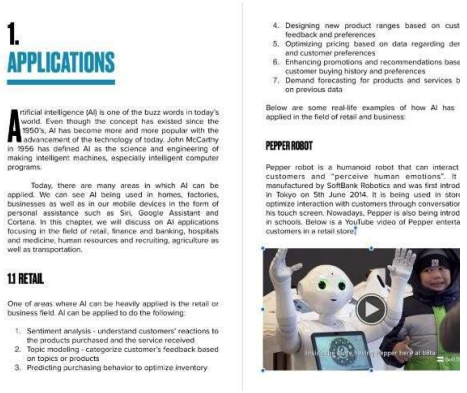

Figure 2 Interactive eBook on AI application topic.

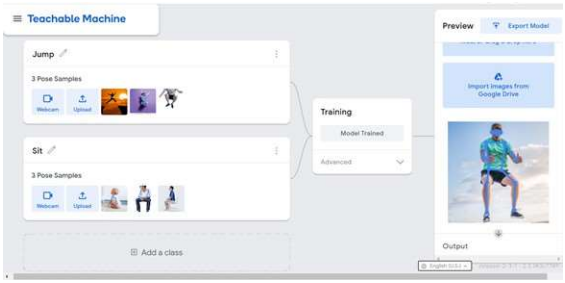

Figure 3 Screenshot of Teachable Machine for hands-on classification experience.

Leveraging the usage of a WhatsApp group for communication, four games on topics related to artificial intelligence were designed. Referring to the taxonomy of game elements [4], acknowledgement, competition, point, puzzles, social pressure, and time pressure were included in the design of all four games which affects students' engagement and motivation. During these games, acknowledgement and feedback from the tutor were also given from time to time in form of praises to encourage students' participation and rewarding their efforts. Discussions were also held after each question to explain the answers to the students and ensure their understanding. Gamification was also introduced in certain topics such as shown in Figure 4 where an "Exit the Maze" game was used to teach the intelligent agent topic.

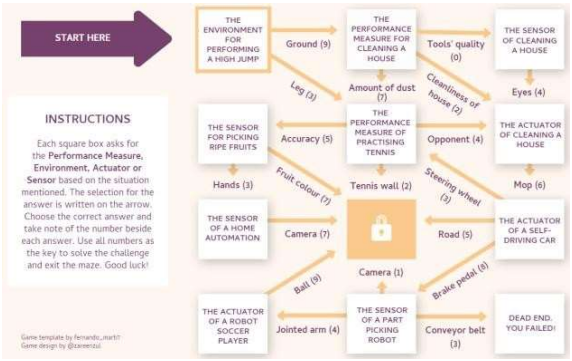

Figure 4 Screenshot of the "Exit the Maze" game

2.2 Survey

The Constructivist Online Learning Environment Survey (COLLES) was designed to assess key quality criteria that make a good online learning course from the perspectives of social constructivism [5]. The survey consists of 24 statements whereby every four statements belong to one of six quality criteria. The six criteria are:

a) **Relevance**: the extent to which online learning is relevant to students' professional practice,
b) **Reflective thinking**: the extent to which online learning stimulate students' critical reflective thinking,
c) **Interactivity**: the extent to which students engage online in rich educative dialogue,
d) **Tutor support**: the extent to which tutors enable students to participate in online learning,
e) **Peer support:** the extent to which students provide each other sensitive and encouraging support,
f) **Interpretation:** the extent to which students and tutors make good sense of each other's online communications.

COLLES consists of three types of forms which are preferred, actual and a combination of preferred and actual, each with its purpose. In this study, the actual form was deployed to students at the end of the course to gauge the students' experience in online learning. The survey was developed using a 5-points Likert scale where students will rate each statement as almost never (1), seldom (2), sometimes (3), often (4) and almost always (5). Based on the ratings, the mean and standard deviation are calculated for each of the quality criteria.

[1] https://padlet.com/
[2] https://flipgrid.com/
[3] https://www.mentimeter.com/
[4] https://quickdraw.withgoogle.com/
[5] https://teachablemachine.withgoogle.com/

The higher the mean, the better the learning experience is for the students. The standard deviation score shows the level of agreement between the students in rating the mean score for each criterion.

3. RESULTS AND DISCUSSION

There were 39 students (68%) who responded to the COLLES out of 57 students enrolled in the course. The respondents were undergraduate students mostly enrolled in the software engineering programme. They consist of 14 males and 25 females. The average age of the class was 21 years old with an average grade point of 3.6 ± 0.5.

At the end of the course delivery, a self-reflection was performed by the tutor, and it was judged that the course was delivered successfully based on the fact that the students achieved a good average grade point, and all three learning outcomes were attained. The feedback from the students was also positive and the level of interaction between tutor-student and student-student were also high. To validate this, the result from the COLLES were analysed.

Figure 5 summarised the result of the COLLES based on the six criteria. A more detailed result showing the means and standard deviation for each criterion is also presented in Table 1. From the summary of the result, it can be seen that the students were almost always satisfied with the tutor support whereby it has the highest mean of 4.4 ± 0.6. Statements such as "the tutor encourages me to participate", "the tutor models critical self-reflection" and "the tutor models good discourse" were rated highly by the students with very small dispersion. The students also showed that they were often satisfied with the criteria of relevance (3.9 ± 0.7), reflective thinking (3.9 ± 0.8) and interpretation (3.9 ± 0.9). These include statements such as "my learning focuses on issues that interest me", "I think critically about how I learn" and "the tutor makes good sense of my messages".

The two criteria with the lowest mean were interactivity (3.6 ± 1.1) and peer support (3.6 ± 1.0). For interactivity, the four statements given were "I explain my ideas to other students", "I ask other students to explain their ideas", "other students ask me to explain my ideas" and "other students respond to my ideas". The four statements rated by students for the peer support criterion were "other students encourage my participation", "other students praise my contribution", "other students value my contribution" and "other students empathise with my struggle to learn". Although these two criteria received the lowest mean, the standard deviation were high which means that there is a huge dispersion in the responses.

Overall, the students rated the course a mean of 3.9 ± 0.9. This is generally a good score as the students were often satisfied with the course delivery. The high mean score for tutor support was justified by the fast response and on-time feedback provided by the tutor, enabled by various learning technologies. Playing games on WhatsApp proves to be beneficial in building a good rapport between the tutor and the students. The informal session makes the students feel more comfortable interacting with the tutor in a casual manner. The students view the tutor as approachable which allows the tutor to simulate the students' thinking, encourages them and models discourse as well as self-reflection.

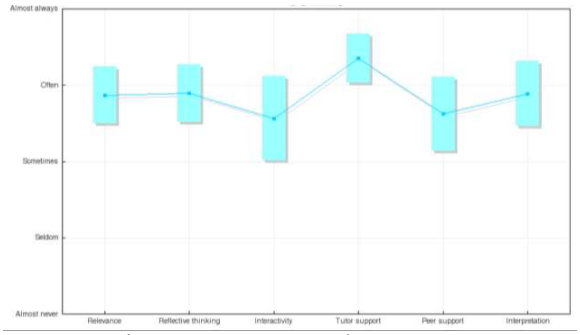

Figure 5 COLLES result summary.

Table 1 Means and standard deviations for each criterion in the COLLES.

Criteria	Mean	Standard deviation
Relevance	3.9	0.7
Reflective thinking	3.9	0.8
Interactivity	3.6	1.1
Tutor support	4.4	0.6
Peer support	3.6	1.0
Interpretation	3.9	0.9

As mentioned before, the tutor views the delivery of the course as successful and highly interactive with the usage of multimodal learning tools. The students were also believed to have well supported one another especially through collaborative activities such as group discussions, developing wiki pages and playing games. However, the result of the COLLES shows otherwise with the criteria of interactivity and peer support being the lowest rated.

The possible reason that interactivity was rated low is because of the unclear expected discourse from the students. Some of the activities and discussions involve questions that have a definite answer. Questions such as identifying characteristics of a game did not encourage a lot of discussion from the students. This is because once a correct answer has been given, there will be no further debate. Ill-defined problems or opinionated questions are much more suitable as it encourages further discussion.

The size of the class is another factor for the low scores of the interactivity criterion. A large class would not give an equal chance for all students to voice out their ideas and get valuable responses from their peers. Although the usage of tools such as Mentimeter increases participation, the response to the ideas is mostly from the tutor rather than their peers. A large class also makes it easier for students to be passive compared to a smaller class. Students are also keener to keep their opinion on their peers' ideas to themselves as they believe that this is normally the task of the tutor.

Another factor could be caused by the personal distance between the students which makes them quite shy and lack of confidence in sharing their thoughts and ideas. This can be seen by the higher mean (3.7 ± 1.1) for

the statement "I ask other students to explain their ideas" as compared to "I explain my ideas to other students" (3.5 ± 1.1). Therefore, even though various modes of learning have been adapted, the participants or contributors to the activities have always been the same set of students. This is reflected by the large standard deviation in the response where the active students rated the interactivity criterion high, and the passive students rating is low.

The physical isolation between the students could be a huge factor in the low scores for the peer support criterion. The students are much more supportive in encouraging other students' participation in the class (3.7 ± 0.9). However, they are not too eager to praise and value their peers' contributions. In a traditional setting, this might happen outside the classroom when they are in smaller groups. When being online, this is much harder to do since there are a lot of students and being physically away might not give them a sense of belonging. The students also feel that their peers did not empathise with their struggle to learn. This could also be because of the online learning concept of openness that discourages private conversations such as the struggle to learn.

4. CONCLUSIONS

The implementation of a multimodal approach in the online delivery of an artificial intelligence course does have an impact on its efficacy. The diversity of the learning technologies used help in building a good relationship between the tutor and the students which then encourages students' participation in the class. The impact of the multimodal approach was assessed based on the social constructivism perspective using the COLLES. The results validate that a multimodal approach has a positive impact on the efficacy of an online artificial intelligence course. This can be seen by the overall mean score of 3.9 ± 0.9 and high mean scores for tutor support (4.4 ± 0.6), relevance (3.9 ± 0.7), reflective thinking (3.9 ± 0.8) and interpretation (3.9 ± 0.7) criteria. However, the multimodal approach still needs to be improved by addressing the problems highlighted in this study, so that the means score for the interactivity and peer support criteria can be improved.

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