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Effect of University Students' Opting Engineering and Time Spent for Study on the Achievement of their Program Learning Outcomes through Online Education

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Abstract

Education process is directed towards the specified ends which are defined as outcomes of education. Educational outcomes may be affected by various demographics of the learners. Present study was designed to find out the effect of engineering students' opting education and time spent for study on their program learning outcomes through online education. Fourteen hundred and twenty-five engineering students were selected as sample of the study. A survey was developed on five-point Likert type rating scale to measure students' program learning outcomes and a demographic sheet to measure the time spent for study and opting education by their interest or forcibly. Collected data were analyzed through descriptive statistics and ANOVA. Results revealed that students opted education by choice had higher program learning outcomes than those who opted by force. Results yielded higher PLOs achievement for 4-6 hours spent for study. The lowest PLOs achievement was found for those students who spent less than 2 hours for study. Parents are recommended let their children opt field of education as per their choice. University administration is recommended to develop students' interest in education for higher PLOs achievement. Engineering students are recommended to spent 4-6 hours daily for study to have higher PLOs achievement.

Key words: Engineering Education, Program learning outcomes PLOs, Online education, COVID-19, Pakistan.

Introduction

Outcome based education (OBE) defines strategic ways to enhance the quality of the whole teaching and learning process. It prepares students for real world problems by practicing the learnt skills and morality. OBE clears the goals and achievements of students to be transformed into practice after the completion of course or program (El-Refae, Kaba, & Eletter, 2021). Both teacher and student work for the development of skills useful for

the society. OBE encourages students to take active participation for the understanding of material and the process of learning (Nugroho, at al., 2021).

Students' PEOs, PLOs, and CLOs may be affected by a number of factors which may be related to a graduate's life or controlled by the institution. These factors may belong to graduate's parents or circumstances. These may be forced through natural disaster also (Kamran, at el., 2020). One of the factors that affect engineering students' PEOs, PLOs, and CLOs is their selection or opting education (Delgado, 2021). There are factors which encourage students to do efforts and regulate their skills for the achievement of desired program learning outcomes, and show persistency when face any obstacles (Malhotra, at al., 2020). One of these factors is defined as students' interest in education.

Students' academic interest not only assists a student's success in school, college or in the university but also helps him to manipulate his learnt skills for the success of his career (Hassan, Mirza, & Hussain, 2020). If the student is struggling to achieve educational ends for his personal satisfaction, it is termed as self-directed interest or selection of objectives. Developing interest in education through external factors such as rewards receiving from others and avoidance of punishment is also beneficial for the achievement of educational objectives (Baltà-Salvador et al., 2021).

Either it is internal or external interest in education, both are important for the achievement of PLOs for engineering students. Students having interest in engineering education can perform well in career as desired by the institution and stated in curriculum. It is well stated and accepted maxim that "there is no learning without interest or motivation".

During COVID-19 Pakistani students and teachers were not well aware to teach students well as for the achievement of program learning outcomes in its true spirit as stated in curriculum. Various factors affected engineering students' educational outcomes. Which factor has statistically significant effect on students' program learning outcomes, should be empirically found out so that proper strategies may be recommended for future. To answer this question, the present study was designed.

The findings of the study may be significant for engineering students to have effective control on their demographics for effective learning through online mode of classes. They can experience effective motivational strategies adopted by teachers and may control their negatively affecting demographics and adopt effective strategies to motivate themselves for effective online classes. The study is equally important for policy makers to revise policy in the light of online education courses to be taught to the teachers and students for effective teaching and learning through online mode of education in higher education institutions.

Literature Review

Pakistan Engineering Council (PEC) (2014) adopted twelve graduate attributes for accreditation of engineering education as suggested under Washington Accord for Outcome Based Engineering Education. Program learning outcomes are the narrower statements that specify students' knowledge, skills, attitudes, and ability to solve problems they face in the field of life. PEC states that engineering programs must possess the content and instructional experiences that develop certain skills, knowledge, and competencies

required for successful career and professional growth. Engineering content at least should develop following graduate attributes (GAs) in engineering students by the end of course.

GA1 Engineering knowledge

This is the ability to apply their learnt fundamental knowledge of mathematics, engineering specialization to solve the complex problems in the field of engineering.

GA2 Problem analysis

The solution of problem depends upon its proper scientific analysis and finding substantiated conclusion and solution of such problem. Engineer students should have the ability to analyze the situation scientifically to reach suitable solution of the complex engineering problems. This ability to analyze the situation is another necessary graduate attribute of engineering students.

GA3 Design/development of solution

All the solutions of a problem are considerable due to their effectiveness for society, health, and environment. Engineering graduates should have the ability and competency to design and develop solution effective for the society, health, safety, and environment. This ability enables engineering graduates to grow in their profession and career (Peltea, 2020).

GA4 Investigation

Investigation is another important graduate attribute of an engineering graduate. This is the ability to analyze the complex problem by different methods and procedures to reach effective and valid solution of an engineering problem. It may involve survey, experiment, observation, review of literature, and synthesis of perceived knowledge for the solution of that particular engineering problem.

GA5 Modern tool usage

Engineering content should train the graduates to have the ability to use modern tools like IT and scientific tools by considering their limitations for the solution of engineering problems. The world is progressing rapidly and inventions are going on. These modern tools may be useful for engineers also. They should have the ability to use them as a tool to reach on effective solution any hurdle (Sathya, & Narayanan, 2021).

GA6 The Engineer and society

It is the ability to act purposefully and effectively in society while practicing engineering practices and solving engineering problems. An engineer should be useful for society and its inhabitants by paying their societal responsibilities.

GA7 Environment and sustainability

Engineering graduate should be able to understand how professional engineering solutions may impact the society and environment. He/she must have knowledge to demonstrate engineering skills and knowledge for societal sustainability and development.

GA8 Ethics

Professional ethics are basics for success in career and profession. Engineer graduates are taught professional ethics which should be demonstrated by the graduates

while performing their services in the society. Engineers have to do many responsibilities. They need to follow the norms of the profession to become effective practitioner (Delgado, 2021).

GA9 Individual and Team work

Engineering graduates have to work in multidisciplinary settings and facets after the completion go their engineering course. Their ability to work in team by following the cooperative and coordinative principles would make them successful in the career and profession. Individual work may not fatigue the graduate. So, individual and team work spirit should be reflected and demonstrated in the field after the completion of engineering course (Hassan, Mirza, & Hussain, 2020).

GA10 Communication

Communication plays central role in every walk of life. Engineers have to convey their ideas properly to the lower as well as higher personnel for proper consummation of task. Therefore, an engineer should have the ability and skill to communicate effectively. It may ensure the progress in career and profession.

GA11 Project Management

Engineering graduates should be taught to manage their individual as well as collective tasks effective in the field. They must be able to demonstrate their managerial skills to handle the team and individual working situations. These managerial skills will enable them an effective leaders and workers in the field of engineering.

GA12 Lifelong learning

Changes keep on in life and field of life. New inventions are going on in the field of engineering by interwoven of technology. Innovations should not be hurdle for an engineer in the career. To cater this situation, an engineering graduate need to update his knowledge and skills. He must have the aptitude of learning and keeps on learning in life after the completion of engineering course (Engineering Accreditation Board, 2014).

Theoretical Framework of the Study

Theoretical framework suggests the canvas under which the study comes as per theories suggested by the experts. Present study is finding the effect of demographics – time spent for study and opted engineering education by self-interest or following others' desire and direction on engineering students' program learning outcomes. This is behavioural phenomenon of learning. Behavioural learning theories suggest that there is a cause or stimulus that takes an action. Such stimulus may be natural or conditioned. Similarly, operant conditioned theory suggests that desired action is maintained by giving proper feedback as required for that action. So, the present study is supported to test the behavioural learning theories.

Figure 1: *Conceptual Framework*

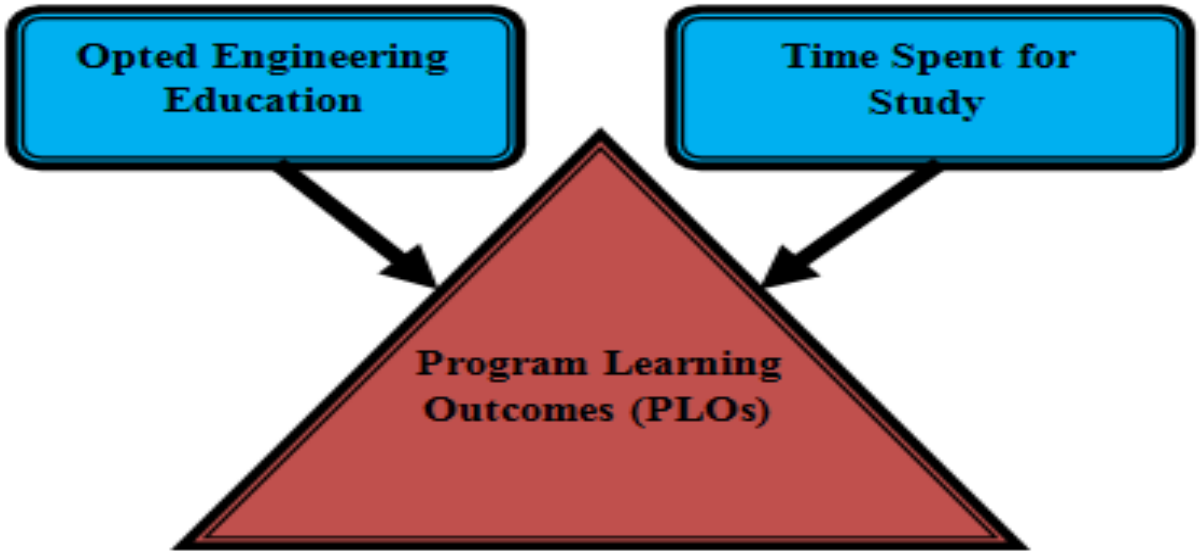

Figure 1 elaborates conceptual framework of the study. There are two independent variables – opted engineering education and time spent for study. These are demographics in nature. One dependent variable – program learning outcomes POLs which are the targeted ends defined by Pakistan Engineering Council (PEC). The independent variables already occurred during the COVID-19 period when education mode was adopted online. The study surveyed the selected sample to find out their effect.

Objectives

The study was conducted to:

1. Find out the effect of engineering students' act of opting engineering education on the achievement of program learning outcomes through online education during COVID-19 period.
2. Find out the effect of engineering students' time spent for study on the achievement of program learning outcomes through online education during COVID-19 period.

Hypotheses

Following hypotheses were developed for the study:

Ho1: There is no statistical significant effect of engineering students' choice of opting engineering education on the achievement of program learning outcomes through online education during COVID-19 period.
Ho2: There is no statistical significant effect of engineering students' time spent for study on the achievement of program learning outcomes through online education during COVID-19 period.

Methodology

Study was quantitative in nature collected data through a survey in the form of five-point Likert-type rating scale. Study answers the question "what is?" therefore it is descriptive in its design. It comes under the umbrella of post-positivism philosophical research paradigm. This philosophical research paradigm supports the idea that fact is measured through numbers effectively. The present study yields results in the form of numbers rather than statements and words. The study is also exploratory in nature because it unfolds the facts which already occurred.

Two survey questionnaires were developed for the collection of data. One was of engineering students' program learning outcomes survey and second was demographic sheet for to measure engineering students' demographic information. The surveys were also validated by the two experts from engineering education. Program learning outcomes were selected from the Manual of Accreditation (2nd ed.) published by Pakistan Engineering Council in 2014. These program learning outcomes were measured through 12 graduate attributes GA (Obaydullah, Rahim, & Rahman, 2020). These GA included, engineering knowledge, problem analysis, design/development of solutions, investigation, modern tool usage, the engineer and society, environment and sustainability, ethics, individual and team work, communication, project management, and lifelong learning. These graduate attributes were surveyed with 49 statements.

Reliability measures revealed .92 statistical values which suggested high suitability of the survey for research study. Reliability was gained through split half method of Cronbach alpha method (Sullivan & Brennan, 2018).

All the 1st and 2nd semester engineering students who studied online during COVID-19 period were the population of the study from public sector universities of the Punjab. Fourteen hundred and twenty-five (1425) engineering students were surveyed for this study as sample of the study.

The data were analyzed through descriptive statistics and ANOVA. It was because independent variables – opting engineering education (by choice or followed others) and time spend for study (less than 2 hours, 2-4 hours, 4-6 hours, 6 - 8 hours) had more than one bifurcation along with one dependent variable – program learning outcomes

Data analysis and interpretation

In this section, data on the cited variables have been analyzed by using ANOVA statistics. Tables reveal statistical values along with interpretations justifying hypotheses testing.

Table 1
Demographics-Time Spent for Study Based Comparison of Engineering Students' Program Learning Outcomes (PLOs)

Time Spent for Study	N	Mean	SD	SS	df	F	Sig.
Less than 2 hours	463	3.76	.53				
2-4 hours	503	3.91	.48				
4-6 hours	306	4.02	.47				
6-8 hours	153	3.99	.61				
Between Groups				15.00	3	18.935	.000
Within Groups				375.24	1421		

Note: n=1425, p=.05

Table 1 is about the values taken from one-way ANOVA statistics for the measurement of effect of demographics –time spent for study on engineering students' PLOs attainment through online mode of education during COVID-19 period. Values yield that there is statistical significant effect of demographics-time spent for study on engineering students' PLOs achievement at the $p<.05$ with the condition [$F(3, 1421) = 18.935$, $p = .000$]. Engineering students who spent 4-6 hours daily have higher achievement as ($M = 4.02$, $SD = .47$) than 6-8 hours as ($M = 3.99$, $SD = .61$) and 2-4 hours daily as ($M = 3.91$, $SD = .48$). Engineering students who spent less than 2 hours daily for study shows least performance in the achievement of PLOs as ($M = 3.76$, $SD = .53$). It reveals that 4-6 hours' time spent for study is the most effective for high achievement of PLOs at engineering level of education through online mode of education. So, the hypothesis "H_o: There is no statistically significant effect of demographics-time spent for study on engineering students' program learning outcomes through online classes during Covid-19 period" is field to support and concluded that time spent for study has statistically significantly different effect on engineering students' PLOs attainment through online mode of education and an alternate hypothesis is stated as "H_1: There is statistically significant effect of demographics-time spent for study on engineering students' program learning outcomes through online classes during Covid-19 period". Engineering students who spent 4-6 hours daily for their study may show higher achievement of PLOs at engineering level through online mode of education. Time spent for study on daily basis matter a lot for the good performance of PLOs achievement at engineering level of education.

Table 2

Demographics-Opted Engineering Education (By Choice/Force) Based Comparison of Engineering Students' Program Learning Outcomes (PLOs)

Opted Engineering Education	N	Mean	SD	SS	df	F	Sig.
By Choice	1271	3.92	.51				
By Force	154	3.67	.56				
Between Groups				8.19	1	30.513	.000
Within Groups				382.05	1423		

Note: n=1425, p=.05

Table 2 is about the values taken from one-way ANOVA statistics for the measurement of effect of demographics – opted engineering education (choice/force) on engineering students' PLOs attainment through online mode of education during COVID-

19 period. Values yield that there is statistical significant effect of demographics-opted engineering education (choice/force) on engineering students' PLOs achievement at the $p<.05$ with the condition [$F(1, 1423) = 30.513$, $p = .000$]. Engineering students who opted engineering education by choice have higher achievement as ($M = 3.92$, $SD = .51$) than by force ($M = 3.67$, $SD = .56$). It reveals that opting engineering education by choice is more effective for the higher achievement of PLOs at engineering level of education through online mode of education than by force or by following others' direction. So, the hypothesis "H_o: There is no statistically significant effect of demographics-opted engineering education (choice/force) on engineering students' program learning outcomes through online classes during Covid-19 period" is field to support and concluded that opted engineering education by choice has statistically significantly different effect on engineering students' PLOs attainment through online mode of education and an alternate hypothesis is stated as "H_1: There is statistically significant effect of demographics-opted engineering education (choice/force) on engineering students' program learning outcomes through online classes during Covid-19 period".

Based on the above data analysis and interpretation, following two key findings are revealed.

1. Time spent for study has statistically significant effect on engineering students' program learning outcomes. 4-6 hours and 2-4 hours spent daily for study produces better results than less than 2 hours spending daily for study. The more engineering student spent time for study on daily basis the more improved results would show for the attainment of their PLOs.
2. Similarly, those engineering students who opted engineering education on their own choice have better performance than those who opted engineering education by following others' direction. Therefore, it is concluded that engineering education should be opted by students' choice.

Discussion

Study was conducted on the effect of engineering students' demographics – time spent for study and opting engineering education by choice or force on their program learning outcomes. Findings of the study revealed that engineering students who spent their time 4-6 hours daily to study gained highest program learning outcomes than those who spent 6-8 hours. At the same time 6-8 hours' time spent for study produced higher program learning outcomes than those who spent 2-4 hours daily. Those students who spent 2-4 hours for study gained higher sores than those who spent less than 2 hours for study. These findings are consistent with Sathya, and Narayanan (2021) and El-Refae, Kaba, and Eletter (2021). Less than 2 hours' time spent for study is discouraged for engineering students. They should have the habit to spent 4-6 hours daily for study to have higher program leaning outcomes achievement.

Study findings are also consistent with Delgado (2021) and Kamran, Nisa, Fazal, Abid, and Abid, (2020) for the opting engineering programs. Those students who have opted engineering education by choice showed higher program learning outcomes. Sullivan and Brennan (2018) supported the idea of by choice opting any program in engineering education. Students should not follow others' direction and desire. Self-abilities and skills must be considered for the adoption of engineering education.

Amiruddin, Nurdin, and Ali (2021) stated that selection of study program should be solely as per student's interest and aptitude. Students cannot perform when they join a program by following others' direction. Ernawati, et al. (2022) have reported that student cannot perform well until they have interest in the program they have opted. Current study findings are also supported by the studies Rambe, and Siregar (2022), Tashlanovna (2022), and Tohir (2022) that engineering students who opted engineering program as per their own interest and will have higher achievement in program learning outcomes than those who followed direction of others.

Findings of the study are also supported by the Sathya and Narayanan (2021) and Malhotra, Dutta, Daminee, and Mahna (2020). They also suggested and reported that students' self-study have its significant effect on their academic achievement. More time you spent the more academic achievement would be the result of it. The same time joining any engineering program as per own choice is better than following others' direction. Therefore, students let them adopt field of study as per their own choice for effective academic achievement.

Conclusion and Recommendations

It is concluded that engineering students should develop habit of spending more time on self-study. Self-study is very important to have higher academic achievement. Study revealed that 4-6 hours daily should be devoted for self-study. Otherwise, the program learning outcomes of engineering education may not be achieved as per decision. Less than 2 hours is discouraged for engineering students for self-study because it did not show any statistically significant result in the achievement of PLOs. Similarly, students who opted engineering education by their own choice showed higher PLOs achievement. Those who opted engineering education as per elders or others' wish and force, revealed very low achievement in PLOs. So, more time should be spent on study and opting engineering education should be based on students' own choice. They should not be forced to join engineering education.

Based on the findings and conclusion, following recommendations are presented:

1. Parents are recommended not to force their sons and daughters to opt engineering education because engineering students opted engineering education forcefully or by following others' directions cannot show improved performance for the achievement of PLOs. Similarly, engineering teachers and administration are recommended to prefer at the time of interview the admission of those students who opt engineering by their own choice. Such engineering students would have good achievement of PLOs in engineering education.
2. Engineering teachers are recommended to encourage engineering students to spend 4-6 hours daily for their study because it showed higher effect on their PLOs attainment. Spending 6-8 hours daily is also effective but less than 4-6 hours. Less than 2 hours has least cannot show satisfactory achievement of PLOs. Engineering students are also recommended to spend 4-6 hours daily for higher achievement of PLOs in their engineering education through online medium of instruction.

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