
Virtual Learning in the COVID-19 Pandemic: A Comparison among Paramedical Students Having the Medical Microbiology Laboratory Course in the First and Second Pandemic years

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Abstract

As the swing of the pendulum has shifted towards empowering students, those students who can utilize virtual learning platforms are more predisposed to succeed especially in the time of COVID-19 pandemic. The present study sought to clarify the views of 50 students in two groups on virtual vs. face-to-face education. They received a series of similar instruction throughout first and second pandemic years. Theoretical and practical virtual contents of medical microbiology laboratory were taught via available academic systems throughout educational semesters in the two pandemic years. Ten-day face-to-face classes were held at the end of each semester in which the whole content was taught. Evaluation of the students were based on their class activity, the responses they provided to assignments, virtual forum participation and scores in the final exams. Moreover, some questionnaires were administered. In accordance with the results of Fisher's Exact Test, the students of the first group who received virtual and intensive face-to-face instruction in the first COVID pandemic year believed that virtual education considerably enhances the quality of face-to-face learning, forum participation greatly improves learners' sense of self-directed learning and Descriptive Questions exam (DQ) highly influences the evaluation of the quality of learning. However, students of the second group who received the same instruction including practical instruction clips and intensive face to face instruction maintained that the level of information transfer is lower and the quality of education may be worse in virtual education in comparison with face to face learning. It was illuminated that the student's motivation was lower in the second pandemic year than the first year. It is advisable to pay sufficient attention to the infrastructures of virtual learning in various educational settings at all times in general and in the time of the Pandemic in particular.

Keywords: DQ, forum, MCQ, Lab education in COVID19 pandemic, Teaching and learning

1. Introduction

The COVID-19 pandemic has affected people throughout the world and has triggered novel ways of learning. In the beginning of the pandemic, a large number of people had to stay at home and practice social distancing. Meanwhile, schools and universities were closed in most parts of the world. Hence, remote education became the most important subject in all educational centers (Hamidah et al., 2020). In Iran, a few classes were held virtually before the pandemic and many instructors, teachers and practitioners of teaching made use of face-to-face classes. However, drastic changes appeared with the emergence of the pandemic, the closure of universities and educational settings. Online learning became much more popular and a bulk of online courses were offered throughout the country because as Chanjaruan et al. (2022) confirmed, education must never cease, for it is a means of fostering stability and bettering life through enhancing individuals' skills, knowledge and competence. Students develop some of their needed skills in the digital milieu (Kashefian-Naeeni & Sheikhnezami Naeini, 2020). Technology and digital platforms can promote learning design and delivery especially in the time of the COVID-19 pandemic. Technology-enabled learning is facilitative and has, according to Chan (2022), proven to be engaging. Though e-learning programs have been around for many years, they have not been carried out in different academic institutions before the COVID-19 pandemic (Salahshouri, 2022). Universities that had previously implemented innovative e-learning programs could use them in this emergency situation. Therefore, due to the nature of the training process, which demands face-to-face interaction, the closure of educational and academic institutions in the COVID-19 pandemic resulted in an unparalleled effect on the education services system which necessitated novel decisions to compensate for the disruption of the education process. Likewise, in medical school at Ruskin University, an undergraduate education program was established since 2018 wherein they held "less than 5% of the curriculum" as virtual classes before the outbreak of the pandemic. In global COVID-19, classes were delivered in the online presentation mode through web conferences. According to the feedback received, students are impelled to learn more via virtual education platforms (Mishra, 2020). Moreover, students' intrinsic motivation was elevated (Gustiani, 2000) and students and teachers' enthusiasm was augmented and even their computer skills were improved (Hidayat D, Noeraida, 2020; Khasanah et al., 2020). The teachers in Ruskin University believed the applied method was usable for theoretical courses, but the learning problem was existent for practical medical courses. Moreover, true and significant assessments by students are the main problems due to sharing of the questions by students (Khasanah, et al.).

The pandemic has affected all aspects of medical education. A statement was written by a committee in several Asian countries around the task of gastrointestinal motility laboratory in COVID-19 pandemic. The statement included several platforms for visiting and triaging highly urgent patients. In that strategy, equipment, laboratory staff and patients were kept from COVID-19 transmission (Sahu, 2020). In Georgia also, transition to online teaching was applied successfully like other countries (Singh et al., 2020).

Due to the maintenance of social distancing and the necessity of teaching laboratory courses, suitable virtual lab teaching about microbiological assays must be taught, too. Traditional Medical Microbiology laboratories training depended on the presence of teachers and their students in the field. Moreover, conventional practical training in the laboratories was based on the processing of

patients' samples, the application of diagnostic tests and finally the management of the tests and the discussion of the results. The nature of such training could not be stopped because health community needs to deliver services from skilled expert to patients in clinical laboratories.

To this end, we designed a strategy for our step-by-step teaching in basic and diagnostic medical microbiology laboratory educations. This strategy included several methods such as PowerPoint presentations with audio and experimental training with film taking. Then, the obtained contents were provided to the students in MP4 content format. In this study, we designed an educational plan whereby both theoretical contents and experimental operations were taught. Of course, it is important that "Efficient and effective use of the platform requires an understanding not only of right platforms and their features but also of their inherent limitations" (Wilcha, 2020). It was opined that students were full of energy and capable to participate in electronic learning. Therefore, the right platform could, according to Hamidah (2020) motivate the students and encourage them for e-learning through on-site and remote teaching.

After the serious modified teaching, a questionnaire was distributed among the students. Question topics included reliability evaluation of descriptive assessment, the role of virtual content preparing in learning, the role of participating in virtual forum in increasing of learning and the role of virtual learning in technical- presence learning during the first and second years of COVID-19 pandemic academic medical microbiology laboratory learning.

2. Methodology

2.1. Participants

On the whole, 50 students who were majoring in Lab Sciences in the Medical Sciences of Shiraz University were involved. They divided into two groups. Thirty students in the first group and twenty in the second group were trained in first and second pandemic years.

2.2. Research Instrument

The researchers constructed a research questionnaire based on the syllabus of the Microbiology lab course highlighting virtual education in the time of the pandemic. The Content Validity Ratio (CVR) based on the formula and experts' views about the questions was 0.75, in accordance with eight experts' views, which is an acceptable ratio. The Content Validity index (CVI) was also 0.86 based on eight experts' views. For measuring the reliability of the questionnaire, a pilot test was carried out. Using Statistical Package for Social Sciences, Cronbach Alpha index was measured which was 0.85 suggesting that the items have high internal consistency

2.3. Teaching Methods

At the beginning of the COVID-19 pandemic, the year in which universities were lockdown, we created some academic WhatsApp groups which the students were joined the groups eagerly and received basic laboratories theoretical training. We went through following procedures: first, we taught the laboratory theoretical contents in voiced PowerPoint presentations which were recorded by Snagit software and changed to MP4 files through the Camtasia software. The MP4 outputs were uploaded on the available academic Navid system (NS) and learning manage system

(LMS). The aforementioned systems included the sections for loading messages, assignments, exams, forums and creating the virtual classes. Virtual contents and videos were uploaded on the systems and students were informed by WhatsApp to download and review the content files. Second, teaching laboratory operations were done by the course lecturer. To this end, the diagnostic tests were demonstrated, performed and videotaped in academic laboratories. Then, the exported films were revised and edited with Camtasia software and uploaded on the NS. In addition, we presented a complementary video PowerPoint presentation for further explanation and uploaded it on NS.

The students were given a time limit for doing and uploading the assigned homework. They could ask several questions through the message section. They could also discuss with their classmates in the forum section about certain topics under our supervision. The aforesaid training classes were held offline. An important part of our educational goals was achieved through online teaching. In online classroom, students could see one another and also their instructor with a webcam and answer or discuss the questions. Accordingly, it was determined which students were present in the class and which ones were absent. In offline and online modes, we were able to monitor the academic level and individual abilities of students. In the foregoing methods, we focused on student's classroom activities, homework completion and the level of their interest.

2.4. Face to Face Teaching Through Intensive Classes

In the present study, teaching and learning were evaluated and emphasized on skills and experimental techniques in the form of intensive practical classes. For this purpose, the instructor held intensive face to face, ten-day classes at the end of each semester. All of the virtual contents were taught from A to Z in an intensive way. In this procedure we evaluated the level of received learning by students. Classes were completed by collecting work reports from students over a period of 7 to 10 days.

2.5. Evaluation

In the first evaluation phase, the questions were uploaded on the Exams section of NS in the form of MCQ and the students had to provide their response to the questions within certain time limits. To the researchers of the present study, the most interesting part of the students' evaluation process was participating in the forum section of the NS. For this purpose, in the first place, clinical challenging problems were planned. Then, students were asked to do a search about the assigned subjects.

Finally, Students were divided into multiple groups and each group had to present a content. Under these conditions, students were introduced to research methods, PowerPoint preparation and virtual lectures. Then, the students were asked to present their findings through PowerPoint video presentations and to upload them on NS so that their classmates could have access to them. The students could discuss about the subjects carefully and learn from their classmates' presentations. All the time the instructor supervised their whole activities.

Gradually, as the lessons progressed, a DQ exam was conducted. Hence, questions were uploaded to the system and students were instructed to write their answers on paper at the specified time, take a photo of their answer sheet and upload it on the main electronic system. For validation of the

exams, students attached their identification cards to the answer sheets. Finally, the main assessment was based on the student's overall performance during the semester and the sum of the total scores.

2.6. Questionnaire Sheet

Students were divided into two groups. The training strategies were the same for both of the groups. One of the groups was trained in the first COVID pandemic year and the other was in the second pandemic year. A questionnaire sheet was distributed electronically among students.

2.6.1. Question Topics

At the end of each semester, which virtual and intensive face to face education were taught, a questionnaire sheet was distributed electronically among students. The research questions which were answered in this study were as follows:

1. Does preparing virtual content on an academic subject influence selected participants' learning?
2. Does taking part in a forum class affect participants' learning?
3. Are participants satisfied with multiple choice tests (MCQs) and DQs in the evaluation of their learning?
4. Does virtual learning which involves theoretical clips and practical movies facilitate and accelerate face-to-face learning?

2.6. Statistical Analysis

Statistical evaluation was performed by the Statistical Package for Social Sciences (SPSS) software version 16. In this study, the statistical significance was measured by Fisher's exact test.

3. Results

The present study sought to clarify the views of 50 students in two groups on virtual vs. face-to-face education. According to table 1, Seventy percent of students who had the practical Medical Microbiology course in the first pandemic year claimed that preparing e-learning content affected their self-learning, while 40% of the students who were instructed in the second pandemic year maintained that the aforesaid activity had an impact on their learning.

Table 1. A Comparison of Responses to Surveys of Students Having the Medical Microbiology Lab Course in the First and Second Years of the COVID-19 Pandemic

Question	Students opinion in first year N (%)	Students opinion in second year N (%)	p-value
The effective role of virtual content preparing in self-learning	21 (70)	8 (40)	0.035
The effective role of virtual forum participating in	19 (63.3)	4 (21)	0.04

learning improvement			
Reliability evaluation of comprehensive assessment in comparison to multiple choice question	19 (65.5)	1 (5)	<0.001
The effective role of virtual learning in technicallaboratory-presence learning	12 (40)	2 (10.5)	0.025

A comparison of students' learning was carried out. The results of surveys demonstrated that 63.3% of the students in the first year of university closures asserted that taking part in forums played an effective role in their learning improvement. However, only 21.1% of students who received the same instruction in the second pandemic year confirmed that forums were of effect in their learning. Statistical analyses revealed that virtual classroom participation significantly influenced students' learning in the first year of the pandemic.

As depicted in Table 1, after conducting equivalent MC and DQs for students who received the instruction in the first and second pandemic years, 65.5% of freshmen, deemed DQs more real criteria in comparison with MC exams. This figure was reduced to 5% among sophomores ($P < 0.001$).

In accordance with the results of the survey performed on students of first and second year of the pandemic regarding the effect of virtual instruction on learning practical face-to-face techniques, it was illuminated that 40% of freshmen held that virtual learning which had been carried out through theoretical movies and practical videos led to the facilitation and acceleration of learning in face-to-face instruction. Surveys on sophomores revealed that only 10.5% of students deemed virtual learning as effective in the improvement of face-to-face instruction. ($P = 0.025$). On the whole, first year students allocated a greater role to virtual content preparation in enhancing their self-learning ($P = 0.035$). As reported by Figure 1, the amount of self-learning through e-learning content with a $p = 0.35$ was at a higher level in the first pandemic year.

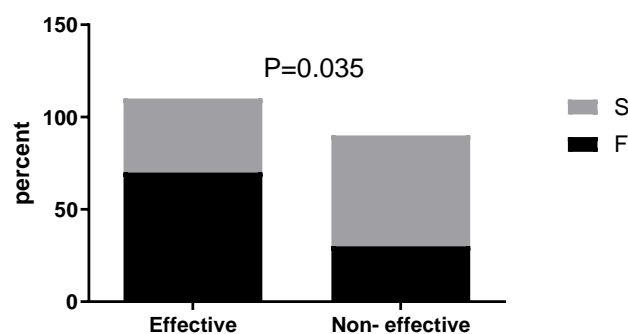


Figure 1. A Comparison of the Role of Virtual Content Preparation in Self-Learning among Students of First and Second Years of the COVID-19 Pandemic

F=First pandemic year

S=Second pandemic year

According to Table 2, 85% of students of second year of the COVID-19 pandemic, deemed MC exam as effective in the evaluation of their learning. Conversely, 35.7% of first year students had differing opinions. All in all, a non-significant effect was found for the role of MC exams in the evaluation of learning of students of first and second years of the COVID-19 pandemic.

Table 2. A Comparison of Views of Students of First and Second Years of the COVID-19 Pandemic about the Role of Multiple Choice Exam in the Evaluation of Their Learning

During Pandemic years			P-Value
N(%)			
	First	Second	0.188
Effective	18(64.3%)	17(85.0%)	
Non-effective	10(35.7%)	3(15%)	

Figure 2 depicts that students of the first year, contrary to those of second year, significantly deemed participation in forums as effective in improving their learning ($P=0.004$). When the role of participation in virtual forums was compared among students of first and second pandemic years to check the improvement in students' learning, it came to light that students who participated in forums had enhanced learning in the first year of the pandemic in comparison with the second year.

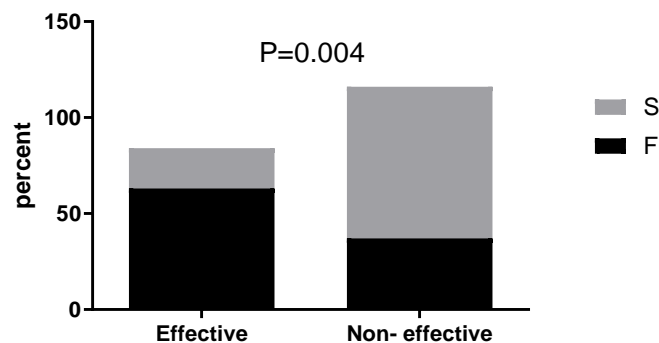


Figure 2. A Comparison of the Role of Taking Part in Forums in the Improvement of Instruction among Students of First and Second Years of the COVID-19 Pandemic

F=First pandemic year

S=Second pandemic year

As it is illustrated in Figure 3, students of first year considered the comprehensive DQ as a real measure of the evaluation of learning. However, students of second years regarded the aforementioned exam as ineffective ($P<0.001$).

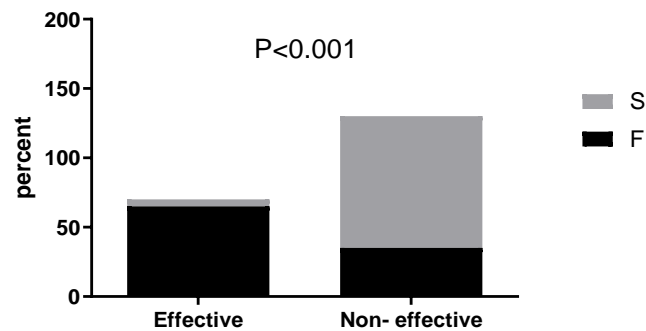


Figure 3. A Comparison of Students' Views About the Rate of Real Learning Through a Comprehensive DQ among Students of First and Second Years of the Pandemic

F=First pandemic year

S=Second pandemic year

Discussion

Santanu De et al. believed COVID-19 pandemic was a global issue which impaired all of live sectors especially in healthcare and education. To prevent the spread of the highly contagious infectious illness, managed cooperation between nations, private company and government factory are warranted (Sharma & Bhaskar, 2020). Misra and colleagues in Mizoram university performed online teaching-learning. The process model was performed by the university systems. During the pandemic period, teachers and learners were motivated in online education and were connected with each other through social media such as WhatsApp, Facebook, Twitter, Instagram, Google Meet and videoconferencing and this is the fact which is also affirmed by different researchers (e.g. Basilaia & Kvavadze, 2020).

The COVID-19 pandemic has affected many aspects of practical lab instructions as other academic education. Although, the teaching of laboratory was not of high quality during the Corona pandemic, but our teaching methods opened new educational perspectives for instructors. Inasmuch as instructors were compelled to stay at home at the start of the pandemic, we had to teach students through effective communication. We used LMS for monitoring the online classes. Likewise, in Mizoram university, Basilaia and Kvavadze (2020) used LMS for monitoring the online classes in which forums were the most interesting part of teaching-learning education. Moreover, WhatsApp was one of the usable digital model for educational connections between students and their teachers and we were not expected from this rule during the covid era.

At the beginning of pandemic, we used WhatsApp for transferring teaching but in the lockdown period of universities, we shifted the teaching to synchronized and non-synchronized training on NS and LMS in our university. The use of WhatsApp application helped us a lot in gathering the students and creating friendly relationships among them. Thus, our informal training started and the students who were worried about closing of universities gradually trusted us. The education was established by participating in online and offline classes, online examinations and uploading

messages, grouped homework and forum participation in NS and LMS. We noticed that by assigning a part of teaching as homework, we can enhance students' motivation. Some of students were experts in PowerPoint preparation and some of them learned the skill in different ways for presenting the homework.

Our educational strategy in the first pandemic year was repeated in the second year in which after virtual theoretical and practical instructions provided to students in the course of Medical Microbiology Lab, an intensive ten-day face-to-face lab instruction course was designed in which repetition of presented contents were avoided. Moreover, practical and laboratory contents which were taught using videos were performed by selected students and in the end a comprehensive DQ was given to the students. It is worth saying that throughout the academic term, different multiple-choice questions (MCQ) and DQ questions (DQ) were provided to students to answer in different exams which were conducted.

Freshmen considered forum participation as a significant factor in the improvement of their learning ($P=0.004$). They had to do the assigned tasks in groups and carried out instructional group work and teach their classmates in forums. These activities though challenging in the first place proved effective as students learned to make powerpoint templates and voiced virtual contents which led to their enhanced motivation and self-learning ($P=0.35$). However, students in the second pandemic year did not deem this instruction effectual. It might be due to the fact that long-time university closure and being far from face-to-face instruction have decreased students' motivation in general and their learning motivation in particular in the second pandemic year.

Freshmen contended that DQs were a more real measure of students' academic evaluation ($p<0.001$), while only 5% of sophomores stated that they were satisfied with DQs and 85% of them regarded MC exams as effective in their evaluation of learning. It seems that the unexpected closure of universities caused a disruption in learning which led to students' dissatisfaction. Therefore, MC exams which could be easily passed with the help of others engendered students' dissatisfaction. It is crystal clear that DQs which were administered in open-book and problem-based format could be challenging and attractive to students as they were in the first year of university closure. However, monotony and being far from university in the second year could lead to students' demotivation and burnout. Therefore, they preferred MCQs to DCQs in the summative evaluation. With students' greater chance of consulting with others in virtual exams, the administration of MCQs in comparison to DCQs were more easily performed and students had a higher chance of getting better scores. It is evident that many students who have been away for a long time from university are less eager to experience learning challenges.

As freshmen could remember that to reach technical skills, they needed to devote their time and practice in labs. Thus, they greatly utilized practical instructional clips in the intensive face-to-face instruction for their final exams. However, no considerable use was made of face-to-face instruction due to loss of motivation and indolence in virtual learning so far so that the ten-day intensive course could not provide the real skills which required time. Accordingly, the short-term instruction which was based on long-term virtual instruction could not appropriately replace lab instruction. The inevitable result of such an instruction were reduced learning of technical skills and eventually dissatisfaction. As Chick et al. (2020) also confirm, the use of remote learning is as a last resort for the transmission of practical skills in that period of time. However, we hold that success in the

course of teaching and learning like any other instruction demands students' heartfelt needs. The knowledge received from virtual learning is indisputable. Similar to any other virtual event, what causes maximum effectiveness is users' requests and the issue of university learners is not an exception.

Hofman et al. (2021) reported a study in which laboratory teaching was provided with forum participation in a pathology training program. The students were oriented with knowledge of other groups. The finding of their study was in line with ours in that it illuminated that virtual education has "high-quality active involvement". In our study, we noticed that learning through forum participation increased the level of learning ($P=0.004$). It may be due to the fact that various student's presentations with possible modern teaching and interesting methods had attracted the attention of other students and led to instructors' satisfaction with students' presentations. Virtual education can be an acceptable alternative model as self-learning in university lockdown period.

Virtual education has some merits and demerits and it is dependent on the web and the internet. Some of the demerits which are also emphasized by Olum et al. (2020) include internet problems, high internet fees for families and lack of students' sufficient computer skills. The researchers are concerned about the sustainability of the learned knowledge of practical lab by students and how much students are able to change the learned practical material to skills. According to the present study, using instructional clips in face-to-face classes can greatly compensate for the deficiencies in practical instruction due to university closures.

It is hoped that the deficiency of academic lab education will be compensated for with targeted workshop holding in the form of face-to-face teaching-learning in the post-corona era because as Milovanović et al. (2020) also asserted workshops could offer a unique learning experience for students in higher education. Therefore, Covid-19 pandemic is a mandatory situation for improvement in virtual education and remote learning.

When students entered the lab for a limited amount of time, they were able to use the training much faster than conventional teaching. Education in Corona period offered several benefits for students such as familiarization with research, preparing power point and presenting virtual content. Students were able to watch videos lessons several times repeatedly and learn how to do research, prepare PowerPoint, present virtual content and especially experience teamwork and specific discussion.

Conclusion

The present study aimed to determine the views of students regarding virtual vs. face-to-face education. The evaluations which were based on students' class activity, the responses they provided to assignments, virtual forum participation and scores in the final exams illuminated that practical virtual instruction may not replace face-to-face instruction and may lower the level of technical instruction. However, if virtual instruction is applied in a way that it is directly used in practical face-to-face education, it not only accelerates the delivery of instruction, but it also enhances the quality and level of instruction. It can be inferred that if the theoretical basis of each practical course together pertinent guidelines are provided to students in the form of video clips and if written or MC tests are given to students before face-to-face instruction, students will enjoy a quality instruction which may lead to higher satisfaction on the part of students. It is suggested that

around a week before students' attendance in practical classes, the theoretical and practical contents of each course be virtually taught and tested. Thence, students will learn lab techniques and will be endowed with greater paraclinical skills.

References

- [1]. Basilaia, G., Kvavadze, D. (2020). Transition to online education in schools during a SARS-CoV-2 coronavirus (COVID-19) pandemic in Georgia. *Pedagogical Research*, 5(4), 10. <https://doi.org/10.29333/pr/7937>
- [2]. Chan, B. (2022). Impact of Covid 19 on the Academic Performance of Undergraduate Students using Performance Prism Model. *SpecialusisUgdymas*, 1(43), 952-960. <https://www.sumc.lt/index.php/se/article/view/109/103>
- [3]. Chanjaruan, I., Chinachana, C., & Damrongkijkosol, C. (2022). View of The Development of Participatory Management Model of Strengthen Motivating Factor of College Personal Management in Private Vocational College, *Res Militaris*, 12(n^o1), 111-119.
- [4]. Chick, R. C., Clifton, G. T., Peace, K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., & Vreeland, T. J. (2020). Using technology to maintain the education of residents during the COVID-19 pandemic. *Journal of Surgical Education*, 77(4), 729–732. DOI: 10.1016/j.jsurg.2020.03.018
- [5]. Gustiani, S. (2020). Students' Motivation in Online Learning During Covid-19 Pandemic Era : a Case Study. *Holistics Journal*, 12(2), 23–40. <https://jurnal.polsri.ac.id/index.php/holistic/article/view/3029>
- [6]. Hamidah, I., Sriyono, S., & Hudha, M. N. (2020). A Bibliometric analysis of Covid-19 research using VOSviewer. *Indonesian Journal of Science and Technology*, 5(2), 34-41. <https://ejournal.upi.edu/index.php/ijost/article/view/24522/pdf>
- [7]. Hidayat D, Noeraida N. (2020). The Communication Experience of Students Conducting Online Classes During the Covid-19 Pandemic. *JIKE J. Communal Science. Effect*, 3(2), pp. 172–182.
- [8]. Hofman, P., Ilić, M., Chamorey, E., Brest, P., Schiappa, R., & Nakache V, et al. (2021). Clinical and molecular practice of European thoracic pathology laboratories during the COVID-19 pandemic. The past and the near future. *ESMO open*, 6(1), 100024. DOI: 10.1016/j.esmoop.2020.100024
- [9]. Kashefian-Naeeni, S., & Sheikhezami-Naeini, Z. (2020). Communication Skills among School Masters of Different Gender in Shiraz, Iran. *International Journal of Advanced Science and Technology*, 29(2), 1607-1611. <http://sersec.org/journals/index.php/IJAST/article/view/3405/2350>
- [10]. Khasanah, DRAU, Pramudibyanto, H., & Widuroyekti, B. (2020). Education During the Covid-19 Pandemic. *Journal of Synesthesia*, 10(1), 41–48.

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- [11]. Milovanović, A., Kostić, M., Zorić, A., Đorđević, A., & Pešić, M., et al. (2020). Transferring COVID-19 Challenges into Learning Potentials: Online Workshops in Architectural Education. *Sustainability*, 12(17),7024. <https://doi.org/10.3390/su12177024>
- [12]. Mishra, L., Gupta, T., and Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *Int. J. Educ. Res.* 1:100012. doi: 10.1016/j.ijedro.2020.100012
- [13]. Olum, R., Atulinda, L., Kigozi, E., Nassozi, D. R., Mulekwa, A., & Bongomin F, et al. (2020). Medical Education and E-Learning During COVID-19 Pandemic: Awareness, Attitudes, Preferences, and Barriers Among Undergraduate Medicine and Nursing Students at Makerere University, Uganda. *Journal of Medical Education and Curricular Development*, 7, 1-9. doi: 10.1177/2382120520973212.
- [14]. Sahu, P. (2020). Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact on Education and Mental Health of Students and Academic Staff. *Cureus*, 12(4), e7541. <https://doi.org/10.7759/cureus.7541>
- [15]. Salahshouri A, Eslami K, Boostani H, et al. (2022). The university students' viewpoints on e-learning system during COVID-19 pandemic: the case of Iran. *Heliyon*, 8(2), e08984. doi:10.1016/j.heliyon. 2022. e08984
- [16]. Sharma D., & Bhaskar, S. (2020). Addressing the COVID-19 burden on medical education and training: the role of telemedicine and tele-education during and beyond the pandemic. *Frontiers in Public Health*, 8, 838. doi: 10.3389/fpubh.2020.589669.
- [17]. Singh, K., Srivastav, S., Bhardwaj, A. et al. (2020). Medical Education During the COVID-19 Pandemic: A Single Institution Experience. *Indian Pediatr* 57, 678–679. <https://doi.org/10.1007/s13312-020-1899-2>
- [18]. Wilcha R. J. (2020). Effectiveness of virtual medical teaching during the COVID-19 crisis: systematic review. *JMIR Medical Education*, 6(2), e20963. <https://mededu.jmir.org/2020/2/e20963/>