

ORIGINAL ARTICLE

Effect of COVID-19 pandemic in service learning process of Industrial Ergonomics course

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Abstract: University Malaysia Perlis supports the ergonomics requirements and practice in industry by teaching the Industrial Ergonomics (IE) course for Manufacturing Engineering students in Faculty of Mechanical Engineering Technology. The teaching and evaluation process in IE course experienced multiple changes due to the Service Learning Malaysia- University for Society (SULAM) requirements and rapidly transform from physical to virtual learning due to COVID-19 pandemic in 2019 year end. This paper aims for investigating the effect of service learning implementation and COVID-19 pandemic in teaching and evaluation process of IE course. The pedagogy methods were applied in IE in the academic year 2018 and it was changed in service learning approach in the year 2019 and 2020 due to SULAM requirements. The main findings in this study show that the changes in the teaching and evaluation methods due to service learning implementation does effect the course satisfaction, teaching satisfaction, course outcomes (COs) and final students' grade in positive form even though there were major challenges happened in service learning implementation especially in academic year 2019. The study also finds out that COVID-19 does effect the course and teaching satisfaction score, but it almost not contribute to significant negative impact to the COs and students' final grade. This paper gives significant contribution for preparing the teaching and evaluation methods for future students in IE course for SULAM program specifically and for the similar course generally especially in uncertainty conditions such as pandemic and endemic scenario.

Keywords: Industrial Ergonomics, SULAM, COVID-19, service learning, virtual learning

1.0 INTRODUCTION

Human factors are significant criteria in industry operation and everyday activities. Human factors contribute to the percentage of human errors and work musculoskeletal disorders (WMSDs) in a specific process, machineries, working environment and working process [1]. The management of human factors can be learned in Ergonomics course in order to identify the ergonomics risks and to propose the intervention to overcome the risks in the work environment.

Ergonomic creates impacts on broad range of workplace aspects including human-machine interaction in complex systems, design of equipment and facilities, product design as well as development of environmental comfort, health and safety. This course discusses the common application of ergonomics in biomechanics, workspace design, physical workload and environmental factors which affect industry productivity. In addition, this course also emphasizes the health & safety in manufacturing industry, human information processing & task performance and human-machine interaction. IE contributes three credits in Manufacturing Engineering Degree program. This course was embedded in Service-learning Malaysia- University for Society (SULAM) program since 2019 [2]. Since then, the learning and evaluation process had been changed in order to suit with the SULAM requirements. Besides, this course also had experienced big changes in learning and evaluation methods due to the COVID-19 pandemic around the world. Therefore, an investigation had been done to compare the teaching and evaluation methods effectiveness of Industrial Ergonomics course before and during COVID-19 pandemic in accordance with SULAM requirements.

This paper aims to investigate the effect of SULAM implementation and COVID-19 pandemic in IE teaching and learning process. The first objective is to compare the students' satisfaction on the course and teaching implementation before and after implementing SULAM as well as the effect of the pandemic on the satisfaction scores. The second objective is to compare the course outcomes (COs) before and after implementing SULAM and the effect of the pandemic in the COs. Finally, the third objective is to compare the students' grade before and after implementing SULAM and the effect of the pandemic in the students' grade. This study gives significant contribution for preparing the teaching and evaluation methods for future students, especially in uncertainty conditions such as pandemic and endemic scenario which lectures and students experience many issues as examples internet connection, field study restriction, high workload and many more.

2.0 LITERATURE REVIEW

2.1 Teaching Industrial Ergonomics

Industrial Ergonomics course in University Malaysia Perlis comprises six topics for a semester which are started with Introduction to Ergonomics i.e. Ergonomics definition, domain & related disciplines, ergonomics principles, ergonomics risk factors and work-related musculoskeletal disorders. The second topic is Human Capacity i.e. Human capability and limitations which include anatomical and mechanical structure of the human body, mental ability, human senses, strength, posture and biomechanics. The third topic is Anthropometry i.e. Definition & types of anthropometric data, anthropometric tool usage and application of anthropometric data. The fourth topic is Workplace Design i.e. General principles of workplace design and workplace design analysis. The fifth topic is Ergonomics Risk Assessment and Evaluation Methods and finally the sixth topic is Ergonomics Intervention i.e. Ergonomics problems solving technique and preliminary design process application [3-4]. At the end of the course, the students are expected to obtain four course outcomes which;

CO1: Ability to apply knowledge of basic concepts and principles of ergonomics and body mechanics.

CO2: Ability to analyze and perform suitable anthropometric study in workspace design, equipment and facilities in ergonomic issues.

CO3: Ability to use suitable assessment tools in the design and evaluation of the work tasks.

CO4: Ability to solve and design an effective and comfortable workplace to ensure workers' productivity, health and safety.

Laura Moody studied a studio-based learning (SBL) approach for teaching Ergonomics and Human Factors for undergraduate engineering students in 2011 [4]. She found that the SBL approach to teach Ergonomics and Work Measurement course gave significant impact in providing an effective means of introducing students to the fundamental concepts and engaging them in the learning process. SBL was related to problem-based learning (PBL), but included two-way interaction with the instructor, frequent critiques of work-in-progress, and the implementation of a studio "space" designed to be conducive to team learning efforts. The goal of SBL was to create a creative

environment within which students engage in active exploration of a problem space. It was found that using SBL in teaching ergonomics was “Helpful” or “Valuable” (the two highest possible ratings) on a 5-point Likert scale assessment.

Next, Marek Bures investigated on establishment of invention in ergonomics education in the conditions of the Czech Republic [5]. This study applied Constructivism theories to provide better understanding of the ergonomics issue in the developed course which emphasized the comparable basic knowledge that should be understood by every ergonomics student around the world i.e. the knowledge base, systems of research governance, and research standards. Therefore, the author suggested applying the International Ergonomics Association (IEA) and Federation of European Ergonomics Societies (FEES) guidelines for ergonomics courses to create the basic structure of proposed course which accounted the ergonomics principles i.e. Introduction to the ergonomics approach and its relation to sciences, human characteristics i.e. basic knowledge from disciplines such as human biology and psychology that has particular relevance for ergonomics and work analysis and measurement i.e. Techniques and methods for analysis, measurement, investigation and computation.

Later, Anazifa aimed at finding the effect of project-based learning and problem-based learning on the student’s creativity and critical thinking, the difference effect of project-based learning and problem-based learning on the student’s creativity and critical thinking [6]. The study revealed that project-based learning and problem-based learning affect student’s creativity and critical thinking, there was a difference effect of project-based learning and problem-based learning on student’s creativity, and finally there was no difference effect of project based learning and problem-based learning on student’s critical thinking.

2.2 Service Learning Malaysia- University for Society (SULAM)

SULAM is a service learning approach initiated by John Dewey in late 1960s [7]. However, the complete model of the service learning concept and practice was published in the first third of the 20th century. Three philosophical principles for service learning were laid in Dewey's early educational writing, which was related to the importance of experiential learning, the need of reflection on service

learning practice and the third was the requirements of stakeholders' involvement actively in the service learning process such as teachers, students, and the communities benefited directly by the service. The implementation of SULAM program in tertiary education, especially in the public universities was started since 2019. The main concept for SULAM implementation was introducing the Quadruple Helix model which every embedded SULAM course was encouraged to involve the students, the lecturers, the local community, the local industry, government agencies or non-profit organization in the problem-based learning activities. Students were exposed to the experience of planning and managing the problem-based project, identifying the community or industry problems, communicating with all stakeholders, proposing the solutions, preparing reports and conducting post feedback on project effectiveness [2].

A similar practice was conducted by Lenore and Laura in 2014 in Ergonomics Industrial Engineering for Industrial Engineering (IE) students at Montana State University. The approach was applied to achieve The Engineer of 2020 objectives which to provide students with opportunities to participate in real-world projects in order to provide them with the skills they will need in the workplace. Accreditation Board for Engineering and Technology (ABET) aimed to have IE graduates that possess the skills to design, develop, implement and improve systems. It was found that service learning had been identified as time intensive for lecturers to implement. However, by using the resources to find a partner on campus, or using a design competition website reduced the off-campus effort required by the lecturer. In addition, the learning experience for students when compared to other IE courses with non-service learning approach, showed the technical, process and awareness skills all ranked above the average ABET course outcomes [8].

2.3 Teaching and Learning Methods During Covid-19 Pandemic

There were many rapid changes in teaching, learning and evaluation methods applied since COVID-19 pandemic happened in December 2019. Six specific instructional strategies had been applied in Peking University for online teaching experiences which were making emergency preparedness plans for unexpected problems, dividing the teaching content into smaller units to help students focus, emphasizing the use of "voice" in teaching, working with teaching assistants and gain

online supports from them, strengthening students' active learning ability outside of class, and finally combining online learning and offline self-learning effectively [9].

A study regarding on how the pandemic affected the pedagogical practice had been conducted in Spain [10]. The shift toward virtual teaching rapid enforcement, caused by the pandemic, gave impact to the future teachers such as feeling disillusioned, tired and stressed, which affects their learning and their passion for the possibility of continuing with online teaching. The lack of training in how to teach properly online seems to strongly undermine their expectations of online Physical Education. It was suggested in the study that teacher training should necessarily take into account the new social circumstances and be able to support teachers in providing an effective response to their students in the current situation. However, this cannot, and should not, be an excuse to establish an educational policy based on online teaching, since teachers are not really trained for it, nor was it their choice to engage in online teaching.

Next, Sana et.al. Studied the design course for grade one students in the Interior Design department, Tishk International University by analysing the questioner to develop the methods and techniques for distance learning during a pandemic [11]. Inside was found that the students and teachers were not adjusting well to online courses when it came to practical classes as compared to theoretical ones. It was because practical courses required a hands-on approach to be fully effective. The role of face-to-face interaction cannot be downplayed because one does not need a fast internet to get or give feedback, statements are not lost in translation, engagement, and overall communication was more active and livelier. Knowing the issues that largely play a part in efficient online learning, many questions arise as follows:

1. How can online learning be made more efficient for students and teachers?
2. What tools can be used to improve communication in distance education?
3. How can distance education be made fair for all students? (Those with poor internet connection and laptop problems)
4. Can distance learning be made a permanent replacement to face-to-face education?
5. How can practical courses be more efficient in distance learning?
6. In what ways do distance learning affect communication skills?
7. How can communication and interaction be improved in distance learning?
8. What protocol for education do schools have to ensure their progress despite emergencies?

Finally, Tinggui et.al investigated seven major online education platforms before and after the outbreak of COVID-19, and by combining the emotional analysis, hot mining technology, as well as relevant literature [12]. The results show that before the outbreak of the pandemic, users were concerned about the access speed, reliability, and timeliness of video information transmission of the platform, and the user experience of the Zoom Cloud platform was the best. After the outbreak of the pandemic, users mainly focused on course management, communication and interaction, learning and technical support services on the platform, and the user experience on the platform was the most important. The authors suggested in the study on improving the user experience of the online education platform during COVID-19 by firstly improving support service, then improving the convenience of interactive communication. It is suggested that the platform should be designed with a split screen so that users can simultaneously interact with the platform, thus timely and effectively share and interact with information resources. Third, optimize the ease of use of digital assignment and submission for mobile learning and pop-up video learning. Finally, enrich the platform resources to cover all disciplines. In addition, most course activities can be added to the platform to continuously improve the enthusiasm of learners.

3.0 METHODS

100 students had been registered in Industrial Ergonomics from 2018 until 2020 which 36 students in year 2018, 43 students in year 2019 and 21 students in the year 2020. The average age of students was 24 years old. The participated students were registered under the Manufacturing Engineering program in Faculty of Mechanical Engineering Technology, University Malaysia Perlis.

The teaching and learning process was conducted by using lecturing technique, discussion and captions and video observations in academic year 2018 and first half semester of academic year 2019 [6]. The service learning approach was introduced in academic year 2019 after the faculty decided to embed the SULAM program into an IE course (Champagne, 2006). Starting the second half of academic year 2019, the physical lecturing was changed to virtual lecturing due to COVID-19 became worldwide pandemic (González-Calvo et al., 2021). The virtual learning was implemented by using

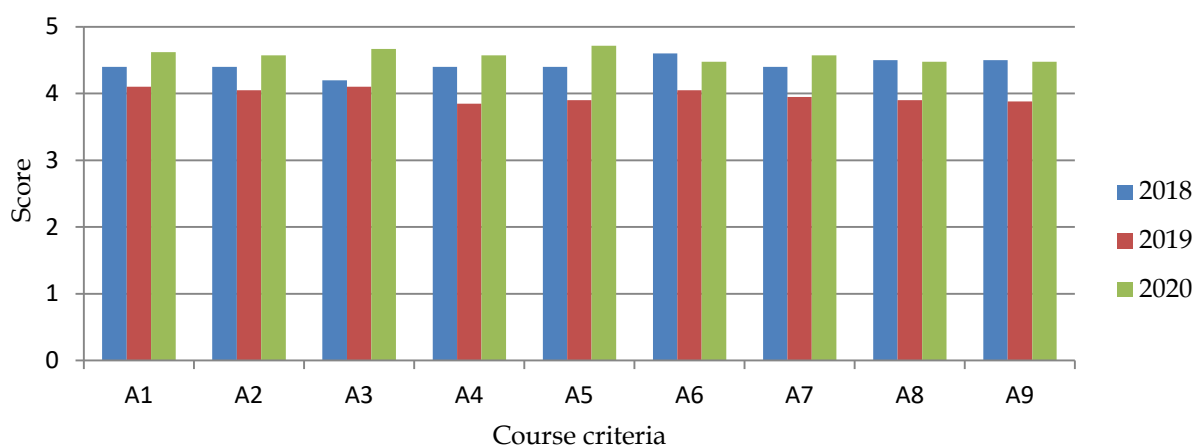
online platform i.e. Google Meeting, Zoom and WEBEX. Most course materials were uploaded in the cloud such as videos, recorded class and references to help students revisited the discussed topics in their free time. Six topics of Industrial Ergonomics were delivered in 2018 to 2020 academic year. The physical teaching time per semester in year 2018 and 2019 was 36 hours per semester. However, the virtual learning process implemented in academic year 2020 with 24 hours per semester in synchronous mode and 2.4 hours per semester in asynchronous mode. An OMR score document was distributed via online at the end of the semester to obtain the feedback from students regarding the course and teaching satisfaction. 5-score scales were used to define the satisfaction score, which was 5 was most satisfy, 4 was satisfied, 3 moderate, 2 was not satisfied and 1 was not very satisfy.

The evaluation process in academic year of 2018 had been divided into 60% examination, 20% test, 15% mini project and 5% assignments or quiz. However, started from 2019 academic year, the evaluation process was changed into 50% SULAM project final report, 20% assignments, 10% SULAM progress report, 15% SULAM project presentation and 5% peer review. The test and examination were aborted because the SULAM requirement for students should conduct the activities in the society for 20 hours (Ministry of Higher Education (MoHE), 2019) which increased the student Self Learning Time (SLT) more than 3.0. Moreover, the low percentage of SULAM evaluation marks are not proportioned to the accumulated hours of a student should spend for SULAM requirement. In addition, in order for the students to pass the course, the students should obtain the pass grade in examination which is 40%. This prerequisite demotivated the students to register the course because this course is just an elective course. Therefore, the examination and test method was aborted and replaced with problem based learning (PBL) method and evaluation such as community based project, reporting, assignments, presentation and peer review. In academic year 2020, the evaluation process implemented the same methods and the same ratio of marks in 2019.

4.0 RESULTS

4.1 Results of Students' Satisfaction on Course and Teaching

Figure 1 shows the results of OMR score on course satisfaction in academic year 2018, 2019 and 2020. The course criteria that had been assessed were students' interest in the subject, the students' understanding of the subject, the course organization, the adequacy of handout, exercise or assessments given, the usefulness of workshops, seminar, tutorial, practices and etc. and the achievement of all course outcomes (COs). Generally, all criteria score slightly drop below score 4 from academic year 2018 to 2019 and increase again in academic year 2020. In academic year 2018, the average score for course criteria assessment is 4.4. The highest score, 4.6 is belong to criteria CO 1 achievement i.e. ability to apply knowledge of basic concepts and principles of ergonomics and body mechanics and the lowest score, 4.2 is belong to the good of course organization criteria. Next, in academic year 2019, the average score for course criteria assessment is 4.0. The highest score, 4.1 is belong to students' interest in the subject, the students' understanding of the subject, the course organization and CO 1 achievement criteria while the lowest score, 3.9 is belonging to the adequacy of handout, exercise or assessments given, the usefulness of workshops, seminar, tutorial, practices and etc., CO 3 and CO 4 achievements criteria. Finally, in academic year 2020, the average score for course criteria assessment is 4.6. The highest score, 4.7 is belonging to the course organization and the usefulness of workshops, seminar, tutorial, practices and etc. criteria while the lowest score, 4.5 is belong to CO 1, 3 and 4 achievements.

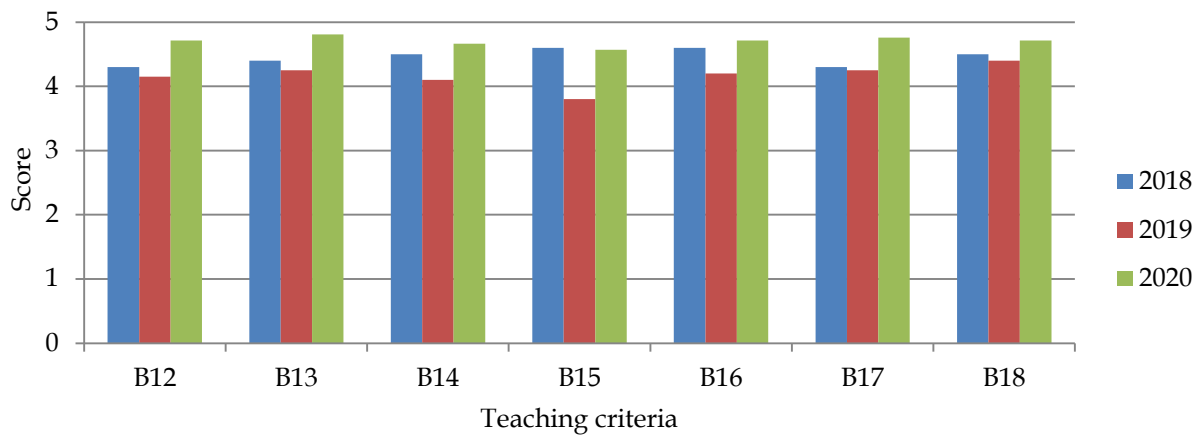


A1	The course has developed my interest in the subject.
A2	The course has given me a good understanding of the subject
A3	The course was well organized
A4	The handouts/exercises/assessments given were adequate
A5	The workshops/seminars/tutorials/practices/etc. were useful
A6	I have achieved Course Outcome No. 1 (CO1)
A7	I have achieved Course Outcome No. 2 (CO2)
A8	I have achieved Course Outcome No. 3 (CO3)
A9	I have achieved Course Outcome No. 4 (CO4)

5 = MOST SATISFY, 4 = SATISFY, 3 = MODERATE, 2 = NOT SATISFY, 1 = NOT VERY SATISFY

Figure 1 Results of OMR score on course satisfaction in academic year 2018, 2019 and 2020

Figure 2 illustrates the OMR score of teaching satisfaction in academic year 2018, 2019 and 2020. The teaching criteria that had been assessed were the clarity of syllabus presentation, the lecturer's knowledge and competency in IE, the sufficiency of practices, the availability of corrected assignments and test, the lecturer's time punctuality, the consultation availability and overall lecturer's performance. In general, the teaching criteria scores in 2019 slightly drop compared to the scores in 2018 and increase again in academic year 2020. In academic year 2018, the mean score for teaching criteria assessment is 4.5. The highest score, 4.6 is belonging to the availability of correcting assignments and test and the lecturer's time punctuality criteria while the lowest score, 4.3 is belonging to the clarity of syllabus presentation and the consultation availability criteria. Next, in academic year 2019, the mean score for teaching criteria assessment is 4.2. The highest score, 4.4 is belonging to the overall lecturer's performance criteria while the lowest score, 3.8 is belonging to the availability of correcting assignments and test criteria. Finally, in academic year 2020, the mean score for teaching criteria assessment is 4.7. The highest score, 4.8 is belonging to the lecture's knowledge and competency in IE and consultation availability criteria while the lowest score, 4.6 is belonging to the availability of correcting assignments and test criteria.



- B12 The course syllabus was presented clearly to the class.
- B13 The lecturer demonstrated knowledge and competence in the subject matter.
- B14 The lecturer gave sufficient practices to test my understanding of concepts and principles.
- B15 Corrected assignments and tests were made available to the students.
- B16 The lecturer was punctual for classes.
- B17 The lecturer is easily available for consultation.
- B18 Overall, I would rate the lecturer's performance as very good.

5 = MOST SATISFY, 4 = SATISFY, 3 = MODERATE, 2 = NOT SATISFY, 1 = NOT VERY SATISFY

Figure 2 Results of OMR score on teaching satisfaction in academic year 2018, 2019 and 2020

Table 1 presented the students’ feedback on teaching and learning process in academic year 2018, 2019 and 2020. Generally, students gave good feedback on teaching and learning process. However, a suggestion to not conduct SULAM in academic year 2020 should be notified and investigated further.

Table 1 Students' feedback on teaching and learning process in academic year 2018, 2019 and 2020

2018	2019	2020
Everything is good	Learning ergonomics is fun	Overall is good
Good	Good	One of my favourite subjects with lovely lecturer.
	Good	Good
	Good	All is good.
	All lecturers were good	The most relaxing class during this semester. when you are stressed with other subjects, entering the class will all disappear.
		SULAM is not suitable during this pandemic
		Everything's good
		Good
		Excellent performance. Thank you

4.2 Results on course outcomes (COs)

Table 2 presents the results of IE average course outcome attainment according to the level of complexity in academic year 2018, 2019 and 2020. The level of complexity in academic year 2019 was reduced from C4 to C3 for CO1 and from C6 to C4 for CO1. Then, it was remaining in the academic year 2020. All COs in academic year 2018, 2019 and 2020 are attained with the percentage marks above 50%.

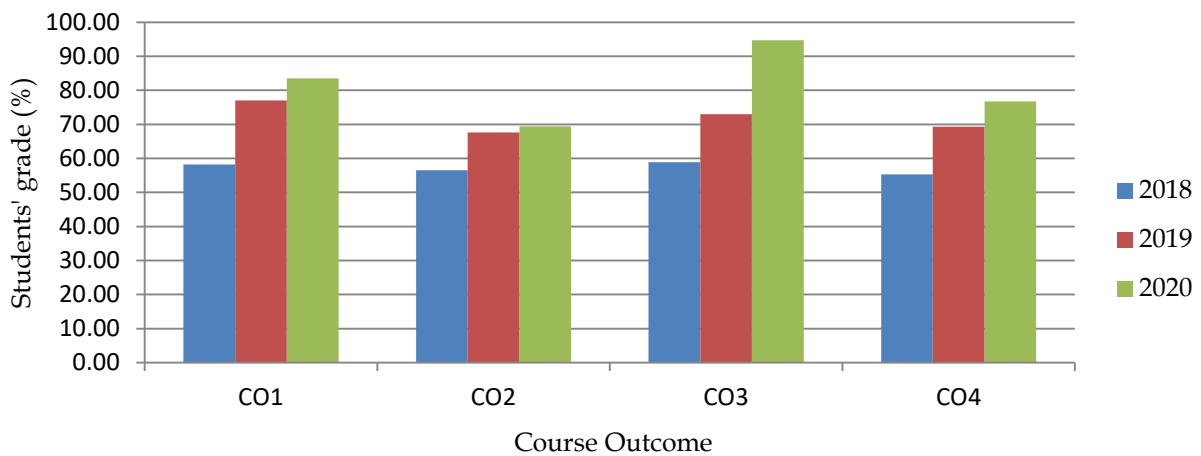
Table 2 Results of IE average course outcome (CO) attainment according to level of complexity in academic year 2018, 2019, 2020

Course Outcome (CO)	Level of complexity			Average of CO Attainment (%)		
	2018	2019	2020	2018	2019	2020
CO1	C4	C3	C3	58.20	77.00	83.50
CO2	C6	C4	C4	56.50	67.60	69.38
CO3	C5	C5	C5	58.90	73.00	94.75
CO4	C6	C6	C6	55.30	69.30	76.74

C3: ABLE TO APPLY; C4: ABLE TO ANALYSIS; C5: ABLE TO EVALUATE; C6: ABLE TO DESIGN OR SUGGEST

0-49%: CO NOT ATTAINED; 50-100%: CO IS ATTAINED

Figure 2 shows the IE course outcome patents in academic year 2018, 2019 and 2020. Generally, the average percentage, of course outcome attainment increases in all COs from 2018 until 2020. In academic year 2018, the highest CO attainment is CO3, which 58.90 %, while in 2019, the CO 1 attains highest percentage, 77.00% and in 2020 CO 3 again attains highest percentage which is 94.75%. In academic year 2018, the lowest CO attainment is CO 4 with 55.30%, in 2019, CO 2 with 67.60% and 69.38% in 2020.



CO1: Ability to APPLY knowledge of basic concepts and principles of ergonomics and body mechanics.

CO2: Ability to ANALYZE and PERFORM suitable anthropometric study in workspace design, equipment and facilities in ergonomic issues.

CO3: Ability to USE suitable assessment tools in the design and EVALUATION of the work tasks.

CO4: Ability to SOLVE and DESIGN an effective and comfortable workplace to ensure workers' productivity, health and safety.

Figure 2 IE course outcome (CO) attainment patents in academic year 2018, 2019 and 2020

4.3 Results on IE students' grade

Figure 3 illustrates the results of students' grade for IE course in academic year 2018, 2019 and 2020. Generally, the bell curve shifted to the left from 2018 to 2020 which showing the increasing of better students' grades in an IE course of each year. In 2018, the highest percentage students, 19.4%

obtained C+, then 39.5% obtained B+ in 2019 and 52.4% obtained A- in academic year 2020. The lowest percentage of students in 2018, 2.8% obtained a grade D in 2018, 7.0% with C+ in 2019 and 4.8% with B grades in academic year 2020. However, only 2.8% students obtained grade A in 2018 and 28.6% students for the same grade in academic year 2020. Finally, no students failed in an IE course for those academic years.

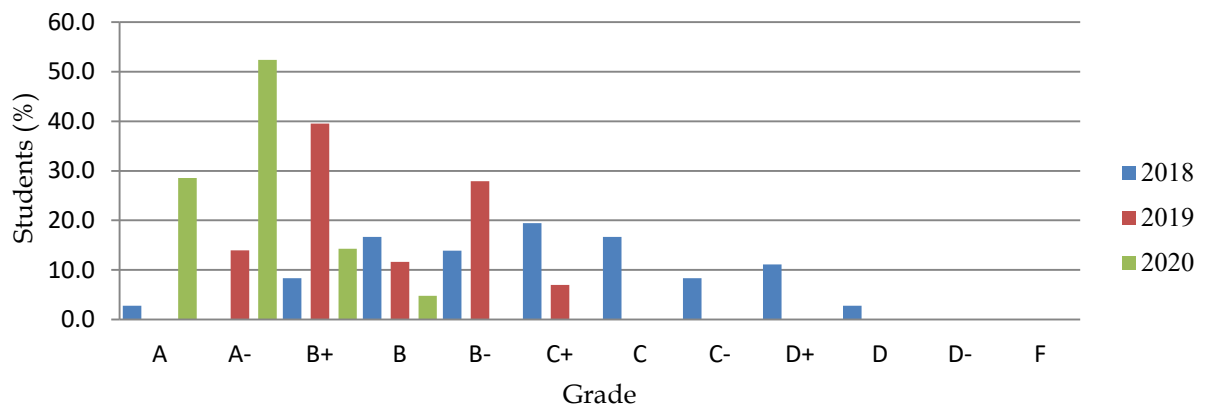


Figure 3. Results of students' grade for IE course in academic year 2018, 2019 and 2020

5.0 DISCUSSION

5.1 Findings on course and teaching satisfaction comparison

The mean score in the academic year 2018, 2019 shows that students satisfy with the IE course and teaching process and almost most satisfy in 2020. Even the mean satisfaction score slightly drop in academic year 2019, it still remains on satisfy level. The changes in course and teaching implementation from pedagogy methods such as physical lecturing, discussion, captions and video observations to SULAM approach that emphasize the service learning activities such as real problem identification, establish the community engagement model, search the target community to help, find the agencies and industries for project support and presents the project solution and outcome to the stakeholders contribute to the mean satisfaction score slightly drop in academic year 2019. The implementation of changes with limited time for the IE course coordinator and lecturers to fully understand the whole process of service learning approach become major challenges in course

management, teaching and evaluation process. They experienced high load on preparing the course content changing documents i.e. HEA-03, Self-Learning Time (SLT) and Teaching Plan (TP), extra meeting with potential project stakeholders, attending short courses and workshops for SULAM implementation and extra effort in self-learning and research on service learning methodologies. In addition, both the course coordinator and lectures conducted the IE course with minimal guidance and zero experience in service learning process. The whole process became more difficult when the COVID-19 pandemic hit around the world in end year 2019 which it had happened in the middle of the teaching and learning process as discussed many researchers and educators such as Bao, Chen et.al., González-Calvo et al. and Mohammed et al. [9-12]. However, after first SULAM implementation, both before and during pandemic, the IE course coordinator and lecturers become more creative, more experience, more understand and more organize in conducting the SULAM approach for IE course in academic year 2020. That explains the increase mean score for both course and teaching satisfaction in the year 2020.

The highest satisfaction score in CO1 i.e. Ability to apply knowledge of basic concepts and principles of ergonomics and body mechanics in sequential year of 2018 and 2019 is expected because the pedagogy and service learning methods conducted physically in those years. The lowest satisfaction score in year 2020 which focuses to CO1 (ability to apply knowledge of basic concepts and principles of ergonomics and body mechanics), CO 2 (ability to analyse and perform suitable anthropometric study in workspace design, equipment and facilities in ergonomic issues) and CO3 (ability to use suitable assessment tools in the design and evaluation of the work tasks) justify the importance of physical interaction between students and lecturers. The same CO 3 and CO 4 (ability to solve and design an effective and comfortable workplace to ensure workers' productivity, health and safety) belong to lowest satisfaction score in 2019 strengthen the justification of physical interaction is required in both pedagogy and service learning approach. The physical lecturing and discussion had been proven the best communication between teachers and students in order to understand the course content compare with virtual class [11]. Finally, the highest satisfaction score in course organization criteria in 2020 reflecting the effectiveness of digital platform in organizing the course materials and documents as example submitting assignments to the cloud, sharing the references and lecture notes

in digital classroom, comparing the previous course organization methods in 2018 and 2019 such as paper based submission and used printed material in the class. This explains the lowest satisfaction score, of course organization and adequacy of handouts, exercise and assignments and its associate learning sessions such as workshops, seminars, tutorials or practices usefulness.

It also finds that the teaching method changes and COVID-19 pandemic influence the teaching satisfaction score for the same justifications for course satisfaction score pattern. The main teaching criteria that appear in those three years is the availability of correcting assignments and tests to be returned to students, which obtain the highest satisfaction score in year 2018 but was scored from the lowest mean point in consecutive years of 2019 and 2020. The justification for this finding is lecturers required longer time in returning the assignments or exercise through digital platform due to individual upload process compare to just compiling the paper based documents and distributed them in the class or the students self-pick up their own assignments or exercises in front of lecturers' office door. However, the lowest mean score obtained for this criteria in this study still belong to the satisfy level.

5.2 Findings of COs attainment comparison

This study finds that all COs attain passing percentage which above 50% whether the IE course apply the pedagogy or SULAM approach, and there is no significant effects on COVID-19 pandemic factor. In addition, the COs' percentage attainment increases after SULAM implementing in IE course. This indicates that the SULAM approach helps students to more understand in applying the IE knowledge, more able to analyse and perform the study case given, more able to use suitable assessment tools, solve and design the solutions for the given problem in the community. However, the results in Table 2 also provides the evidence that mapping the correct complexity level of the course content helps increasing the COs attainment percentage.

5.3 Findings of IE students' grade comparison

Finally, this study finds that the students' final grade in IE course improves significantly after changing the pedagogy to SULAM method. Again, the final grade graph looks promising and more students obtained good grades i.e. A and B in academic year 2020 after second SULAM implementation. The results in Table 1 support this finding which students expressed the satisfaction feeling during learning the IE course even during pandemic. This is because after second year of the pandemic, the lecturers and student become adapted with the new norm of teaching and learning process [12]. Thus, the teaching, learning and evaluation process do influence the IE students' final grade but not COVID-19 pandemic.

6.0 CONCLUSION

This study aims for investigating the effect of SULAM implementation and COVID-19 pandemic in teaching and evaluation process of IE course. The objectives of this study are to compare the students' satisfaction on course and teaching implementation before and after implementing SULAM as well as the effect of pandemic on the satisfaction scores, to compare the COs before and after implementing SULAM and the effect of pandemic in the COs and to compare the students' grade before and after implementing SULAM and the effect of pandemic in the students' grade. The pedagogy methods were used in IE in the academic year 2018 and it was changed into service learning approach in year 2019 and 2020 due to SULAM requirements. The results in this study lead to the finding that the changes in the teaching and evaluation methods due to SULAM implementation does effect the course satisfaction, teaching satisfaction, course outcomes (COs) and final students' grade in positive form even though there were major challenges happened in SULAM implementation especially in academic year 2019. The results also provide evidences that COVID-19 does affect the course and teaching satisfaction score but it almost not contribute to significant negative impact to the COs and students' final grade. This paper gives significant contribution for preparing the teaching and evaluation methods for future students in IE course for SULAM program specifically and for the similar course generally especially in uncertainty conditions such as pandemic and endemic scenario.

6.1 Limitations and Future Studies

The comparison limited to the years of 2018 to 2020 because the major and rapid changes happened in the education system within these three years. So that, it is important to investigate what had happened and find the gaps to suggest continuing improvements for future implementation of IE course and become the benchmark to other courses that involve in SULAM program in future.

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REFERENCES

- [1] R. S. Bridger, "Introduction to Human Factors and Ergonomics", (4th ed.), Boca Raton: CRC Press. <https://doi.org/10.1201/9781351228442>, 2017.
- [2] Ministry of Higher Education (MOHE), "Service learning Malaysia - university for society", Putajaya, Malaysia: Ministry of Higher Education, 2019.
- [3] P. Bush, "Ergonomics: Foundational Principles, Applications & Technologies", New York: CRC Press, 2012.
- [4] L. Moody, "A studio-based approach to teaching ergonomics and human factors", *Proceedings of the Human Factors and Ergonomics Society*, pp 545–549. <https://doi.org/10.1177/1071181311551111>, 2011.
- [5] M. Bures, "Efficient Education of Ergonomics in Industrial Engineering Study Program", *Procedia - Social and Behavioural Sciences*, 174, 3204–3209. <https://doi.org/10.1016/j.sbspro.2015.01.983>, 2015.
- [6] R. D. Anazifa, & D. Jukri, "Project-based learning and problem-based learning: Are they effective to improve student's thinking skills?" *Jurnal Pendidikan IPA Indonesia*, vol6 no.2, pp 346–355, <https://doi.org/10.15294/jpii.v6i2.11100>, 2017.
- [7] N. Champagne, "Service learning: Its origin, evolution, and connection to health education", *American Journal of Health Education*, vol 37 no. 2, pp 97–102, <https://doi.org/10.1080/19325037.2006.10598885>, 2006.
- [8] L. T. Page, & L. M. Stanley, "Ergonomics service-learning project: Implementing an alternative educational method in an industrial engineering undergraduate ergonomics course", *Human Factors and Ergonomics In Manufacturing*, vol 24 no. 5, pp 544–556, <https://doi.org/10.1002/hfm.20544>, 2014.
- [9] W. Bao, "COVID -19 and online teaching in higher education: A case study of Peking University", *Human Behavior and Emerging Technologies*, vol 2 no. 2, pp 113–115, <https://doi.org/10.1002/hbe2.191>, 2020.

- [10]G. González-Calvo, R.A. Barba-Martín, D. Bores-García & D. Hortigüela-Alcalá, "The virtual teaching of physical education in times of pandemic", *European Physical Education Review*, <https://doi.org/10.1177/1356336X211031533>, 2021.
- [11]S. B. Mohammed, M. S. Taha, R. B. Mohammed, S. Abdullah & D. A. Mohammed, "Teaching Methodology for Interior Design Studio-I during COVID-19 Pandemic at Tishk International University", *EAJSE*, vol 7, pp 185–196. <https://doi.org/10.23918/eajse.v7i1p185>, 2021.
- [12]T. Chen, L.Peng, B.Jing, C. Wu, J.Yang, & G. Cong, "The impact of the COVID-19 pandemic on user experience with online education platforms in China", *Sustainability (Switzerland)*, vol 12 no.18, pp 1–31. <https://doi.org/10.3390/SU12187329>, 2020.