engagement for sustainable development in higher education: a systemic approach and self-improvement tool

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Abstract.

The paper addressed the engagement for Sustainable Development Goals (SDGs); a simple model based on Design of Experiment (DOE) is developed as a self-improvement tool. First, measuring the factors affecting the students' academic performance to improve quality of the higher education; and to provide high quality outcomes. Second, quality management consider the results and proposed indicators that help the decision makers to make the right decisions to achieve the SDGs. The proposed model has been implemented on a sample from different colleges at the University of Sharjah (UOS) to identify factors influencing students' performance. Results showed that knowing factors that affecting the academic performance enable the administration to review teaching process; take the corrective actions to achieve the SDGs; contribute in providing the society with professional outcomes; fulfill needs of the society; and improve the relationship between academic institutions and the society.

Keywords: Sustainable Development; Quality Management; Performance Evaluation; Higher Education; Quality Tools.

الملخص:

تستعرض هذه الورقة دمج أهداف التنمية المستدامة وقياس مستوى التحصيل العلمي للطلبة وتحديد مؤشرات تساعد ادارة الجودة في صناعة القرارات التصحيحية وتطوير عملياتها التعليمية بهدف مساعدة المجتمع في تحقيق اهداف التنمية المستدامة من خلال قياس وتقييم التحصيل العلمي للطلبة ومعرفة العوامل التي تؤثر في مستوى التحصيل للطلبة بهدف تحسين وتطوير العمليات التعليمة والبحثية و تقديم مخرجات تساهم بشكل فعال في التنمية المستدامة للمجتمعات. تهدف هذه الورقة الى عرض نموذج مبسط لتقييم مستوي التحصيل العلمي للطلبة ومعرفة العوامل التي تساهم في الرفع من المستوي العلمي والبحثي للطلبة وربط مخرجات مؤسسات التعليم العالي بحاجة سوق العمل. تم تطبيق النموذج المقترح على عينة من طلبة جامعة الشارقة وتم دراسة العوامل التي تؤثر في مستوي التحصيل العلمي للطلبة واستنباط ما تدل عليه هذه النتائج في مساعدة صناع القرار في تطوير العمليات التعليمة بما يتوافق وحاجة سوق العمل وكذلك تذليل الصعاب امام الطلبة من خلال التطوير المستمر للعمليات بما يتماشي مع سياسات الجامعة.

الكلمات المفتاحية : التنمية المستدامة ، ادارة الجودة ، تقييم وقياس الاداء، التعليم العالي ، مقاييس الجودة

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1. INTRODUCTION

Higher quality management in education is most important to achieve because it has central role in community development (Series, 2020). Quality education is understood as one of the most powerful and proven drivers for ensuring sustainable development, which can be applied in various educational contexts, formal and non-formal, and which can generate multiple benefits for the general public (Gonz & Magaña, 2020). At this critical time, the race towards the achievement of the Sustainable Development Goals (SDGs) has involved in the strategic plans of organizations. 17 goals related to the sustainable development were set when General Assembly of United Nations selected the 2030 Agenda for Sustainable Development. Quality Education was the goal 4 (called SDG-4) that seeks to "Ensure inclusive and quality education for all and promote lifelong learning" as a priority objective of 2030 Agenda (Gonz & Magaña, 2020). The 2030 Agenda focuses on the shifting of fundamental thoughts and recognizing the dynamic interrelation between three aspects i.e., economic, social and environmental, driving integrated and universal development in all the nations of the world. Through (Nazar, et al 2018). In this paper, the role of quality education for sustainable development goals (SDGs) is explored; they designed a simple model to study the factors that influence the academic performance, the most significant factor, the interaction among these factors, and how to direct the education to achieve to provide the Sustainable Development Goals.

2. LITERATURE REVIEW

(Simion, 2020) stated that collaborative learning can strengthen positive attitudes towards learning, improve performance in academic results, and enhance self-esteem, by promoting interaction and mutual support among young people. They concluded that students prefer to use new technologies in education because of the high interactivity. (Idham, et al 2020) reported that the successful of sustainable development in Malaysia was a supported by its comprehensive development plans, inclusiveness of various parties and collaboration with various stakeholders. (Sung, et al 2019) studied the effects of mobile learning have become one of the most popular topics in education research. They concluded that utilizing advanced technologies, mobile-learning research employs laggard methodologies compared with standards proposed in educational and psychological research. (Gonzalo, Gonz, & Garc, 2020) analyzing the learning motivation in Industrial Engineering Teaching in University of Extremadura (Spain), and they concluded that the acquisition of knowledge by students is according to their motivations to achieve maximum academic performance. Further, they presented the baseline to design student-centered learning activities to promote sustainability and Sustainable Development Goals at university level. (Huan, et al 2021) proposed a method for assessing regional progress of achieving SDGs; they classified SDGs into four dimensions (society, economy, environment, means of implementation and cooperation). The concluded that the feasibility of the achievement of goals and targets can be perceived affects international organizations, funding agencies and countries to respond to the challenges posed by these goals. The integration of SDGs in management education is a further step towards the society; this integration helps students to understand the complex challenges faced by businesses and societies and to provide them with the required skills, values, and knowledge related to the achievement of the SDGs. Furthermore, education management addressed the social implications of the application of the conducted research to ensuring that the outcome of these projects is useful for different stakeholders. Therefore, there is no doubt that measuring the academic performance of the students and connecting the teaching process is required to maximize the academic performance and to achieve the SDGs. Further, based on the results of the performance evaluation, the education management makes the strategic plans that able to cope with the changes in the society. This

study proposed a simple model to investigate parameters that affecting the academic performance of the student. Further, to draw the required steps that help to maximize the academic performance to contribute in attainment of the Sustainable Development Goals (SDGs).

3. METHODOLOGY

Quality education management has a vital role to achieve the Sustainable Development Goals in the society. Quality introduce the programs continuously review the teaching process to maximize the outcomes. Through education, many other Sustainable Development Goals (SDGs) can be achieved. Education can also foster tolerance in people and make the society more peaceful (Nazar et al., 2018). Therefore, education is considered the top priority because it is helpful to build strong networks with society and to achieve sustainable development. In this study, identifying the factors affecting the academic performance helps to highlight the strength and weak points of the teaching process to fulfill the society expectations. Design of Experiments (DOE) has been used in this study; DOE is a statistical tool most commonly used to examine the effect of several factors with or without associated weights that influence the manufacturing process. The most important feature of DOE is its ability to study the interaction effects between the considered factors (Ibrahem, et al 2014).

3.1 Problem formulation

As mentioned the introduction part, the focus of this paper is to present the results of a comprehensive study performed to investigate the factors affecting students' academic performance at the University of Sharjah. To effectively achieve and facilitate the investigation, the students were divided into two groups based on the admission criteria, language of instruction, the nature of the topics and the structure of the academic programs. The first group (G1) includes students enrolled in the following five colleges: Engineering, Communications, Business administration, Health Sciences, and Basic Sciences. The second group (G2) comprises students enrolled in the Arts, Humanities and Social Sciences, Sahieia & Islamic Students and the College of Law. The factors (or parameters) that were identified as the main factors to influence students' academic performance are summarized in Table1. These effect or impact of these factors on students' academic performance will be investigated using advanced DOE techniques.

The goal of this study is to investigate the impact and influence of these factors and parameters on the academic performance of the students based on the Cumulative Grade Point Average (CGPA) as a performance indicator. Furthermore, to compare the academic performance among the students based on gender, colleges, high school curriculum, high school GPA, and the location (campus) to provide feedback to university administration and local authorities on these factors with recommendations for corrective actions needed to improve the students academic performance so that they can easily achieve their goals in becoming high quality graduates, and to accomplish a high standards of education.

Table 1: Parameters and the levels of each parameter

Parameter/Factor	Group 1 (G1)	Group 2 (G2)
High School Curriculum	IGCSE National American Indian/Pakistani Technical Certificate	National American IGCSE
High School Score	Excellent Very Good Good Satisfactory	Excellent Very Good Good Satisfactory
Program of Study (College)	Sciences Engineering Business Administration Health Sciences Communications Pharmacy	Arts, Humanities and Social Sciences Law Sahria and Islamic Studies
Gender	Male Female	Male Female
Campus	Dhaid Men (DHM) Dhaid Female (DHW) Khourfakan Men (KHM) Khourfakan Women (KHW) Kalba Men (KUM) Kalba Women (KUW) Main Campus Men (MAM) Mai Campus Women (MAW)	Dhaid Men (DHM) Dhaid Female (DHW) Khourfakan Men (KHM) Khourfakan Women (KHW) Kalba Men (KUM) Kalba Women (KUW) Main Campus Men (MAM) Mai Campus Women (MAW)

4. RESULTS

In this section, results of the proposed model are explained. Design of Experiments (DOE) is used to investigate the influence and impact of parameters to gain a quantitative insight on the influence of the studied parameters on the academic performance. Minitab Software is used to analyze the data to address the main effects of these parameters and interaction among these parameters. Minitab is used to perform DOE analysis for many applications that investigates the effects of input variables (factors) on an output variable (response) at the same time. The first and most important step in applying DOE techniques is to identify the factors contributing to the outcome indictor. In industrial processes, these are usually identified as factors (or parameters) that influence process conditions and product components, which affect quality of the end product. Once these factors are identified, Minitab can be run to determines the factor-settings that optimize results. In our case, the output (or response factor) is the CGPA of the students, which is affected by several factors or parameters. Minitab offers four types of designs: factorial designs, response surface designs, mixture designs, and Taguchi designs (also called Taguchi robust designs). After the values of each of the factors are entered for each student, Minitab provides several analytical tools and graph tools that help understand and interpret the results. One of the main features of DOE is its ability to analyze the effect (or impact) of each parameter and its interrelationship among the parameters

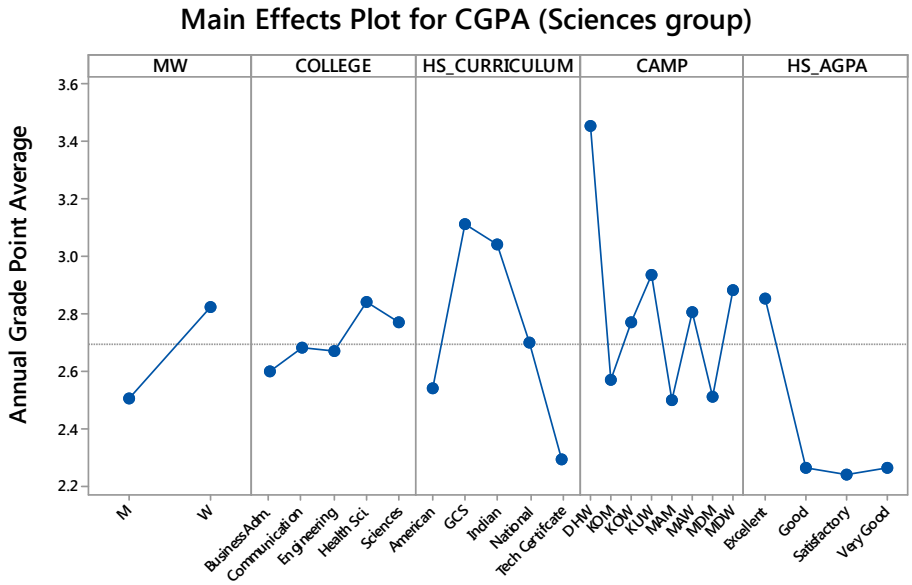
5. DISCUSSION

5.1 Investigating the Main effect of the parameters

The impact of the gender, program of study (college), high school curriculum, campus or location, and high school GPA are investigated separately as shown in the following figures. In Figure1 for instance, it is clear that the most significant factor for Group 1 is *high school curriculum*. While, the least significant parameter is the gender; yet, in both groups, female

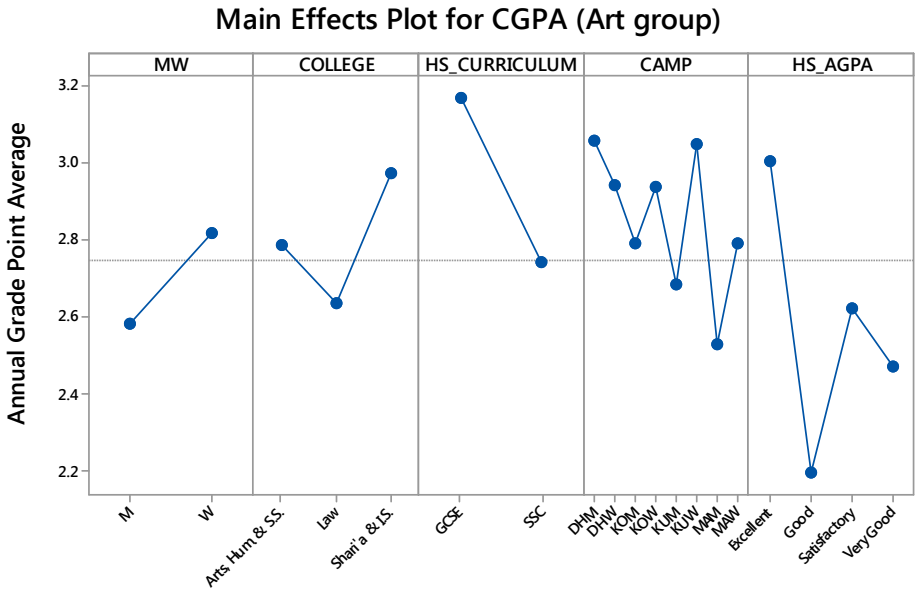
students showed better academic performance based on the CGPA of the selected sample. Further, students have a higher CGPA are found in DHM campus. In the same group, i.e. Group 1, and as shown in Figure 1, students in the College of Health Sciences have attained the highest CGPA among the subjects included in the investigation. On the other hand, students in the College of Business Administration have attained the lowest CGPA among the subjects investigated. For the Colleges of Engineering and Communication, the average CGPA for the students in these colleges is comparable. The next factor investigated is the high school curriculum and its impact of influence of students' performance. It is evident from Figure 1 that American and Technical Certificate have attained the lowest CGPA (It recommended to give the least chance of acceptance to those students). According to the high school GPA, only the students with excellent GPA are able to show a high academic performance, while there is *no* significant differences among other students regardless their high school GPA.

Figure 1: The main effect of the studied parameters of Group A



For Group 2, which include students enrolled in the Colleges of Sharia & Islamic Studies, Arts, Humanities & Social Sciences and Law. As shown showed a very interested result where students with satisfactory GPA showed a higher CGPA than students with good and very good GPA. Further, the least CGPA is found at the law college.

Figure 2: The main effect of the parameters of group B



5.2 Interaction among factors investigated

In addition to the impact of each factor on the indicator, DOE also provides statistical comparison to investigate the interactions among the various factors. It provides an insight on the interrelationship among the investigated factors; interaction among the studied parameters is presented in the following subsection:

- **Gender vs. College**

Figure 3 illustrates that the lower CGPA is found for G2 female students have shown to have higher academic performance than male students. The same trend is observed in G1 (Figure 4). However, the gap between women and men is higher than that of G1. In addition, for G1, female students showed to have higher CGPA at the Colleges of Health Science and the College of Sciences while male students have attained higher academic performance in the College of Engineering. The lowest CGPA was found in the College of Business Administration and the College of Sciences. In G2, there is a noticeable difference between men and women at the Arts, Humanities & Social Sciences in comparison to law and Sharia'a colleges. Furthermore, the least CGPAs for men is found at the Humanities & Social Sciences College; while the highest CGPAs are found at Sharia'a & Islamic Studies.

Figure 3: Interaction between the gender and colleges for the sciences group

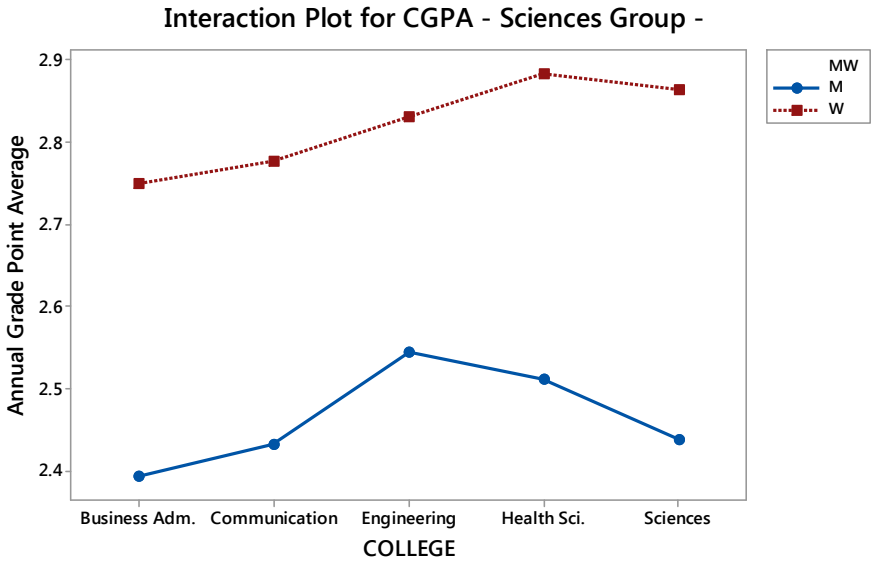
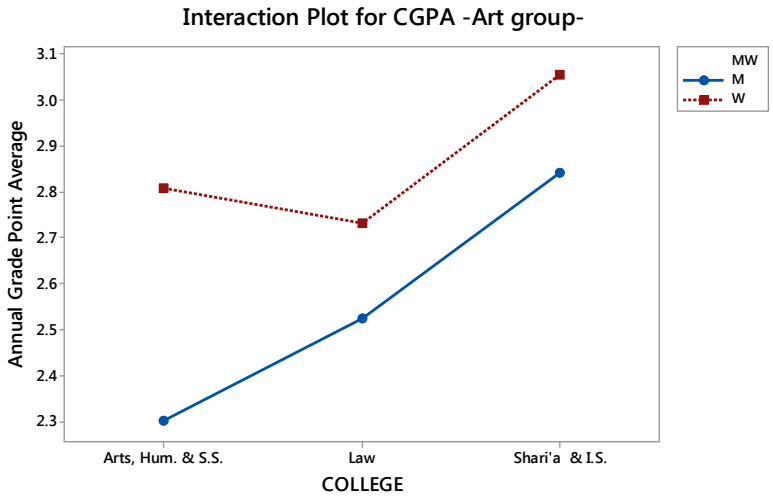


Figure 4: Interaction between the gender and colleges for the Arts group



- **Gender *vs.* High school Curriculum**

As mentioned before, CGPA is highly influenced by high school curriculum. Yet, in G1, there is no significant difference between female and male students, with the exceptions of students from Indian high schools. Students coming from American and Technical Diploma attained the lowest CGPA.

Figure 5: Interaction between gender and high school curriculum for Sciences group

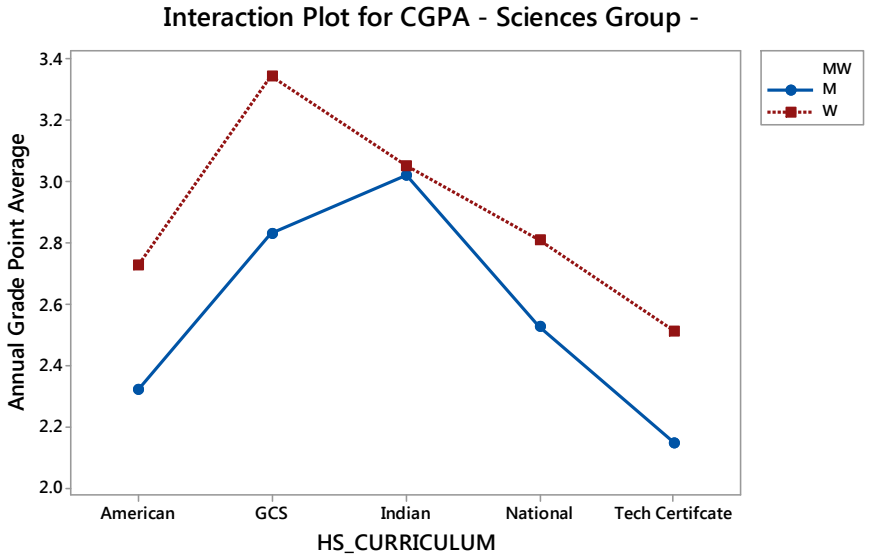
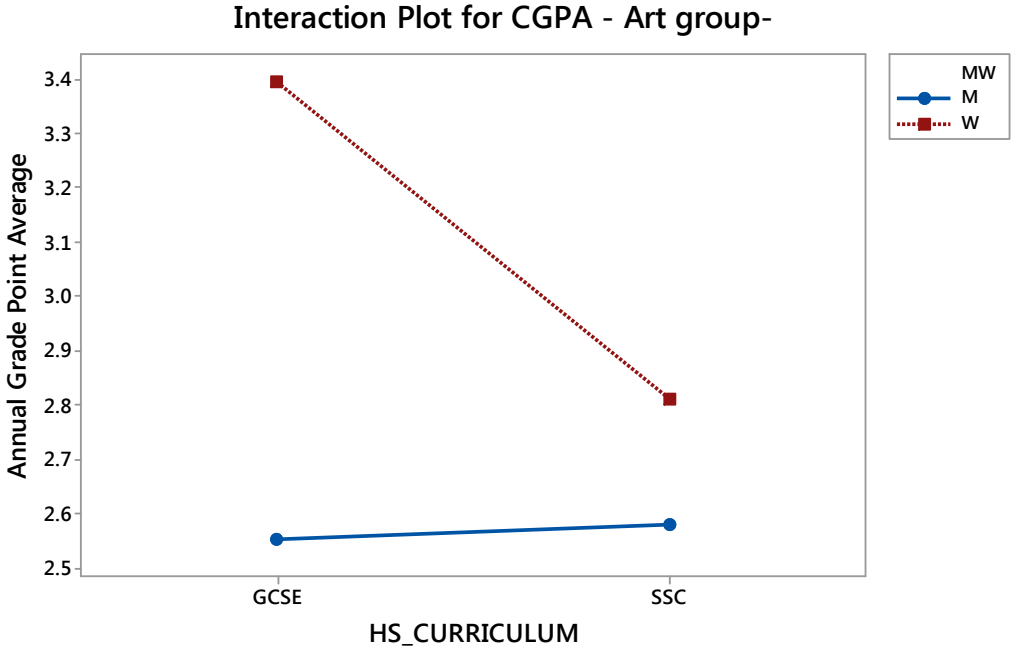


Figure 6 shows that students with different high school curriculum have a different CGPA for the Arts group, male students have shown almost the same academic performance regardless the high school curriculum. Nevertheless, the academic performance of female students is highly affected by the high school curriculum.

Figure 6: Interaction between gender and high school curriculum for Art group



- **Gender *vs.* High school GPA**

Figures7 and 8 clearly showed that student's academic performance is highly influenced by the high school GPA. For Sciences group, student with high GPA in high school are maintained their academic performance at university; while there is no significant difference between all students who had satisfactory, good, and very good. Generally speaking, these plots are used to examine and measure the impact of each factor on the indictor, which is done by the differences among the level means for the studied factors. The impact of any factor is measured by the variation from the mean value. If for example, the difference is large, the impact of that factor on

the response variable (CGPA) is significant. On the other hand, if the variation from the mean is small, then the impact of that factor on the indicator/response factor (CGPA) is insignificant. Therefore, when there is a considerable difference between the lower level and the higher level for a factor, then the factor has a significant effect on the response. Obviously, as shown in Figure 1, the most significant factor is high School curriculum for both G1 and G2.

One interesting point that can be seen from Figure 8 is that females in Art group who have satisfactory GPA in their high school curriculum have achieved higher academic standing than students with good and very good GPAs.

Figure 7: Interaction between gender and high school GPA for the sciences group

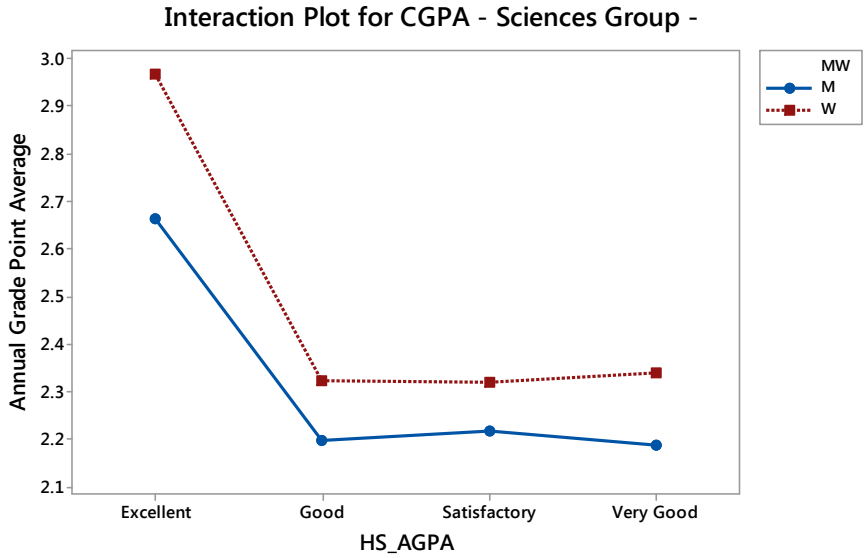
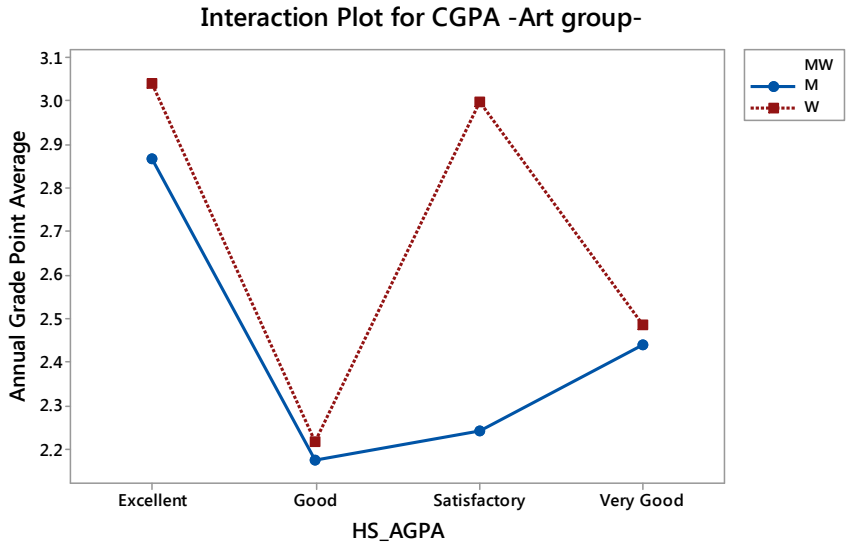


Figure 8: Interaction between gender and high school GPA for the Art group



- **Gender *vs.* Campus**

As shown in Figures9 and 10, male students from Sciences group have shown almost the same performance irrespective of the campus at which they study. For female students, the performance varies from one location to another and the best is found at DHW campus. For Art group, the academic performance varied across campuses with higher CGPA at DHM and least CGPA at MAM.

Figure 9: Interaction between gender and location (campus) for Sciences group

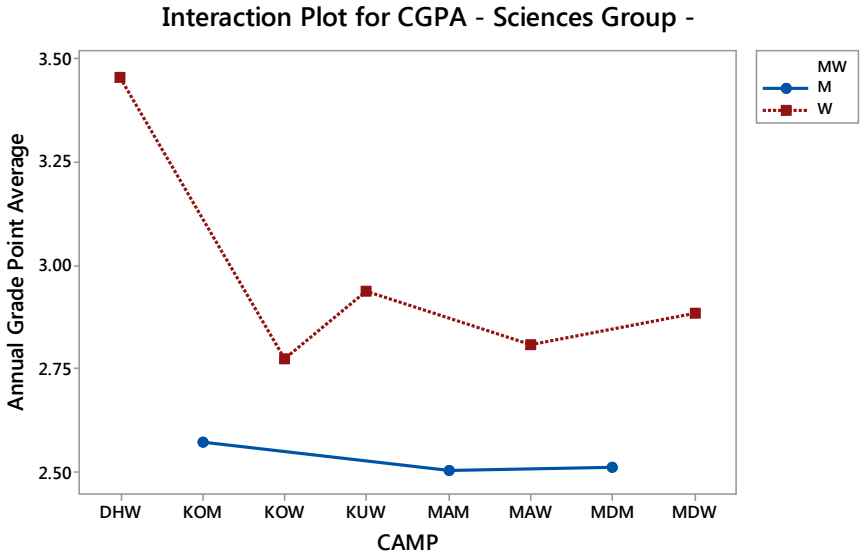
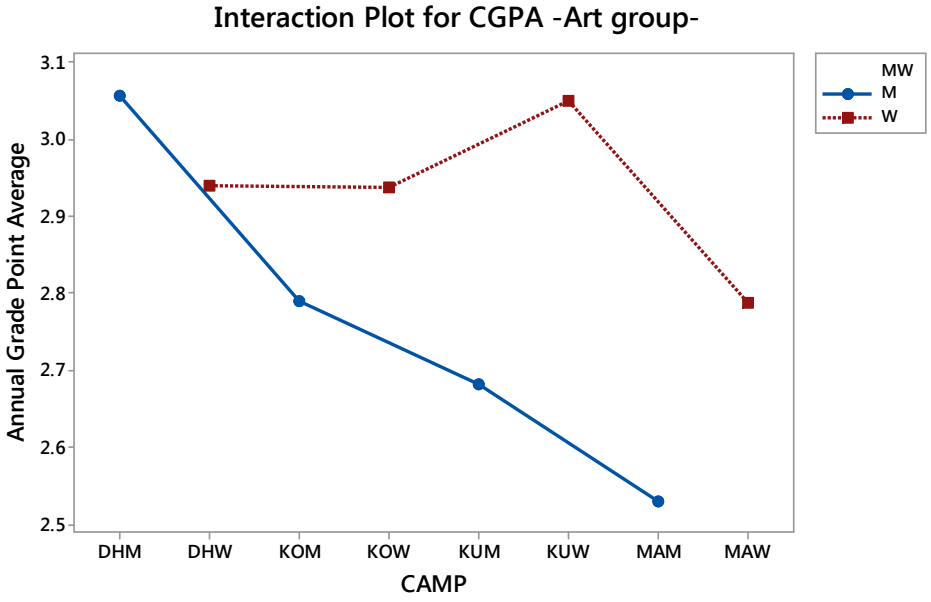


Figure 10: Interaction between gender and location (campus) for Art group



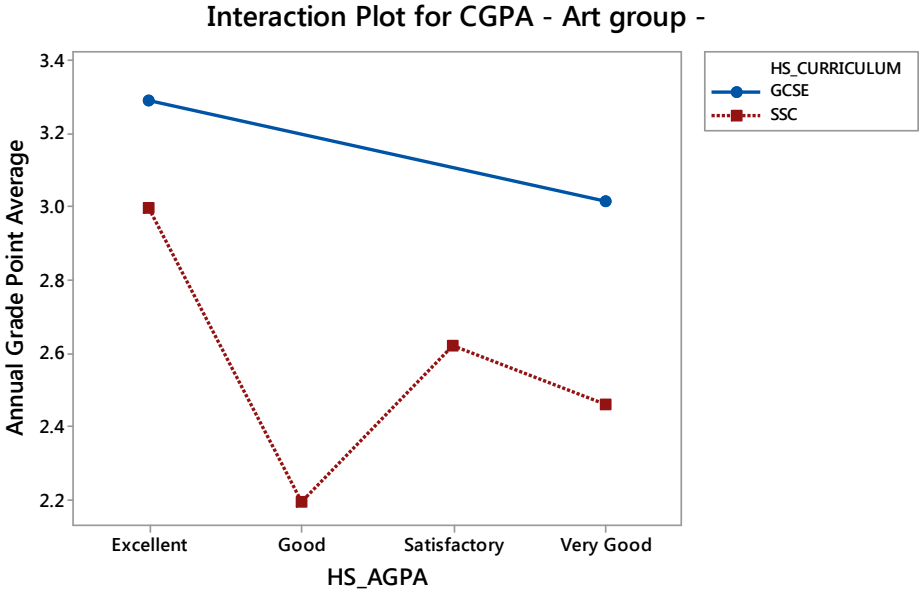
- **High school curriculum *vs.* high school GPA**

The relationship between high school GPA and high school curriculum is presented in Figures 11 and 12. Obviously, for student who attained excellent GPA in high school still maintained their excellent performance at university: For Sciences group, best CGPAs are attained by students who have the Indian curriculum *even though their number* is low compared with other students. Furthermore, the international, American, and technical curriculum showed the same academic performance even for different high school GPAs.

Figure 11: Interaction between High school GPA and high school curriculum for Sciences group

For G2 (as shown in Figure 12), students with satisfactory GPA performed much better than students who have good and very good GPAs if the students have SSC Curricula. While the GCSE showed a normal academic performance.

Figure 12: Interaction between High school GPA and high school curriculum for Art group



6. CONCLUSIONS

In this paper, the factors influencing the academic performance of the students were investigated; the studied factors are included the following: gender, college, campus (or location), high school curriculum, and high school grade point (GPA). The results showed that the influence of the investigated parameters on students' performance vary among the factors examined. It was found that the most significant parameters that are affecting the students' academic performance are: high school curriculum and high school GPA. Gender gaps were evident with female students were showed to attain higher academic performance than males in the entire sample. High school curriculum had greatest impact on the academic performance of the UOS students. However, no significant differences were found among high achievers (students with overall all academic standings of good, very good, and satisfactory). The implementation of the proposed approach enabled to gain an insight to provide the administration with very important predictors, which may be utilized in many recruitment programs as well academic advising and counseling programs to achieve the sustainability goals.

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