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Challenges, benefits & drawbacks of chemical engineering on-line teaching during Covid-19 pandemic

Nayef Ghasem, Mamdouh Ghannam *

Department of Chemical and Petroleum Engineering, United Arab Emirates University, Al-Ain City, P.O. Box 15551, United Arab Emirates

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A B S T R A C T

Distance learning demand has increased and turned into an obligatory educational system during the COVID-19 Pandemic. Within this period, students need exceptional support and assistance to be adjusted to the Online framework environment. The current study investigates distance learning on chemical engineering students’ educational performance during this pandemic period. This study addresses many issues related to distance learning, such as the household setting suitability with the internet connections, Online lecture activities, Online classroom experience and assessment tools, and student’s perception of the Online graduation projects. A comprehensive survey was organized and structured to observe and evaluate these associated issues to distance learning. The study targeted the third, fourth, and fifth-year students. The responses of the students revealed positive and negative assessments of the Online teaching during this Pandemic. Generally, the participated students did not experience significant technical obstacles to acquiring all the Online activities. Most of the contributed students expressed some difficulties concentrating during the Online sessions with limited student-instructor interactions. Graduation Project students encountered problems in performing technical discussions with their academic advisors, coordinators, and teammates compared to the face-to-face approach.

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1. Introduction

The COVID-19 Pandemic distracts nearly everything in our day-to-day life and entirely the world’s commercial, social, and academic sectors. COVID-19 Pandemic has forced academies everywhere to go distance learning (Alqurshi, 2020a; Debaq et al., 2021). With the international widespread of COVID-19 in March 2020, there was a shutdown of face-to-face classes and an unexpected swipe to distance learning (Ripoll et al., 2021). At the United Arab Emirates University (the oldest Federal public university in the United Arab Emirates, established in 1976 and located in Al-Ain city, U.A.E.), on March 4, 2020, after the closure of all schools and institutions in U.A.E., the instructors delivered the courses and tutorials distantly in virtual classrooms with Blackboard Collaborate Ultra. A user-friendly and convenient platform, by contrast, has few drawbacks such as complex to write on the whiteboard due to limited screen area and not smooth writing, it is difficult for the student to stay focused during the lecture on screen, connection problems (Debaq et al., 2021). Fortunately, in UAEU university many instructors were well prepared before the Pandemic, thanks to the CETL (Continuous Education, Teaching and Learning) center, which provides many lectures on pedagogy and on improving the teachers’ quality and style of teaching, such as blended learning (mixed between online and face-to-face teaching), flipped classroom, and problem-based learning. The CETL activities fully turned Online and intense during the lockdown to enable instructors and students to master the use of Blackboard Collaborate Ultra and to train them on how to use Blackboard to create class sessions, preparing Online assignments, quizzes, tests, and final exams using the lockdown browser and webcam monitor. These activities were intended to be a follow-up to what had been done in class before lockdown. The proposed work also obviously had to be adapted to the knowledge and maturity of the students. The CETL activities significantly helped instructors who had no solid Online elearning experience and no skills in using scientific devices and suitable software to deliver this online education during this Pandemic.

Distance learning has been a practical approach during the COVID-19 Pandemic, primarily for chemical engineering students and other engineering programs, science, medicine, and technology, where distance learning was not favored earlier (Pintaric and Kravanja, 2020). The quarantine affected both the teachers and students differently, depending on the degree of achievement of their primary responsibilities and their preceding skills with computing and virtual tools, among other factors (Nogales-Delgado
et al., 2020). Compulsory supporting courses for chemical engineering programs such as introductory chemistry were significantly influenced during the covid–19 Pandemic (Talanquer et al., 2020). Several fields within chemical engineering and related areas positively applied to create innovative and effective answers in the fight against the COVID-19 were presented (Santana et al., 2020). COVID-19 Pandemic influenced fields other than chemical engineering education (Konrad et al., 2020; Alqurshi, 2020b; Abe, 2020; Mokel and Canty, 2020; Schophuizen et al., 2018).

Researchers elicited the themes that presented the challenges and opportunities, which obstructed overall operations effectiveness mass use. The learning process is more significant and sustainable if active participation and interaction with commitment and support from members of the distance learning community (Schophuizen et al., 2017).

The present study focused on the challenges, advantages, and disadvantages of distance teaching on UAEU chemical engineering students’ performance during the Covid-19 Pandemic. Three diverse levels of students were targeted: junior, senior, and students with a final year graduation project (GP2). The study explores the influence of distance learning on students’ satisfaction and challenges during this Pandemic.

2. Description of context and method

A comprehensive online survey was structured and designed to investigate and assess the most related Online learning issues (O.L.L) compared to face-to-face (F.T.F.) teaching for the chemical engineering courses. Google Forms was used to conduct the survey. The Google Forms generated links were emailed to the students enrolled in CHME 390, CHME 411, and CHME 590 through the blackboard tools send the email. The teaching process before the COVID-19 Pandemic was traditional (teacher center base method) up to March 4, 2020. Due to the COVID-19 Pandemic and lockdown in U.A.E. started on March 4, 2020, UAEU shifted to distance learning. As this behavior was new to the UAEU students, it was wise to conduct the survey to listen, analyze and tackle the students’ responses to improve the Online learning process's quality when possible. The questionnaires were composed of short sentences in understandable language to encourage students to read and respond to the questionnaire.

The questions were designed on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). The survey was composed of two sets of the questionnaire: the first questionnaire was directed to the third & fourth levels courses, CHME 390 (email to students on 23/9/2020) and CHME 411 (email to students 24/9/2020); respectively. By contrast, the second survey addresses the fifth-level students’ feedback of the Graduation Project course CHME 590 (email to students on 29/10/2020). The first survey was classified into seven categories: the impact of household Environment during distance learning on the students, Technical Challenges, Imitated On-Line Lecture, Classroom Activities, Classroom Experience, Classroom Assessment Tools, and O.L.L versus F.T.F. mechanism. Table 1 shows a detailed questionnaire of the first survey. This survey was conducted on 65 third-year students enrolled in the Course Engineering and Strength of Materials (CHME 390), on which all students responded to the questionnaire, and 83 of 125 of the fourth-year students participated in the course of Reactor Design (CHME 411). The second survey addresses the CHME 590 (Graduation Project, G.P.) related issues, such as library scientific resources, scientific & industrial data, simulator & software programs, teamwork collaborations & tasks distribution, and personal communication teammates & G.P. advisor, and completion of the G.P. tasks. The entire 50 students enrolled in CHME 590 responded to the survey. The online teaching and learning methods were similar for all modules. Typically, the class sessions are created before the class starts and allows students to join before 15 min to enable smooth joining. The instructor uploaded the class notes as PDF or PowerPoint files and shared them with the student. All lectures were recorded in the Blackboard to enable students to revisit the lesson when needed. The UAEU core courses are 3.0 credit hours (15 weeks of teaching).

3. Results and discussion

An inclusive assessment was accomplished to collect feedback from three students diverse levels to complete this study’s analysis and observations. Two separate surveys were structured and utilized to serve specific objectives; the first survey assessed regular courses (CHME 390, CHME 411), and the other one is for the Graduation Project level (CHME 590: Capstone Engineering Design Project, known as Graduation Project 2). The collected results are analyzed and presented in the following sections.

3.1. Household environment

The first category of the planned survey is directed to discuss and assess the issues connected to the students’ household environment, such as convenience & suitability of attending lectures at home, saving times & efforts that usually available between actual classes, accessibility of the recorded lectures, the flexibility of the daily schedule around the Online lectures, and strengthen family relationships & safety during the Pandemic period. Fig. 1A and B show the students’ responses enrolled in CHME 390 and CHME 411. Generally, this student assessment category is very constructive, with percentages higher than 50% answered for both Agree or Strongly Agree. Regarding the five measured sub-categories mentioned above, all of the students’ actual approval percentages for the third-level Course of CHME 390 & fourth-level Course of CHME 411 are provided between brackets. The first percentage will be for the third-level course, while the second percentage will be for the fourth-level course. These results show that both courses surveyed are more comfortable attending lectures at home (50.7 % & 61.5 %) and save time and effort (66.5 % & 67.5 %). The recorded lectures are frequently available any time as valuable reference materials (89 % & 96.5 %), and students organized their time efficiently around lectures (58.3 % & 73.5 %). Furthermore, staying at home strengthens family relationships because of the increased time spent at home (78 % & 78.3 %). This study shows that the Household Environment category received a positive assessment from all students of both classes.

3.2. Technical challenges

This category is addressing some of the technical challenges encountered during the O.L.L. The second focussed classification of the structured survey is on the assessment issues such as obtainability of communication means such as computers/!,-pad/mobiles, internet accessibility at home, appropriate internet specifications, internet interruptions with the provider company, and the university link discontinuations (Santana et al., 2020). It is essential to evaluate this category from the students’ side because they are the whole service receivers. This item plays a crucial role in the success of the entire O.L.L process because it is the only means to connect between the course’s instructors (i.e., service provider) and the course’s students (i.e., service receivers). Fig. 2A & B display all students’ results and feedback for CHME 390 & CHME 411.

Concerning the first sub-category item of the accessibility of communication means, most of the students (74.3 % & 82 %) have a high level of accessibility. For the home internet accessibility, the student scored 80 % & 77.1 % for agreed and strongly agreed, which exhibits that almost three-quarters of all students are approved
Convenience taking lecture at home.
Saving time & efforts between real lectures.
Accessibility of recorded lectures any time.
Establishing your own daily schedule around assigned lectures.
Strengthen family relationships & safety during the pandemic period.

(A)

Convenience taking lecture at home.
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Strengthen family relationships & safety during the pandemic period.

(B)

Fig. 1. Students benefit from the household environment during the distance learning (A) CHME 390 (B) CHME 411.

Availibility of a proper means such as computers, I-pad, mobiles, etc.
Internet availability at home.
Internet appropriate specifications.
Internet disconnections with the provider company.
University link disconnections (Blackboard).

(A)

Availibility of a proper means such as computers, I-pad, mobiles, etc.
Internet availability at home.
Internet appropriate specifications.
Internet disconnections with the provider company.
University link disconnections (Blackboard).

(B)

Fig. 2. Technically associated concerns during the distance learning (A) CHME 390 (B) CHME 411.
the internet availability at home, and almost one-quarter of the students are neutral about it. For the third item of this category, which is the proper internet specifications, students scored 67.5% & 72.3%, respectively, for both courses. These results show almost one-third of all students neutral about this item (Mohamad et al., 2015). Nearly one-third of all students in both classes admitted their significance for the last two items of this category related to the internet interruptions by the provider company and the university. In contrast, the rest of the students were divided between neutral and disapproval of the provider & the university connections. Almost 33% & 45% of both courses were neutral about the provider & university connections, while 22.5% & 35% were disapproved of the provider & university connections quality.

3.3. Imitated online lecture

The third category of the planned survey was dedicated to the Imitated Online lecture to evaluate the student’s experience and performance through O.L.L. This category comprises five items. In general, these are follow-up the lecture materials & slides, follow-up the instructor discussions & explanations, attention throughout the lecture period, the instructor’s extra support, and the class social environment between students & instructor. Fig. 3A & B display that around 30–40% of all surveyed students of both course CHME 390 & CHME 411 agreed that they experienced some difficulty to follow-up the lecture’s materials and instructor’s discussion. The survey revealed 38% and 48% of the students’ concern about problem focusing and encirclement attention during the lecture period. Furthermore, most of the students (i.e., in the range of 55%–65%) of both courses agreed on missing the instructor’s extra assistance means such as body language and missing the class social environment generated between students and their teachers (Jamieson, 2020).

3.4. Online classroom activities

Another imperative category to address and investigate for this study is the instructive activities within the Imitated classroom. These activities include student-instructor interactions, student-student interactions, cooperative & teamwork activities, student oral discussions for their colleagues, and seminar presentation effectiveness. Fig. 4A & B show that most of the students of both courses, CHME 390 & CHME 411, are either agreed or neutral with the limitation of the mentioned face-to-face class activities (Jamieson, 2020). Therefore, substantial determinations and innovative strategies should be adopted by instructors to involve alternative approaches to include such activities for the benefit of undergraduate students.

3.5. Online classroom experience

Assessment of the Online teaching process necessitates this study to incorporate and evaluate the sub-category items such as the previous knowledge of Online lectures before the current Pandemic situation, appropriate learning tools available for Online classes, gaining essential knowledge & fundamental concepts. Online lectures enhance students’ skills & capabilities, understanding the theoretical & practical applications, and the satisfaction level of the Online lectures of the former semester (i.e., Spring 2020 courses). Fig. 5 shows that around 23% of all CHME 390 & CHME 411 students agree with the previous experience regarding the first sub-category item of the previous experience with distance learning, while 23% disagree and almost 54% answered with neutral as average knowledge they have. Besides, 63% of both courses agree on the availability of appropriate learning tools for Online classes. For the subsequent two sub-categories (third & fourth), students’ opinions for both courses were divided as 51 & 34% agreed, 35 & 38% neutral, 14 & 28% disagreed on whether Online lectures enhance their skills and understanding of theoretical & practical applications. Furthermore, the students’ feedback was almost distributed equally regarding the 5th sub-category of understanding the theoretical & practical applications. Lastly, students show their satisfaction level with the previous Online lectures, with 46% agreed to both courses, 31% neutral, and only 23% disagree.

3.6. Online classroom assessment tools

One of the delicate and crucial educational elements from both instructors & students is the fair evaluation for all students. In general, it is believed that the level of success & acceptance of the O.L.L. strongly relies on student confidence in the Online assessment tools. Therefore, the current study allocates this category to address the oral evaluation’s approval, correctness, effectiveness, the Online assignments & tutorials, the Online exams, the Online
student grades reflect actual student performance. Fig. 6 displays that 42% of students of both CHME 390 & CHME 411 courses agree regarding the first sub-category, while 20% disagree on the oral evaluation.

Regarding the Online assignments and tutorials, 10% of the students in both courses disagreed. The rest are either agreed (58% of both courses) or meet expectations (32% of both courses). As far as the Online exams are precise tools for student evaluation, only 28% of students in both courses disagree while the rest are either being agreed upon or meet the student expectation. Furthermore, almost 35% of students in both courses disagree that Online courses grades will reflect the students’ actual performance. Lastly, most students (i.e., 75%) in both courses of CHME 390 & CHME 411 are either meet or in agreement with the Online assessment’s expectations, while only 25% of students have disagreed.

### 3.7. Online learning versus face-to-face learning

It is worthwhile for the current study to address this sub-category of O.L.L compared with F.T.F. from the students’ point of view. This sub-category takes account of many activities as listed in Table 2. Due to the numerous activities and the critical analysis, these activities will be sub-grouped into three main sections; each section contains five activities. The first section includes the student-enthusiasm, the student-participation, student-problem solving skills, student-critical thinking, and the student-knowledge. The first section analyses the role of O.L.L. to enhance the students’ activities (such as enthusiasm, participation, solving skills, critical thinking, and knowledge). The analysis results revealed that 28–48% of the responded students of both courses answered in favor of the first group, a range of 35–48% based on the total number of the responded students are answered in the middle (i.e., neutral), and the rest disagree (i.e., 13–31%). Another & modest display for the first section’s role, as listed in Table 2, is almost 60–68.8% of all students’ feedback is in favor of the positive influence of the first section on the student activities.

The second section of this category contains learning independence, life-long learning, creativity skills, Information Technology (I.T.) skills, and exposure with international counterparts.
are vital skills & capabilities for students to possess either before or during Online learning. Thus, it is valid for the current study to assess the students' feedback accordingly. The detailed analysis of

| Limited student-instructor interactions. | 23 | 29 | 14 | 19 |
| Limited student-student interactions. | 8 | 6 | 33 | 18 | 18 |
| Limited cooperative & team work activities. | 11 | 2 | 34 | 12 | 19 |
| Limited student oral discussions for their colleagues. | 12 | 11 | 31 | 14 | 15 |
| Limited seminar presentation effectiveness. | 14 | 6 | 27 | 18 | 18 |

Fig. 4. Distance learning classroom activities compared to face-to-face traditional learning methods (A) CHME 390 (B) CHME 411.

| Limited student-instructor interactions. | 23 | 29 | 14 | 19 |
| Limited student-student interactions. | 8 | 6 | 33 | 18 | 18 |
| Limited cooperative & team work activities. | 11 | 2 | 34 | 12 | 19 |
| Limited student oral discussions for their colleagues. | 12 | 11 | 31 | 14 | 15 |
| Limited seminar presentation effectiveness. | 14 | 6 | 27 | 18 | 18 |

Fig. 5. Online classroom experience compared to traditional face-to-face approach (CHME 390 & CHME 411).

the second section can be summarised as 37–61 % of all students in both courses are in favor of the second section effect, 28–43 % are in neutral feedback, and a limited number of students are in
disagreement with the response range of 11–17 % of both courses. Table 2 demonstrates that the range of 61.6–75.1 % of all students’ feedback favors the second section’s constructive impact on the student activities.

The third section of this category includes capabilities to face Engineering challenges, participation in the United Arab Emirates University’s vision, involvement in the country’s future strategic plans, future job-market expectation, and student satisfaction. The third section of this category is directed toward the future involvements of chemical engineering graduates. Besides, analysis shows 37–53 % of the students in both courses responded cheerfully for the third section, a range of 31–43 % answered neutral, while 9–27 % of the students in both courses disagree. Table 2 reports that the range of 63.2–71.2 of all responses supports the third section’s optimistic impression on the student expectations.

3.8. Students satisfaction for the online graduation project

Performing an Online graduation project during this Covid-19 Pandemic is a challenging task. The students have to collaborate remotely with their peers in team activities such as weekly meetings with their G.P. advisor and presenting their weekly tasks in weekly G.P. coordinator meetings. Accomplishing undergraduate Graduation Projects during the period of the Covid-19 Pandemic were faced with many obstacles. Since these projects require teamwork and collaborations within teams, unfortunately, students have been deprived of these essential team activities. Table 3 shows all the second survey’s main items and the student responses to the given questionnaire. Table 3 revealed the positive areas of performing Online Graduation Projects: teamwork collaborations & tasks distribution and managing their schedules.

In contrast, this study highlights some of the drawbacks that should be addressed. These are hard to follow-up with the G.P. advisor discussions & explanations (60 % satisfaction level), tough to express their opinion to the G.P. advisor & teammates (56 % satisfaction level), low ability to demonstrate the G.P. details, G.P. results, and G.P. calculations (67 % satisfaction level). In this study, the G.P. course is similar to the chemical engineering design course studied by Jamieson (Jamieson, 2020); a comparison of the results was in good agreement. The satisfaction level percentage is calculated based on the number of strongly agreed and agreed-upon responded students’ total number.

4. Conclusions

This current study covers a comprehensive survey and analysis on the satisfaction of chemical engineering students, in the United Arab Emirates University, during the lockdown of the Covid-19 Pandemic from March 2020 to December 2020. The survey targeted three chemical engineers students’ levels; junior, senior, and students who were doing their final year graduation project. The junior and senior students’ responses to a questionnaire related to the household environment mostly received positive feedback, with percentages close to or more than 50 % answered with Agree or Strongly Agree. Several students faced internet technical disruption. However, most of the students Strongly Agreed that it is hard
to focus through the Online lecture periods, Neutral responses with limited student-instructor interactions.

Regarding the Online assessment tools, the students’ expectations with answers concentrated on Neutral to Agree. Nearly all responses showed comparable results of the two surveyed, CHME 390 & CHME 411, with a sample representing the population. This result confirms the validity of the surveys. Compared to the standard case of the Face-to-Face learning method, the senior students doing their final year graduation project Online experienced some difficulties in performing their Graduation Project’s weekly tasks, such as the scientific conversations with their academic advisors, coordinators, team members, and peers.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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