THE PATTERN OF LEARNER-CONTENT INTERACTION USING INTERACTIVE DIGITAL MATERIALS IN AN ONLINE LEARNING-BASED

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Abstract

Interaction between learners and learning content is one of the most important aspects in the learning process. The study was designed to facilitate learners-content interactions by developing interactive digital content termed as Interactive Digital Materials (IDM). This study aims at exploring the learner-content interaction in the context of online learning environment, to see how students use the IDM, and whether there is any pattern in how students interact with the content within the IDM. The digital learning material that was used in the study was defined as self-contained and interactive learning material that consists of text-based materials enriched with illustrations and videos. The study used one Universitas Terbuka's graduate course (Design and Model of Innovative and Interactive Instructions or MPDR 5203). The observation of the learner-content interaction was done through two approaches: (1) the IDM was provided through a web-based Learning Management System (LMS) and students were expected to read the IDM online and (2) the IDM was provided also through an application based LMS that was pre-installed in a computer tablet lent to the student, and students were expected to read the IDM either online or offline. Interaction data was collected electronically through the LMS data analytics.

Keywords: learner-content interaction, learning interactions, online learning, distance learning.

1 INTRODUCTION

Interaction between learner and learning content is a major component and fundamental in any learning process, and it is especially true in online learning mode (Bernard et al., 2009; Zimmerman, 2012). In terms of online learner-content interaction, not only it supports passive interaction between learners and the content, but it also enables new opportunities to use of interactive content that can respond to student behavior (Anderson,2008). Kearsley in Zimmerman (2012) mentioned that to comprehend the learning materials, interaction between learners and learning content occurs when leaner do the actual studying, such as reading learning content, giving highlights, doing self-tests etc. While Kumar, Saxena, and Baber (2021) denoted learning content as a comprehensive and accurate learning material delivered to learners.

With today's technological advances, the development of interactive learning material with various learning activities is becoming more popular in online learning's environment. However, according to Kumar, et al (2021), online learner-content interaction has never been studied in too detail. This condition is contradictory to the important meaning of learner-content interaction in online learning that indicates the interaction between learners, learning resources and learning programs. Therefore, it is deemed necessary to conduct a study the interaction patterns of students with the content delivered as digital learning materials (Zimmerman, 2012) to observe the activities happened during the learning process.

In accordance with this, UT has been trying to develop course materials that are designed to enhance learner-content interactions. One of the development projects was conducted for this study, which initiated by converting the printed based learning materials into interactive digital materials termed as Interactive Digital Materials (IDM). To see how students use the IDM, and whether there is any pattern on how students interact with the content within the IDM, the completed IDM was then used in a two-phase experiment as follows.

1 In the first phase the IDM was provided through a web-based Learning Management System (LMS) and students were expected to read the IDM online.

2 In the second phase, the IDM was provided also through an application- based LMS that was pre-installed in a computer tablet lent to the student, and students were expected to read the IDM either online or offline.

The second phase was conducted based on the result of the first phase which reveals that reading the IDM online was difficult due to poor and unstable Internet connection in students' place.

2 METHODOLOGY

As an experimental research, data on students' behavior in reading the IDM was collected based on their real activities in using the IDM. The experimental intervention in this study is the provision of the IDM, which is enriched (with videos, pictures, and highlight of some key content) interactive digital learning materials that are developed based on printed-based learning materials.

As previously explained that the experiment was done by providing the IDM through the online tutorial in two phases, which are in the second semester of 2018/2019 and in the first semester of 2020/2021. Students' behavior in using the IDM was electronically recorded by the LMS and thus becoming the data for this study.

The learning materials used for this study was one of the graduate courses titled *Design and Model of Innovative and Interactive Instructions* (Disain dan Model Pembelajaran Inovatif dan Interaktif). The course consists of nine (9) modules and each module has 1-3 units of learning activities (LA). In the first phase, only Module 5 and Module 6 were converted into IDM format and provided to all registered students for the course in the semester in which the experiment was conducted (second semester of 2018/2019). The 'web-based' version of LMS used in the first phase experiment allows the study to include all students who are spread in several cities in the country. In the second phase however, because the IDM were provided through a pre-installed 'application-based' LMS in a limited number computer tablet lent to students, the IDM were only provided to selected students in the city of Jakarta and Bogor. Nevertheless, in the second phase, all nine modules were converted into IDM format. The IDM was formatted as SCORM file so that students' activities within the IDM can be tracked as the data of the learner-content interaction.

The first phase of the experiment in the semester of 2018/2019.2 involved all 266 students who registered in the MPDR5203 course, and they were spread in 10 cities within 8 provinces in Indonesia. As Table 1 shows however, only 148 (58%) students 'read' the IDM, and their data used for the analysis of the first phase. As the IDM was a converted format of the printed learning materials, students still had the choice to read the content through either the printed version, the IDM version, or both. In other words, the use of IDM in the online tutorials was not obligatory, it was only intensely encouraged by the tutors.

For the second phase however, even though there were 299 students registered for the course of MPDR5203 in the first semester of 2020/2021, only 20 students were invited to be involved in the experiment due to the limited number of computer tablet to be lent to the students. Out of those 20 invited students, only 18 students participated. Two students failed to pay the tuition fees in due time and thus were not able to take the course.

3 RESULTS

3.1 The Number of Readers, Reading Frequency, and Duration of the Interactive Digital Materials

As stated earlier, the objective of the study is to see how students interact with the content in the IDM. The interaction is defined as students' activities in using (opening, reading/viewing) the IDM. The first set of data observed was the number of students who take advantage of the IDM, the frequency of opening and reading the IDM and the time duration students spent with the IDM.

The total number of students in Phase 1 who were recorded to have opened the IDM of both Module 5 and Module 6 is 148 (defined as the participants). Table 1 shows that not all 148 participated students read the IDM of both Module 5 and Module 6, only 112 students 'read' Module 5 and only 99 students 'read' Module 6. In addition, 26 out of the 112 (23%) of students who read Module 5 and 20 out of the 99 (20%) students who read Module 6 could be categorized as non-starters, as they only recorded to read the cover page of the IDM. While in the second phase, although all 18 participated students opened the IDM, not all students actually read through some of the content (opened beyond the cover page) either. The number of students who read the modules also tend to be less in the latter modules. In summary, the average percentage of students reading the IDM in the first phase is 31% and in the second phase is 75%. With the acknowledgement that the number of participants in the second phase

is very small, this finding indicates that the use of computer tablet and an 'application-based' LMS to deliver the IDM seems to have increase the possibility of students read the provided IDM, which may be potentially enhance the learner-content interactions.

Table 1. Numbers of Readers

Number of Students	Module								
	1	2	3	4	5	6	7	8	9
Phase 1									
Not Open at all					154	167			
Open only Cover					26	20			
Readers					86	79			
Total Respondent					266	266			
Phase 2									
Not Open at all	0	5	2	6	2	4	2	5	3
Open only Cover	0	1	1	2	1	1	0	0	1
Readers	18	12	15	10	15	13	16	13	14
Total Respondent	18	18	18	18	18	18	18	18	18
	100	67	83	56	83	72	64	72	77

Regarding frequency of opening and reading the IDM, Table 2 presents the frequency of the students opened the IDM. As the IDM was provided to students through online tutorial sessions, and modules were deployed gradually in sequence in accordance with the relevant sessions for the topic, students had the opportunity to open and read each module for one week before the following module was uploaded into the online tutorial platform. Students may read the module at once or gradually within the week. Modules were also available throughout the semester once they have been uploaded.

As shown by Table 2, most students in Phase 1 (96%) opened the IDM only once (one login), only few students opened the IDM more than once. In fact, none of the students opened Module 5 more than twice. While for students in the second phase, Table 3 also shows that for Module 1 for example, most students (67%) read the module twice. Although it does not present any specific pattern, it seems that in general most students read each module once or twice, and very few students read more than two times. The findings based on these two phases shows that the use of tablet-based IDM, even though it can be read offline, does not seem to influence the frequency of students to open and read it.

Table 2. Frequency of Reading IDM

Frequency of Access	Module								
	1	2	3	4	5	6	7	8	9
Phase 1									
1 time					108	80			
2 times					4	16			
3 & 4 times						2			
No record						1			
Total					112	99			
Phase 2									
1 time	3	13	8	8	7	9	11	3	4
2 times	12	0	8	4	7	4	5	5	4
3 times	3	0	0	0	4	1		1	4
No record	0	0	0	0	0	0	0	4	3
Total	18	13	16	12	18	14	16	13	15

Nevertheless, if we look further to the time duration spent by students in reading the IDM, we can see the difference between Phase 1 and Phase 2 (Table 3).

Table 3. Duration of Reading Activity

Duration	Module								
	1	2	3	4	5	6	7	8	9
Phase 1									
Range in minutes					0 – 73	0 - 319			
Average Duration of readers in minutes					12.47	32.29			
Average Duration of readers in hours					0.21	0.54			
# of students spent ≥ 1 hour					4	12			
Phase 2									
Range in minutes	20-1343	11-783	3-1571	1-443	8-1051	1-2302	1-950	2-758	1-2733
Average Duration of readers in minutes	521.28	409.3	364.00	98.00	320.07	3246.4	207.43	220.4	709.0
Average Duration of readers in hours	8.69	6.82	6.07	1.63	5.33	54.11	3.46	3.67	11.82
# of students spent ≥ 11 hours	7	2	3	12	4	1	2	1	3

As presented by Table 3, the reading duration of students in Phase 1 ranges from zero (0) to 1 hours 13 minutes (73 minutes) within Module 5 and from zero (0) to 5 hours 19 minutes (319 minutes) within Module 6. The increased length of reading time from Module 5 to Module 6 most likely is caused by the difference length of the modules, where Module 5 only contains 2 units of Learning Activity (LA) while Module 6 contains 3 units of LA. However, the average time students spent in reading the modules are both very short (an average of 12.47 minutes in Module 5 and 32.29 minutes in Module 6). In fact, data show that only very few students spent more than one hour reading the modules (4 students in Module 5 and 112 students in Module 6). Those data imply that students may still prefer to read the content from the printed Modules. Furthermore, over 50% of the 26 students who were invited into the FGD in phase 1 also complained about the slow internet connection that they often experienced and have some impact on their easiness in reading the IDM. They also claimed to have encountered many technical difficulties in navigating the IDM due to the slow internet connection. Some students even said that they could not even open some pages (perhaps those with images) at all.

Table 3 also shows that using tablet-based IDM seems to positively affect the duration spent in reading the modules. The average duration of reading the modules in Phase 2 ranges from one hour 63 minutes to over 54 hours (total of reading regardless of frequency of reading). This is encouraging and significantly longer than the first phase study, which average duration was only less than 30 minutes. The data record of the second phase also shows that there were students who spent more than 11 hours in total. Based on the questionnaire response, 67% of students said that they spent most of the reading time in the explanation of concepts and examples. Nevertheless, since there is no data available to track what students were actually do when the record states 'viewed' in any activity of the module, the data gathered from the Moodle Analytics need to be read cautiously. There is a possibility that when students opened certain parts of the module for too long of a time (such as for more than 5 hours straight for example), they may or may not really reading the content all the time or continuously. They might open the IDM and read any particular part of the module, work on other things for a while, and come back to read the modules again then closing the IDM. The analytics will record the timing from the second the student opened the IDM until the time he/she closed it. The same possibility also applied in the context of online IDM in the first phase of the study. Considering this same possibility in both cases (online and offline IDM), the significant increase in average duration of reading time from the first phase of study provides a positive suggestion that offline tablet-based IDM encourages students to read it without worrying about the unstable and expensive internet connection.

3.2 Video Viewers of the Interactive Digital Materials

One of the enrichment materials added to IDM is videos that are relevant to the content and inserted in every unit of LA. The videos were taken from YouTube (with permits) and for videos in English were also subtitled with Bahasa Indonesia. Table 4 presents that the number of Phase 1 students who viewed the videos was only 21 in Module 5 and 28 in Module 6. The table also shows that most video viewers only viewed one video, and none of the students viewed all videos in both Module 5 and Module 6.

Table 4 Number of Video Viewers

Video View	Number of Students who View Video in Module								
	1	2	3	4	5	6	7	8	9
Phase 1					21	28			
Phase 2	16	4	5	2	2	10	0	0	2

Table 4 also shows that in Phase 2, except for videos in Module and 6, not many students watched the videos. This is very disappointing as the videos were selectively chosen to enhance and enrich the concepts' understanding, especially when the videos themselves were perceived to be of good quality (image and sound), attractive, relevant, and helpful by all students. It is predicted that the poor internet connection may have hinders their interest in viewing videos in a meaningful way.

3.3 Reading Patterns of the Interactive Digital Materials

The modules have standardized template that layouts every Module in particular activities sequence. Each module has cover, introduction section, two or more learning activities (LA), and references. Each LA contains the main substance of content, self-exercises, a summary, and a self-formative test. The module was designed as self-instructional materials to allow students study the content independently. In other words, the designed sequence of modules sections is expected to be followed by the students in reading the modules. Within each LA, students are also urged to begin by reading the main content which explains concepts and principles of the subject being studied, as well as examples and or case studies, followed by doing the exercise, reading the summary, then completing the self-test before moving into the next LA. Therefore, by studying the modules that way, students are projected to have a systematic interaction with the content. Table 5 shows data on students' interactions pattern with the content.

As shown by Table 5, not all students read the IDM following the expected sequence. In fact, in Phase 1, on average, only 58% of participated students read the IDM following the structured sequence up until last LA 1 and only 15 % of student read the IDM following the structured sequence up until the end of the modules (until the last LA). Similarly, in Phase 2, not all students read the IDM following the expected sequence either.

Table 5. Reading Pattern

Percentage of Students who:	Module									Average
	1	2	3	4	5	6	7	8	9	
Phase 1										
Read in expected sequence up to LA1					67%	48%				58%
Read in expected sequence up to the last LA					28%	1%				15%
Phase 2										
Read in expected sequence up to LA1	33%	54%	0%	25%	38%	29%	50%	31%	7%	22%
Read in expected sequence up to the last LA	11%	23%	13%	17%	38%	29%	50%	31%	7%	24%

The data indicate that there are no particular patterns shown. Students seem to have different preferences in reading the IDM, perhaps related to their individual learning styles, which are beyond the scope of this study.

The data shown in the tables are quite concerning as they indicated by the low frequently of opening the IDM and by short duration of time spent within the IDM. One of the reasons for this perhaps because many students claimed to face difficulty in opening the IDM. Ten out of the 18 participated students said they experienced technical difficulties in navigating the IDM. One of the most mentioned difficulties is that the IDM sometimes moves the pages by itself, and it is difficult to go back to the page where they were before. This experience seemed to have affected some students and stop reading beyond Module1.

At the beginning of the experiment in Phase 2 when students were gathered to receive the computer tablet, they were asked to study the course only using IDM even though they have the printed version of the modules. However, based on the questionnaire, only one student followed through that suggestion and the rest said that they studied more using the printed materials. Ten out of 18 students claimed that

they in fact find it easier to study from the printed learning materials/modules than from the digital modules. Only six people said that they find it easy to study from digital modules, and that they will be willing to pay a tuition fee, which includes a purchase of computer tablet. They said they will be willing to pay an extra of IDR 250 - 500 thousand per semester in return for getting a computer tablet.

4 CONCLUSIONS

Learning process is an accumulation process of students' experience in interacting with content, instructor, and their peers. This has been confirmed by previous studies which propose that interactions in learning consist of learner-learner, learner-instructor, and learner-content interactions (Moore,1989; Anderson and Garrison, 1998, Anderson, 2003b), which facilitate the social, teaching, and cognitive presence (Garrison, D. R., Anderson, T., & Archer, W., 2000; Saadatmand et al., 2017). The intensity and quality of those interactions in an online learning environment are influenced by the learner-interface and learner-self interactions (Mutalib et al., 2016). The friendliness and seamless interactions between learners and the technology being used will have an impact on students' learning experience.

This study was exploring the interactions between the learner and the learning content delivered through an interactive digital material (IDM), which was developed in SCORM format and provided to students through the online tutorial LMS. When reading the IDM, students can read in the sequence of their own convenience. They can also make notes, highlight, watch video, and browse related external resources. The data was collected based on students' actual behavior in reading the IDM as recorded by the LMS. Similar Zimmerman (2012) approach, the reading behaviors recorded were the frequency and time of reading, the amount of time that learners spent, and most importantly the reading pattern.

Based on the data, this study found that not all participated students 'read' (opened) the IDM. However, the reading frequency data shows that even though the tablet-based IDM in this study can be read offline, most students only opened each module once or twice. Further data also shows that there are no particular reading patterns could be detected. With regards to the duration spent in reading the modules, using tablet-based IDM seems to have affected positively as shown by the average duration of reading the modules that ranges from one hour 63 minutes to over 54 hours (total of reading regardless of frequency of reading). These are longer than the average duration of the first phase, which was only less than 30 minutes. This, however, need to be read cautiously since there is a possibility that students did not continuously read the content when they opened certain parts of the module for too long of a time (such as for more than 5 hours straight for example. Nevertheless, taking it into account the same possibility in both cases (online and offline IDM), the significant increase in average duration of reading time from the first phase of study provides a positive suggestion that offline tablet-based IDM is encouraging.

The findings of Phase 2 study confirm that students interact with the content of course materials in IDM format with no specific pattern. There is also a possibility that students spent more time reading the printed version of the modules, and thus reading the IDM was only a side activity in studying. In fact, only one student in second phase study who read the materials merely from the IDM, and the other said they study more through reading the printed modules. The non-compulsory nature of reading the IDM combined with some difficulties related to technical difficulties in navigating the IDM seem also to affect students' preferences in reading the printed modules. The technical difficulties impacted the speed of navigating within the IDM, viewing video, as well as browsing external references. They claimed that these difficulties have demotivated them to reading the IDM thoroughly.

The low use of IDM found in this study confirms the importance of learner-interface interaction stated by Mutalib et.al. (2016). It is understandable because a non-seamless access to the content would prevent students from having enjoyable experience of reading the IDM and thus less pleasant learning experiences as a whole. This underlines the importance of technology dimension in online learning. In conclusion, although reading duration has increased, providing tablet-based IDM that can be read offline has not significantly made learner-content interaction as optimal as initially expected. Duration of time spent in reading through the materials may have increased and potentially enhance the quality of learner-content interaction; however, the fact that not all students could stay and complete the reading until the end of materials show significant effect of the technical difficulties

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REFERENCES

[1] A.G. Picciano, Theories and frameworks for online education: Seeking an integrated model. *Online Learning, 21*(3), 166-190, 2017. doi: 10.24059/olj.v21i3.1225

[2] D.R. Garrison, T. Anderson, & W. Archer, Critical inquiry in a text-based environment: Computer conferencing in higher education model. *The Internet and Higher Education, 2*(2-3), 87-105, 2000

[3] M.A. Mutalib, N.D.A., Halim, & N. Yahaya, Meta-analysis on interaction in online learning. *RCEE Conf. Proc. 1*. 2016, Retrieved from https://people.utm.my/ noordayana/files/2012/10/paper-mas_rcee.pdf

[4] M.G. Moore, Three types of interaction. *American Journal of Distance Education, 3*(2), 1-7. 1989

[5] M. Saadatmand, L.Uhlin, M.Hedberg, L. Abjornsson, & M.Kvarnstrom, Examining learners' interaction in an open online course through the community of inquiry framework. *European Journal of Open, Distance, and E-learning*, 20(1), pp.61-79, 2017. retrieved from http://www.eurodl.org/index.php?p=archives&year=

[6] P. Kumar, C. Saxena, & H. Baber, Learner-content interaction in e-learning- the moderating role of perceived harm of COVID-19 in assessing the satisfaction of learners. *Smart Learn Environ.* **8,** 5, 2021. https://doi.org/10.1186/s40561-021-00149-8.

[7] R.M. Bernard, P.C. Abrami, E. Borokhovski, C.A. Wade, R.M.Tamim, M.A. Surkes, & E.C.Bethel. A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research*, *79*(3), pp.1243–1289, 2009. https://doi.org/10.3102/0034654309333844.

[8] T. Anderson, Toward a theory of online learning. In T. Anderson (Ed.). The theory and practice of online learning, pp.33-60. Athabasca, AB: Athabasca University Press. 2008. Retrieved from http://www.aupress.ca/books/120146/ebook/01_Anderson_2008-Theory_and_Practice_of_Online_Learning.pd

[9] T. Anderson, T., & D.R. Garrison. Learning in a networked world: New roles and responsibilities. In C. Gibson (Ed.), *Distance Learners in Higher Education*, pp. 97-112. 1998. Madison, WI.: Atwood Publishing.

[10] T. Anderson, Getting the mix right again: An updated and theoretical rationale for interaction. *International Review of Research in Open and Distance Learning, 4*(2), pp 1-14, 2003a

[11] T. Anderson, Modes of interactions in distance education. Recent developments and research questions. In M.G. Moore & W.G. Anderson (Eds), *Hanbook of Distance Education,* pp.129-144, 2003b New Jersey: Lawrence Elbaum Associates, Publishers.

[12] T.D. Zimmerman, Exploring learner to content interaction as a success factor in online courses. *The International Review of Research in Open and Distributed Learning, 13* (4), pp.152-165, 2012