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What Works and What Does Not: A Reflective Practice on an Online Mathematics Class

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Abstract: *As most courses turn into distant formats, what are the benefits and hindrances of conducting university math courses using multiple technologies? In this e-learning environment, are content-neutral platforms necessary for teaching and learning in these classes? Specifically, what activities on the Moodle e-learning platform are more effective than others in supporting undergraduate student math learning and achievement? This paper will report on a reflective practice that examines both qualitative and quantitative datasets in understanding the implemented multimedia distance learning environment at an entry-level math classroom at a large state university in the Midwest and its resulting consequences on the math learning and assessment performance of the students.*

Keywords: Postsecondary; Mathematics Education; E-learning; Reflective Practice

INTRODUCTION

When COVID-19 hit, higher education institutes globally experienced an unprecedented shifting from traditional classroom-based instructions to blended or entirely e-learning environments. For Fall 2020, most US colleges and universities adopted the hybrid learning format and offered a mixture of in-person and online learning. While technologies enabled students to continue with their education during this pandemic, researchers had ambivalent attitudes on the topic of e-learning in the subject of mathematics. What technology works, and what does not, when it comes to teaching and learning in a virtual university math course? What activities completed in a multi-technology setting positively impact student assessment performance? Through a practice reflection on my current teaching for two sections of an entry-level university math course at a Midwest public university, this paper employs mixed datasets in exploring the advantages and disadvantages of used content-neutral technology (namely, Moodle, Zoom, and Campuswire) and in testing quantitative connections among activity involvement on the Moodle LCM platform and student performance in three monthly exams.

The paper contains the following sections: Literature Review, which outlines varied views on impacts of technology on education and presents content-specify and content-neutral tools applied in math education; Methodology, which provides a detailed explanation of the methods implemented, the course structure, and participants; Results and Discussion, which contains qualitative and quantitative data obtained from the study and a thorough reflection and reading of the data presented; Conclusion, which summarizes the previous sections and elaborates on future research directions.

LITERATURE REVIEW

Views on Technology in Mathematics Education

As early as the 80s, there was an emerging view of technology as a ground-breaking tool that manifested mathematical investigation and facilitated student development of mathematical thinking and understanding (Shumway, 1989; Fey, 1993). At the seventh International Congresses on Mathematical Education (ICME-7), three workshops and lectures, on Impact of Calculators on Elementary School Curriculum, Technology in Service of the Mathematics Curriculum, and TV in the Mathematics Classroom, are organized to promote technology, especially computers, in modeling and experimenting with mathematical ideas in various school levels. Praises for new technology in the late twentieth century were not limited to calculating X's and Y's. Online modes of communication in mathematics education are also well received by researchers who pointed out that developments in transmissions of graphics, sound, and videos opened the door to an unknown era in distance learning (Knight, 1994). More recently, a group of researchers (Gadanidis & Geiger, 2010; Hughes, 2008) focused their work on the benefits of technology in reconceptualizing social interactions in learning by integrating math performance and collaboration into multi-medias. As Gadanidis and Geiger (2010) mentioned, new technologies and, in particular, various media platforms could bring a common mathematics experience to the general public.

While many researchers were confident towards technology in education, less so were the others. Turkle (2018) argued in her study that technology made us forget what we knew about life. She suggested that technology imperatives were only constructive for bounded populations and that we saw technology as the panacea for many of our education problems ranging from the lack of student engagement to the issue of measuring educational productivity. With the example of online forum participation taken as an always-available discussion, Turkle argued that communications in sizable online courses could have a contrary effect on the learning experience despite what educators intended and believed, based on how, in two MOOCs, interviewees described discussion board and posts as hardly seen or difficult to follow. The viewpoint of e-learning as inferior to face-to-face instructions raised the initial question for this study: If one technology is not accommodating, will having varied technologies add to the diversity and foster a better online classroom experience? This project incorporates both positive and negative perceptions on technology in education while reflecting on whether various technologies are as

prominent as discussed by Gadanidis and Geiger (2010) and whether using more than one type of technology solves the communication problem presented by Turkle (2018).

Content-specific versus Content-neutral Technologies

As technology prevails in the field of math teaching, educators adopt all types of aids ranging from computer-based graphic calculators to large-scaled learning management platforms. According to the National Council of Teachers of Mathematics (2011), these technological tools can be categorized as content-specific and content-neutral. The definition of content-specific is revolving around the idea of solving particular mathematical problems, no matter algebraically or geometrically. This category contains computer algebra systems (e.g. Wolfram Alpha), dynamic geometry environments (e.g. Geogebra and Desmos), interactive applets (e.g. Mathematics Vision Project), and data analysis devices (e.g. R and Tableau). Researchers brought forward the notion that, as technology became a part of the learner environment, it was more than substitutions for regular chalks and boards but a new way of fluid knowledge construction within the field of mathematics (Olive and Makar, 2010). Goos et al. (2010) also proposed that computer algebra systems could support student learning when engaged in mathematical modeling tasks. Understanding and identifying mathematical concepts and relationships is the goal of applying these content-specific instruments.

Contrary to this, content-neutral technologies center on eliciting communications and transmitting the information. Typical content-neutral platforms include Moodle Learning Management System (LMS), Canvas LMS, Blackboard LMS, Compass LMS, Piazza, Campuswire, and Google Classroom. While possessing individual features, all these provide opportunities for collaborative learning and multi-media content delivery in this digital era. This benefit of content-neutral technologies can also positively influence student access to course announcements, materials, interactions, and ultimately ownership of knowledge (NCTM, 2011). The LMS is also identified as a powerful assessment tool. For example, Moodle LMS can contribute to the formative e-assessment of students in math courses by enabling an innovative alternative to the traditional testing system and by providing useful analysis of question difficulty levels through psychometric coefficients of the data stored on the platform (Blanco and Ginovart, 2012). For the purpose of the study, Moodle platform was used for announcements, study reflections, lesson materials, and tests; Zoom meeting tool was used for synchronous sessions; Campuswire forum was used for communications among students and instructors.

Nonetheless, strategic usage of both types of technologies is equally vital as a topic. The teacher and the curriculum play critical roles in technology mediation (Suh, 2010). Without effective lesson plans and carefully designed tool implementations, classes that only consist of unguided appliances are not sufficient in math teaching and learning. Upon the call for practitioner knowledge of technology in math classrooms, this study aims to reflect from the practitioner's

point of view on conducting an online undergraduate-level math classroom in a content-neutral technology-rich environment.

METHODOLOGY

Research Questions

The study investigates two aspects of technology in an e-learning undergraduate math course. Firstly, both positive and negative experiences with implemented technology instruments are sought to review my current practice of incorporating Moodle, Zoom, and Campuswire. Secondly, correlations among Moodle activities and assessment results from three monthly exams are explored to analyze the critical relationship between technological tasks and student performance in standardized tests. With an emphasis on these two aspects of the topic, the following two research questions are studied.

1. What are the benefits and hindrances of conducting an online entry-level university course using multiple technologies?
2. How do types of activities (watching asynchronous videos, participating in weekly quizzes, and completing weekly reflection forums) on Moodle correlate to test performance?

Participants and Procedures

Since this is teacher research and reflective practice for a single classroom, the reporter is the instructor for the course subject. Twenty-one participants of the course volunteered in this study. The survey, activity, and exam data were collected from these volunteered students. The observations of the classroom were made by perusing the recorded Zoom synchronous meeting sessions. The university that this study took place is a public institute in the Midwest.

This reflective practice project is empirical, involving qualitative and quantitative data collection and interpretation. More specifically, this is a classroom study where the teacher conducts an inquiry into relationships between technology and the classroom with data based on observation, interview, and document collection (Cochran-Smith and Lytle, 1993). This teacher research inquiry is intentional, systematic, public, voluntary, ethical, and contextual (M. Mohr et al., 1994). The project incorporates Gibbs' cyclical model on the theoretical approach of reflection (Gibbs, 1988). In this six-stage model, the practitioner starts by describing the situation, then expresses their opinions on the matter, followed by evaluating classroom data and analyzing the teaching experience, and ends with a conclusion on possible improvements and an action plan for making advancements. The introduction and literature review sections of this paper correspond to the first two stages; the sections on results and discussion articulate the evaluation and analysis; the conclusion elaborates on the last two stages.

The current data-driven research investigates open questions and does not perceive any preconceptions regarding the effectiveness of technology in math teaching and relationships between technology and math learning. Because no one data source can offer a whole and accurate picture of a complex classroom study, triangulation is applied with multiple perspectives from classroom observations, surveys, Moodle activity logs, and exam data. The mixed types of data obtained in this research are not generalizable because of reflective practice's characteristics. However, analysis of the data could be transferable to other similar contexts. Upon evaluating the data, the insider perspective secures a more grounded, discovery-oriented, exploratory, expansionist, descriptive, and inductive study (Larsen-Freeman & Long, 1991).

During the 2020 Fall semester, this course on the subject of Finite Mathematics, composed of topics such as basic set theory, probability theory, and matrix theory, is taught at a Midwest public university. Two one-hour synchronous sessions were met through Zoom conference technology on Tuesdays and Thursdays; an extra hour of prerecorded lecture video was posted on Moodle LMS each previous Thursday. In total, ten weekly quizzes and three monthly exams were distributed on Moodle. Each quiz and exam was not cumulative and assessed only on contents from the designated unit. Since the class and all research components were conducted in English only, language should not be an issue in this study.

In addition to classroom observations, a student survey that focused on the multi-technology environment and its impacts on math learning was collected; other collected items included Moodle LMS system data on activity logs and exam scores. The survey asked students five questions that are indicated in Table 1. Moodle system data consisted of assessment scores from three exams (Exam 1, taken in Mid-September, Exam 2, taken in Mid-October, and Exam 3, taken in Mid-November), and activity logs for participation in videos, quizzes, and study reflection forums. All datasets were collected under the consent of voluntarily participated students. The data are analyzed in three steps. First of all, different statistics are applied to quantitative data to test relationships among factors. Next, the results are interpreted and cross-analyzed with qualitative data from the student survey. Lastly, while reflecting on my own teaching experience, I also scrutinize the differences and similarities among different viewpoints from the student survey and connect key points with findings from the previous stages.

Question No.	Description
1	In our Tuesday lectures, we experimented with both Hybrid learning and E-learning formats. In particular, attendance requirement for synchronous sessions were cancelled starting from Week 9. What are the academic reasons behind your preference for continuing studying in the Hybrid format (synchronous lectures and prerecorded lessons) or your preference for switching into a fully e-learning environment (asynchronous recorded lectures and prerecorded lessons)? Please reply with one or more sentences.
2	In light of cancelling the attendance for synchronous courses, we started to adopt weekly study reflection forums. This forum is meant for you to reflect on your personal study journey regardless of your choice of hybrid or e-learning formats. Were the reflection forums beneficial for your learning in any way? Why or why not? Please reply with one or more sentences.
3	In regular classrooms settings, group study has long been recognized as one of the best way of math learning. In on-line classrooms, however, things could be quite different. In our Thursday sessions, we usually had synchronous group activities. Did you participate in these on-line group activities as much as you did for in-person ones? If you didn't participate as much, what are some of the reasons? Please reply with one or more sentence.
4	We have used many technologies in this course, ranging from the Moodle platform (for broadcasts, assessments, and forums), the Zoom meeting room (for synchronous and asynchronous sessions), and the Campuswire communication (for student discussion). Please use one sentence or more to reflect on your experience with one or more technology helped you learning in our course.
5	Following from the last question. I have learnt from some students earlier that the current multi-media environment of our course could be overwhelming because of the amount of various tasks they needed to complete using different types of technologies. Do you think having all three technologies mentioned is beneficial to your learning in this course? Or do you think having all of them can present unnecessary burdens in learning? If so, what technologies do you think we should keep using/abandon for this course?

Table 1: Student survey questions

RESULTS AND DISCUSSION

Variable	No. of observations	Mean	Standard Deviation	Min.	Max.
Assessment results	*(out of 100)*				
Exam 1	20	73.625	15.972	44.00	100
Exam 2	20	92.750	5.720	84.00	100
Exam 3	21	90.670	11.090	54.06	100
Moodle Activities					
Videos B. Exam 1	21	5.952	4.177	0.00	12
Videos B. Exam 2	21	3.667	3.526	0.00	11
Videos B. Exam 3	21	2.286	2.125	0.00	6
Forums	21	3.143	1.315	0.00	4
Quiz	21	9.762	0.768	7.00	10

B.: Before.

Table 2: Descriptive statistics for assessment results and Moodle activities

Groups [G.1, G.2]	Group 1 (G.1) Mean (SD)	Group 2 (G.2) Mean (SD)	df Welch	T-test T-statistics (p-value)
Improvement:	*EX 3 - EX 2*			
[S., AS.]	-3.58 (3.54)	-0.21 (7.72)	12	t(12) = -1.201 (0.126)
[AS.V, AS.NV]	-4.97 (11.16)	4.014 (3.710)	4	t(4) = -1.528 (0.100) *
[F.L, F.]	-6.26 (12.50)	-1.53 (0.81)	6	t(6) = -0.926 (0.195)
[V., V.L]	-7.75 (9.41)	3.88 (0.79)	10	t(10) = -3.893 (0.001) **
Improvement:	*EX 3 - EX 1*			
[VT., VT.L]	12.76 (14.52)	21.07 (-5.74)	11	t(11) = -1.608 (0.068) *

S.: Attended at least one synchronous session after Exam 2 before Exam 3.

AS.: Attended no synchronous session after Exam 2 before Exam 3.
AS.V: Attended no synchronous session and watched at least one video after Exam 2 before Exam 3.
AS.NV: Attended no synchronous session and watched no video after Exam 2 before Exam 3.
F.L: Posted on not all forums after Exam 2 before Exam 3.
F.: Posted on all forums after Exam 2 before Exam 3.
V.: Watched more than one videos after Exam 2 before Exam 3.
V.L: Watched no or only one video after Exam 2 before Exam 3.
VT.: Watched more than or equal to ten videos in total before Exam 3.
VT.L: Watched less than ten videos in total before Exam 3.
Note *p < 0.11; **p < 0.0011

Table 3: T-tests for pairs of groups based on their technology usage and academic improvement

Items	Yes	NA	No
Technology			
Moodle	15	6	0
Campuswire	1	10	10
Zoom	9	12	0
Activity			
Forum	8	1	12
Async. Format	14	1	6
Group Activity	3	0	18

Table 4: Student survey data

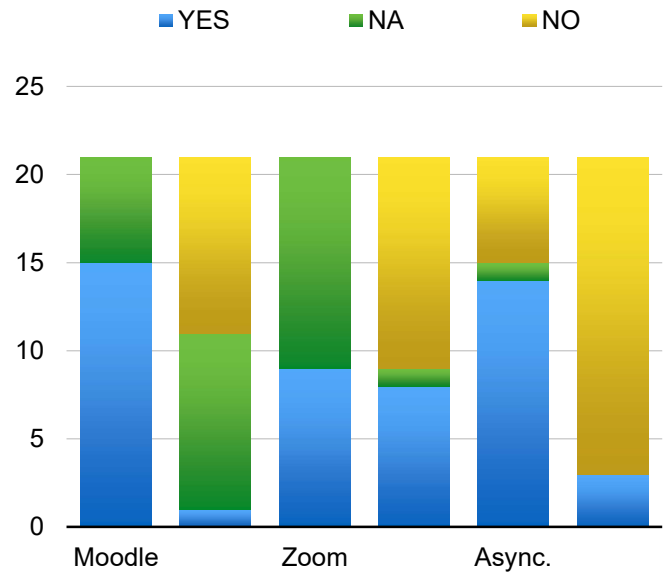

Figure 1: Student survey chart

RELATIONSHIP BETWEEN MIXED VS. ASYNCHRONOUS E-LEARNING AND IMPROVEMENT

Firstly, students are assigned into two groups based on whether they chose to continue studying synchronously or switch to learning asynchronously: Group S. with at least one synchronous session attended; Group AS. with none synchronous session attended. Then, a T-test is conducted to compare the mean improvement in exam scores between these two groups of students. The null hypothesis is that there is no difference in their improvement, and the alternative hypothesis is that the students who attended asynchronously have higher improvement scores. The results are displayed in Table 4.

One-sided two-sample mean Welch's T-tests are employed. The mean score differences from Exam 3 to Exam 2 ($t(12) = -1.201$, $p < 0.15$) are relatively more negative for Group S. students who are taking synchronous sessions. Thus, there is some statistical evidence rejecting the null hypothesis. The statistics conclude that students who participate synchronously after Exam 2 before Exam 3 do not necessarily tend to have more developments, compared to their peers who participate asynchronously.

Therefore, it is arguable that pure non-concurrent e-learning is more beneficial to assessment performance than in a mixed manner where students need to manage both synchronous and asynchronous videos. This result could be related to the concept of *Zoom fatigue*, where students experience tiredness from attending concurrent sessions due to not being able to determine facial expressions and caring too much about self-appearance on camera along with other internet issues. Even though this comparative profit of fully asynchronous learning is displayed, there is value in having both synchronous and asynchronous options available for students. This is also mentioned by Student X, shown in Excerpt 1.

"I like how both options are available. At points I fell behind and it would not have been beneficial for me to go to the live lecture because I hadn't seen the previous lecture, watched the instructional videos, or maybe I had gone to bed really late and I needed the sleep. However, when I am caught up, it is better for me to watch the live lecture because it is much more time-efficient since I can't pause it and get distracted by my phone or something else."

Excerpt 1: Student X's opinion on having both synchronous and asynchronous options available

To further explore the reason behind this, four similar T-tests are performed on the following pairs: 1. Attended no synchronous session and watched at least one video after Exam 2 before Exam 3 (AS.V) vs. Attended no synchronous session and watched no video after Exam 2 before Exam 3 (AS.NV); 2. Posted reflections on not all forums after Exam 2 before Exam 3 (F.L) vs. Posted reflections on all forums after Exam 2 before Exam 3 (F.); 3. Watched more than one videos after Exam 2 before Exam 3 (V.) vs. Watched no or only one video after Exam 2 before Exam 3 (V.L); 4. Watched more than or equal to ten videos in total before Exam 3 (VT.) vs.

Watched less than ten videos in total before Exam 3 (VT.L). The results from these four findings are discussed in more detail in the sections below.

RELATIONSHIP BETWEEN MORE VIDEOS VS. FEWER VIDEOS WATCHED AND IMPROVEMENT

From test statistics in Table 3, there is relatively significant statistical evidence at 0.1 rejecting the null hypothesis for AS.V and AS.NV. The statistics conclude that students who do not participate in Zoom concurrent meetings nor recorded videos after Exam 2 before Exam 3 tend to have more improvements compared to their peers who do watch recorded videos while taking the course in an asynchronous format. Within the group of asynchronous-only learners, it is suggested that not watching as many videos correlates to the increase in student improvements. This could result from the confusing layout of videos. Each week, instructors posted two sets of pre-lecture videos on the same contents and a recorded Zoom session. Originally, the repetitions and similar explanations of concepts and problems were designed to provide students with a non-uniform learning experience, which, in turn, should promote student growth academically. However, the result says otherwise.

There is also highly significant statistical evidence at 0.001 rejecting the null hypothesis for V. versus V.L. The statistics conclude that students who watch fewer than two recorded videos after Exam 2 before Exam 3 tend to have more improvements compared to their peers who do watch more than one recorded video during the same period. This fact reveals that having fewer recorded videos required-to-be-watched is better in assisting student learning inquiry, which is in parallel with the viewpoint demonstrated in AS. V vs. AS.NV. In a similar vein, there is some statistical evidence at 0.1 disapproving of the null hypothesis, when it comes to the pair VT. and VT.L. The statistics conclude that students who watch fewer than eleven videos in total before Exam 3 tend to grow more academically in math, compared to their peers who watch more than ten recorded videos throughout the three months. This information extends the former findings.

On top of this, upon analyzing relevant qualitative data from the survey, Videos is not a factor positively influencing improvement in both mixed and asynchronous e-learning settings. For the mentioned five students who switched to asynchronous study without videos, their growth in academic achievement is relevant to their satisfying experience with the content-neutral aspect of Moodle LMC. All five students mentioned lucid structures of the course Moodle page and discussed how they prefer fewer technologies and focus on only Moodle non-videos resource as a course tool.

In Group S., there is one student who has the same improvement score as the previous five Group AS. students. This student also mentioned enjoying Moodle non-video resources as the only tool for the course. These two cases demonstrate that students can benefit from not viewing as many videos on Moodle because they chose to concentrate on fewer tasks at a time, which could lead to higher study efficiency and learning outcomes. Fewer recorded videos should be uploaded

to Moodle to enforce a more minimal layout. However, it is noteworthy that the findings are not significant enough to reject all the synchronous and asynchronous sessions. The course should still provide students with learning opportunities via media, but just not as many to the state that can burdensome for students to manage.

RELATIONSHIP BETWEEN FEWER FORUMS VS. ALL FORUMS COMPLETION AND IMPROVEMENT

For the groups, F.L and F., there exist some minor significance at 0.2 rejecting the null hypothesis, as illustrated in Table 3. The statistics conclude that students who do post all four weekly study reflection forums after Exam 2 before Exam 3 tend to perform more ideally, compared to their peers who are not involved in as many posts. This finding shows that, by completing all weekly study reflections, it is likely for students to improve more in exam scores.

Contrary to our finding that forum is a factor in increasing exam scores, from Table 4, more than half of the students thought of the forum as not helpful in academic improvement. From the twelve students' reasons for not perceiving Forum as a useful activity, many pointed out that it only asks for what they have done but does not provoke any deep thoughts and considerations. For reference, the question in Excerpt 2 is used in all forums. Based on the positive effects Forum has on student math learning, this activity can still be maintained but surely with changes in question wordings. In light of this, it may also be advantageous to have multiple versions of questions to help facilitate a less static and more active learning environment.

"Please reflect on your learning this week and write a sentence or two describing one or more of the following: What have you studied? What appears to be interesting/difficult? Are there any questions regarding this week's materials?"

Excerpt 2: Questions on four weekly reflection forums

TEACHING REFLECTION

Multiple technologies for this online mathematics course benefited the class by presenting diverse activities and enabling the switch from synchronous mandatory to synchronous optional. These content-neutral tools also allowed me to engage in more conversations and closer connections with my students regardless of the distance between us. Meanwhile, reducing the technologies, in the second half of the semester for this course, made positive impacts on student learning. By choosing either Zoom and Moodle (synchronous lectures) or only Moodle (asynchronous recordings), students could invest energy in their ideal way of learning. With fewer technologies required for the course, they also had a clearer vision of how to master the materials. Before the schedule altered, the course contained multiple, even an excessive amount of, obligatory activities and systems that induced much confusion. After the change, students had less workload and also took part in course structure decisions.

Another tool Campuswire Discussion Platform (DP), with powerful messaging and grouping tools, was planned to engender conversations among students and ultimately build a mathematical community for the course. Sadly, barely any student was willing to participate in study groups and extra activities for this course, which might be because of the already heavy workload in- and out-side of the class. Based on survey data from Table 4, half of the students voted for abandoning this technology. Several of them suggested using the conversation and group feature on Moodle instead. Through this three-month teaching, I had not been a frequent user of Campuswire either. The inconsistency and disconnection, between this DP and the most used platform Moodle, is the problem. It is indeed time- and energy-consuming to monitor all the conversations that happened sparsely over the space, which is similar to the previous scenario with multiple technologies for one course.

As the only highly praised technology by over half of the students in the questionnaire, shown in Table 4, Moodle LMC played a vital role in my teaching. It provided a common platform for everyone to share course resources, including activity problems, videos, Zoom links, and forums. The fact that all materials could be easily found on the course website lessened tasks for students and provided a more organized environment for concentrating on the course materials. Among the Moodle activities, Videos was found in previous sections to be less effective in elicit testing improvement. This is associated with the large volume of videos available for students and the mentioned repetitions of video contents. While one student indicated having two sets of videos was beneficial, others pointed out the redundancy within these videos which resulted in their uncertainty of what was more important. In alignment with the previous discussion, either the number of videos should be reduced, or some clear identifications on the importance of videos should be given. With fewer items to concentrate on, students can improve more efficiently in assessment performance.

CONCLUSION

Reflecting on my teaching experience, I have gained deeper understandings of the benefits and hindrances of having multiple technologies for math online learning. With mixed types of data, the study shows that students prefer to use fewer technologies for this online course due to the deducted difficulty in management. This is in alignment with the finding that the higher the number of content-neutral tools is, the lower student engagement is. Among the multiple tools used for this class, Moodle LMS was the most used because of its clarity and functionality. A majority of course contents were delivered on Moodle with its activity features, especially in the second half of the semester, where asynchronous videos were uploaded as Moodle videos. Both the instructor and the students identified this LMS platform as easily accessible. Zoom meeting tool was mostly used for holding synchronous sessions and recording the lecture videos. It is beginner-friendly but has only two functions: meeting and chat. For the purpose of this study, the chat function of Zoom was not investigated. Zoom, by itself, cannot deliver this undergraduate math course completely

online, since vital features (announcements, permanent file uploads, etc.) are missing. Campuswire, different from the previous two, was not used often in this course. The main reason is the overlapping of its conversation feature with the one on Moodle. With the forum and chat option available on Moodle, students did not see the need to learn new technology and spend effort managing it.

Besides analysis on the multi-technology setting for the course, I also discovered correlations between Moodle activity involvement and student examination performance. From the quantitative data collected, an appropriate number of pre-lecture and lecture videos are in need to assist students with academic improvement. It is surprising that the higher the number of videos watched, the lower the degree of improvement is seen in standardized testing. Considering this reflection, the content and organization of Videos should be adjusted to accommodate only key theorems and questions without overlapping materials. Unlike the strong correlation displayed, a minor relationship exists between forum participation and academic achievement. This low level of correlation could be from the lack of data. The forum activity was only implemented for the last four weeks of the term. In the future, the course will start the study reflection forum activity from Week 1. In this way, more data can be analyzed to determine a more explicit relationship. On the other hand, weekly quiz participation does not provide interesting results for this study, owing to the fact that all quizzes were completed by everyone and cannot be viewed as a variable for statistical tests.

In conclusion, less is more. This study on an online undergraduate math course reveals that the multi-technology environment is not as fruitful as many theoretical researchers described. Even though there exist limitations due to the nature of the reflective practice, it is evident that, in this course, students improve much more in test performance when using fewer technologies and tools. For my future teaching, I plan to keep Moodle LMC, remove Campuswire, and make changes to activities like Videos and Forum. These updates will ensure a more straightforward and manageable virtual learning environment for students, while creating more quality opportunities for student performance improvement in standardized tests. Further studies on this topic can explore the associations between participation in activities on Moodle and performance in weekly quizzes.

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