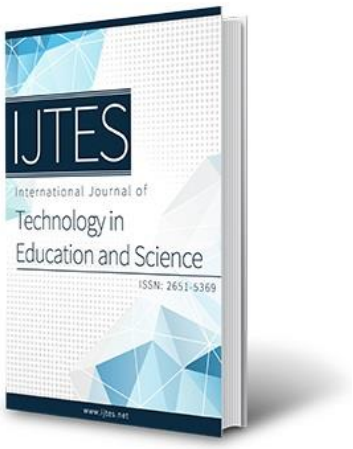

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A Two-year Follow-up Case Study on Pre-service Science Teachers' Attitudes towards Online Learning and Academic Achievement in Science Education Courses

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To cite this article:

El Takach, S. (2022). A two-year follow-up case study on pre-service science teachers' attitudes towards online learning and academic achievement in science education courses. *International Journal of Technology in Education and Science (IJTES)*, *6*(4), 585-601. https://doi.org/10.46328/ijtes.403

International Journal of Technology in Education and Science

2022, Vol. 6, No. 4, 585-601 https://doi.org/10.46328/ijtes.403

A Two-year Follow-up Case Study on Pre-service Science Teachers' Attitudes towards Online Learning and Academic Achievement in Science Education Courses

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Article Info

Article History

Received:
05 May 2022
Accepted:
20 September 2022

Keywords

Distance education
Remote learning
COVID-19
Draw-yourself-as-remote-learner

Abstract

The present paper attempts to answer the following research questions: 1.What are students' attitudes towards distance education during COVID-19? 2. What are students' feelings and opinions towards online education? 3. What are the impacts of distance learning on students' development of their PCK skills? And 4. What is students' academic achievement in taught online science education courses? To collect data, a total sample of 117 students enrolled in undergraduate program for science teaching at the elementary level, was used. Data was collected over three semesters, during the academic years 2020/2021 and 2021/2022. The data collection tools used are: a. a questionnaire administered to students enrolled in their 2nd through the 6th semesters, at the Faculty of Education, Lebanese University, at the end of science education courses, b. students' grades in formative and summative assessments in science education courses, c. students' drawing themselves as remote learners, and d. a post-interview of a purposeful sample. Data analysis was done using interim analysis in the form of post-zoom class conferences and data validation using member check at the end of courses. Findings showed that students at the beginning of the state successive and long lockdowns were happy to learn remotely. But as time passes, they were dissatisfied with online learning, 38% of students missed the campus life and 16% lacked the interaction with their teachers and classmates. In addition, students' academic performance decreased significantly and many were concerned about the little expertise to deal with students in real classes. For 57% of students, distance learning was difficult than classroom, and 70.5% admitted that home environment was not suitable for participating in online lectures due to distractions by their families. Quality teaching and the need for evaluation the online teaching/learning process at the level of the Faculty of Education and the Lebanese University is an urgent need.

Introduction

In November 2019, the world was puzzled with a new virus that started to cross countries boundaries. The worst happened in 2020; the world lived international health crisis. In order to minimize the damages caused by COVID-19, infected countries went to state lockdown. This alarming situation affected the education sector too. In

Lebanon and for almost two years, schools were closed and students were obliged to learn via online, as well as university students. In Lebanon, the Lebanese University (LU), the state university was the first university in the country who changed into online education, when COVID-19 started to emerge in February 2020. Noteworthy to add that, the LU homes more than 85000 students, the highest number of students in the Lebanese universities in the private sector, with more than 6000 employees and 4000 professors. At that time, the number of infected people did not exceed the fingers of the hands; for health reasons regarding the students and their families, employees and teachers and their families, it took the decision on the level of faculties to close all campuses deployed in Beirut and provinces. This situation, teaching via distance education, remained for the four semesters, during the academic years 2020-2021 and 2021-2022. But the finals were done for each semester on campus, after taking the necessary precautions and the permission from the Lebanese government and the Ministry of Health. Starting February 2021, the Lebanese University main campus changed into a hub for students and staff for free vaccination. This decreased fears especially among students, who started to urge faculties' administrations to have lectures again on campus.

During COVID-19 time, numerous published studies in education investigated the use and the role of social media during COVID-19 pandemic. Zarzycka et al. (2021) study findings indicate that the increasing use of Facebook (FB) for professional purposes improves students' communication and collaboration during distance learning courses. Other studies focused on students' attitudes towards online education during COVID-19 (Ekmel & Hakkı, 2022), the perceptions of tutors, and the challenges they faced by restrictions caused by the COVID-19 pandemic as they adapted to teaching remotely, and the limitations of access to online resources (Dankers, Stoltenkamp & Donson) (2022), and students' perceptions and challenges about online education during Covid-19 outbreak in Oman (Al Aisri, Al Harthi & Al Riyami, 2021). In this study, 240 university students participated, from different specializations: Business, Information Technology, and Engineering. The findings revealed that students moderately rated teaching materials, online assessment, and lecturers during online education. The study also found that the university did not provide students with sufficient support. Students encountered many challenges during online education, such as weak internet connection and not having a good atmosphere at home to attend their online classes. Another survey study done by Alghamdi and Ali (2021) on 241 students in Saudi Arabia, found that students had easy access to the technology, online skills, motivation and overall favorable acceptance for online learning and examinations. These students have general acceptance for online education delivery due to more technology access and online skills. But these researchers recommended more research to explore the factors affecting and the extent of the impact of online education on student learning and training (Alghamdi & Ali, 2021).

The factors, such as, the students' knowledge, the students' needs and the preferences for the quality of online education, influence students' behavior and attitude towards online education during COVID-19 (Boca, 2021). In the latter study, students at Romanian Technical University admitted that online education in a pandemic situation is beneficial. However, students found online education stressful, but preferred online assessment for evaluation. In Taiwan, a case study in college, secondary and elementary teachers, on how teachers have conducted online teaching during the COVID-19 pandemic (Wu, 2021). It showed that the instructional behaviors most frequently performed by teachers were roll calls, lectures with a presentation screen, in-class task, and whole-class

synchronous video-/audio-based discussion. College teachers reminded students of some matters first and then called the roll after the students went online. Secondary school teachers were more likely to arrange practical or experimental courses and to use synchronous and asynchronous interactive activities. Finally, elementary school teachers were more likely to use homemade videos and share their screens for teaching and to arrange a large variety of teaching interactions. In Turkey, the views of 20 high school students and 16 teachers, on distance education practices during the Coronavirus (COVID-19) pandemic, were different: teachers, unlike students, viewed distance education more positively. Teachers highlighted the positive aspects of distance education process and drew attention to the importance of sustaining education. Students who were not satisfied with distance education explained the reason for their dissatisfaction as a result of not understanding the subject, finding the teacher inadequate, inadequate time, and lack of infrastructure (Hebebci, Bertiz & Alan, 2020).

In Lebanon, an online study conducted in 2020 by the Centre for Lebanese Studies (CLS) on 678 persons. The majority were parents (299), followed by teachers (274) and (105) students. It aimed at mapping out the impacts of COVID-19 on the access and quality of education. The platform that was the most used is Whatsapp, followed by Zoom and Microsoft Teams. While Television requires low technology (connectivity) and the Lebanese Ministry of Education and Higher Education (MEHE) provided classes through local TV channels, teachers seemed to refrain from using it as a source for teaching. Similar to teachers and students, some parents indicated that they face the challenge of electricity cuts. During the pandemic and the closure of schools, parents found themselves in a position where they have to homeschool and that their children's' education is the main responsibility. According to this survey, the deteriorating quality can be linked to two factors. First, parents indicated that they have limited experience using technology. While the majority of schools relied heavily on technology for distance education during the closure period. Second, some parents indicated that they had to do their own work and research to be able to support their children, an effort that many parents are unable to commit to due to their other responsibilities, such as work, having a number of children and not having the knowledge or skills to be able to support their children. All these factors negatively impacted the quality of education for children.

The purpose of this qualitative case study was to examine about students' positions regarding online learning, majoring in LMD (Licence-Master-Doctorate) program or BS in science teaching for the elementary level, at the Faculty of Education, Lebanese University. Data was collected from 70 prospective science teachers related to their attitudes, academic performance and experiences towards online and remote learning, during COVID-19 pandemic, since the beginning of distance education, regarding the science education courses during semesters 2 till 6, during the academic years 2020-2021 and 2021-2022.

Method

Sample

The present study is formed of 70 pre-service teachers (see Table 1), who attended regularly all the sessions and made the formative and summative exams, majoring in undergraduate science Education program for elementary

level, at the Faculty of Education, Lebanese University. All students were females and their minor were Mathematics, Arts and Language Education.

The researcher is the teacher of the six science courses under study, deployed on 2 semesters, that cover the basics of science teaching at the elementary level, from basics in teaching and learning educators, common students' alternative conceptions in science, designing and implementing science lesson and unit plans as well (Course: Teaching Science 1/TS1), as well the analysis of the Lebanese science curriculum and various science curricula abroad, as well as, the different assessment and evaluation forms and techniques (Course: Curriculum and Evaluation in Science/ CU), the foundations of science research proposals and applications of action plans (Course: Action Research 1 and 2 /AR1 and AR2), science literacy and 21st century skills, the historical development of scientific ideas and inventions, and scientists' ideas and their contributions to the development of science through history (Course: History and nature of science/HNOS) and finally, analysis and reflections on newest trends in science education research and journals (Course: New Trends in Science Education/NT). At the end of the courses, students were administered a questionnaire and they filled it in and returned it back via e-mail. Out of 70 students, 56 students filled in the questionnaire and returned it back via e-mail (Table 1).

Purposeful Sample

The purposeful sample was formed of 20 students, who were involved in all the phases of the study: 18 out of 20 filled in and send the questionnaires (during semesters 2020-2021) and 15 (during semesters 2020-2021). In total, 33 questionnaires were filled in by the purposeful sample.

Table 1. Sample Distribution based on the Total of Filled Questionnaires by Students at the End of Each Course

Class	Semester	Total no of students per class	Number of filled questionnaires						
			TS1 (2021-2022)	NT/AR1/ CU (2021-2022)	HNOS (2020-2021)	TS1 (2020-2021)	HNOS (2020-2021)	NT/AR 1/CU (2020-2021)	AR2 (2020-2021)
1	3rd	9	7						
2	5th	11		8					
3	2nd	12			8				
4	3rd	13				10			
5	4th	20					11		
6	5th	8						7	
7	6th	7							5
Total		70				56			

N.B: Classes highlighted in pink form the purposeful sample

As mentioned in Table 1, the purposeful sample consisted of classes 1 and 2, because students in their 3rd semester (class 1) did not attend till now any class on campus, while students in their 5th semester (or in their 6th semester,

during the time of writing this paper), will graduate this year 2021-2022, and almost all their learning in all courses were mostly receiving it remotely.

During 2020, students were not infected with COVID-19 due to the strict state lockdown, and the number of patients in Lebanon, at that time, did not exceed the fingers of two hands. But the number of infections nationwide increased dramatically after the holidays of the New Year 2021.

During winter 2021-2022, Lebanon has suffered from a severe wave of Omicron. Students were asked then, if they get affected by Corona virus/Omicron since the beginning of the surge. Out of 20 students, 13 were infected or recovered from the virus; the purposeful sample was almost all infected but with the type Omicron.

Students of the purposeful sample were asked whether they you feel ready to go back to the Faculty. Only 4 students in semester 2020-2021 wished to study on campus, while the number of students increased to 16 students out of 20 students of the purposeful sample, during the winter semester 2021-2022.

Data Collection Tools

1. A questionnaire (16 open- and closed-ended questions)
2. Post-interview for the purposeful sample
3. Students' achievement scores during 2020-2021 and 2021-2022
4. Students' drawing themselves while learning online to express their feelings, whether positive or negative

For each class, data was tabulated and displayed at the end of the course, discussed and commented by students, during the last zoom sessions.

In sum, the sample research design is represented in Figure 1.

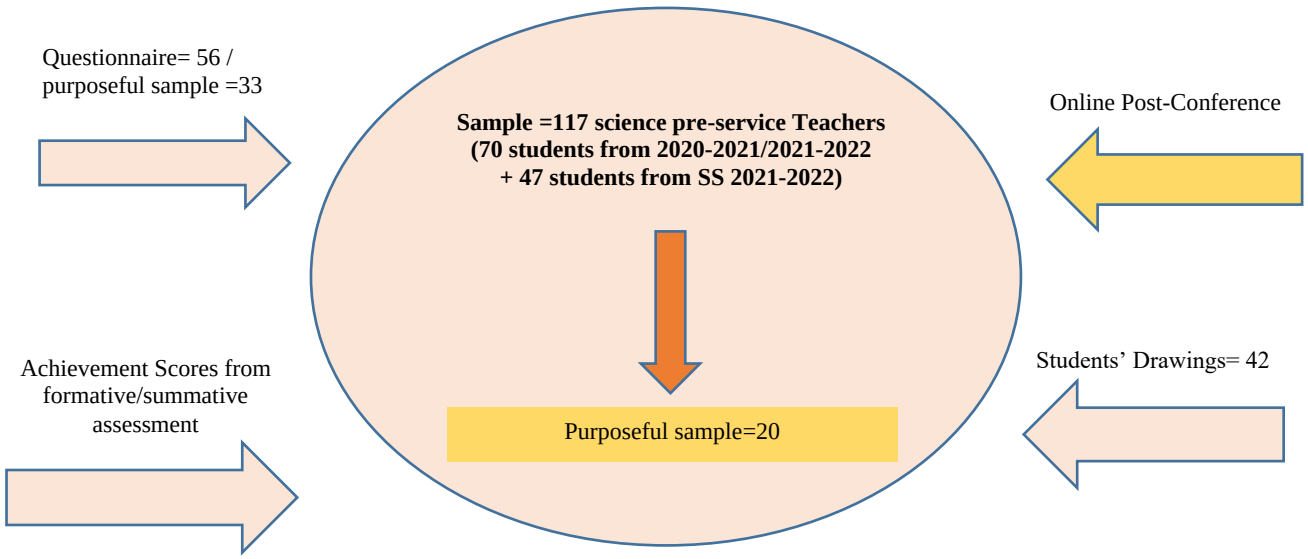


Figure 1.Research Design

Results and Discussion

Noteworthy to mention that, when the Faculty of Education, Lebanese University, shifted to distance education, starting Spring semester 2020-2021, students at the Faculty, plunged suddenly into online technologies such as, Zoom, Google meeting, Microsoft Teams without any preparation before. They had to download, learn to use the different platforms and applications by themselves in order to attend the different online courses.

Research Question 1: What are students' attitudes towards distance education during COVID-19?

In general, when students were asked about their attitudes towards distance education (see Table 5 and 6), only 5% of the sample were satisfied of distance learning, and 40% of the purposeful sample had an average satisfaction.

Data from the Questionnaire

First of all, to ensure that students were able to attend online courses distance, students were asked about the internet at home and its quality; forty three students out of 56 of the sample or 76% have a regular access to the internet (see Table 2), the mobile phone is the most used device by 44 students (see Table 3), and Zoom and Microsoft Teams were the most used online applications in distance education at the Faculty (see Table 4).

Table 2. Do you have access to a device for learning online?

Sample	Yes	Yes, but it doesn't work	No, I share it with others	Total
Purposeful sample	24 (73%)	9 (27%)	-	33 (100%)
Total sample	43 (76%)	12 (21%)	1 (3%)	56 (100%)

Table 3. What device do you use for distance learning?

Sample	Laptop	Computer	Tablet	Mobile phone	Total
Purposeful sample	21 (44%)	-	1 (2%)	26 (54%)	48 (100%)
Total sample	39 (47%)	-	1 (1%)	44 (52%)	84 (100%)

Table 4. You are using these tools in online learning (you can match more than one choice)

Sample	Zoom	Microsoft Teams	Google Classroom	Whatsapp/ Voice messages	Email	Total
Purposeful sample	33 (30%)	33 (30%)	9 (8%)	11 (10%)	25 (22%)	111 (100%)
Total sample	56 (29%)	56 (29%)	20 (10%)	23 (12%)	41 (20%)	196 (100%)

Table 5 showcased in details students' attitudes towards online education during the academic years 2020-2021 and 2021-2022. Students of the purposeful sample' attitudes towards online learning did not change significantly from one semester to the other, except for their decreasing dislike of online learning as time passes (it changed from 44% of students' dislike to 33% of students' like), they have also lacked motivation in participating

online lectures (it was neutral then it increased by 46%, and half of the sample could not have the opportunity to ask questions or clear doubts during online lectures.

Table 5. Students' Attitudes to the 17 Statements Related to Online Learning

		Purposeful sample=33			Total sample=56
Items	Legend	2020-2021	2021-2022	2020-2021/ 2021-2022	2020-2021/ 2021-2022
		Total 18	Total 15	Total 33	Total 56
1. I have sufficient equipment and facilities (computer/laptop/Internet/softwar) to participate for online lectures	Agree	7 (39%)	10 (67%)	17 (52%)	29 (52%)
	Neutral	6 (33%)	2 (13%)	8 (24%)	14 (25%)
	Disagree	5 (28%)	3 (20%)	8 (24%)	13 (23%)
2. I have sufficient computer knowledge and IT skills to manage your online learning	Agree	9 (50%)	12 (80%)	21 (64%)	39 (70%)
	Neutral	7 (39%)	3 (20%)	10 (30%)	15 (26.5%)
	Disagree	2 (11%)	-	2 (6%)	2 (3.5%)
3. My teacher provided me with guidelines (ex. how to use relevant online tools) before starting online lectures	Agree	5 (28%)	1 (8%)	6 (18%)	15 (26.5%)
	Neutral	8 (44%)	4 (27%)	12 (36%)	19 (34%)
	Disagree	5 (28%)	10 (67%)	15 (46%)	22 (40%)
4. Online tools are easy to use	Agree	7 (39%)	10 (67%)	17 (52%)	29 (52%)
	Neutral	5 (28%)	3 (20%)	8 (24%)	17 (30%)
	Disagree	6 (33%)	2 (13%)	8 (24%)	10 (18%)
5. I am happy about online teaching methods and lecture materials	Agree	4 (22%)	3 (20%)	7 (21%)	18 (32%)
	Neutral	4 (22%)	4 (27%)	8 (24%)	12 (21.5%)
	Disagree	10 (56%)	8 (53%)	18 (55%)	26 (46.5%)
6. I have frustration and lack of interest in learning while being locked down	Agree	8 (44%)	7 (46%)	15 (46%)	23 (41%)
	Neutral	4 (22%)	3 (20%)	7 (21%)	12 (21.5%)
	Disagree	6 (33%)	5 (33%)	11 (33%)	21 (37.5%)
7. Online lectures are effective than traditional/live classroom lectures	Agree	2 (11%)	4 (27%)	6 (18%)	10 (18%)
	Neutral	2 (11%)	2 (13%)	4 (12%)	10 (18%)
	Disagree	14 (78%)	9 (60%)	23 (70%)	36 (64%)
8. I like online learning	Agree	6 (33%)	5 (33%)	11 (33%)	22 (40%)
	Neutral	4 (22%)	6 (40%)	10 (30%)	17 (30%)
	Disagree	8 (44%)	4 (27%)	12 (36%)	17 (30%)
9. I have gained experience of learning in a new online environment	Agree	13 (72.5%)	13 (86%)	26 (79%)	44 (78.5%)
	Neutral	4 (22%)	2 (13%)	6 (18%)	10 (18%)
	Disagree	1 (5.5%)	-	1 (3%)	2 (3.5%)
10. There is lack of direct contact with other students /friends	Agree	12 (66.5%)	11 (73%)	23 (70%)	38 (68%)
	Neutral	5 (28%)	3 (20%)	8 (24%)	15 (26.5%)
	Disagree	1 (5.5%)	1 (6%)	2 (6%)	3 (5.5%)
11. There is inconsistent/poor contact and communication with the teachers	Agree	7 (39%)	13 (86%)	20 (60%)	32 (57%)
	Neutral	5 (28%)	1 (6%)	6 (18%)	10 (18%)
	Disagree	6 (33%)	1 (6%)	7 (21%)	14 (25%)
12. Distance learning is difficult than classroom	Agree	11 (61.5%)	10 (66%)	21 (64%)	31 (57%)
	Neutral	4 (22%)	1 (6%)	5 (15%)	10 (18%)
	Disagree	4 (22%)	3 (20%)	7 (21%)	14 (25%)
13. I lack motivation in participating online lectures	Agree	6 (33%)	7 (46%)	13 (40%)	23 (41%)
	Neutral	8 (44%)	4 (27%)	12 (36%)	19 (34%)
	Disagree	4 (22%)	4 (27%)	8 (24%)	14 (23%)
14. I am satisfied about the student-teacher interaction during online teaching & learning	Agree	3 (16.5%)	3 (20%)	6 (18%)	16 (34%)
	Neutral	7 (39%)	6 (40%)	13 (40%)	17 (28%)
	Disagree	8 (44%)	6 (40%)	14 (42%)	24 (43%)
15. Do you have facility to ask questions or clear doubts during online lectures?	Agree	11 (61.5%)	6 (33%)	17 (52%)	28 (50%)
	Neutral	3 (16.5%)	7 (46%)	10 (30%)	17 (30%)
	Disagree	4 (28%)	2 (13%)	6 (18%)	10 (18%)
16. Home environment is suitable for participating online lectures	Agree	4 (22%)	6 (40%)	10 (30%)	19 (34%)
	Neutral	3 (16.5%)	2 (13%)	5 (15%)	11 (20%)
	Disagree	11 (61.5%)	7 (46%)	18 (55%)	26 (46%)
17. Possibility of distractions from other family members during online lectures	Agree	13 (72.5%)	10 (66%)	23 (70%)	39 (70.5%)
	Neutral	3 (16.5%)	2 (13%)	6 (18%)	10 (18%)
	Disagree	2 (11%)	2 (13%)	4 (12%)	6 (11.5%)

Overall, students were dissatisfied with online teaching content and management; their highest percent responses targeted statements related to: 57% highlighted the non-existence or poor communication between with the teachers, their teachers' little online guidelines (40%), 46.5% were not happy about online teaching methods and lecture materials, 43% were not satisfied about the student-teacher interaction during online teaching and learning, and 64% confessed that online lectures are not as effective as traditional/live classroom lectures. Although 78.5% of students acknowledged that they have gained experience of learning in a new online environment, and that 70% believed that they have sufficient computer knowledge and IT skills to manage their online learning, but 41% have frustration and lack of interest in learning while being locked down, because in their opinions, 57% admitted distance learning is difficult than classroom, and 41% were demotivated in participating online lectures. Finally, 46% admitted that home environment did not help them with their online sessions, because 70.5% of them had to be in the same room with the modem nearby with their family members because of the poor internet connection. For the purposeful sample, students' answers were aligned with the ones' of the total sample, except for the statements related to: I like online learning; it was 36% of the purposeful sample compared to 40% from the total sample who liked distance learning.

Research Question 2: What are students' feelings and opinions towards online education?
From the Questionnaire

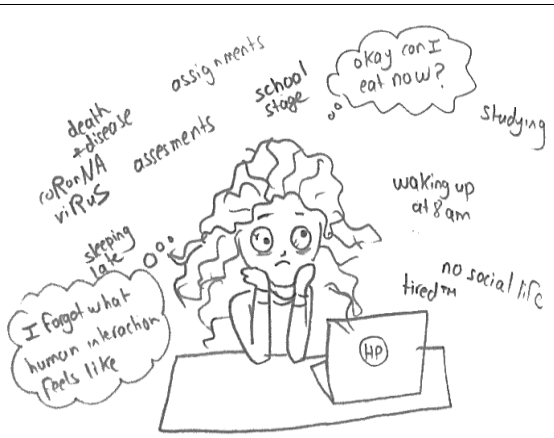
Students were asked about their feelings towards online learning, equal number of the total sample (34%) specified it as good and average, and 13% of the purposeful sample mentioned it as a mediocre tool for learning (Table 6).

Table 6. How do you feel overall about distance education?

Sample	Poor	Below average	Average	Good	Excellent	Total
Purposeful sample	4 (12%)	8 (24%)	13 (40%)	8 (24%)	-	33 (100%)
Total sample	6 (10%)	9 (17%)	19 (34%)	19 (34%)	3 (5%)	56 (100%)

From Students' Drawings

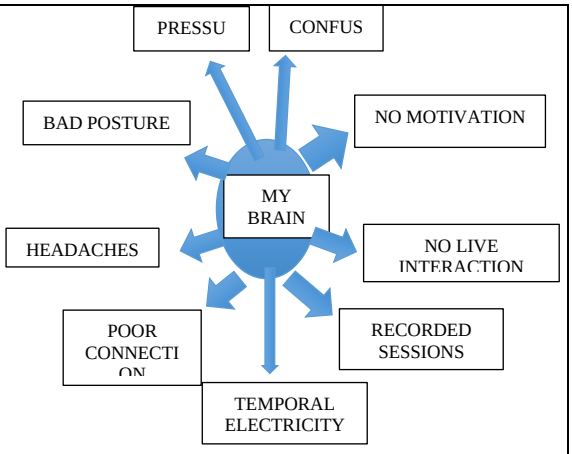
Drawings are important in education. To express their feelings regarding online education, students were asked to draw themselves during online sessions. In fact, this tool is used in education first in 1957 by Mead and Metraux, followed by many educators (e.g., Chambers, 1983; Barman, 1999; Sjøberg, 2000; Finson, 2003; Schibeci and Lee, 2003; El Takach, 2018; El Takach and Yacoubian, 2020; El Takach and Al Tobi, 2021; El Takach, Ayoubi and Rawas, 2018). The majority of students drew expressive drawings about themselves during their online learning. In total, 22 drawings displayed students' positive/negative feelings towards online education. In fact, students hold diverse feelings and attitudes towards online learning: from one hand, they felt safe not to attend campus and to get infected with Corona virus, but on the other hand, they were aware of the little expertise they are gaining via distance learning, especially with the poor internet connection in Lebanon and the severe electricity cut. They have developed their technological skills, and but their PCK skills remains poor; most of them advocated that they did not go to school for macro teaching, and that they missed the class interaction with their teachers and classmates, and the social life on campus. Figure 2 highlights some drawings with explanations advanced by students themselves.



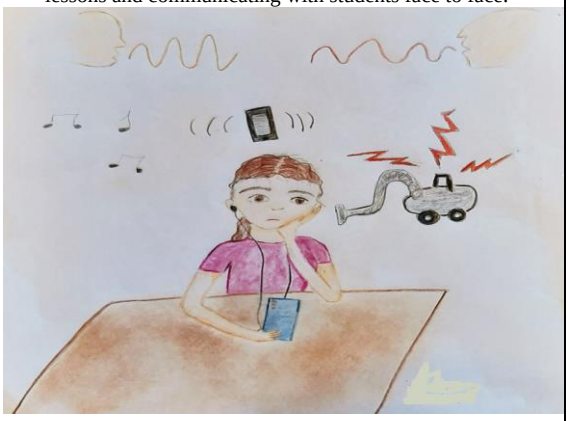
Student 8 (5th sem 2021-2022): Distance learning during the pandemic is stressful for students like me. Other than being extremely paranoid about conducting the virus, you're expected to turn your assignments within a very short period of time. Physical health starts to slowly decline. As you can see my eyes appear cross sighted and there are bags under them due to the nonexistent sleep that I've been getting lately. While effective time management can barely earn you 1 extra hour of sleep, empathy on the instructors' side can get you through a whole semester.

Student 56 (6th sem 2020-2021): I use both laptop and mobile phone while studying online courses. It is in general good for some materials (and under appropriate settings, but in case having some problems (electricity, Wi-Fi…). For the material can be given and discussed online while some materials ,don't suit online setting and mood, and need interaction during teaching (e.g., lab…). It is somehow unfair for some students.

Student 10 (5th sem 2021-2022): My drawing tells how online learning was proceeding. Although we were tired and wearing our pajamas while studying, but we were targeting to build a successful and bright future. Moreover, the family members used to distract us while the online sessions, and this because of them discussing family issues. Finally, despite of all the stressful conditions we are still facing, we haven't given up, but we are more ambitious to achieve our goals.



Student 20 (2nd sem 2020-2021): Online learning is definitely an alternative for on campus learning. It became a part of our life especially that everything is shifting towards networking. Despite all of this, it is hard sometimes if there`s no electricity and poor connection. I am really afraid to graduate and finish my license via online learning, especially in our field, future teachers must be well trained how to deal with explaining lessons and communicating with students face to face.



Student 16 (2nd sem 2020-2021). It was a new experience where it has advantages and disadvantages. The most advantage that I have gained experience of learning in a new online environment. However, it is full of disadvantages in which that Lebanon has poor Wi-Fi connection which cause many misunderstanding for ideas. In addition, some doctors have one way of teaching that make the courses sometimes boring.

Student 3 (3rd sem, 2021-2022): This is me holding my baby girl and learning online. I feel lucky to learn online. In this way, I am not leaving my newborn and I am not taking the risk to go out and be infected with Corona virus!

Figure 2. Some of Students' Drawings

Research Question 3: What are the impacts of distance learning on students' development of their PCK skills?

From the Questionnaire

Students concerns and fears of the little expertise as future science teachers, they are acquiring, were reflected also in their explanations. Many students were aware of *"I am really afraid to graduate and finish my license via online learning, especially in our field future teachers must be trained very well how to deal with explaining lessons and communicating with students face to face"*. One student wrote that *"Online learning is challenging especially in the difficult circumstances that we are passing through currently, however it is bearable when the instructor is understanding, knowledgeable in technology and material given"*. Another student complained *"we are just listeners and receivers in such a learning method"*, while others said that it is beneficial nowadays with the high costs of transportations in Lebanon. A student complained "i*t was the worst experience in my life. Online learning is literally psychological, physical and mental stress. There is no comfort at all, and there is no privacy. The situation has worsened from last year, due to the economic situation we are all living in Lebanon, and due to lack of electricity throughout the day. The process costs a lot to charge internet bundles to continue attending sessions. The worst thing I've been through in the last two years was online education*. "

Overall, students were stressing on the little quality of *"the internet connection and the electricity make it impossible to understand everything in a session"*.

To the question, what do you miss the most now you are learning online? Students missed the human interaction and the daily routine, such as going to the university, meeting and mingling with friends… A variety of 94 students' answers are tabulated in Table 7. Students lacked mostly the face-to-face human contact with their classmates and teachers (38%), as well as the social life on campus (16%). Only 1% mentioned the absence of practicum at schools.

Table 7. What do You Miss the Most Now You are Learning Online?

Students' answers	Purposeful sample N=33	Total sample N= 56
Face-to-face Interaction/communication with teachers/classmates	20 (38%)	36 (38%)
Clear explanation of lecture	5 (10%)	8 (9%)
Learning atmosphere at Faculty	6 (11%)	9 (10%)
Sharing ideas and thoughts with my friends	3 (5.6%)	3 (3%)
Doing live presentations	1 (1.8%)	1 (1%)
Practicum at schools	1 (1.8%)	1 (1%)
Working with peers	2 (3.7%)	6 (6.3%)
Social life on campus/ meeting with my friends/feeling of being a university student	9 (17%)	16 (17%)
Going to university	4 (7.5%)	7 (7.4%)
I am curious to know teachers/classmates	1 (1.8%)	2 (2.1%)
I feel like a robot/no motivation/ I feel bored staying and learning at home	1 (1.8%)	3 (3.1%)
No answer	-	2 (2.1%)
Total	53 (100%)	94 (100%)

Students in higher semesters missed the social life on campus: *I miss being in class to interact with my instructor and colleagues. I also miss having a daily routine like waking up early to reach the university and managing my time to finish assignments and studies,* while students in lower semesters missed mostly *the face- to- face communication, so we can understand the lesson with more interaction.*

From Students' Post-conference (Purposeful Sample)

At the end of the semester 2021-2022, students in 5th semesters were asked to give their positions of distance learning during COVID-19. They have had to discuss the 2 questions via zoom: 1. Do you think that distance learning and teaching is efficient during the last 2 years? And 2. Worldwide and in the Lebanese context.

Most students complained of the internet and electricity on and off, during live sessions! Students agreed on the fact that online education is not efficient as physical presence. As prospective teachers, they weighed the importance of student/teacher interaction and the engaging learning atmosphere in class.

At the beginning, all of them did not know how to use the different online applications (e.g., Zoom, Microsoft Teams, Google Classroom...). They admitted at the end, that they get familiar with the different online applications and that they will themselves also use these tools as future teachers soon. They have realized that it was a beneficial experience for them.

Finally, many students believed that worldwide, distance education may function better than in Lebanon, due to technology facilities and the low cost of internet and 24/24ours electricity. Students believed that because of severe electricity cut, in Lebanon, many of them were not able to attend online sessions, and this caused to have misunderstandings in many concepts.

Research Question 4: What is students' academic achievement in taught online science education courses?

Noteworthy to point out that the sample increased to 117 students, after the academic performance for the summer semester 2021-2022 was released. The achievement scores of 47 students in semesters 2 (HNOS for Science/Major), 4 (HNOS for Science/Minor) and 6 (AR2 for Science/Major) were added to this section.

Formative Assessment/ Summative Assessment

Table 8 and 9 showed students' assessments during the academic years 2020-2021 and 2021-2022; the highest percent of students, took in formative assessment, grades between 80 and 89, 30% of the total sample took grades between 60 and 69.

Obviously, as online education continues at the Faculty for a second year, during the academic year 2021-2022, students' grades in formative and summative assessments decreased significantly (see Table 10 and 11). Thirty eight percent of students' grades from the purposeful sample shifted back from 70 and 79 during the academic semester 2020- 2021 to 50 and 59 during the academic semester 2021-2022.

Table 8. Distribution of Students' Grades for a Total of 116 Exam Sheets from Formative/summative Assessment for All the Sample during WS and SS 2020-2021, and WS 2021-2022

Sample= 70	Formative assessment	Summative assessment
[20-29]	-	1 (1%)
[30-39]	-	1 (1%)
[40-49]	-	8 (8%)
[50-59]	4 (4%)	33 (27%)
[60-69]	12 (10%)	36 (30%)
[70-79]	31 (26%)	21 (17%)
[80-89]	56 (49%)	16 (16%)
[90-99]	13 (11%)	-
Total	116 (100%)	116 (100%)

Table 9. Distribution of Students' Grades for a Total of 36/44 Exam Sheets From Formative/Summative Assessment for All the Sample during SS 2021-2022

Sample= 47	Formative assessment	Summative assessment
[0-9]	-	2 (5%)
[10-19]	-	-
[20-29]	1 (3%)	2 (5%)
[30-39]	1 (3%)	-
[40-49]	-	4 (10%)
[50-59]	2 (5%)	5 (11%)
[60-69]	4 (11%)	15 (32%)
[70-79]	8 (22%)	10 (22%)
[80-89]	10 (28%)	4 (10%)
[90-99]	10 (28%)	2 (5%)
Total	36 (100%)	44 (100%)

Table 10. Comparison of Summative Assessment for the Sample during 2020-2021 and 2021-2022

Grades	Summative assessment 2020-2021		Summative assessment 2021-2022	
	WS (45 exam sheets)	SS (39 exam sheets)	WS (41exam sheets)	SS (44 exam sheets)
[0-9]	-	-	-	2 (5%)
[10-19]	-	-	-	-
[20-29]	-	1 (3%)	-	2 (5%)
[30-39]	1 (2%)	4 (10%)	1 (2%)	-
[40-49]	1 (2%)	2 (5%)	9 (22%)	4 (10%)
[50-59]	11 (24%)	11 (28%)	15 (37%)	5 (11%)
[60-69]	16 (36%)	14 (36%)	10 (24%)	15 (32%)
[70-79]	13 (29%)	5 (13%)	6 (15%)	10 (22%)
[80-89]	3 (7%)	2 (5%)	-	4 (10%)
[90-99]	-	-	-	2 (5%)
Total	45 (100%)	39 (100%)	41 (100%)	44 (100%)

Table 11. Comparison of Formative/summative Assessment for the Purposeful Sample during WS 2020-2021, WS2021-2022 and SS 2021-2022

Sample= 20	SS Academic year 2020-2021		WS Academic year 2021-2022		SS Academic year 2021-2022
Grades	Formative assessment/35	Summative assessment/34	Formative assessment/42	Summative assessment/41	Summative assessment/11
[30-39]	-	-	-	1 (2%)	-
[40-49]	-	2 (6%)	-	6 (16%)	-
[50-59]	-	5 (15%)	4 (10%)	15 (35%)	-
[60-69]	4 (11%)	12 (35%)	5 (12%)	12 (29%)	3 (28%)
[70-79]	9 (26%)	13 (38%)	14 (33%)	4 (10%)	2 (18%)
[80-89]	18 (52%)	2 (6%)	18 (43%)	3 (8%)	4 (36%)
[90-99]	4 (11%)	-	1 (2%)	-	2 (18%)
Total	35 (100%)	34 (100%)	42 (100%)	41 (100%)	11 (100%)

From the Questionnaire

Students were asked: 1. whether they have learnt as much as before the COVID-19 crisis. 2. If their teachers providing you several different ways to demonstrate your learning and if they were satisfied with the different ways of assessment. Table 12 and 13 displayed students' answers. In fact, 42% admitted that they were somewhat learning as before the pandemic, and 59% agreed that their teachers used with them variety of learning techniques that help them to present their work. Finally, 59% were content how they were assessed. These findings were validated with the outcomes of the purposeful sample; 52% and 67% of students acknowledged the average use of learning and assessment approaches consequently, while 70% advocated teachers' relevant ways to assess their learning.

Table 12. Students' Opinions about Distance Learning

Sample	Are you learning as much as you were before the COVID-19 crisis?				Are your teachers providing you several different ways to demonstrate your learning?			
	No	Somewhat	Yes	Total	No	Somewhat	Yes	Total
Purposeful sample	9 (27%)	17 (52%)	7 (21%)	33 (100%)	3 (9%)	22 (67%)	8 (24%)	33 (100%)
Total sample	16 (29%)	24 (42%)	16 (29%)	56 (100%)	7 (12%)	33 (59%)	16 (29%)	56 (100%)

Table 13. Were you satisfied with the different ways of assessment used by the teacher?

Sample	No	Somewhat	Yes	Total
Purposeful sample	1 (2%)	20 (28%)	49 (70%)	70 (100%)
Total sample	1 (1%)	44 (40%)	66 (59%)	111 (100%)

A testimony from a student in 6th semester from 2020-2021:

> *Online learning especially in the Lebanese University was very effective. The university provided us with emails for the Microsoft teams. Everything was organized where each course has a group on Teams and has a place to upload the folders and requirements for the course. The doctors were very helpful that they used to help us get higher grades by doing different assessment techniques (no 54).* Another student (no 53) from the same class, mentioned that *distance learning is good but sometimes home environment isn't good for it. Some disturbances might occur such as unstable internet connection that makes us unable to enter the lecture or even to listen well to our doctor explanation or even electricity problems and unfortunately part of the lecture will be missed. Another disturbance that occurs most of the time is from my family members when they make some noises, and I lose concentration while trying to calm them. Moreover, lacking face to face communication with some of our doctors, make me feel upset for not knowing who's teaching me, even though I know his/her name and we cannot see their facial expression when we answer a question, etc. studying online started to be exhausting and tiring because of the loads of assignments and projects that we are assigned to do!*

A student (no 56) advocated that

> *It's in general good for some materials and under appropriate settings, but in case having some problems (electricity, Wi-Fi…) it's somehow unfair for some students. But in general it works for some materials which means that some materials can be taken and studied online because the nature of the material can be given and discussed online while some materials don't suit online setting and mood, and need interaction during teaching environment (class, lab …)*

Some quotations from students of the purposeful sample showed their concerns about keeping on with learning via online education; a student (no 1) in 3rd semester during the academic year 2021-2022 confessed that "*I am really afraid to graduate and finish my license via online learning, especially in our field future teachers must be trained very well how to deal with explaining lessons and communicating with students face to face."* Another student (no 6) from the same class admitted that "*online learning is somehow good nowadays because high payment for transportation."*

As online education continues at the Faculty, students increasing concerns and stress were revealed; unlike students from the promotion 2020-2021, students in 3rd and 5th semesters during the academic year 2021-2022 were not at all satisfied with their education. One student (no 15) in 5th semester wrote:

> *It was the worst experience in my life. Online learning is literally psychological, physical and mental stress. There is no comfort at all, and there is no privacy. The situation has worsened from last year, due to the economic situation we are all facing in Lebanon, and due to lack of electricity throughout the day. The process costs a lot to charge internet bundles to continue attending sessions. The worst thing I've been through in the last two years was online education.*

Conclusion and Recommendations

The purpose of the present case study was to investigate in-depth about pre-service science teachers' attitudes towards online learning and their academic achievement in science education courses during COVID-19 time. Findings showed that students stressed on the importance of a stable, low-cost and good internet connectivity, a good Faculty administrative management and the nature of the teaching materials and courses are the major components for a successful online courses.

Besides the surge of COVID-19, because of total falling of the national currency and the bad economic crisis, the Lebanese educational system undergoes unprecedented hard time. Burdens have been added from the high costs of internet and the poor quality, the severe electricity cut, as well as the high costs of transportations. All these factors make teaching difficult and ineffective to a large section of students enrolled, in particular, in higher education in Lebanon.

Moreover, the Faculty of Education is living a real dilemma: these aforementioned problems especially, the quasi total absence of electricity made further online teaching challenging, besides, the high costs of transportations made the return back to university very difficult for the upcoming semesters. Noteworthy to mention that factors affecting distance education like the internet and electricity are still deteriorating in Lebanon. On the level of the Lebanese University, quality teaching and the need for evaluation online teaching/learning process at the level of the Faculty and the Lebanese University is an urgent need.

The present study sample was done on female students. It is recommended to do future research on samples including male students and on different courses at the different departments at the Faculty of Education: the Language department, humanities and social science, music and art, and sport departments. Finally, educators are aware that learning and teaching during and after COVID-19 will change forever, and it is researchers and teachers' duty to include and to adapt teaching and training, curricula... accordingly. There is no more traditional teaching, without technology and online education.

Notes

The paper is presented at ICSES Conference that will take place Antalya, Turkey, during 10-13 November 2022.

The researcher thank students in semesters 2 till 6, majoring in LMD Science education, during the academic years 2020-2021 and 2021-2022, who participated with enthusiasm to this study.

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