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Online Education Efficacy in Construction

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The COVID-19 pandemic has had an enormous and long-term impact on education systems across the nation. Consequently, many colleges and universities adopted a verity of different instructional strategies and new policies to mitigate the effects of this transition on academic achievement, student learning, and emotional well-being. This instantaneous change to the new pedagogical models was likely to impact both students and instructors. In this study, a survey was conducted to analyze the effectiveness of adopting innovative teaching approaches in online and hybrid frameworks on students' engagement, achievement, and attainment at Northern Kentucky University. Two statistical t-test and ANOVA test were performed to compare the results and demonstrate the significant differences between groups of data. In addition, the survey responses were correlated with grades in the subsequent semesters to determine efficacy. The result shows that incorporating active and interactive learning strategies can improve online learning experience of students. The responses indicate that introductory level and lab-based courses may benefit more from aforementioned strategies.

Key Words: Construction Education, Online Education Efficacy, COVID-19

Introduction and Background

For the first-year and second year students, moving to online learning was shown to be the worst outcome of the initial Covid-19 transition in Spring 2020 (Karimi et al., 2021). Their junior and senior counterparts, however, felt the social distancing was the worst outcome (Karimi et al., 2021). The faculty sought to create an environment of learning which would overcome the different concerns of both the lower and upper-level students.

Including inclusivity in an online classroom can focus on accessibility (Harris et al., 2020), which can be defined in multiple ways. Construction, Engineering and Engineering Technology students have identified accessibility in an online classroom as a concern, although it was not well-defined (Mosier et al., 2022). While accessibility is often associated with inclusivity, it may also be as simple as access to online content (Harris et al., 2020) or access to faculty outside of the online classroom. Students reporta preference for a combination of synchronous and asynchronous over either one used solely as a delivery method (Karimi et al., 2022).

An active learning pedagogy and online learning do not have to be mutually inclusive. Rather, it is

incumbent on the faculty to identify create active learning opportunities (Harris et al., 2020). Active learning pedagogies are generally considered to be student-centered (Liszka, 2013). Active learning pedagogy includes many sub-categories, like problem-based learning (PBL), inquiry-based learning (IBL), collaborative and cooperative learning and case studies (Liszka, 2013). One of the aspects of student-centered pedagogies is students working together, collaborating, to find solutions. Group projects can create opportunities for interactions outside of an online classroom. Group work does not necessarily increase satisfaction in an online course as scheduling face to face meetings between students can still be difficult (Lee et al., 2016).

While self-efficacy includes "technology, learning, and social interaction" (Shen et al., 2013). Technology does not necessarily promote student collaboration. As collaboration is related to self-efficacy (Stump et al., 2011), assignments may focus on group laboratory exercises or projects. Outside of the classroom, students may seek collaborate learning opportunities, irrespective of any effect it may have on grades (Stump et al., 2011). In pre-pandemic online courses, collaborative earning was utilized to encourage course participation through student perception of responsibility to each other based on mutual trust (Stoytcheva, 2018).

Based on the results of the initial move to online learning, faculty changed their courses to better support students in the unique environment. A survey instrument was created to determine student responses to the course changes. As grades have been used in education research as a comparative bases for survey results in the past (Jones et al., 2010), this method is used herein. This research seeks to determine if grades were affected by the course changes and if students found these modifications helpful.

Methodology

Students from Northern Kentucky University in two different programs, were surveyed over their experience after the initial Covid-19 transition. The survey was distributed in Fall and Spring 2021. The students were enrolled in Construction Management (CMGT) and Engineering Technology (EGT) with survey distribution in the following courses: Introduction to Construction Management, Soils and Foundation Interaction, and Mechanical Systems for Construction, Industrial Electricity, Signals and Systems, and Mechatronic Systems. The CMGT courses were offered in a hybrid format which in this case consisted of a combination of synchronous, asynchronous, and in person. The EGT coursework delivery was split between two in person and one online. Students were asked to reflect on their experiences.

In order to create an environment for students to connect with each other and develop rapport with and within student groups (Harris et al. 2020), active learning techniques were employed in the classroom. Hybrid courses consisted of in person, synchronous, and asynchronous delivery modes to give the students a sense of togetherness while providing them with the flexibility they needed during COVID-19 Weekly updates have been sent every Monday to give a heads up to students about upcoming topics and deadlines. A "Jeopardy" style game was incorporated into all courses, which can be used online or in person. It has the same setting as Jeopardy Show which is a review of study materials for the exams while students competing to answer questions to gain extra credit. Zoom breakout rooms were used for all online group activities like case study, assignment, and project.For the Soils and Foundation course, a group project required students to find a jobsite and apply outcomes from foundation design, stormwater pollution prevention plans, compaction, dewatering, and stabilization. Soils and Foundations labs included the Atterberg limit tests and hydrometer analysis which were conducted in person. The Mechanical Systems for Construction course included a group project where students had to illustrate course objectives in their own home or office

including the type of HVAC system and sustainable strategies. There was a split between in person and online labs such as estimating pipes and fittings, sustainability case study, and isometric symbols and drawings. For the Introduction to Construction Management course, students worked as a group on case studies in Zoom breakout rooms, used an online simulation platform to learn and practice soft skills on the jobsite, and completed a group project to visit a jobsite through the semester and report its progress.

Group lab experiments incorporated into EGT161 and EGT404. The instructor had one-on-one (1:1) meetings with his EGT 161 students to discuss their progress, issues, problems, concerns, etc. since it was an introductory level course, and the research shows that freshmen were suffering the most from online delivery. EGT408 included Group lab experiments, assignments in form of Canvas Discussion Board, and Group Final Project. While the faculty introduced changes in the EGT courses and collected responses to the survey, that data is not discussed at length here as this paper is focused on Construction Management courses.
Student were asked to rate the following, using a 11- point Likert scale of 0 to 10, with 0 being not at all helpful and 10 being extremely helpful which has closest distribution to normal compared to 5-point and 7-point scales (Leung, 2017).

1. How in-person labs/lectures embedded in online course helped you to feel more connected to the university and your peers compared to completely online course?
2. How active learning elements such as jeopardy game, Zoom breakout rooms activities, and online software added to online course improved your online experience compared to completely online course?
3. How group projects/assignments included in online course helped you to feel more connected to your peers?
4. How sending weekly updates helped you to keep on track and layout the week?
5. How combination of synchronous (Zoom/live) and asynchronous (pre-recorded) lectures gave you flexibility to study at your own pace while still experiencing some degree of connectedness to the university compared to fully synchronous or asynchronous course?
6. How integrating self-discipline training or courses into curriculum especially for new college students will be a game changer during these unprecedented times?
7. Are you a female or international students? If yes, what accommodations you think you need/needed to better cope with COVID-19 situation compared to other students?

Results were determined by analyzing the data received from 111 students, based on survey responses on the perceptions of CMGT and EGT students about strategies incorporated into the courses. Although larger group was surveyed, this paper focuses on the construction management responses. One hundred and eighty nine CMGT students were enrolled in CMGT 101, 228, and 305 during Spring 2020, Spring 2021, and Fall 2021.Therefore, the average of final grades of CMGT courses when pandemic started were compared to the following semesters' when instructors applied more active and interactive learning activities to the classes. Both t-test and one way ANOVA tests were performed to ascertain if the grades significantly changed. Then, a more in-depth analysis was performed to lab, project, and exam grades to see if they changed.

Data Analysis

In this section, Excel software was used to analyze and interpret the data. Descriptive statistical techniques were used including identifying the mean, variance, coefficient of variation and one-way ANOVA (analysis of variance). Inferential statistical methods like the t-test were used when appropriate.

1- Survey Summary

After a fast transition to online delivery format in Spring 2020, modifications were made to online and hybrid courses in the following semesters. Active and interactive learning strategies were incorporated into the courses during the pandemic to make them more engaging for the students. Students were asked to submit a survey to measure how these strategies helped them to feel more connected to their peers and university and improve their online learning experience.

The average score to question one was 7.83 with a variance of 5.77 and coefficient of variation (CV) of 0.74. A CV equal or greater than 1 indicates a relatively high variation which is not the case here. It shows that students found in-person labs/lectures somewhat helpful. However, based on the policy at Northern Kentucky University, it was not mandatory to attend in-person labs or lectures. Therefore, it would affect the results since a small group of students took advantage of this opportunity while a majority of students who submitted the survey did not attend the in-person sessions.

The mean for the second question was 7.42. It shows that students believed that the "Jeopardy" game, Zoom breakout rooms, and online software improved their online experience to some degree. However, the variance is 6.68 and CV is 0.9 which is close to 1. A CV which equals 0.9 shows that the data points are spread out from the mean, and from one another. So, the variance can be interpreted as students had different perceptions about it as it was mentioned several times by the students in their final evaluation of the course that how much aforementioned activities helped them during COVID-19 to feel more connected.

The average score to question 3 was 7.1. This result indicates that the group projects and assignments were not perceived to help students feel more connected to their peers. However, the variance is 6.9 and CV is 0.97 which shows that some students may find it more helpful than others. The mean score for question 4 was 8.81. The variance of 3.64 and CV of 0.41 reveals that students strongly believed that the weekly update with alerts about upcoming topics and deadlines helped students to keep on track and layout the week ahead.

The average score to question 5 was 7.65, indicating that the combination of synchronous and asynchronous lectures gave the students the opportunity to study at their own pace while still experiencing some degree of connectedness to the university and their peers. The variance of 7.07 and CV of 0.93 for this question which indicates some students found it more helpful compared to the others. The mean for question 6 was 7.59 with a variance of 5.9 and CV of 0.78, which reveals that students feel that incorporating self-discipline training or courses into curriculum especially for new college students will dramatically affect their learning experience. A moderately high variance can come from the fact the survey was not submitted by only freshmen students, but also by sophomore, junior, and senior students who may have different perspectives and online experiences. The summary of results is shown in Table 1 to compare the answers for questions 1 through 6.

Table 1

Survey Summary

Question	Average	Variance	Coefficient of Variance (CV)
1-In person labs/lectures	7.83	5.77	0.74
2-Active learning elements	7.42	6.68	0.9
3-Group projects/assignments	7.1	6.9	0.97
4-Sending weekly updates	8.81	3.64	0.41
5-Combination of synchronous and synchronous	7.65	7.07	0.93
6-Self-desipline training/course	7.59	5.9	0.78

At the end of survey, students were given an open-ended question about what accommodations they need to better cope with the pandemic if they are female or international students. Some of them stated they are not sure about it, some wanted more in-person learning, and some showed interest in learning to manage the online classes and self-discipline. The latter refers to the fifth question and confirms that integrating self-discipline training or course into curriculum can better prepare students not only for unprecedented situation, but also equip them with a necessary skill throughout their life.

2- Grades Comparisons and Statistical Tests

COVID-19 hit the universities across the U.S. in Spring 2020 while there was many faculty with minimum experience with online learning and many universities were suffering from lack of adequate infrastructure for online learning. Therefore, a survey was distributed in Spring and Fall 2021 when faculty applied the lessons learned during the first phase of the pandemic in their courses, and the university established necessary infrastructure for online learning. In this section, a comparison is performed between the average scores of students in Spring 2020 to those in Spring and Fall 2021 to see if there were any improvements.

The CMGT 101 Introduction to Construction Management is an introductory level course and is the first Construction Management course that students take after being admitted to the CMGT program. Figure.1 illustrates how the average grades improved from spring 2020 (71.29) when pandemic hit U.S. to Spring 2021 (77.38) when the instructors adopted to pandemic and embedded more interactive and active practices into the courses. There was a slight decrease from Spring 2021 to Fall 2021 (75.58) which can be impacted by multiple factors such as having another cohort of students who were experiencing online learning in high school before entering the university environment. Someresearch shows that first-year and second-year student perceptions found online learning as the worst outcome of the pandemic compared to social distancing and unemployment (Karimi et al. 2021). This result shows that aforementioned strategies were helpful to improve freshmen performance.

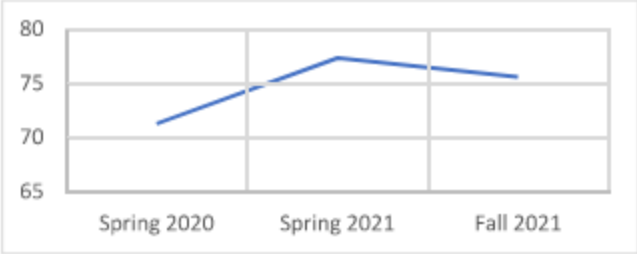

Figure 1. Average grades for CMGT 101

Furthermore, to determine if these changes were significant or not, a one-way ANOVA (analysis of variance) is used to compare the means of two or more independent groups to determine if their means are significantly different or not. Therefore, the test was run in Excel to examine the hypothesis that the average of grades in Spring 2020, Spring 2021, and Fall 2021 were significantly different. As shown in Table 2, p-value is 0.586 which is greater than 0.05. Since the alpha level was 0.05 for the test, the null hypothesis is accepted which states there is no significant difference between the means of groups.

Table 2

CGMT 101 One way ANOVA test

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	206.019	2	103.0098	0.537	0.586	3.131
Within groups	13021.802	68	191.497			
Total	13227.822	70				

The CMGT 228 Soil and Foundation Interaction is a course including labs and a group project. Figure 2 shows that there was a slight decrease in the average of grades from Spring 2020 (81.24) to Spring 2021 (78.06), and it bounced back to 81.61 in Fall 2021. It can be interpreted that there are no significant differences among grades.

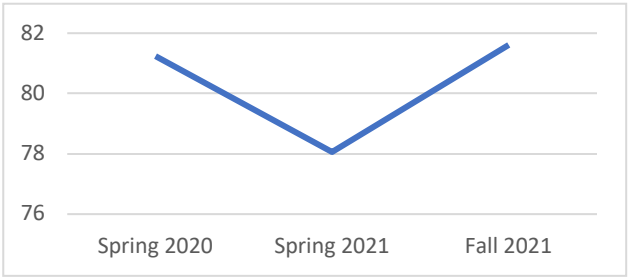

Figure 2. Average grades for CMGT 228

A one-way ANOVA test was run to have a scientific answer. The test proves there is no significant differences among average grades since p-value is greater than 0.05 which depicts that the null hypothesis is correct (Table 3).

Table 3

CGMT 228 One way ANOVA test

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	57.73	2	28.86	0.537	0.893	3.182
Within groups	12814.228	50	256.28			
Total	12871.962	52				

The CMGT 305 Mechanical Systems for Construction is a course in which multiple labs and a final project are embedded. The average grades comparison indicates that the students' performance slightly changed from Spring 2020 (80.58) to Spring 2021 (79.08). However, it dropped to 74.1 in Fall 2021 (Figure 3). This course was offered in a hybrid mode in Spring and Fall 2021, and the in-person lab attendance was not mandatory according to Northern Kentucky University policy. Although some simulation software was used to facilitate conducting labs, but not all the labs could be performed using these software. This may have affected the grades of students who did not participate in all of the in- person labs.

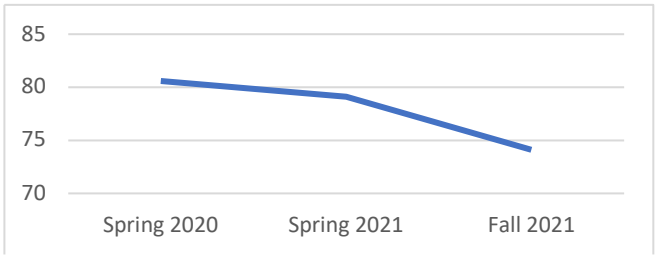

Figure 3. Average grades for CMGT 305

A one-way ANOVA test was conducted to see if the means of grades are significantly different. As it is shown in Table 4, p-value is 0.036 which is less than 0.05. The null hypothesis must be rejected, with the conclusion that the means are significantly different.

Table 4

CMGT 305 One way ANOVA test

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	547.263	2	273.63	3.496	0.036	3.145
Within groups	4851.636	62	78.252			
Total	5398.899	64				

A T-test is a statistical test used to compare the means of two groups and tests the hypothesis to determine if a treatment has any effects on the population of interest (Bevans 2022). The T-test was conducted, and the result indicates that the average grades are significantly different between Spring 2020 and Fall 2021 since p-value is 0.001 which is less than 0.05 (Table 5).

Table 5

CMGT 305 T-test: two sample

	Spring 2020	Fall 2021
Mean	80.58	74.101
Variance	52.34	37.13
P(T<=t)two-tail	0.001	

3- Comparisons of Grade Details

After a close look at different grades, the results led to the following conclusions. The only improvement among all different sections of CMGT 101 was the project grades. The data depicts that the average grades of project improved dramatically from Spring 2020 (60.29) to Spring 2021 (85.31), and from Spring 2021 (85.31) to Fall 2021 (90.34) semesters. In CMGT 228, the project grades were improved from Spring 2021 (78.32) to Fall 2021 (80.23). Similarly, the final grades were improved from Spring 2021 (74.72) to Fall 2021 (78.94). Furthermore, overall quiz grades increased from Spring 2020 (80.56) to Spring 2021(81.61). More improvements were found in CMGT 305 which is a lab and project-based course. The project grades improved significantly from Spring 2021(73.0) to Fall 2021(91.09) . The midterm grades increased from Spring 2020 (79.48) to Spring 2021 (87.83). The quiz grades improved from Spring 2021 (74.17) to Fall 2021 (82.0).The lab and assignment grades improved from Spring 2021 (77.36) to Fall 2021 (89.62).

Conclusion and Recommendations

The data and analysis presented in this study show that incorporating active and interactive learning strategies into online and hybrid courses can improve online learning experience. Among aforementioned strategies, students reported greatest appreciation for the weekly updates for planning. In person labs and lectures were appreciated next in term of helping students feel more connected to the university and their peers. Students next recognized the combination of synchronous and asynchronous delivery modes helpful to experience connectedness to the university while having more flexibility.

Additionally, the results show the projects that were assigned for team-based collaborative learning opportunities, Zoom breakout rooms, and the "Jeopardy" game have improved the students' online learning experience. Students emphasized in their formal evaluation at the end of the semester how Zoom breakout rooms created opportunities for them to develop rapport. They also found games in class, like "Jeopardy" helpful not only for active learning opportunities, but also for allowing students to interact.

Data analysis shows an improvement in CMGT 101, average course grades and project grades over the time. The results can be interpreted as following incorporating active and interactive learning elements into an introductory level course could help the students. These active and interactive learning elements allowed students to connect, collaborate, and submit the final project successfully which resulted in better final grades. By analyzing the data for CMGT 228, improvements were identified in the final exam, quiz, and project grades.

Although in the CMGT 305, the average grades decreased from Spring 2020 to Fall and Spring 2021, many improvements can be seen in the detailed grades. A significant improvement was found in the

project, quiz, midterm exam, labs and assignment grades as well. The CMGT 305 course is lab based and relies on multiple labs and a final project. The data depicts that the aforementioned strategies enhanced online learning experience of the students specially for those courses which contain more teamwork and group activities. Making the conclusion based on solely the average grades is not possible since the university policy regarding to grading was an exception during Spring 2020 semester when COVID-19 hit the university.

The necessary infrastructure is in place for online learning, and more universities are offering online courses for Construction Management and Engineering major students these days. Although we cannot predict the future, we know that it is not the last pandemic we will face. Therefore, we need to proactively embed more active and interactive learning practices into online and in person courses. Moreover, it is necessary to include some in person activities in predominantly online courses in order to create a sense of belonging and togetherness which improves the performance of the students. Finally, integrating self-discipline training or courses into curriculum can better prepare students for unprecedented situation and life challenges.

References

Bevans, R. (2022).”An Introduction to T-Tests, Definitions, Formula and Examples.” Scribber. https://www.scribbr.com/statistics/t-test/

Harris, B.N., McCarthy, P.C., Wright, A.M., Schutz, H., Boersma, K.S., Shepherd, S.L., Manning, L.A., Malisch, J.L., and Ellington, R.M. (2020). “From panic to pedagogy: Using online active learning to promote inclusive instruction in ecology and evolutionary biology courses and beyond.” Ecology and Evolution. V.10: pp.12581–12612. https://doi.org/10.1002/ece3.6915

Jones, B. D., Paretti, M. C., Hein, S. F., & Knott, T. W. (2010). “An Analysis of Motivation Constructs with First-Year Engineering Students: Relationships Among Expectancies, Values, Achievement and Career Plans.” Journal of Engineering Education. V.99. N.4. pg. 319-336.

Karimi, B., Yazdanpour, M., Lewis, P. (2021). “COVID-19 Effects on Higher Education: A Case Study.” Paper presented at 2021 ASEE Annual Conference & Exposition Virtual Meeting, July 2021.

Lee, S.J., Ngampornchai, A., Trail-Constant, T., Abril, A., Srinivasan, S. (2016). “Does a case-based online group project increase students’ satisfaction with interaction in online courses?” Active Learning in Higher Education. V.17. N.3. pp. 249 –260. DOI: 10.1177/1469787416654800

Leung, S.O. (2011). “A comparison of psychometric properties and normality in 4-, 5-, 6-, and 11-point Likert scales,” Journal of Social Service Research, vol. 37, no. 4, pp. 412-421.

Liszka, J. (2013). “Charles Peirce’s Rhetoric and the Pedagogy of Active Learning, Educational Philosophy and Theory.” V.45 N.7. pp. 781-788, DOI: 10.1111/j.1469-5812.2011.00763.x

Mosier, R., Ramming, C. S., Adhikari, S., Agnew, R. J. (2022). “Student Post-Pandemic Perceptions of Supplemental Instructional Videos.” Paper presented at 2022 ASEE Annual Conference & Exposition, June 2022.

Shen, D., Cho, M.H., Tsai, C.L., Marra, R. (2013). “Unpacking online learning experiences: Online learning self-efficacy and learning satisfaction.” The Internet and Higher Education. V.19. pp. 10-17. https://doi.org/10.1016/j.iheduc.2013.04.001.

Stoytcheva, M. (2018). “Students’ Perceptions of Online Collaboration in a Distance Learning French Language Course.” AIP Conference Proceedings. V.2048. https://doi.org/10.1063/1.5082048

Stump, G.S., Hilpert, J.C., Husman, J., Chung, W.C., Kim, W. (2011). “Collaborative Learning in Engineering Students: Gender and Achievement.” Journal of engineering education (Washington, D.C.) 100.3 pg.475–497.