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Improving the Quality of Engineering Education in Libya

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Abstract— **Engineering education has a crucial role in the economic and social development of society; this paper aims to investigate the most significant factors that contributing in improving the quality of the engineering education. Furthermore, identify the factors affecting the students' academic performance. The study was conducted by using statistical Design of Experiments (DOE) approach to investigate the main effects of lecture delivery, assessment, engagement, communication, and interaction with instructors. Minitab software is implemented to perform statistical analysis to identify the significance of each factor, and degree by which each factor influences the students' academic achievement. Results showed that the students' academic performance is affected by the availability of course materials, and communications with instructors.**

Keywords— Service Quality measurement, Quality improvement, engineering education, Design of Experiment (DOE)

I. INTRODUCTION

There is no doubt that people realize the importance of education in many disciplines, especially engineering education. Engineering Education (EE) plays a vital role in the social and economic development of society. EE is mainly concerned about the implementation of the applied science to come up with products that fit the customer requirement. Therefore, there is a need to understand how to improve the quality of engineering education to ensure that future engineers have the required skills to address societal challenges. This research aims to investigate the most significant factors that contribute to enhancing the quality of engineering education and to identify the factors that affect students' academic performance. Specifically, the statistical Design of Experiments (DOE) [1] approach to study the main effects of lecture delivery, assessment, engagement, communication, and interaction with instructors. Minitab software was performed to conduct statistical analysis to identify the significance of each factor and the degree by which each factor influences students' academic achievement. The results indicate that the availability of course materials and communications with instructors are significant factors that affect students' academic performance. This research provides insights into how engineering education can be improved to meet the needs of students and society. Therefore, the engineering education system and curriculum must be updated accordingly. In literature, there are numerous studies on improving the quality of learning approach especially during the pandemic covid-19. For instant, Pham, et al assessed factors affecting students' online learning outcomes during the COVID-19 pandemic [2]. They concluded students' online learning outcomes are affected by six factors in the descending order, respectively, learner characteristics, perceived usefulness, course content, course design, ease of use, and faculty capacity. Ali et al reported that As engineering has become a more global profession [3]. They stressed that education has been impacted by globalization, schools and education systems now are competing on a global arena. Therefore, engineering institutions must have Accreditation Board for Engineering and Technology (ABET), to maintain quality of engineering education and to survival in the global market. Navas, et al [4] have been used several quality tools such as Six Segma to develop effective strategies to improve the quality of the education system. Furthermore, an excellent strategy of teaching mode is proposed by [5], which provides theoretical support and practical path for instructors to engage students in effective way. The quality of the learning approach is affected by several factors such as interaction between student and professor, technical support availability, structured online class modules, etc. [6]. Readers might referred to a comprehensive review of predictive factors of student success in and satisfaction with online learning [7] which is similar to the tradition learning approach. The main objective of this study is to investigate the most factors that affected the students' academic performance and achievement in the engineering education in Libya.

II. RESEARCH METHODLY

A. Factors affecting the students' academic performance

A well-designed questionnaire has been distributed to a sample of 120 engineering students from different departments and academic year. The Statistical Design of Experiment using Minitab software is used to investigate the effect of the following factors: lecture delivery, assessment, engagement, communication, and interaction with instructors, and which factor is considered as the most significant one.

Therefore, the main goal is to identify the most significant factors that affect the student's academic performance or achievement based on the average GPA.

The purpose of this study is to investigate the factors influencing students' perception, experience, and satisfaction with the learning approach at the Faculty of Engineering, University of Gharyan. The full description of the studied parameters is tabulated in Table 1. Factors are classified into two main groups (Factor1, and Factor2). In the first group, there are three parameters to be investigated: the ability of students to understand the course material, communication with instructors, and the student engagement in the class. While Factor2 is concerned about the assignment and it consists of the following parameters: fairness of the exams, format of the questions, forms of assessments, and the grading and assessment.

TABLE I. THE STUDIED FACTORS

Factors	Attribute	Indicator	Description
Factor1	Understanding	Idicator_A1	Course material is understandable
	communication	Idicator_A2	Easy to communicate with instructor
	Engagement	Idicator_A3	Easy to be involved in the class
Factor2	Fairness	Idicator_D1	Questions of exams were fair
	Preference	Idicator_D2	The format of questions is preferred
	Variety	Idicator_D3	several forms ate provided: Quizzes, assessments,
	Grading	Idicator_D4	Grading is suitable and cover all activities

In our analysis, we used advanced statistical Analysis Of Variance (ANOVA) technique, an analysis tool used commonly in statistics to investigate the degree of influence of a set of factors on the expected outcome. In other words, in a regression study, the ANOVA test is used to determine the degree of influence of the independent variable it has on the dependent variable. In our case, we employed the technique to investigate the effect of multi-factors (independent variables) and investigated the response (the dependent) variable. The model is very commonly used in design if experiments to measure the response of the factors. Each factor can take a certain value (or level) that varies across the variables [8]. The influence of each factor is determined by the main effect plots that are provided by Minitab software. In a simple way, for each factor, there are four levels, and the effect of each level is shown based on the response (in this case the average GPA). Further, the surface plots are used to investigate the variation among the most significant factors.

III. RESULTS AND DISCUSSION

As mentioned in the previous sections, we focused on two main factors, each represented by several indicators or parameters. The results obtained will be presented and discussed in the following subsections.

A. Factor1: The academic indicators such as understanding theoretical, and practical course materials

As shown in Figure1, students agree with the statement that "explanations and lecturing in theoretical lectures are not good enough. However, the results showed that students agreed that there is excellent communication with instructors. Furthermore, students disagreed with the statement "it was easy for me to engage with the professor during the class".

Analysis of Variance (ANOVA) is used to explain the variation caused by each level. The ANOVA uses F-tests to examine main effects and interactions. Further, p-value in the ANOVA output to identify whether the differences between some of the means are statistically significant. (DF = Degree of Freedom; Adj SS = Adjusted sums of squares; Adj MS = Adjusted mean squares) [9].

TABLE II. TABLE TYPE STYLES

Source	DF	Adj-SS	Adj-MS	F-Value	P-Value
A1	3	0.8183	0.2728	1.21	0.312
A2	3	1.1482	0.3827	1.69	0.174
A3	3	1.3050	0.4350	1.92	0.131
Error	89	20.1177	0.2260		

As shown in Table II, ANOVA results showed that these factors have less significant on the academic performance Since the p-values if greater than 0.05. Further, the interval plot is shown if Figure 2 that indicates the variation in data.
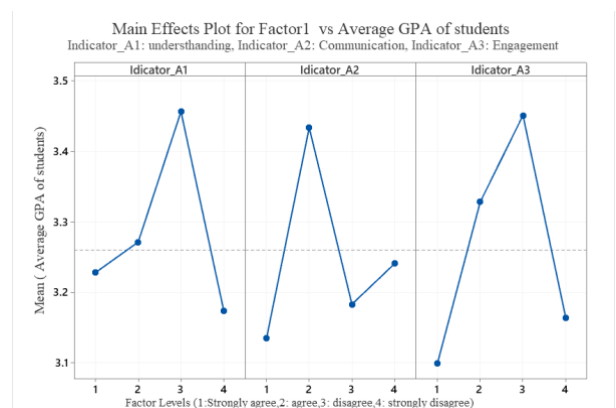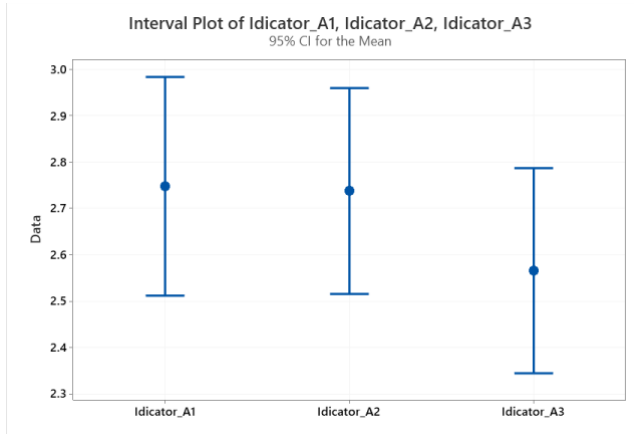

Fig.1: The main effect of the academic indicators.
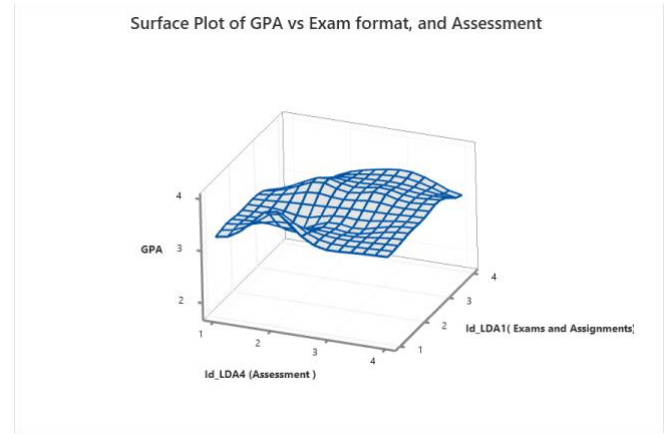
Fig.2: The interval plot of the academic indicators.

Fig.4: The surface plot of assessment and exams indicators.

IV. CONCLUSION

In conclusion, engineering education plays a critical role in the development of society and the economy. This research aimed to investigate the most significant factors contributing to the improvement of the quality of engineering education and to identify the factors that affect students' academic performance. The study used statistical Design of Experiments (DOE) to investigate the main effects of lecture delivery, assessment, engagement, communication, and interaction with instructors. The results of this research showed that course materials availability and communication with instructors are significant factors that impact students' academic performance in engineering education. Based on the findings, strategies for improving course design, delivery, and communication in the classroom are suggested. Future research in this area could explore the impact of other factors on the quality of engineering education, such as technology and curriculum design. Additionally, this research can be expanded to other disciplines and fields beyond engineering. It is essential to continue investigating the factors that contribute to students' academic performance to improve the quality of education and provide students with the skills necessary to address societal challenges. Ultimately, this research provides insights that can be used to improve the quality of engineering education and the development of society and its economy.

B. *Factor2: Assessment and Evaluation*

As shown in Figure 3, the most important parameter in this study is the assessment and evaluation, which include format, and fairness of exams, homework assignments, and grading [10]. As shown in Figure 3, most of the students are satisfied with grading and strongly agree that exam format was understandable. These results may be taken to nominate assessment and evaluation as the most influential factor on the students' satisfactions as indicated by the results.
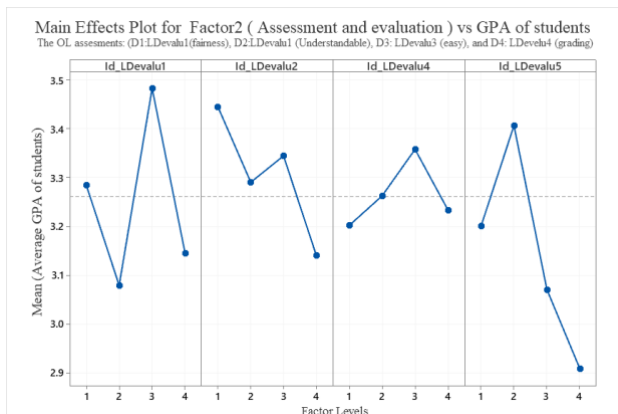

Fig.3: The main effect of the assessment and evaluation indicators.

As shown in Table III, ANOVA results showed that the most significant factors are the fairness of exams and the grading. Students agreed that questions in online exams were fair and better than in-person exams. Furthermore, the grading of online exams was fair and better than in-person exams. Figure 4 supported this fact. There is no doubt that students are satisfied with grading of exams and assignments. Further, they believe that exams are easy to understand and fair.

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