# iJEP
## International Journal of
## Engineering Pedagogy

PAPER

# Evaluation of Learners' Academic Performance in Teaching and Learning Civil Engineering During the COVID-19 Pandemic

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**ABSTRACT**

COVID-19 has had a significant impact on teaching and learning (T&L) pedagogies, which shifted from 100% face-to-face instruction to online and hybrid formats. The diversity of online and offline teaching and learning tools and platforms during the pandemic led to adjustment issues for students early in the pandemic. The preference for teaching and learning in choosing appropriate methods during a panic affects academic outcomes. However, students' academic performance on the T&L preference approach during the pandemic is questionable. This paper evaluates the academic performance of learners in the geotechnical course at the Centre for Civil Engineering Studies, Universiti Teknologi Mara, Malaysia, during the COVID-19 pandemic. The impacts of teaching and learning the course content through a preferential approach and the use of digital communication technologies on learners' academic performance during this period were investigated. A representative group recording was chosen as the case study method to assess learners' academic performance. Quantitative data were analyzed using descriptive statistics, and thematic analysis was used to evaluate qualitative data. The novelty of this work is to use student performance data and descriptive analysis of online surveys to reveal trends that can help identify preferred pedagogies in teaching and learning during the pandemic and in the future, and avoid failure among students. The results of the analysis revealed that during open and distance learning, learners' preferred asynchronous method with the social media platform WhatsApp and unrecorded video were chosen as the means of communication between educators and learners. The results show that learners can perform well on course assessments despite the pandemic. T&L pedagogies are identified for best practices in face-to-face and non-face-to-face classes in the future.

**KEYWORDS**

academic performance, course and program outcomes, COVID-19, open and distance learning

# 1    INTRODUCTION

COVID-19 has had a significant impact on teaching and learning (T&L) pedagogies, which moved from offline to online and hybrid methods. The variety of online and offline teaching and learning tools and platforms during the pandemic posed challenges for students and educators to adapt early in the pandemic. T&L's preference in choosing appropriate methods during panic situations has an impact on academic performance. Santiago et al. [1] highlighted that issues related to teaching and learning in higher education globally in response to the pandemic can be categorized into three groups: (1) maintaining classroom teaching with social distancing, (2) creating hybrid models (blended learning, limiting students to campus), and (3) moving to online teaching. Rafique et al. [2] conducted an investigation into the readiness of Pakistani students to transition from offline to online learning during the COVID-19 pandemic. The results of the short teaching and learning period implemented by Pakistani educators and learners revealed that the changes were not fully personalized and the students were unable to make decisions regarding their online educational activities during the COVID-19 pandemic. It is recommended that university management implement clear policies and guidelines and monitor the quality of online education provided by their universities. Similar research conducted in Malaysia on 354 undergraduate students through online surveys by Kamal et al. [3] found that the transition to online learning had a significant and positive impact on students' participation in active learning but had impacts on emotional feelings such as anxiety about digital literacy and technical complexity for students who were unfamiliar with technology and also affected their study time management and educational costs.

In Korea, a study conducted by Shim and Lee [4] on a total of 393 university students who experienced distance teaching and learning during the pandemic found that the most common environment and method for participating in classes were students' homes and personal laptops, where they enjoyed a comfortable educational environment, smooth interactions, and efficient use of time. At the same time, the negative effects of distance teaching and learning included network instability, one-sided interactions, and reduced concentration [4].

Santiago et al. [1] studied the impact of emergency distance learning due to the pandemic in Spain on factors such as the impact of organizational aspects related to unplanned changes and teaching-related variables, such as class size, synchronous/asynchronous teaching, and use of digital support technologies, on students' academic performance. The study found that the School of Telecommunications Engineering successfully implemented emergency distance education due to an increase in student academic performance and that student performance was not affected by different class sizes or modes of instruction (offline/online).

Meanwhile, a survey conducted by Aucejo et al. [5] on 1,500 students at one of the largest public institutions in the United States showed that socioeconomic factors were responsible for various effects of the pandemic, such as graduation rates, length of study, job offers, job loss, and earnings. The education sector is not the only one affected by this pandemic, Mofijur et al. [6] studied the impacts of the COVID-19 pandemic on social, economic, environmental, and energy domains. Nevertheless, teaching in synchronous online spaces through a pandemic pedagogical approach can support student-centered learning, especially in remote and online environments, through homework assignments. Through educator-provided homework, students have adopted an action research approach that relies on observation

and reflection and treats learning experiences as sites of inquiry and learning, as explained by Kiernan [7].

Thus, the challenges and impacts of teaching and learning during the COVID-19 pandemic focus on the implementation of open and distance learning as a flexible learning pathway where content must be made available in a way that students can access it anytime and anywhere, as reported by Müller et al. [8], Kormaz et al. [9], Yaseen et al. [10]. Müller et al. [8], Kormaz et al. [9], and Yaseen et al. [10] stated that with flexible learning through open and distance learning, students have access to at least one of the following dimensions: time, place, pace, learning style, content, assessment, or learning pathway, which can be assessed online and offline (recorded lectures). In addition to these factors, it is also important to consider educator/learner facilities and equipment, digital literacy, and technical aspects [11]. Other challenges of distance learning include lack of physical, environmental, and psychological preparedness, with some differences in perspectives by gender, age, and state of residence.

Despite all these challenges, distance learning does not affect the academic performance of electronic and electrical engineering students in France who use Microsoft Teams and Zoom video conferencing and chat tools to complement the activities made available by the digital work environment, as found by Jacques et al. [12]. Another study, conducted by Kanetaki et al. [13], demonstrated the effectiveness of the online learning framework in applying innovative teaching methods to influence student learning styles and overcome the challenges of distance-learning approaches, such as enhancing students' spatial conceptions and the unavailability of a physical classroom. In the Discover, Learn, Practice, Collaborate, and Assess (DLPCA) strategy introduced by Lapitan et al. [14], the asynchronous portion of instruction is provided by streaming prerecorded lecture videos on YouTube, while the synchronous mode is provided by videoconferencing platforms such as Zoom or Google Meet. These strategies had a positive impact on student performance, with students achieving better grades online than in face-to-face sessions, in effective online blended teaching and learning during the COVID-19 pandemic.

Researchers have conducted several studies on the preferred distance-teaching and -learning platforms for educators and students [15], [18], [19], such as WhatsApp and/or Telegram for messaging applications and Google Meet, Microsoft Teams, or Moodle as a communication platform for teaching and learning. Both communication and messaging applications were combined for effective teaching and learning during the pandemic. The evolution of teaching and learning modes from physical classrooms to nonphysical classrooms has highlighted the importance of digital technologies and platforms in conducting synchronous and asynchronous courses. The emergence of the Industrial Revolution 4.0 and digital technologies such as virtual reality are facilitating distance, remote, and online learning. COVID-19 has made it mandatory and easier for educators and learners to share information, provide guidance, and perform documentation via open educational resources [17]. Kanetaki et al. [16] concluded that the emergence of technologies has brought benefits to students and teachers in teaching and learning by using a single online platform for real-time course delivery and assessment of tasks, course notes, and grading, as well as providing links for asynchronous support, integration of links of course and learning materials published on social media channels, and organization of tasks. As teaching and learning shifted from conventional to online methods during the pandemic, the organization of the course to achieve the described learning outcomes, activities, and assessments also changed. During the pandemic, course assessments were conducted via an online platform with various tools available for

an automated grading process that gave more flexibility in planning and execution by reducing operational time [3]. However, there are some precautions that need to be taken into account to prevent students from cheating or arguing during the online evaluation process.

The objectives of this study are to evaluate the academic performance of open- and distance-learning students during the COVID-19 pandemic. The impact of teaching and learning course content using a preferential approach and the use of digital communication technologies for the assessment of learners' academic performance during this period is also investigated. The study will compare the academic performance of male and female students on course evaluations. A limited number of students, enrolled in any of the engineering courses offered at Universiti Teknologi Mara (Malaysia), are selected to be part of the study. For this purpose, a limitation of teaching and learning tools and platforms are adopted in the study.

The remainder of the paper is organized as follows. Section 2 presents the methodology used. The main results obtained will be presented and discussed in Section 3. The proposed discussion will provide specific answers to the three research questions previously stated. The main conclusions and research perspectives will be presented in Section 4.

## 2 MATERIALS AND METHODS

The research study presented in this paper was conducted with the participation of students from the Civil Engineering Study Center of Universiti Teknologi Mara, Malaysia. The total number of participants was a representative group of students who enrolled in the geotechnical course in semester 4 of the March 2020 to July 2020 session. The geotechnical course was introduced for the Bachelor of Engineering (Hons.) Civil (Infrastructure) program at the Civil Engineering Study Center, Universiti Teknologi Mara, Malaysia, to help engineering students become familiar with geotechnical engineering and its applications. The course was first offered in the Bachelor of Engineering course of study in 2007 and has been taught every semester since then.

A total of fifty second-year engineering students, divided into five groups, participated in this study. An online demographic survey was distributed to respondents via a WhatsApp group. The purpose of this study is to examine the preferred approach in open and distance learning during the COVID-19 pandemic and its evaluation of learners' academic performance through course evaluations.

Geotechnical Engineering is a three-unit credit course with two major learning and program outcomes that are assessed and addressed in the course evaluation. The course outcomes are i) analysis of various geotechnical engineering parameters and design methods (CO1) and ii) conceptualization and solution of geotechnical engineering problems (CO2). Concurrently, the course outcomes are i) problem analysis (PO2) and ii) solution design/development (PO3). The course outcomes designated by the study center are mapped to the program outcomes introduced by the Engineering Accreditation Council (EAC) [21]. The EAC is the delegated body by the BEM for accreditation of engineering programs in Malaysia. In geotechnics, the course assessments are designed as non-exam based, using a CO-PO grade distribution consisting of a test (30%), quiz (10%), and homework (60%) during the pandemic.

The study was organized into seven themes and subthemes according to the research methodology presented in Table 1. The first theme describes the demographic information of the learners. For this theme, two subthemes were collected by the researchers, namely gender and group enrollment. The second theme lists the open- and distance-learning platforms with three subthemes: Microsoft 365, Telegram, and WhatsApp. The third theme illustrates teaching and learning techniques with five subthemes, including setup, method of teaching and learning during the pandemic, and preference for a platform/technology. The fourth and fifth themes are program outcomes and course outcomes, respectively. Course and program outcomes were assessed using course assessments such as tests, quizzes, and final assignments. Finally, the last theme of the study is the scoring and evaluation of students' academic performance for the entire course. All responses were analyzed, tabulated, and converted to percentages. The data and variables involved in the study were analyzed using open-source software, JASP 0.14.1.0.

**Table 1.** Types of evaluations measured by themes according to course and program outcomes

| Themes | Subthemes |
|---|---|
| **1.** Demographic | **1.** Gender |
| | **2.** Group Registration |
| **2.** Open- and Distance-Learning Approach | **1.** Synchronous |
| | **2.** Asynchronous |
| **3.** Open and Distance-Learning Platforms | **1.** Microsoft 365 |
| | **2.** Telegram |
| | **3.** WhatsApp |
| **4.** Program Outcomes (PO) | **1.** Problem Analysis (PO2) |
| | **2.** Design/Development of Solutions (PO3) |
| **5.** Course Outcomes (CO) | **1.** Acquire various geotechnical engineering parameters and design methods (CO1) |
| | **2.** Conceptualize and resolve problems related to geotechnical engineering (CO2) |
| **6.** Evaluation Course | **1.** Test |
| | **2.** Quiz |
| | **3.** Final Examination (Assignment 1 & Assignment 2) |
| **7.** Grading Score | **1.** Academic Performance |

## 3 RESULTS AND DISCUSSIONS

The results and discussions are presented according to the seven main themes identified in the data analysis section: (a) teaching and learning preferences during the COVID-19 pandemic (demographics, preferred open- and distance learning approach [online/offline], and platforms), (b) assessment of student academic performance based on program and course outcomes, types of assessments, and students' overall grade for the geotechnical course.

### 3.1 Demographics

The respondents were asked about their gender, group enrollment, and teaching and learning preferences during the COVID-19 pandemic. The survey collected information such as demographics, group enrollment, and open- and distance-learning preferences (preferred online/offline platform and approach). A total of 50 ($n = 50$) second-year engineering students from the fourth semester of the March 2020 to July 2020 term enrolled in the geotechnical course and participated in the study. For the purpose of the study, the participants were divided into five small groups. Table 2 shows the number of students in the enrollment group.

**Table 2.** Number of students participating in this study

| Group Name | Number of Students |
|---|---|
| PEC2214F1 | 11 |
| PEC2214F2 | 10 |
| PEC2214J1 | 14 |
| PEC2214J2 | 6 |
| PEC2214K2 | 9 |
| Total | 50 |

The largest percentage of students in group registration participating in the study was PEC2214J1, and the lowest percentage of students was PEC2214J2, as depicted in Figure 1. A total of 50 participants were involved in the study, with the major constituent of 33 male students (66%) and the remaining 17 students being female (34%).

### 3.2 Preferred teaching and learning approach during the COVID-19 pandemic

Results show 32 male and female learners preferred open and distance learning as a flexible method for teaching and learning during the COVID-19 pandemic, as shown in Figure 2 (with nine missing responses). The figure also shows that most respondents preferred open-and distance-learning approach with asynchronous lectures. Preference for open and distance learning and asynchronous approaches are because students come from different demographics and backgrounds, with internet connection becoming a concern for some students, especially those residing in remote areas.
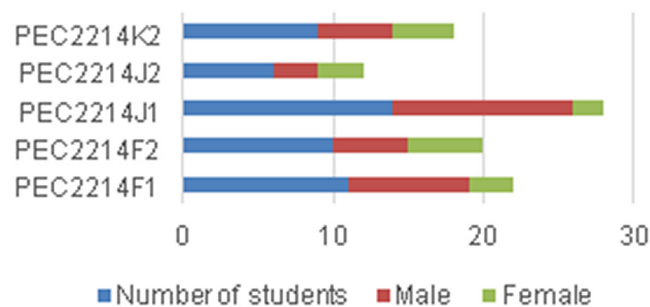


**Fig. 1.** Percentage of male and female students in each group

These methods were preferred because educators and students could choose their own time to connect to the internet and perform teaching and learning sessions. These findings are similar to Lapitan et al. [14], where students in the Philippines also chose the asynchronous method.

Instructors and students could meet online using video conferencing software during the designated class hours, and instructors could give lectures on the course via synchronous online lecture mode in real time. Students participated in the lectures and could ask questions verbally or via live chat. This finding is similar to Shim and Lee [4], where online learning that allows one to choose one's environment for taking classes freely was considered a great advantage for emergency remote learning. Lazzarini et al. [24] found that online courses are an effective approach for professional off-campus students to further their studies.

Kormaz et al. [9] listed the advantages of distance education to educators and students, which include saving time, flexible teaching and learning pedagogies with educational tools available online, and flexible teaching and learning time. Despite the advantages of open and distance learning, educators and students are also facing difficulties in adapting and adopting teaching and learning changes, such as stability of internet connection, digital literacy, and familiarity with tools or technical aspects of teleconferencing or online teaching application [3], [14]. Another issue is engagement between educators and learners during online and offline classes [9], which must consider the possibility of disruption of electricity and disconnection during online teaching and learning.
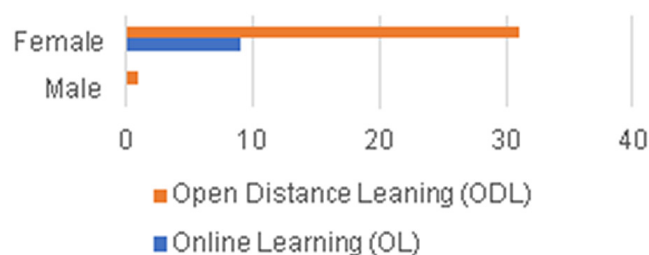


**Fig. 2.** Teaching and learning approach preference by gender

### 3.3 Preferred teaching and learning platform during the COVID-19 pandemic

Figure 3 shows the platform preferred by respondents to conduct open and distance learning in teaching and learning during the COVID-19 pandemic, where asynchronous methods via Microsoft 365 (Form) and WhatsApp were the most popular platform. This finding is in line with Saidi et al. [25] where students and educators chose WhatsApp as the preferred open and distance learning platform. The result shows students felt difficulty engaging with the platform due to unfamiliarity and lack of exposure during face-to-face classes before the transition mode to online learning. This result may affect the dropout rate among students due to the utilization of a different learning tool used for asynchronous support (e.g., Moodle) as stated by Kanetaki et al. [15]. A similar result was found in a study by Elmira et al. [20] the level of understanding of the related concepts was quite high using online learning platforms such as Google Meet. There is an insignificant gender difference in choosing any platform during open and distance learning, according to Pal and Vanijja [18]. The findings also agree with those by Kanetaki et al. [15], where teaching approaches may not have a direct impact on students' enjoyment and familiarization with the learning platforms.
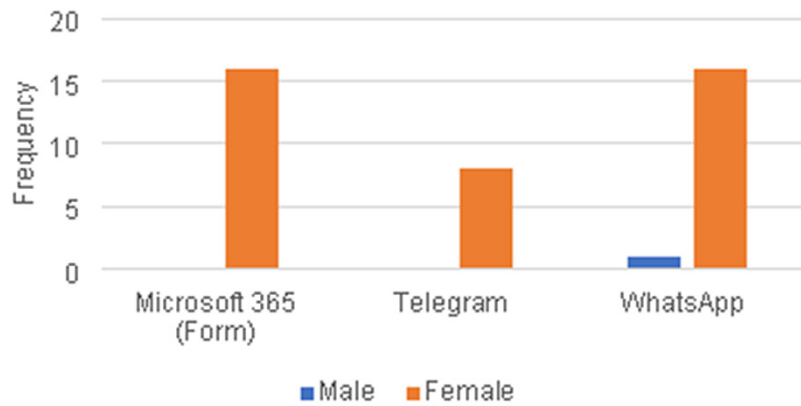
Fig. 3. Teaching and learning platform preference by gender

### 3.4 Evaluation on students' academic performance by program and course outcomes

Figure 4 depicts academic performance based on course and program outcomes (COPO) for courses taken by registered students. The CO1PO2 and CO2PO3 were evaluated from quiz, test, and final examination. The course contents were addressed in COPOs from grade distribution evaluated in the course assessments. The average COPO attainment shows the achievement of students registered in the course. In a total of 100 percent of grade distribution, the CO1PO2 and CO2PO3 distribution percentages were 41 and 59, respectively. The average percentage attainment of COPOs was 67 (CO1PO2) and 81 (CO2PO3), respectively. Evaluation shows that the average percentage of each PO and CO was at a satisfactory level (more than 50%). These COPOs demonstrate the achievement of students' academic assessment on the ability to design analysis and propose a solution to geotechnical problems by adopting engineering parameters. The teaching and learning delivery in the course is suitable for achieving the outcomes despite facing challenges in open- and distance-learning approaches. Jacques et al. [12] found that the performance of engineering students in France was not reduced in open and distance learning during the pandemic. Maaddawy et al. [23] stated the students' performance on academic achievement may be enhanced by improving learning engagement and assessment between educators and learners. Applying innovative teaching methods helped in reducing the failure as well as dropout rates [13] during the pandemic.
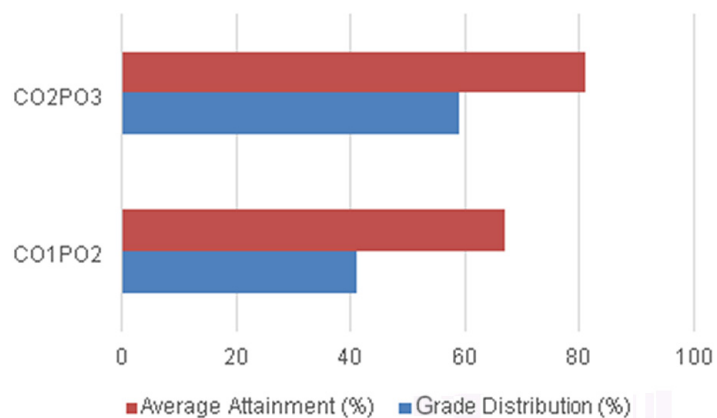


Fig. 4. COPO grade distribution and average attainment

Figure 5 shows the different types of assessments in the geotechnical course, where CO1PO2 and CO2PO3 scored the highest percentages in the quiz. The two CPOs scored the lowest in the quiz. Course performance in the assessments was based on the course content mapped to the CPOs with different levels of the cognitive domain. During the pandemic, all assessments were requested in a timely manner through online platforms such as Microsoft Teams. The panic situation shifted from physical face-to-face classes at the beginning of the semester in mid-March 2020 to open and distance learning just after three weeks into the semester. It is apparent from the average COPO results that academic performance can be improved through effective content delivered in the classroom and problem-based learning in the classroom. Lapitan et al. [12] mentioned various factors that can influence academic performance during the pandemic—for example, study environment, time, location, tools, and platforms—and cannot be considered the same as for the previous face-to-face classes. Similarly, Kanetaki et al. [13] found that when the pandemic occurred, students' learning styles also changed based on content delivery through online and offline approaches. Somehow, Jacques et al. [12] found that the pandemic has not affected the academic performance of engineering students for the same course assessed.
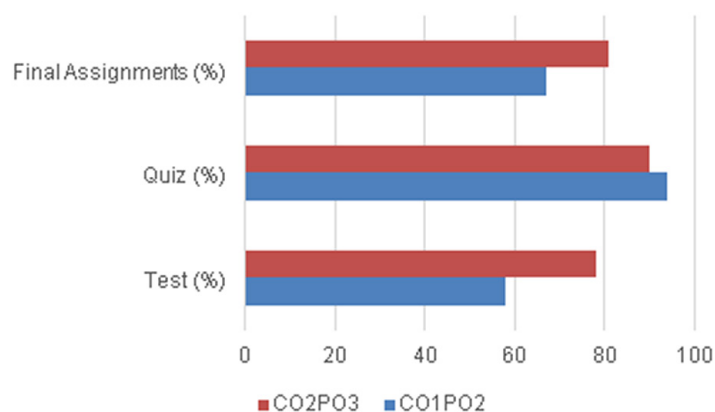


**Fig. 5.** Types of course evaluation

The mean values and standard deviation of student performance and their statistically significant differences with respect to gender and assessment types for the respective course and program outcomes were evaluated. The performance data of 50 students for assessment types such as test, quiz, and final exam that achieved the COPOs are presented in Table 3.

**Table 3.** Achievement of COPOs in course evaluations

| Assessment | COPOs | Male | | Female | |
|---|---|---|---|---|---|
| | | Mean ($M$) | Standard Deviation ($SD$) | Mean ($M$) | Standard Deviation ($SD$) |
| Test | CO1PO2 | 7.348 | 2.77 | 6.088 | 3.032 |
| | CO2PO3 | 13.99 | 15.00 | 14.00 | 15.00 |
| Quiz | CO1PO2 | 4.879 | 5.00 | 4.353 | 5.00 |
| | CO2PO3 | 4.697 | 5.00 | 4.176 | 5.00 |
| Final Assignment 1 | CO1PO2 Topic 1 | 5.879 | 0.857 | 6.118 | 0.69 |
| | CO1PO2 Topic 3 | 10.136 | 10.50 | 9.853 | 10.50 |
| Final Assignment 2 | CO2PO3 Topic 2 | 11.091 | 11.00 | 10.471 | 11.00 |
| | CO2PO3 Topic 4 | 18.227 | 18.500 | 18.838 | 19.00 |

The table shows from test assessment a mean CO1PO2 for male and female students of $M$ = 7.348 (male) and 6.088 (female), $SD$ = 2.77 (male) and 3.032 (female). From quiz assessment, for CO1PO2, male and female students scored $M$ = 4.879 (male) and 4.353 (female), $SD$ = 5.00 for both male and female students. From another assessment, final examination, where CO1PO2 was evaluated for topics one and three, the results indicate $M$ = 5.879 (male) and 6.118 (female), $SD$ = 0.697 (female) and 0.857 (male) for topic one, and $M$ = 10.136 (male) and 9.853 (female), with both males and females scoring $SD$ = 10.500 for topic three. CO2PO3 attainments were obtained from topics two and four in which $M$ = 11.091 (male) and 10.471 (female), with both males and females scoring $SD$ = 11.00 for topic two, and $M$ = 18.227 (male), 18.838 (female), $SD$ = 18.500 (male) and 19.00 (female), for topic four.

In order to assess intellectual skills of learners acquired in the course from tests, quizzes, and assignments, Wei et al. [26] stated that cognitive domain is employed for course evaluation. Course evaluation from examinations that focus more on the knowledge-discipline-related and practice-related skills are also part of learning outcomes assessment [26]. Students' performance can be improved by providing more exercises to enhance students' ability in identifying and solving engineering problems [27].

### 3.5    Grading score

Figure 6 shows the academic performance of students in the geotechnical course by gender. Overall, male students performed better than female students. Of the total students surveyed, 96% passed the course and only 4% failed. The passing grade was a C, with a minimum of over 50% of the course evaluation grade. This shows that online teaching and learning does not affect students' academic performance, as confirmed by Jacques et al. [12] and Kanetaki et al. [15], despite the many challenges faced by teachers [25] and learners in adopting teaching and learning styles and strategies, e.g., DLPCA [14], during the pandemic. Factors such as class size, choice of synchronous or asynchronous instruction, and choice of virtual communication tools did not influence students' academic performance in distance teaching and learning [1]. Other factors may contribute to the academic evaluation of the course, such as the total number of assessments given to students throughout the semester, methodological approaches to teaching and learning, methods of organizing examinations, and the distribution of student-learning time between face-to-face and non-face-to-face approaches.
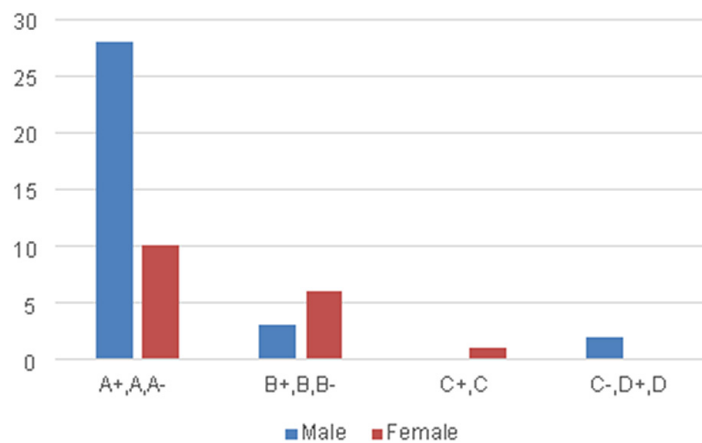


**Fig. 6.** Course grade, by gender

# 4 CONCLUSIONS

The COVID-19 pandemic has disrupted the teaching and learning process, preventing educators and learners from attending physical classes in the traditional manner. Many researchers have studied the challenges and impacts on learner and educator preparedness and preferences for teaching and learning during a pandemic.

This study evaluates learners' academic performance for the geotechnical course at Universiti Teknologi Mara (Malaysia) University Learning Center during the COVID-19 pandemic via open and distance learning as a flexible teaching and learning method.

The results of the analysis reveal that during open and distance learning, learners preferred the asynchronous method via WhatsApp as the preferred open and distance learning platform for delivery of course content in combination with recorded video. This preference is due to the limitations faced by students in remote areas in terms of internet coverage and bandwidth speed. The COVID-19 pandemic had an impact on learners' academic performance. Most of them performed well in the course assessments, with CO1PO2 and CO2PO3 scoring the highest percentage in the quizzes and tests assessed in the final exam (homework) and tests. The influence of gender is insignificant in achieving good academic performance in offline and online learning.

In future research, the sustainability of the teaching and learning environment is considered in mapping course assessment to OPT, as well as appropriate instructional methods and tools for online and offline teaching and learning to ensure constructive alignment.

# 5 ACKNOWLEDGMENT

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