



Perspective of dental medicine students learning in remote biochemistry laboratories during COVID-19

Emna ElGolli-Bennour¹ · Asma Kassab² · Samia Dabbou³

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Abstract

Students at the Monastir Faculty of Dental Medicine were required to remain inside during the COVID-19 pandemic for their own safety and in accordance with official directives. It is evident that learners' perceptions are a recognized indicator of the efficiency of any teaching approach. Therefore, we focused on students' input on the validity of online biochemistry laboratories to assure their preferences with the finest teaching approaches. The study included 116 undergraduate dental students from the Faculty of Dental Medicine of Monastir. The survey has 40 questions. This investigation covered (i) information technology tool accessibility, (ii) course presentation, interactions in a virtual classroom, teachers' availability, and (iii) preferred learning styles. The percentages were then determined for each item and assessed. Our results showed that almost students were equipped with computers, smartphones and tablets but have encountered some connectivity issues. Moreover, participants find courses well presented, approved class interactions, and were satisfied with teachers' availability. Nevertheless, students were not already prepared for entirely online learning. Despite, the overall positive perception among students toward remote education during the COVID-19 outbreak; they preferred considering shared learning between face-to-face and online once the pandemic is over.

Keywords Biochemistry laboratory · Online education · E-learning platforms · Students' preferences

✉ Emna ElGolli-Bennour
emnagol@yahoo.fr

✉ Samia Dabbou
dabbou_samia@yahoo.fr; samia.dabbou@fmdm.u-monastir.tn

¹ Laboratory of Research On Biologically Compatible Compounds, LR01SE17, Faculty of Dental Medicine, University of Monastir, Avicenne Street, 5019 Monastir, Tunisia

² Present Address: Laboratory of Research of Oral Health and Oro-Facial Rehabilitation LR12ES11, Faculty of Dental Medicine, University of Monastir, Avicenne Street, 5019 Monastir, Tunisia

³ Unit of Bioactive and Natural Substances and Biotechnology UR17ES49, Faculty of Dental Medicine, University of Monastir, Avicenne Street, 5019 Monastir, Tunisia

1 Introduction

The unprecedented pandemic related to the spread of Corona Virus (COVID-19) has led the world to restrictions on all non-essential public trades and movements (Saha et al., 2020; WHO, 2020). The closure of educational institutions was among the Tunisian emergency protocols implemented to prevent virus propagation. Therefore, remote education has been proposed as an alternative to the conventional one.

This study highlighted our first experience of online teaching within the faculty of dental medicine of Monastir and particularly biochemistry teaching. We started delivering online teaching in both lessons and laboratories from October 2020. This transition of educational mode is a great concern in itself and is considered an integral part of modern education. However, several reviews have documented this education modality's advantages even in medical practice (Gazza & Matthias, 2016; Ruiz et al., 2006; Shi-Chun et al., 2014). Virtual laboratories are frequently intended to supplement traditional in-person instruction in science. Despite this, computer-based simulations have been used for decades (De Jong & Van Joolingen, 1998; de Jong et al., 2014; Plass et al., 2012). However, in laboratories, students have the opportunity to touch and interact with materials as well as to assist teachers in experiments (National Research Council, 2005). This can increase their interest and improve their scientific attitude (Tüysüz, 2010). For that reason, teachers' responsibility in e-learning is important and not restricted to providing lessons but also to motivate students. The teachers are brought to prepare interactive meetings that encourage learning and involve students directly (Chen & Tseng, 2012; Gares et al., 2020).

Although, it was an unfamiliar situation for the administration, teachers as well as students; we have been prepared as best we could over the limited time. An online training session was assured by expert trainers in September 2020 for the teachers to explore how to use the Moodle platform where they could insert their courses and related documents. Likewise, teachers were initiated to use Microsoft Teams for the live videoconferences. This adaptation to online platforms is time and effort-consuming, making it difficult for the teachers to finish online courses (Rapanta et al., 2020; Sunasee, 2020).

It is evident that learners' perception constitutes a recognized index in the effectiveness of any teaching method (Coman et al., 2020; Young et al., 2008). However, in this paper, we focused on students' feedback about the progress of online biochemistry laboratories to balance their preferences with the best teaching practices.

2 Materials and methods

2.1 Participants

Undergraduates (grade 1 and 2) at the Dental Medicine faculty of Monastir made up the target population of this investigation. A total of 420 undergraduate dental

students were requested to participate: 230 students from grade 2 and 190 students from grade 1. During the COVID-19 outbreak, we used standardized surveys to evaluate the impact of online instruction on these students. The survey URL designed by Google Forms was disseminated to students on Moodle platform as the last task of the laboratory. All questions had the validation option "Required" applied in order to prevent participants from skipping any while utilizing Google Forms. To guarantee data confidentiality and dependability, participants were advised that participation was fully voluntary, anonymous, and that the replies provided would not be disclosed. Participants were asked to complete a 40-item survey. Information was collected, and the average percentages were calculated.

2.2 Questionnaire design

A descriptive and cross-sectional research was used as the strategy. A total of 40 survey questions were conducted to assess the efficiency of online teaching during the COVID-19 pandemic. Student grade, gender, and age were among the fundamental details. The other questions included yes or no questions, a Likert scale, and requested feedback questions. The survey was designed and distributed electronically to respondents from June 27th to July 26th. The headteacher, who was in charge of ensuring that the students complete the questionnaire, carefully posted the questionnaire to the students online in the form of a link through Moodle platform. In total, 116 students completed the survey. The online survey questionnaire enrolled four sections; the students were asked if:

- (1) they were prepared to learn online with required tools accordingly?
- (2) they obtained enough assistance and availability from the instructors?
- (3) the practical sessions were clear with goals and objectives achievement?
- (4) this remote teaching mode is suitable for them and can replace the direct one?

2.3 Online laboratories sessions' method

The first-grade dental medicine students have received 6 sessions extended over 6 weeks. Likewise, the grade 2 students have received 4 sessions extended over 4 weeks. Therefore, we have organized our biochemistry laboratories' sessions in six steps as below:

Step 1: On Sunday, an administrator posted the session schedule on Facebook teams that were only accessible to students as well as Microsoft Teams.

Step 2: The biochemistry teacher contributed relevant pre-educational e-resources hosted on the internet to the Moodle platform on Monday.

Step 3: The same teacher added a pre-test to the Moodle platform on Tuesday as a diagnostic assessment. After passing this test, the student was able to review extensive papers about the lab session.

Step 4: On Wednesday, the instructor set up a live, synchronous videoconference using Microsoft Teams.

Step 5: On Thursday, the students participated in exercises and practical workshop-related tasks that their teacher had already added to the Moodle platform.

Step 6: The students completed a summative evaluation exam on Saturday, which was graded and recorded on the Moodle site.

2.4 Statistical analysis

Data were analyzed with SPSS software (Statistical Package for the Social Sciences), version 14 for Windows 7. Descriptive statistics were conducted; means (M), standard deviations (SD), one-way analysis of variance (ANOVA) for Likert scale questions, and the Khi-deux test for yes or no questions to analyze the interactions among the variables (gender/level of education) of the study.

3 Results

As shown in Table 1, this sample consisted of 89 females (76.72%) and 27 males (23.28%), and 58 (50%) students from grade one and 58 (50%) students from grade two. We were surprised to have an equal number of participants from each grade.

3.1 Accessibility and handling of information and technology tools

The analysis of Fig. 1 showed that almost all respondents (90.52%) have personal computers, smartphones and/or tablets and have accessibility to an internet connection. Moreover, 71.55% reported they have a dedicated area where they can study remotely in comfortable surroundings (Fig. 1). When asked about the ease of Moodle platform use; on a scaled scoring for agreement, 42.24% scored agree, 25% strongly agree, and 13.78% extremely agree. This resulted in 81.03% who had a positive perception. Handling Microsoft Teams appear more complex, then 37.07% of respondents indicated they agreed, 13.79% strongly agreed, and 6.03% extremely agreed, with a significant difference between men and women ($p=0.03$). Nevertheless, men appear to be more adept at using this platform ($M=3.07$, $SD=1.14$; Table 2). Along the same line, 68.97% of participants reported needing training provided by the university to get used to online learning platforms; which corresponded

Table 1 Students' demographic characteristics

	Sample	Frequency	Percent (%)
Genre	Femele	89	76.72
	Male	27	23.28
Educationl Level	Grade 1	58	50
	Grade 2	58	50
Total (N)		116	

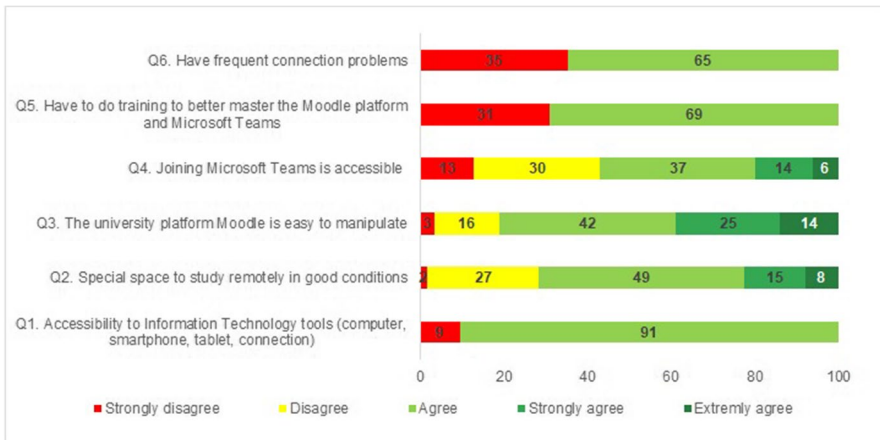


Fig. 1 Obstacles encountered to follow lessons. Students’ responses were expressed by percentage, (N= 116)

Table 2 Distribution of students who had overcome obstacles encountered during online education based on gender and education level

		Q1		Q3		Q4	
		M	SD	M	SD	M	SD
Genre	Female	3.06	0.93	3.21	1.00	2.58	1.01
	Male	2.81	0.74	3.59	0.97	3.07	1.14
	F	1.51		2.99		4.97	
	p	0.22		0.09		0.03	
Education level	Grade 1	3.03	0.9	3.43	0.97	2.71	1.15
	Grade 2	2.97	0.88	3.17	1.03	2.69	0.96
	F	0.17		1.93		0.01	
	p	0.68		0.17		0.93	

*significant difference at $p \leq 0.05$, $N = 116$

to 79.31% of the first grade and 58.62% of the second grade (Table 3). Concerning the obstacles faced during this online experience, students reported the disruption of the internet (weakness or absence), as 67.24% declared having major connection problems that prevented them to participate in a live course with no significant difference between gender or educational level ($p = 0.50$; Table 3).

3.2 Courses presentation, class interactions, and teachers’ availability

According to Fig. 2, when asked about the accessibility and affordability of the documents offered on the Moodle platform, 69.83% of participating students gave a good response. According to the distribution, 40.52% of respondents agreed, 18.1% highly agreed, and 11.21% strongly agreed (Fig. 2). However, slides were favored over documents by 53.54% of respondents; the videos came in second with a rate

Table 3 Distribution of students who had overcome obstacles encountered during online education based on gender and education level

	Frequency	Percent (%)
Q2. Special space to study remotely in good conditions		
Grade 1	36	62.07
Grade 2	47	81.03
F	59	66.29
p	24	88.89
Khi-deux test (p)	0.67	
Q5. Have to do training to better master the Moodle platform and Microsoft Teams		
Grade 1	46	79.31
Grade 2	34	58.62
F	58	65.17
p	22	81.48
Khi-deux test (p)	0.11	
Q6. Have frequent connection problems		
Grade 1	43	74.14
Grade 2	35	60.34
F	62	69.66
p	16	59.26
Khi-deux test (p)	0.5	
Total (N)	116	

* significant difference at $p \leq 0.05$, $N = 116$

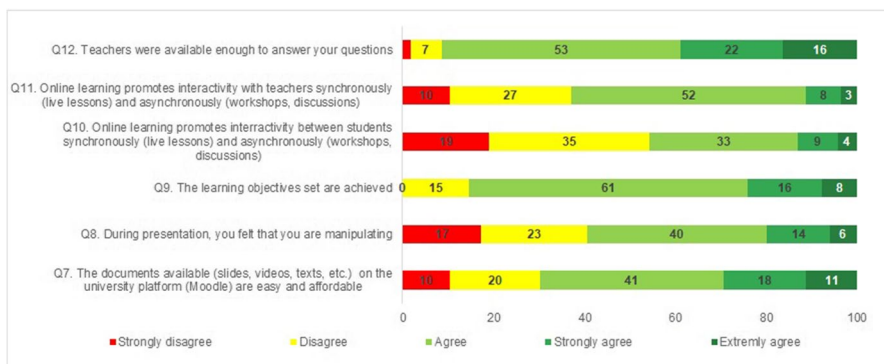


Fig. 2 Lessons presentation, objectives achievement, interactions, teachers help and availability. Students' responses were expressed by percentage, ($N = 116$)

of 37.93%. The synchronous session was the most important step in the online education process, and this is where teacher added value was highlighted. Thus, the experimental protocol explained in detail that 60.34% of students felt like they were manipulating on their own. In terms of mean, the first grade found the live meeting more understandable ($M = 2.79$, $SD = 1.17$; Table 4). Interestingly, 85.34% of

Table 4 Distribution of students who appreciated lessons presentation, objectives achievement, interactions, teachers' help, and availability; based on gender and education level

	Q7		Q8		Q9		Q 10		Q11		Q12		
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	
Gendre	Female	2.96	1.17	2.67	1.16	3.16	0.80	2.58	0.84	2.37	0.99	3.37	0.91
	Male	3.15	0.95	2.70	0.91	3.22	0.70	2.96	1.02	2.67	1.14	3.70	0.87
Education level	F	0.61		0.01		0.14		3.82		1.71		6.41	
	p	0.43		0.90		0.70		0.04 *		0.19		0.01 *	
	Grade 1	2.97	1.21	2.79	1.17	2.93	0.99	2.72	0.95	2.55	1.05	3.47	0.94
	Grade 2	3.03	1.02	2.57	1.03	3.50	0.98	2.62	0.83	2.33	1.01	3.43	0.88
F	0.11		1.21		9.71		0.39		1.37		0.04		
	p	0.74		0.27		0.00		* 0.53		0.24		0.84	

* significant difference at $p \leq 0.05$, $N = 116$

students reported that the learning objectives set were achieved. However, a significant difference in the education level ($p=0.00$) was attributed to the second grade being more convinced. Interactions in the virtual classroom are a key parameter for online learning success. Consequently, 62.93% of participants noticed that online learning promotes interactivity with teachers either synchronously via live lessons or asynchronously by forums and chats. This perception was shared as 51.72% scored agree, 7.76% scored strongly agree and 3.45% scored extremely agree, a significant difference was observed between men and women ($p=0.04$). When asked about the interactivity between themselves, 56.03% of participants gave a positive feeling, devised as 32.76% scored agree, 15.52% scored strongly agree and 7.76% scored extremely agree. Among the points that made us pleased and satisfied during this study and despite the limited period in which we had to adapt to the new education model was the testimony of students about the teacher's availability. Hence, 91.38% of respondents reported that teachers were available enough to respond to their questions and needs with a significant difference between men and women ($p=0.01$). Men appreciated more teachers' obtainability (Mean=3.70, SD=0.87; Table 4). Thus, we managed to cope successfully with the challenges, but improvement will always have room.

3.3 Preferred learning style

As shown in Fig. 3, 56.03% of students thought that the courses required a lot of homework. With a considerable gender difference, 41.38% of respondents rated agree, 12.93% strongly agreed, and 1.72% extremely agree ($p=0.00$; Table 5). Then, the men believed that there are too many tasks (M=3.04, SD=1.05). There was equally a significant difference among the educational level ($p=0.05$). Thus, 65.52% reported that they no longer had the same free time as in face-to-face learning.

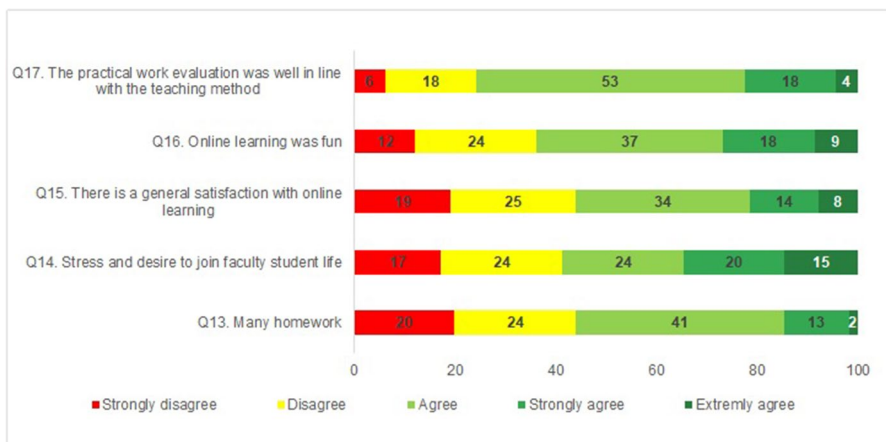


Fig. 3 General satisfaction with different aspects of e-learning (stress, time, evaluation). Students' responses were expressed by percentage, ($N=116$)

Table 5 Distribution of students who were satisfied by the different aspects of e-learning (stress, time, evaluation); based on gender and education level

	Q13		Q14		Q15		Q16		Q17		Q18		Q19		
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	
Gendre	Female	2.37	0.95	2.31	1.39	2.62	1.20	2.33	1.14	2.47	0.95	2.30	1.15	2.22	1.26
	Male	3.04	1.05	2.30	1.26	2.81	1.04	2.33	1.27	2.26	1.13	2.81	1.14	2.52	1.28
	F	9.73		0.00		0.59		0.00		0.94		3.61		1.11	
Education level	p	0.00 *			0.44		0.98		0.33		0.06		0.29		
	Grade 1	2.71	1.03	2.26	1.36	2.57	1.22	2.12	1.14	2.36	1.15	2.47	1.34	2.26	1.30
	Grade 2	2.34	0.96	2.36	1.37	2.76	1.11	2.53	1.16	2.48	0.82	2.38	1.14	2.33	1.25
F		3.83		0.17		0.77		3.77		0.42		0.14		0.08	
	p	0.05 *		0.68		0.38		0.05 *		0.52		0.71		0.77	

* significant difference at $p \leq 0.05$, $N = 116$

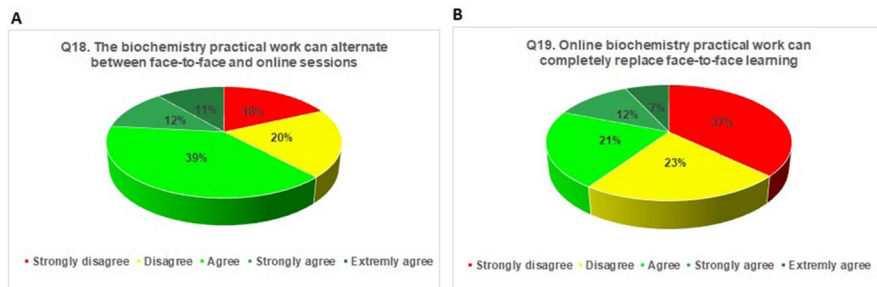


Fig. 4 Students' opinions about biochemistry laboratories alternation between face-to-face and online sessions (A) VS completely online learning (B). Students' responses were expressed by percentage, ($N=116$)

The COVID-19 outbreak can affect students' social life and mental health. However, 58.62% of respondents felt isolated and missed their anterior student life with no significant difference between both gender and educational level as $p=0.95$ and 0.68, respectively. Basically, in our experience it was general satisfaction with online learning as 34.48% scored satisfied, 13.79% scored strongly satisfied and 7.76% scored extremely satisfied. Hence, men and the second grade seem to be the most satisfied groups ($M=2.81$, $SD=1.04$ and $M=2.76$, $SD=1.11$, respectively). Moreover, 58.62% had found this educational mode funny. One more time, a significant difference was found with the second grade as $p=0.05$ (Table 5). Figure 4 reported the students' preferable educational modes as 62.07% opted for a hybrid mode, a balance between online and face-to-face learning in the biochemistry laboratory. When 39.97% thought that biochemistry laboratories can take place entirely online. Ones asked about what they liked the most and what worked best in this new educational style, students' top five answers were reported in Fig. 5. However, teachers'

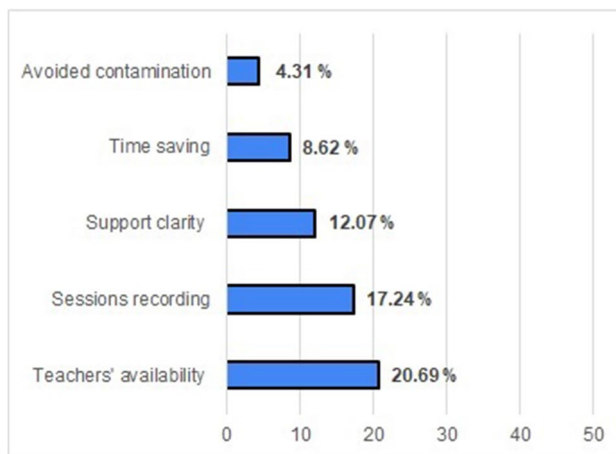


Fig. 5 Top 5 positive perceptions of online learning perceived by students, ($N=116$)

availability won first place in the ranking with 20.69% followed by the recording of the sessions with 17.24%. Support clarity, time-saving, and avoided contamination come after with 12.07%, 8.62%, and 4.31% respectively.

4 Discussion

The decision to postpone the opening was made in response to the COVID-19 outbreak in order to manage the spread of the school epidemic. Universities had decided to use online instruction throughout the suspension period. The impact of the sudden move to entirely online teaching on education quality has aroused researchers' great attention. Even if universities, teachers, and students were not prepared for this shift, they had to cope with many challenges. It is crucial to know how internet technologies and universities platforms' can be exploited to attend online educational objectives. However, it is important to us as teachers and scientists to evaluate students' satisfaction levels. Certainly, the availability of internet technology to all users is the success key to this education transition. Students at dental medicine were asked to complete an online questionnaire survey in order to analyze the impact of online instruction during the pandemic.

Ninety-point fifty two percent (90.52%) of our responders reported that they were equipped with personal computers, smartphones and/or tablets and had their own internet subscription. In China, 81.91% of questioned students thought that online courses are indispensable in this period as they were unable to move (Pan, 2020). Despite the availability of online educational tools in public schools, the opinion of Indonesian learners was different; according to them, online learning was not interesting than classical one (Mulyanti et al., 2020). When asked about their own educational equipment, 78.7% of Algerian students from the faculty of chemistry and hydrocarbons responded that they used their smartphones to take courses focusing on the lack of personal computers. Additionally, internet disruption was frequent (Blizak et al., 2020).

It should be noted that the students who had less benefits from this online teaching were those from rural regions and with low revenue due to financial and technical difficulties (Alipio, 2020). Nevertheless, the universities' platforms offered many advantages such as they are not restricted by time or place and thus these processes can be adaptable according to every student's needs (Dhawan, 2020). Even if there is a connection problem, the synchronous meetings were all recorded for the learners who were unable to join the planned conferences (Marinoni et al., 2020; Seery, 2015). Adding to that, the asynchronous tools provided such as inserting documentation in courses space, chats, workshops, and e-mails give students the opportunity to always catch up (Adnan & Anwar, 2020). Our students also benefited from this kind of option. However, participants reported an internet disruption (weakness or absence), as 67.24% declared having faced at least one time a major connection problem that prevented them from joining a live meeting.

Many analyses have reported more students' positive perceptions of remote learning than negative ones (Mufflih et al., 2021; Perets et al., 2020). This satisfaction is gender-dependent (Yu et al., 2021). In fact, the results of our survey showed

a significant difference between male and female satisfaction of $p=0.03$. However, interactions in virtual classrooms are among the most important parameters which made online teaching more suitable for students. Still, 62.93% of participants noticed good interactivity with teachers either synchronously via live lessons or asynchronously through forums and chats. Concerning interactivity between students themselves, 56.03% of respondents gave a positive feeling. According to Aboagye et al. (Aboagye et al., 2020), Ghanaian students were lacking in interactions with both teachers and colleagues. Yet, for them, live video projection could replace the missed physical interactions and minimize isolation feelings (Huang et al., 2020). For that, certain teachers managed to replace traditional direct interaction by assigning collaborative teaching methods as creating a comfortable learning atmosphere and bringing students closer by capturing their attention (Coman et al., 2020; Tham & Werner, 2005). Indeed, in the organic chemistry I class at Suny Plattsburgh, in the synchronous meeting the teacher and students solved problems together and a real-time comment was delivered to learners. While, in the asynchronous sessions, students were provided with online graded exercises with bonus marks (Sunasee, 2020).

During this period of online teaching, we tried to be available as much as possible to support students in this new transition by answering their questions as soon as possible and by encouraging them via explanatory videos and forums. We held on to make this new phase of education work. Accordingly, we worked hard and were delighted to see the recognition in the testimonials of our students. As a result, 91.38% of respondents reported that teachers were available enough to respond to their questions and requirements. Thus, we managed to cope successfully with the challenges, but improvement will always have room. Our next concern will be to identify individual students who may be disproportionately affected by this educational switch and thereby providing appropriate support.

Knowing that student perceptions of online learning cannot be ignored and constituted an essential success factor in this transition; we have asked our respondents about their preferable educational mode (online vs face to face). Thus, about 60% opted for a balance between online and face-to-face learning regarding the laboratory biochemistry and thought that this discipline cannot take place entirely online when the pandemic is over. Likewise, 48.1% of Romanian students preferred fully face-to-face learning, 41.3% would choose a hybrid mode that is a combination of online and traditional courses and only 10.6% would select exclusively online teaching (Coman et al., 2020). Nevertheless, Algerian students have a negative perception of digital learning. Thus, 63.7% preferred traditional learning, while 26% opted for a blended education (Blizak et al., 2020). As well, about 82% of surveyed students from New York University realized that working on problems together with the teacher during the live meeting improved their problem-solving rate. Thus, about 90% confirmed that this method is efficient for exam training. Therefore, about 64% still preferred face-to-face education (Sunasee, 2020).

Like any study, ours is subject to limitations, the most important one is the fact that it cannot be generalized. Since it was only conducted in one discipline and at one university with a specific educational, political, and cultural context. In addition, the response rate from each grade was low, and we had intended to get a bigger number of participants. The factors included in the questionnaire

have only been used in one study before, therefore they could need to be improved in future research. We believe that each characteristic should be examined separately to expand the potential for future research to raise the standard of dental instruction.

5 Conclusion

The global feeling regarding remote education was positive and exhibited several benefits such as the home comfort factor, time and money saving since it does not require moving. As a new pedagogical mode, online education is restricted by some limitations. The most frequent were internet disruption, the absence of a virtual laboratory and simulators, and the lack of social connection. However, the teachers are effectively expected to maintain traditional face-to-face education without stopping virtual remote learning. Nevertheless, there is a need for concrete improvement actions for online education optimization such as training organization programs to improve teachers' technical competencies and adapt their teaching mode to the digital world.

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Data availability Data from the corresponding author is available upon reason request.

Declarations

Conflicts of interest There are no conflicts to declare.

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