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Impact of Online Learning on Engineering Students' Learning Motivation in Design Classes

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ABSTRACT

Online learning is becoming more prevalent in the academic sector, and many institutions have changed their teaching methodologies from face-to-face learning to online learning. However, the issue is whether all students are prepared for the changes in the learning method. This paper presents a study on students' motivation in an online learning environment of the Introduction to Engineering Design course. The first objective is to identify the differences in students' motivations between the early and end of the semester. The is adapted from Pintrich's Motivated Strategies for Learning Questionnaire (MSLQ). The questionnaire consists of six constructs: intrinsic motivation, extrinsic motivation, task values, control of learning, self-efficacy, and self-regulation. The data collected are analyzed using Wilcoxon Signed Ranks Test. The results show no significant difference in the overall students' motivation between the beginning and the end of the semester ($p=0.856$). However, based on the six constructs, intrinsic motivation ($p=0.034$) and self-regulation ($p=0.005$) are identified to be significantly different. The second objective is to investigate the factors affecting students' online learning motivation. Responses on four items are tested using Multiple Linear Regression. The findings indicate that the lecturer's contribution and guidance are the most significant factor influencing students' motivation. Results from this study suggest that in conjunction with the online challenges, students establish their expectations at the beginning of the semester, and towards the end, they can adapt and act appropriately to suit the circumstances. Secondly, the lecturers' contribution and guidance are significant predictors of students' motivation in online learning.

1. Introduction

Online learning refers to web-based learning, where the teaching is conducted via the internet, electronic media, extranets, and intranets [1]. Online learning is gradually becoming part of the educational system, making education more comfortable to access and compatible with the current environment. Furthermore, the urgency to switch the teaching method was abrupt, without

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preparation and experience to conduct online learning. It is necessary to study the influential aspect of implementing online teaching and whether the students are susceptible to the shifting method of teaching and learning. Online learning has appeared as the best solution amidst this chaotic pandemic. Therefore, it is critical at this phase to improve the quality development of online learning. During this challenging period, online learning approaches can offer quality teaching, and how the university's online learning adoption can be implemented in a massive way [2]. Additionally, using online learning to deliver the course material makes them feel motivated and satisfied with the class's knowledge, information, and learning process.

Online learning can be well-defined as learning experiences in the synchronous or asynchronous setting of numerous appliances with internet access such as laptops and mobile phones, where possible interaction between student and instructor can be anywhere [3]. Introduction to Design is one of the essential subjects in a Mechanical Engineering course. Online learning could influence student's motivation, especially for the courses that needed high-thinking knowledge and skill from the students. Jacob and Radhai [4] stated that if students want to learn effectively in online learning, the students should require extra motivation, effort, discipline, and organisation. Motivation is commonly regarded as one of the most significant influences on student's performance [5,6]. Motivation is an essential feature for the student to help and improve their learning behaviour. Therefore, it is necessary to consider student's motivation and satisfaction to conduct online learning.

Literature study suggested that online learning affects student's motivation. The lecturer's teaching method must be helpful because it will provide satisfaction and increases class understanding.

This paper aims to answer these research questions:

(i) How will the implementation of online learning affect the student's motivation between the beginning and end of the semester?
(ii) What will be different in the categories of students' motivation between the beginning and end of the semester?
(iii) What are the factors that are affecting students' motivation in the online learning platform?

2. Methodology

2.1 Questionnaire

In this study, the Motivated Strategies for Learning Questionnaire (MSLQ) was chosen as the instrument to observe the students' learning characteristics in online learning. MSLQ is a personality measure required to assess the students' motivation and different learning techniques [7]. The MSLQ is divided into two parts; (a) the motivation section and (b) the learning strategies section. However, only the motivation section will be used in this study. The motivation section originally consists of 31 categories that determine the students' expectations, quality, students' opinions about succeeding in a course, and student's depression about the studies in a course. A condensed of 6 categories consisting of 37 measurement items using a 7-point Likert scale was used in this study. The condensed version was developed by Pintrich [7]. Table 1 lists the 37 measurement items.

Table 1
Questionnaires items [7]

Categories	Items
Intrinsic Motivation	(a) In a class like this, I prefer course material that really challenges me so that I can learn new things. (b) In a class like this, I prefer course material that arouses my curiosity, even if it is challenging to learn. (c) The most satisfying thing for me in this course is understanding the content as thoroughly as possible. (d) I choose coursework that I can understand from when I have the opportunity in this class.
Extrinsic Motivation	(e) In this class, getting a good grade is the most satisfying thing for me right now. (f) The most important thing for me is improving my overall grade point average, so my main concern in this class is getting a good grade. (g) I want to get better grades than most of the other students in this class. (h) In this class, I want to do well because showing my ability to family, friends, or others is essential.
Task Values	(i) I believe that in other courses, I will be able to use what I learn in this course. (j) It is important for me to learn the content of the course in this class. (k) The content of this course is very interesting to me. (l) I think it is useful for me to study the course material in this class to learn. (m) I like this course's topic.
Control of Learning	(n) If I study effective method, then in this course I will be able to understand the subject. (o) If I do not understand the content in this course, it is my own fault. (p) If I work hard enough, then I can understand the materials of the course. (q) If I don't understand the materials for the course, that's because I haven't worked hard enough.
Self-Efficacy	(r) I hope I would receive an excellent mark in this class. (s) I am sure that I can understand the most problematic material for this course presented in the learning. (t) I am sure that I can follow the basic techniques that this course offers. (u) I am sure that I can understand the most complex concepts discussed in this course by the lecturer. (v) I'm sure that I would do an excellent work in this course on assessments and exams. (w) I expect to do well in this class. (x) I'm sure I can learn the skills that this class offers. (y) I assume I would do well in this class, considering the difficulty of this course, the lecturer, and my abilities.
Self-Regulation	(z) I often miss the main points during class time, when I think about other things. (aa) I ask questions when studying for this course to help concentrate my learning. (bb) I look back and try to sort things out whenever I get confused about something I'm reading for this course. (cc) I change the way I read the content if course topics are difficult to understand. (dd) I also review to see how it's structured before I study properly for new course material. (ee) I ask myself questions to ensure that I understand the content I studied in this class. (ff) I try to adapt the way I learn to fit the course criteria and the teaching style of the lecturers. (gg) I often find that I learn for class, but I don't remember what it was all about. (hh) Instead of just reading it over when studying, I try to think through a subject and decide what I should learn from it. (ii) I try to decide which topics I do not understand well when I study for this course. (jj) When I study for this class, I set targets for myself to guide my behaviors throughout each study period. (kk) In this class, if I get confused about taking notes, I make sure I sort it out afterwards.

2.2 Sample and Data Collection

The data were obtained through questionnaires distributed to Mechanical Engineering students taking Introduction to Design classes. The questionnaire was provided through an online survey for the students due to the limitations of conducting it face-to-face.

2.3 Item Analysis

Reliability and normality analysis were conducted using Statistical Package for Social Sciences (SPSS). A research instrument was reliable if the data is consistent and stable, thus predictable and accurate [8]. Questionnaire items are judged to be reliable if their Cronbach's alpha values exceed 0.70. The normality assumption must also be considered when validating the data since it indicates a parametric test, or a non-parametric test is required. The p-value determined is lower than 0.05; thus, the study will be analysed using non-parametric test.

2.4 Demographic

The demographic data of this study were interpreted based on gender, current motivation, and quality of internet connection. Those factors analysed based on frequency and percentage to describe the distribution of the participants.

2.5 Six Categories of Motivation

Wilcoxon Signed Ranks Test was used to achieve two objectives of this study as shown in Table 2. It investigates the direction, intensity, and significance of the relationship on student's motivation during synchronous online learning classes at the beginning and end of the semester.

Table 2
Statistical test for inferential statistics

Research Objective	Test variable	Statistical Measurement
(i) To identify the differences in students' motivation between the beginning and end of the semester. (ii) To investigate the difference of six categories for assessing self-motivation among the students between the beginning and end of the semester.	• Students' motivation in the beginning and end of the semester • Intrinsic Motivation • Extrinsic Motivation • Task Values • Control of learning • Self - Efficacy • Self - Regulation	Wilcoxon Signed Ranks

There are two components analysed on the Wilcoxon test: the ranks table and the statistical test table. The ranks table provides the data about the comparison of the participant on two variable scores. The statistical test table gives the p-value that indicates the significant value for the two variables measured. Table 3 shows the theoretical hypothesis for these variables to achieve the objective.

Table 3
Theoretical hypothesis

Hypothesis	Hypothesis Explanation	Significant Value
H_0	The mean of the two variables is not different from each other	$p > 0.05$
H_1	The mean of the two variables is different from each other	$p < 0.05$

2.6 Factors Affecting Student's Motivation

According to Benjamin *et al.,* [9] and Kukreja [10], multiple regression analysis is used to evaluate the relationship between the dependent variable and two or more independent variables and create conditional variable predictions. Hence, this indicates that the variable to be clarified is the dependent variable, and independent variables are factors used to describe the dependent variables. Therefore, multiple regression analysis is a suitable statistical method in evaluating the factors that affect student's motivation in online learning classes. Additionally, Meng and Hu [11] employed a similar technique to study the connection between two variables, including student motivation and academic achievement, during Covid-19 to 145 Chinese students who used online learning. Next, research from Liu and Zainuddin [12] use regression linear to find out the relationship between student motivation and student perception toward blended learning component during Covid 19 to 364 Malaysian students in public university. Kotera *et al.,* [13] also used multiple regression analysis to identify which type of students' motivation which may affect to learning engagement, self-criticism and self-compassion to 109 postgraduate UK students. Hence, multiple regression analysis is also considered to be used in this research since the output can be easily interpreted, and unnecessary work can be neglected without influencing other's implementation. The variables consist of were the factors that will affect students' motivation in online learning classes. This study's variables are obtained from researchers' previous data and used as the independent variables. The factors that have been taken into the independent variables are shown in Table 4.

Table 4
The factors in regression analysis

Research Objective	Independent Variables	Independent Variable
(i) To determine the factors aspect that affects students' motivation in the online learning platform	• Students' skills in internet technology and related software • Encouragement and engagement from the peers • Contribution and guidance from the lecturers • Students' willingness to participate in online learning	Students' motivation

3. Result and Discussion

3.1 Item Analysis

Cronbach's alpha value was observed based on the variable. There are two variables in this study: students' motivation in the beginning and students' motivation at the end of the semester. Table 5 shows the result of Cronbach's alpha values of students' motivation in the beginning and students' motivation in the end of the semester.

Table 5
Cronbach's Alpha result

Variables	Cronbach's Alpha value
Students' motivation in the beginning semester	.978
Students' motivation in the end semester	.977

This shows that all sets of questions are reliable to measure the study's variables since they are greater than 0.70. Strong reliability indicates that questionnaires items were closely connected and that the survey accurately reflected students' motivation. Two variables need to be considered about their normality before the analysis can be done: the data collected for students' motivation in the beginning and the students' motivation at the end of the semester. The result of the normality test with Lilliefors correction significant or Kolmogorov-Smirnov is shown in Table 6.

Table 6
Normality Test Result

Variables	Degree of freedom (df)	P-value
Student's motivation in the beginning of the semester	94	0.005
Student's motivation in the end of the semester	94	0.045

Table 6 shows that significant values show that both variables have a p-value lower than 0.05, indicating the data is not normally distributed. Therefore, this result indicated that non-parametric statistics should be used instead of parametric statistics. The non-parametric statistics being used is the Wilcoxon Signed Ranks test for further analysis of the data collection.

3.2 Demographic Analysis

The respondent's backgrounds were described using demographic analysis based on their gender, current motivation, and internet connection quality. 94 respondents completed the analysis, and demographic information of the respondents is summarised in Table 7.

Table 7
Demographic information

Factor	Category	Frequency	Percentage (%)
Gender	Male	74	78.7
	Female	20	21.3
Current Motivation	High	18	19.1
	Moderate	51	54.3
	Low	25	26.6
Quality of Internet	Excellent	26	27.7
Connection	Moderate	57	60.6
	Bad	11	11.7

Based on Table 7, male respondent has greater number than female respondents in this study. Besides, the current motivation of the most students was dominant at the moderate level. Other than that, 60.6 percent students perceive that quality of internet connection at the moderate level.

3.3 Six Categories of Motivation Analysis

This part of the study investigates the difference between students' motivation and six categories for assessing self-motivation between the beginning and end of the semester (*objective 1*). Wilcoxon Signed Ranks Test was run to analyses these variables to investigate whether there are differences in students' motivation and six categories for assessing self-motivation. The output of analyses will show the significant level for the variables that be measured. The significant level indicates if there are differences in the mean variables for both objectives.

The first analyses of testing are students' motivation between the beginning and end of the semester. The analysis can be interpreted from the result obtained by comparing the significant value of the measured variables. The result from the Wilcoxon test for students' motivation is shown in Table 8.

Table 8
Result of Wilcoxon test: Student's motivation

Descriptive Statistics				Ranks			Significant
Scale (Students' Motivation)	N	Mean	Standard Deviation	Negative	Positive	Ties	Value (p-value)
Beginning of semester	94	4.5244	1.2133	41[a]	37[b]	16[c]	0.856
End of semester	94	4.5282	1.2119				

a. Beginning < End b. Beginning < End c. Beginning = End

The mean or average for questionnaires in both variables is relatively equal, but the end of the semester is slightly more than the beginning of the semester. The same goes for the standard deviation, where the difference is slightly small for both variables measured. For 94 respondents, 41 had higher motivation at the end of the semester, while 37 were the other way around. Lastly, 16 had equal motivation. Referring to Table 8, the p-value suggested that the means for students' motivation at the beginning of the semester were found not to have statistically significant differences at the end of the semester since the significant value is 0.856. Therefore, there is no substantial evidence to conclude that students' motivation at the beginning and end of the semester is statistically different.

Overall, for this result, the students' motivation is unaffected by the synchronous online learning method implemented in the Introduction to Design course. Furthermore, it is illustrated that the students could adapt to the learning method in this course even though this course should be carried out in a face-to-face manner. Students also could manage themselves to maintain their motivation throughout the whole semester. Similar results from Stefanou *et al.,* [14] found synchronous online learning does not affect motivation in non-procrastinators students.

The second analysis tests the six categories for assessing self-motivation among the students between the beginning and end of the semester (*objective 2*). This analysis measures different categories or constructs: intrinsic motivation, extrinsic motivation, task values, control of learning, self-efficacy, and self-regulation. Figure 1 shows the average score for each category in the beginning and end of the semester. The analysis can be interpreted from the result obtained by comparing the significant value of the measured variables. The result from the Wilcoxon test for six categories for assessing self-motivation is shown in Table 9.

Referring to Figure 1, four categories had a little different score between the beginning and end of the semester: extrinsic motivation, task values, control of learning and self-efficacy. Interestingly, the case is different for intrinsic motivation and self-regulation. Besides, only self-regulation shows

that the average score in the beginning is lower than the average score at the end of the semester compared to others that show otherwise pattern. According to Stefanou *et al.,* [14], the suitability of online learning with the instructional environment encourages strengthening students' self-regulation and critical thinking, where the score at the end of the semester is higher than at the beginning. Based on Table 9, two categories produced a smaller significant value below 0.05: intrinsic motivation and self-regulation. The intrinsic motivation on online learning increases when they perceive discussion activities as enjoyable and valuable [15]. Also, the technology applied during online learning makes the learning more fun, students are more motivated, and at the same time they can learn independently – thus, improve the performance [16].

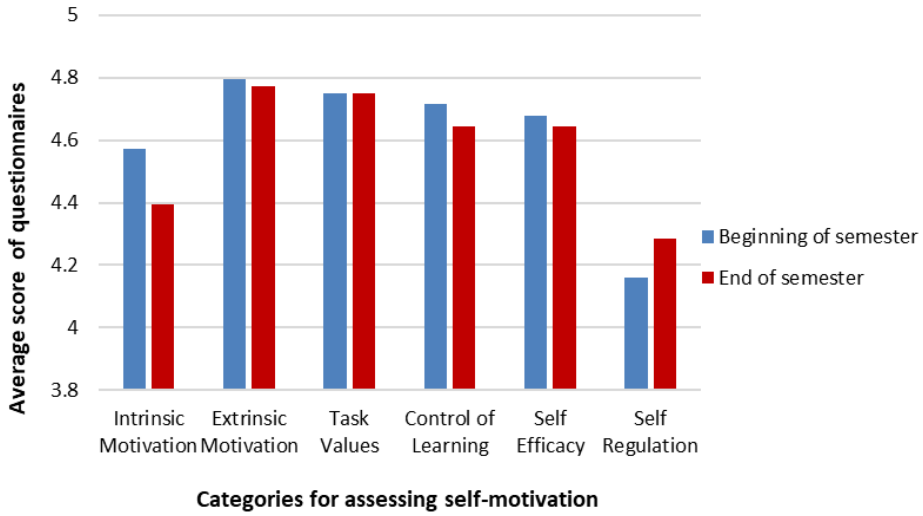

Fig. 1. Average score for six categories in beginning and end of the semester

Table 9
Result of Wilcoxon test: Six categories for assessing self-motivation

Categories for assessing self-motivation	Descriptive Statistics		Significant value (p-value)
	Scale (Students' motivation)	Mean	
Intrinsic Motivation	Beginning of semester	4.5718	0.034
	End of semester	4.3936	
Extrinsic Motivation	Beginning of semester	4.7952	0.409
	End of semester	4.7739	
Task Values	Beginning of semester	4.7489	0.870
	End of semester	4.7511	
Control of Learning	Beginning of semester	4.7154	0.490
	End of semester	4.6436	
Self-Efficacy	Beginning of semester	4.6769	0.463
	End of semester	4.6423	
Self-Regulation	Beginning of semester	4.1596	0.005
	End of semester	4.2837	

However, as shown in Table 9, the intrinsic motivation decreases significantly towards the end of semester. This pattern correlates with the findings stating that students' performance during online for course learning outcomes that involve concept definitions is better as compared to hybrid learning. The performance during hybrid for course learning outcomes that involve more theoretical definitions is better as compared to online learning [17]. This corresponds with the decrease of intrinsic motivation when the topic become tougher, and the students need more engagement and explanation from the lecturers.

From the result, the means for extrinsic motivation, task values, control of learning and self-efficacy were found not to have statistically significant differences between the beginning and end of the semester. Without a doubt, the significant values are larger than 0.05. Thus, there was no strong evidence to conclude that the means for these four categories in the beginning and end of the semester are statistically significantly different. The result for categories of students' motivation will be interpreted by referring to Table 10.

Table 10
Interpretation of result

Categories	Statistical Result	Result Interpretation
Intrinsic Motivation	• Statistically significant differences (p=0.034)	• Students had established the desired expectation for learning that comes from themselves at the beginning of the semester.
Extrinsic Motivation	• Not statistically significant differences (p=0.409)	• Students could engage in learning tasks to achieve goals in this course for the rest of the semester.
Task Values	• Not statistically significant differences (p=0.870)	• Students understood the course content and were interested in the material course for the whole semester. • Students like to participate in this course and use the knowledge of the content course for their future.
Control of Learning	• Not statistically significant differences (p=0.490)	• Students can achieve the expectation for their grades with their hardworking and action in the course.
Self-Efficacy	• Not statistically significant differences (p=0.463)	• Students also can gain the skill in this course and implemented their abilities to understand well and to do their task perfectly for the whole semester.
Self-Regulation	• Statistically significant differences (p=0.005)	• Students had the determination to pursue their learning goals even in the learning method's difficulties at the end of the semester. • Students could adapt and decide what they need to do to maintain their learning and behaviours for a better result for themselves for the whole semester.

3.4 Factors Affecting Student's Motivation Analysis

This study investigates factor aspects affecting students' motivation in the online learning platform (*objective 3*):

(i) Students' skills in internet technology and related software.
(ii) Encouragement and engagement from peers.
(iii) Contribution and guidance from the lecturers.
(iv) Students' willingness to participate in online learning.

The output of analyses shows the R-squares and significant level for the variables that are measured. R-squares indicates the percentage of the factors contributing to the students' motivation, and the significant level will indicate if these factors were significant for student motivation. Table 11 shows that the summary table from regression analysis consisted of the R square value. Meanwhile, Table 12 shows the regression coefficient for each variable for this analysis.

Table 11
Result of Regression: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.611[a]	0.373	0.345	0.57616

Table 12
Result of Regression: Coefficients

Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.673	0.412	-	6.488	0.000
Students' skill in internet technology and related software	0.158	0.082	0.210	1.928	0.057
Encouragement and engagement from the peers	0.093	0.063	0.173	1.484	0.141
Contribution and guidance from the lecturers	0.250	0.079	0.369	3.146	0.002
Students' willingness to participated in online learning	0.020	0.079	-0.031	-0.250	0.803

Referring to Table 11, all the four factor aspects measured contributed as much as 37.3 percent to students' motivation. This analysis found that many students strongly agreed regarding the existing relationship between these four factors and student's motivation.

Based on Table 12, the only significant factor that affect students' motivation in online learning is contribution and guidance from the lecturers. Thus, contribution and guidance from the lecturers is a significant predictor of students' motivation. This finding is in-line with Savage *et al.,* [18] stated that lecturers' roles are essential in motivating students to ensure that online learning helps achieve learning goals and encourages self-confidence. Meanwhile, the significant value for students' skills in internet technology and related software, encouragement and engagement from the peers, and students' willingness to participate in online learning are 0.057, 0.141 and 0.803, respectively. As mentioned in the literature review, lecturers' contribution is also essential in students' motivation to care about their student progress and performance [19]. This shows that the student in Introduction to Design needs more of the lecturer's concern with their study progress for this course. The students require the lecturer's feedback to inspire and motivate them in this online learning platform. This course requires the students to have good knowledge, especially critical thinking and creativity, to create the design, solve the problem, and manage the project.

4. Conclusion

The questionnaires were used to investigate the impact of online learning on students' motivation in the Introduction to Design course. In general, students' motivation remains unchanged, and they could manage to maintain their motivation throughout the whole semester. Students' motivation is found to be unaffected by the synchronous online learning method implemented in the Introduction to Design course. However, deeper investigation revealed that two categories had significant changes: intrinsic motivation and self-regulation. Intrinsic motivation is found to be significantly decreased, and thus, this aspect requires further exploration. It is also shown that with online learning, the self-regulation aspect is significantly improved. This finding could be a handy hint for lecturers when the classes are back to face-to-face implementation. Finally, this study also shows

that many students strongly think that the lecturers' contribution and guidance affect their motivation.

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