

Evaluation on Academic Performance of Students in Teaching and Learning in Engineering Course

Masyitah Md Nujid^{a*}, Duratul Ain Tholibon^b

^a School of Civil Engineering, College of Engineering, Universiti Teknologi MARA, Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Permatang Pauh, Pulau Pinang, Malaysia

^b School of Civil Engineering, College of Engineering, Universiti Teknologi MARA, Cawangan Jengka, 26400 Bandar Tun Razak, Pahang, Malaysia

* masyitahnujid@gmail.com

Article history

Received

28 February 2022

Received in revised form

11 April 2022

Accepted

19 June 2022

Published online

30 June 2022

Abstract

Teaching and learning session all over the world—refraining teachers and students from primary, secondary and tertiary education levels from attending physical classes in the traditional way has disrupted due to pandemic. The uncertainty situation in teaching and learning have brought concern in academic performance of the students to educators, students, institutional higher education as well as parents. However with emergency circumstance with proper planning and action in delivering their subject matter, impacts evaluation on academic performance to educators and students can be assessed. This study evaluates the course and program outcomes on academic performance of students for specific course at a department of university A in engineering course using open and distance learning approach. Case study method was used to evaluate the students' academic performance by having quantitative data which were analyzed using descriptive statistics. The findings show the students are able to perform well in the course assessments despite the pandemic. The future trend in T&L will be flexible learning and open distance learning as well student-centered learning.

Keywords: Course outcomes, programme outcomes, academic performance, open and distance learning

1. Introduction

Outcome based education (OBE) may include a range of knowledge (cognitive domain), skills (psychomotor domain) and emotional (affective domain) aspects. In Malaysia, OBE is under the responsibility of Malaysia Quality Agency (MQA) (established in 2007) to ensure the quality of all levels of education starting from primary, secondary and tertiary levels in public and private sectors. The implementation of OBE was firstly introduced for engineering education and essential requirement by the year to become a fully signatory member of a multinational agreement for the mutual recognition of engineering degrees, i.e. The Washington Accord (WA) (Noor Al-Huda Abdul Karim and Khoo Yin Yin, 2013). The Board of Engineers Malaysia (BEM) is responsible to ensure that the quality of engineering programme obtained by its registered engineers fulfil the minimum standard comparable to global practice (Engineering Programme Accreditation Manual, 2017) according to the WA. Engineering Accreditation Council (EAC) is the body delegated by BEM for accreditation of engineering degree programmes where all bachelor in engineering degrees are required to implement OBE in line with industrial globalization (Wan Abdullah Zawawi et al., 2013) needs and demands. There are three learning domains in the OBE system namely cognitive, psychomotor and affective domains as required by the MQA with eight learning outcomes: knowledge; practical skills; social skills and responsibilities; values, attitudes and professionalism; communication, leadership and team skills; problem

solving and scientific skills; information management and lifelong learning skills; and managerial and entrepreneurial skills (Noor Al-Huda Abdul Karim and Khoo Yin Yin, 2013). Meanwhile, the EAC outlined twelve programme outcomes (PO) to describe what students are expected to know, be able to perform or attain through the programme by the time they graduate (Engineering Programme Accreditation Manual, 2017). The PO are engineering knowledge (PO1), problem analysis (PO2), design/development of solution (PO3), investigation (PO4), modern tool usage (PO5), the engineer and society (PO6), environment and sustainability (PO7), ethics (PO8), individual and team work (PO9), communication (PO10), project management and finance (PO11) and lifelong learning (PO12). According to Liew et al.(2021), based on the Engineering Programme Accreditation Manual, (2017), there are three requirements for outcomes-based assessment; 1) curriculum-T&L activities-assessment, 2) POs attainment are evaluated for continuous quality improvement (CQI) at the course and programmes level, and 3) high degree of stakeholders' involvement.

In order to ensure the quality of education through OBE system, constructive alignment is an important design in T&L. Constructive alignment is what we want, how we teach and how we assess academic performance of students as well as the course offered. Malmqvist (2011) and Borrego & Cutler (2010) studied the importance of constructive alignment to ensure the quality of programme offered by Institutional Higher Learning (IHL) which its intended

learning outcomes as well as teaching and assessment activities can be identified, aligned and improved in future. Iqbal et al., (2020) illustrated a smart learning management system framework which imposed the importance of students feedback/response and strategies for continuous quality improvement by utilizing smart educational tools and learning management systems in T&L. They also highlighted additional prerequisite goals for students, namely; 1) organizational attributes, 2) technological tools, 3) conceptual framework, 4) interconnected and communication and 5) ethical attributes.

The OBE implementation could not be taken for granted in any way of T&L especially during the pandemic situation such as Covid-19 (C-19). The open and distance learning (ODL) has changed the T&L landscape during the C-19. The ODL is as a flexible learning pathway where the contents must be made available in such a way that students can access it anytime and anywhere. Müller et al. (2018), Kormaz et al. (2021), and Yaseen et al. (2021) stated with flexible learning through ODL, students gain access and flexibility with regard to at least one of the following dimensions: time, place, pace, learning style, content, assessment or learning path which can be assessed online and offline (recorded lectures).

The objective of this study is to evaluate students' academic performance in engineering course. The study will compare academic performance between male and female students according to course and programme outcomes.

Course Programme Outcomes

Outcome based education was first implemented in year 2007 at school of department in university A and the program educational objectives, program outcomes, curriculum and syllabus with outcome based education approach were reviewed periodically and accredited by Engineering Accreditation Council to ensure the quality of the program delivered and graduates sufficiently fulfil the standard requirement of Board of Engineers Malaysia to be in line with the vision and mission of university A. The school has developed and implemented a Geotechnics course for its students in Year Two Semester 4. The three-unit credit civil engineering course introduces the course outcomes (CO) as the roles of geotechnical engineer in analysing various geotechnical engineering parameters and design methods (CO1) and conceptualizing and resolving problems related to geotechnical engineering (CO2). Table 1 lists programme outcomes (PO) of Geotechnics course which are Problem Analysis (PO2) and Design/Development of Solutions (PO3).

Table 1. Geotechnics programme outcomes

Programme Outcome (PO)	Description
PO2: Problem Analysis	Ability to identify, formulate, research literature and analyse complex civil engineering problems in reaching substantiated conclusions using principles of mathematics, sciences and engineering knowledge
PO3: Design/ Development of Solutions	Ability to design systems, components or processes for solving complex civil engineering problems that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations

The school has decided in the OBE system, cognitive domain and level of difficulty for Year Two students are designed with 20-30% for Knowledge (C1) and Comprehension (C2), 60-80% for Application (C3) and Analysis (C4) and remaining cognitive domain (Evaluation (C5) and Create (C6)) are 0-10%. In the Geotechnics course, the school decided that during the C-19 pandemic, the level of difficulty in the evaluation of assessments for Test, Quiz and Final Examination (Assignment 1 & 2) were 27% (C1-C2), 69% (C3-C4) and 4% (C5-C6).

Several online platforms used by the educators and students for offline/online T&L include Microsoft 365, Telegram and WhatsApp. Mohammed et al. (2020) stated those online tools and platforms for offline/online T&L experienced by educators and students in Oman was very excellent and efficient but has small technical issues such as poor internet connection in the remote area. Similar difficulties found by a study (Md Nujid and Tholibon, 2021) for remote area is having a good internet connection. In order to avoid any issue in accessing the course, the course was delivered via two hours online lecture (synchronous) and one-hour offline lecture (asynchronous) in which recorded lecture video was uploaded to YouTube to allow flexible time accessed by registered students. The course assessments were conducted asynchronous (offline) within specified period in allowing students to answer the questions at their convenience time. The learning activities were given mostly in asynchronous mode for students' to perform self-learning, conduct revision session, overview the topic content and do exercise on the topic given. Via this method, student-centered learning was employed through T&L using lecture and problem-based learning which were evaluated from test, quiz and assignments.

2. Methodology

A total number of fifty students/respondents who registered for Geotechnics course in Semester 4 of session March 2020 to July 2020 was selected for the study. This study adopted focus group method which divides the respondents into small groups. An online demographic survey was distributed to the respondents via WhatsApp group. The study intended to evaluate academic performance of students' during C-19 pandemic. The Geotechnics course was introduced for the Bachelor of Engineering (Hons.) Civil (Infrastructure) program at the school of department in university A to help engineering students learn about geotechnical engineering and its applications. The course was first offered to the engineering majors' under-graduate course in 2007 and has been taught every semester since then.

The course is offered as a major for engineering junior students in Semester 4 Year 2 of degree programme, with an average class size of 30 students. The course was outlined based on PO set by EAC, BEM with CO set by the school. The three-unit credit course deals with the roles of geotechnical engineers in analysing geotechnical engineering parameters based on various fields and laboratory tests. The course consists of four learning topics namely Geotechnical Investigation (GI); Foundation and Settlement (FS); Slope Stability (SS) and Earth Retaining Structure (ERS) and teaching is conducted via three hours per week lecture and problem-based learning methods.

The course evaluations comprised of summative and formative assessments where continuous assessment namely test, and quiz contribute to 30% and 10% respectively of the course grade. Meanwhile, final examination which contributes to 60% of the course grade focuses on the design and analysis of geotechnical problems in the context of developed/developing world. Table 2 shows marks distribution based on assessment types, course outcomes and program outcomes.

However, during the pandemic, the final examination was changed to final assignments and maximum of four assessments were allowed to be evaluated to decrease students' burden in facing the pandemic. The same goes to continuous assessment where only selected topics was asked in each assessment. For example, questions from topic's one (GI) and two (FS) were included in the test which contributed to 30% marks, while topics three (SS) and four (ERS) were asked in quiz for 10% marks. For final assessment which contributed to 60% of course grade, two set of assignments were provided where topic's one (GI) and three (SS) were included in Assignment 1 (24%) and topics two (FS) and four (ERS) were assessed in Assignment 2 (36%). All assessments were conducted through online platforms such as Microsoft Teams (MT) and university A learning management system known.

Table 2. Assessment types measured by topics according to course and programme outcomes

Assessments	Topics	Course Outcomes (CO)	Programme Outcomes (PO)
e-Test	Topic 1 (GI)	12 (CO1)	12 (PO2)
	Topic 2 (FS)	18 (CO2)	18 (PO3)
e-Quiz	Topic 3 (SS)	5 (CO1)	5 (PO2)
	Topic 4 (ERS)	5 (CO2)	5 (PO3)
e-Assignment 1	Topic 1 (GI)	8 (CO1)	8 (PO2)
	Topic 3 (SS)	16 (CO1)	16 (PO2)
e-Assignment 2	Topic 2 (FS)	12 (CO2)	12 (PO3)
	Topic 4 (ERS)	24 (CO2)	24 (PO3)

In the beginning of every semester, the educators described the course in detail in terms of its learning outcomes, module topics, teaching methodologies, references list and evaluation methods. The Geotechnics course was selected for this study because of its unique challenges: (a) it conceptualizes the geotechnical engineering theories and parameters based on field and laboratory data, (b) it applies geotechnical engineering parameters in design and analysis of complex problems, (c) it is composed of students from diverse demographic background, and (d) its structure consists of problem-based learning modules.

A quantitative study was conducted to obtain respondents' demographic information background. Results from test, quiz and assignments provided were evaluated to measure students' achievement for CO1PO2 and CO2PO3. Each two course and programme outcomes CO1PO2 and CO2PO3 were evaluated and addressed using course assessments (test, quiz and final examination) and the course learning outcomes were to: a) acquire various geotechnical engineering parameters and design methods, and b) conceptualize and resolve problems related to geotechnical engineering using direct approach (El Maaddawy et al., 2017).

Meanwhile indirect measures used include student self-assessment survey on course outcomes (Diagnostic Test (DT)) and online student course evaluation survey (for instance Entry Survey (ES) conducted at the beginning of the semester to evaluate their knowledge before taking the course). Exit Survey (ES) and Student's Feedback Online (SUFO) were answered by students' after completing the course to evaluate knowledge gained. However, as shown in Figure 1, data for DT and ES, evaluations of learning outcomes and output data such as Student's Feedback

Online (SUFO) and Exit Survey (ES) were out of scope of the present study and were not analysed.

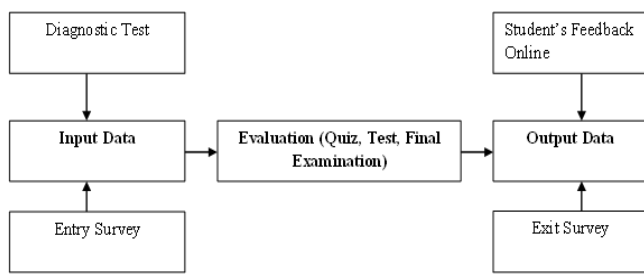


Figure 1. Data collection for study

All the responses were analysed, tabulated, and converted to percentages. Data and variables involved in the study were analysed using open-source software, JASP 0.14.1.0.

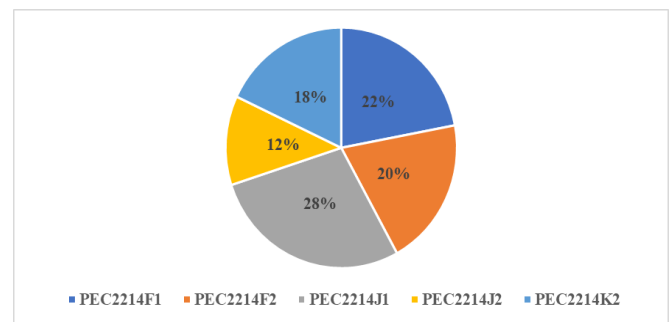
3. Results and Discussions

The results and discussions are presented based on the evaluation on students' academic performance based on programme and course outcomes (PO-CO), evaluation course from various assessment types and overall grading score earned by the students for Geotechnic course.

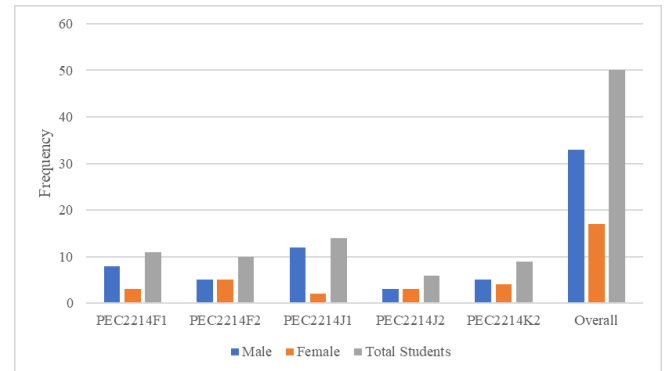
Demographics

A total of 50 (n=50) participants from Semester Four Year Two students registered for the Geotechnic course participated in the study. For the purpose of this study, the participants were divided into five small groups. At the beginning of the semester, each group was allocated a maximum of 30 students.

As shown in Figure 2a, PEC2214J1 group has the largest percentage of total respondents while the smallest percentage is recorded by PEC221J2 group. Majority of the participants are male (66%), and about one third of them are female (34%) as depicts in Figure 2b. In contrast to the current finding, Shahzad et al. (2020) stated that the number of female students enrolled in Malaysian universities is higher compared to their male counterparts. This issue may be because the participants involved in this study consist only half of the total batch of engineering students in the university. Figure 2b shows the percentage of students in each group and percentage of male versus female students for all groups indicating imbalanced gender segregation for each group where male respondents constitute a large portion of the survey. The course group registration was done by students individually to choose their group followed to their own's time table arrangement for the particular semester with considering class from other courses registered in the semester from avoiding clash while attending the online course.



a.



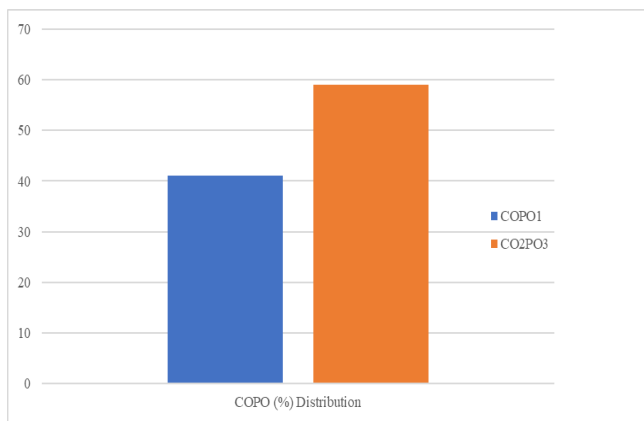
b.

Figure 2. Percentage of students in each group and gender

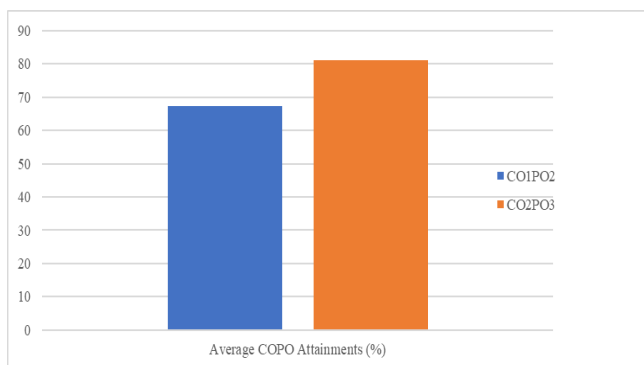
Evaluation on students' academic performance (assessment marks) by programme and course outcomes

Programme and course outcomes are evaluated based on designated by school members and in this study only PO2 and PO3 for CO1 and CO2 respectively are evaluated. These POs and COs are evaluated from quiz, test and final examination. Figure 3(a) and (b) below show the COPO (%) distribution and average attainments of CO1PO2 and CO2PO3 for undergraduate Geotechnics course for Semester 4 of March 2020 session. The CO1PO2 and CO2PO3 distribution percentage are 41 and 59 respectively.

The average COPOs percentage are 67 (CO1PO2) and 81 (CO2PO3). Evaluation shows that the average percentage of each PO and CO are at below satisfactory level (more than 60%). The study from (Arshad, Razali and Mohamed, 2012) indicated the satisfactory level on program outcomes achievement is above 60%. This result demonstrates achievement of PO2 and PO3 for respective CO1 and CO2 with assessment on the ability to design analysis and propose solution to geotechnical problems by adopting engineering parameters. The T&L delivery in the course are suitable in gaining the outcomes. Students' performance on COPO achievement may be enhanced by improving learning engagement and assessment between educators and students (El Maaddawy et al., 2017). It is also important to be transparent on the evaluation methods utilized and quality of the learning environment.



a.



b.

Figure 3(a,b). COPO (%) mark distribution and average COPO attainments (%)

Evaluation on students’ academic performance (assessment marks) by course topics

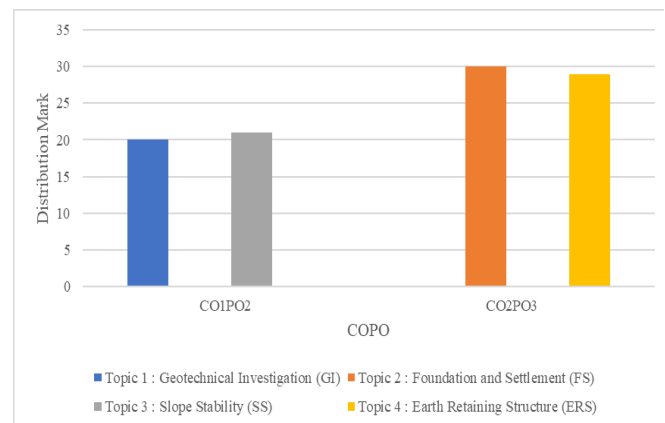
Table 3 and Figure 4 show the distribution marks according to topics, course and programme outcomes. The CO2P03 outcomes evaluated in topics two and four contributed higher marks because it evaluates students’ ability to design, develop, conceptualize and resolve problems related to geotechnical engineering. Students are assessed using CO1P02 outcomes from topics one and three to be able to understand various geotechnical engineering parameters and design methods. As can be seen from Figure 3, the mark distribution for CO1P02 is 41 out of 100 total marks for all assessments evaluated in the course.

Table 3. Distribution marks according to topics, course and programme outcomes

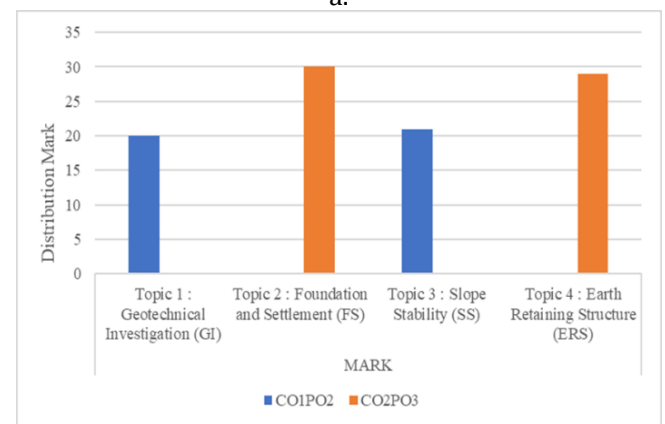
COPO	Topics	Marks
CO1P02	Topic 1 : Geotechnical Investigation (GI)	20
CO2P03	Topic 2 : Foundation and Settlement (FS)	30
CO1P02	Topic 3 : Slope Stability (SS)	21
CO2P03	Topic 4 : Earth Retaining Structure (ERS)	29
Marks		100

T&L delivery for Geotechnics assessments are through lecture and problem-based learning were performed on formative assignment and summative assignment (online class). Meanwhile the learning activities were assigned weekly to students in non face to face (offline class).

The purpose of giving the learning activities to students in which they can achieve basic knowledge and comprehension by identifying geotechnical engineering parameters and design methods as well as familiarize design concept and to resolve geotechnical engineering problems. It is a best pedagogies practice to achieve sustainability learning outcomes in Civil and Environmental Engineering students in United State as reported by Bielefeldt (2013).



a.



b.

Figure 4(a,b). COPO distribution mark by topics with respective COPO and distribution marks

Meanwhile Figure 5 shows assessment types for course evaluation where CO1P02 and CO2P03 obtained the highest percentage from quiz and test which were assessed via final examination (assignments) and test. The course started off with face-to-face physical class in the early semester before ODL commenced in mid-March 2020, after three weeks the semester started. CO1P02 and CO2P03 are able to effectively deliver the lecture and problem based learning that were supposedly delivered through physical class. Students' performance for ODL cannot

be assumed similar to the previous face-to-face classes due to various factors (Lapitan et al., 2021).

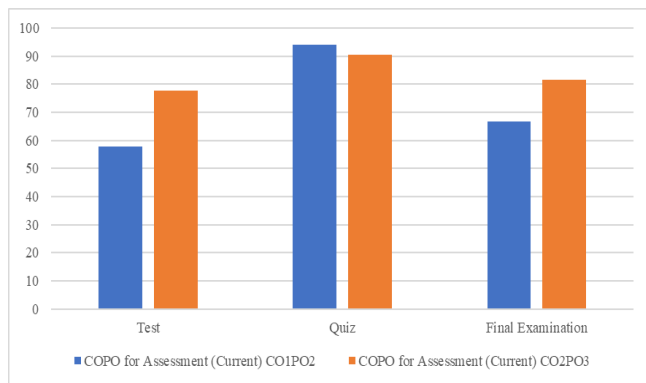
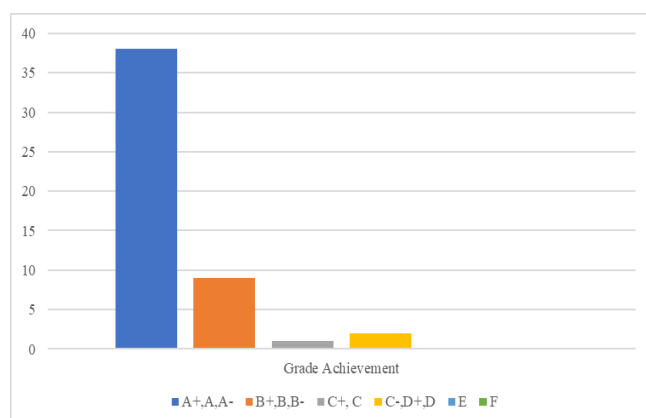


Figure 5. Assessment types for course evaluation

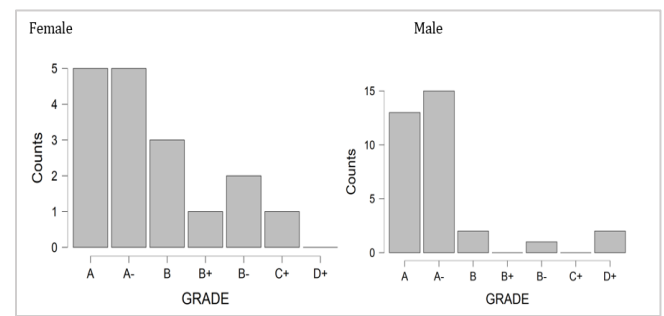
Grading Score

Figure 6a shows that overall, 96% students passed the course and only 4% students failed with grading score D+/D the subject. Meanwhile, Figure 6b provides scoring grade by gender where male students performed better than female students, scoring more A and A- grades than their counterparts. Academic performance of students' taking online class improved although there is no physical class data available to be compared to. There are factors contribute to students' academic performances such as total number of assessments given to students throughout semester, methodology approaches in T&L, methods of examination conduct and student learning time allocation for face to face and non face to face approaches.

Santiago et al., (2021) reported students achieved better results under emergency remote teaching which is insignificantly affected by class size, choice of synchronous and asynchronous delivery and choice of virtual communication tools.



a.



b.

Figure 6. Grade achievement for the course

Conclusion

This study evaluates students' academic performance for Geotechnics course at the school department of university A via ODL as a flexible method for T&L. The findings show the students are able to perform well in the course assessments in which CO1PO2 and CO2PO3 obtained the highest percentage from quiz and test which were assessed via final examination (assignments) and test despite the pandemic. The future trend in T&L is to promote flexible learning and open distance learning as well student-centered learning to educators and students.

Acknowledgement

The authors are grateful to the university administration for their support in providing trainings in online instruction.

References

Arshad, I., Razali, S. F. M., & Mohamed, Z. S. (2012). Programme Outcomes Assessment for Civil & Structural Engineering Courses at Universiti Kebangsaan Malaysia. *Procedia - Social and Behavioral Sciences*, 60, 98-102. <https://doi.org/10.1016/j.sbspro.2012.09.353>.

Bielefeldt, A. R. (2013). Pedagogies to Achieve Sustainability Learning Outcomes in Civil and Environmental Engineering Students. *Sustainability (Switzerland)*, 4479-4501. <https://doi.org/10.3390/su5104479>.

Borrego, M., & Cutler, S. (2010). Constructive alignment of interdisciplinary graduate curriculum in engineering and science: An analysis of successful IGERT proposals. *Journal of Engineering Education*, 99(4), 355-369. <https://doi.org/10.1002/j.2168-9830.2010.tb01068.x>.

El Maaddawy, Tamer and Deneen, C. (2017). Outcomes-Based Assessment and Learning: Trialling Change in a Postgraduate Civil Engineering Course Outcomes-Based Assessment and Learning: Trialling Change in a, 14(1). *Engineering Programme Accreditation Manual*. (2017).

Iqbal, H. M. N., Parra-Saldivar, R., Zavala-Yoe, R., & Ramirez-Mendoza, R. A. (2020). Smart educational tools and learning management systems: supportive framework. *International Journal on Interactive Design and Manufacturing*, 1179-1193. <https://doi.org/10.1007/s12008-020-00695-4>.

Lapitan, L. D., Tiangco, C. E., Sumalinog, D. A. G., Sabarillo, N. S., & Diaz, J. M. (2021). An effective blended online teaching and learning strategy during the COVID-19 pandemic. *Education for Chemical Engineers*, 35(May 2020), 116-131. <https://doi.org/10.1016/j.ece.2021.01.012>.

- Liew, C. P., Puteh, M., Lim, L. L., Yu, L. J., Tan, J., Chor, W. T., & Tan, K. G. (2021). Evaluation of Engineering Students' Learning Outcomes: Creating a Culture of Continuous Quality Improvement. *International Journal of Emerging Technologies in Learning*, 16(15), 62-77. <https://doi.org/10.3991/ijet.v16i15.23763>
- Malmqvist, J. (2011). Constructive Alignment (CA) for Degree Projects-Intended Learning Outcomes, Teaching and Assessment. In Proceedings of 7th Retrieved from <http://publications.lib.chalmers.se/publication/143185-constructive-alignment-ca-for-degree-projects-intended-learning-outcomes-teaching-and-assessment>.
- Md Nujid, Masyitah and Tholibon, D. A. (2021). An Investigation on the Preference Approach in Experiencing Open and Distance Learning Methods. *International Journal of Asian Education*, 2(3), 356-368.
- Mohammed, A. O., Khidhir, B. A., Nazeer, A., & Vijayan, V. J. (2020). Emergency remote teaching during Coronavirus pandemic: the current trend and future directive at Middle East College Oman. *Innovative Infrastructure Solutions*, 5(72), 1-11. <https://doi.org/10.1007/s41062-020-00326-7>.
- Noor Al-Huda Abdul Karim and Khoo Yin Yin. (2013). Outcome-Based Education: An approach for teaching and learning development. *Journal of Research, Policy & Practice of Teachers & Teacher Education*, 3(1), 26-35.
- Santiago, I.-P., Ángel, H.-G., Julián, C.-P., & Prieto, J. L. (2021). Emergency Remote Teaching and Students' Academic Performance in Higher Education during the COVID-19 Pandemic: A Case Study. *Computers in Human Behavior*, 119(January), 106713. <https://doi.org/10.1016/j.chb.2021.106713>
- Shahzad, A., Hassan, R., Aremu, A. Y., Hussain, A., & Lodhi, R. N. (2020). Effects of COVID-19 in E-learning on higher education institution students: the group comparison between male and female. *Quality and Quantity*, (0123456789). <https://doi.org/10.1007/s11135-020-01028-z>
- Wan Abdullah Zawawi, N. A., Liew, M. S., Na, K. L. L., & Idrus, H. (2013). Engineering the civil engineering education: A capstone case study in a Malaysian university. *Proceedings of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering, TALE 2013*, (August), 791-795. <https://doi.org/10.1109/TALE.2013.6654546>