Strategies for teaching an online forensic science course during the pandemic

Nirmala Krishnamurthy[1]*

[1]*Department of Chemistry, Indian Institute of Science Education and Research, Karakambadi Road, Mangalam, Tirupati 517507, Andhra Pradesh, INDIA*
*corresponding author: nirmala@labs.iisertirupati.ac.in

Abstract: A significant consequence of the pandemic in higher education has been the switch to an online mode of teaching. This work highlights the various strategies adopted to teach an online introductory forensic science course at the Indian Institute of Science Education and Research (IISER) Tirupati during the pandemic. In addition, it also provides information on students' perspectives on the effectiveness of these methodologies adopted to teach forensic science as a subject. A combination of methods including live synchronous classes, asynchronous pre-recorded videos followed by active discussion in class, usage of Canvas as a learning management system, continuous assessment with individual and group activities were adopted as strategies to teach this online course. Survey results indicate that our students felt that the learning resources (such as live recording of classes and pre-recorded videos), interactive polls, chats, discussion forums, group projects and presentations helped them as they navigated through the online course. Furthermore, students also felt that online quizzes on Canvas and remotely proctored exams were effective in testing their knowledge and understanding of the subject. Overall, students enjoyed the forensic case study discussions, the interactive style of teaching and the various pedagogical strategies employed in the course. This report on our experience will hopefully guide educators in designing strategies to enhance student learning experience in forensic science.

Keywords: forensic science, online learning, synchronous, asynchronous, learning management system

Introduction

The COVID-19 pandemic resulted in the enforcement of strict social distancing and lockdowns in several parts of the world. Consequently, colleges and universities had to face the unprecedented challenge of moving from face-to-face teaching to an online mode of education (1, 2). In India, with the spread of the pandemic in Spring of 2020, higher educational institutions had to make an overnight transition to online teaching. While the first wave abated by Fall of 2020, India was in the grip of a devastating second wave during Spring 2021. As a result, several educational institutions across the country had to continue online classes throughout 2021.

The Indian Institute of Science Education and Research (IISER) Tirupati is an institute of national importance established by the Government of India (3, 4). The Institute offers a Bachelor of Science-Master of Science (BS-MS) five-year dual degree program in the basic sciences. Students in this program take two years of mandatory core courses in Physics, Chemistry, Biology and Mathematics along with the associated laboratory courses. This is followed by two years of various elective courses in their preferred field. The final year involves intensive research work on a thesis topic culminating in a BS-MS dual degree.

At IISER Tirupati, an introductory forensic science course is offered as an elective by the chemistry department as part of our undergraduate curriculum. This course covers various topics in forensic science such as crime scene investigation, time of death, blood and DNA analysis, ballistics, narcotics, toxicology etc. It is offered in the fall semester and is lecture-based with no laboratory component involved at this point of time. The course is open for third or fourth year students of the dual degree program at IISER Tirupati and is a popular choice of elective among the students of various majors.

In India, over the last two years, the pandemic has necessitated a transition from the traditional pedagogical methods of teaching to an online mode which has created several challenges. As a result, it is imperative that educators introduce effective pedagogical strategies for systematic teaching in this virtual mode. The goal of this work is to provide detailed documentation and insights into the various strategies that I adopted to teach an online forensics science course at IISER Tirupati. A combination of methods including live synchronous classes, asynchronous pre-recorded videos followed by active discussion in class, usage of Canvas as a learning management system, continuous assessment with individual and group activities were adopted as strategies to teach this online course. In addition, this work also delves into students' perspectives of the effectiveness of

these strategies in their learning and the various challenges encountered along the way. This work will hopefully provide information in designing effective teaching strategies and methodologies as we move beyond the pandemic.

Methods

General course information

This study was conducted in an elective forensic science course (CHM315) for third- and fourth-year students enrolled in the BS-MS program at IISER Tirupati during Fall 2021. The course covered a variety of forensic science topics such as crime scene investigation, time of death, elemental and compound analysis, law and forensics, blood analysis, DNA fingerprinting, wildlife forensics, ballistics, narcotics, fibre analysis and toxicology. The lectures on these topics were also interspersed with several case studies related to the topic of discussion for the week.

Strategies adopted in the online forensic science course

In order to overcome the challenges faced in online learning, I employed three different strategies to effectively teach and communicate in this forensic science course. These included the following:

a. Teaching methodology comprising live synchronous and asynchronous modes
b. Use of a learning management system (Canvas)
c. Individual and group assessments

In addition, to determine the perceived effectiveness of the above methods adopted in this course, data corresponding to student perspectives was collected by conducting an online survey for all the students registered in the course **(Appendix A)**. The survey was sent out through a Google Form to all the registered students of the class and was open for responses for two weeks. The survey was anonymous, voluntary and the students did not receive any points for participation. Out of 80 students registered in the course, 63 students (79%) responded to the survey (51% female, 41% male, 8% preferred not to say). The survey consisted of closed, open-ended and Likert scale questions and data analysis was performed on Excel software. This work was declared to be of exempt status by the ethics board and the office of the Dean of Research and Development at IISER Tirupati.

Results and Discussion

a. Teaching methodology comprising live synchronous and asynchronous modes

An effective teaching methodology is paramount to the success of any forensic science course (5, 6). For the online course in forensic science at IISER, I used a combination of synchronous and asynchronous teaching methods to communicate the material. This is a 4-credit course that involves 3 lecture hours per week. Two of these lectures were taught live in a synchronous fashion, while the remaining lecture hour was taught in an asynchronous fashion with short videos (that were pre-recorded) provided to the students. The students were then expected to watch these videos, participate in online discussion forums and complete any required activity for the week.
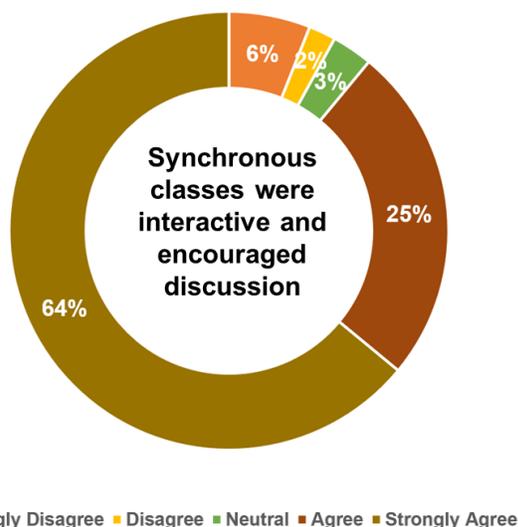
Synchronous mode of teaching

Synchronous mode involves course materials to be taught live via remote instruction through a video conferencing tool. For the online forensic science course, this was done during regular class hours twice a week via a video conferencing tool, Google Meet, GMeet (7). In order to encourage interaction and foster active participation amongst the students, the live lectures were interspersed with Q&A sessions, open discussion and online polls using mentimeter (8). The students also had the ability to ask questions and discuss during class on the live chat session on GMeet. The effectiveness of these methods is exemplified in the results of student survey in which 89% felt that the classes were interactive and encouraged active discussion **(FIGURE 1A)**.

All of these live class sessions were recorded and made available to the students through their Learning Management System (LMS). This implied that even if the students lost connectivity during live class and missed out on a crucial piece of information, they could still listen to these live recordings and learn the class material. In addition, they could go back and listen to these live recordings if needed as they prepared for their assessments and online exams. The effectiveness of providing this resource is evidenced by the fact that in our student survey, 88% agreed or strongly agreed that these recorded lectures helped them catch up with the class material that they had missed due to interruption in their connections **(FIGURE 1B)**. A significant majority of surveyed students also agreed or strongly agreed (80%) that these recording were extremely helpful in their preparation for assessments and online exams as it provided them an opportunity to "follow" the lecture multiple times **(FIGURE 1B).** Overall, the students perceived these synchronous lectures as interactive sessions that encouraged active discussion. In addition, recordings of these live sessions were

perceived to be helpful in catching up on class material and in preparation for their online assessments.
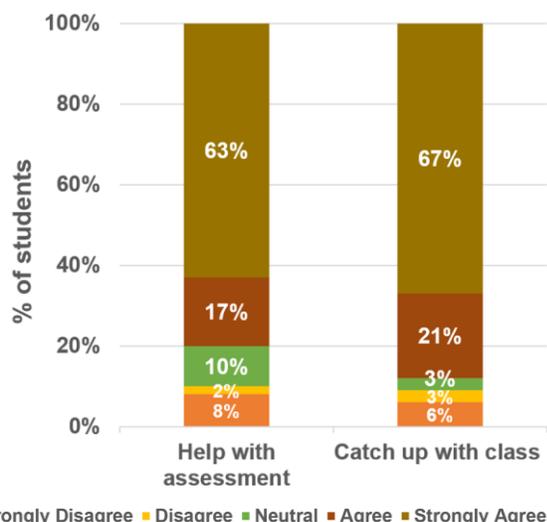
A

B

FIGURE 1 Student responses on live synchronized mode of teaching, N= 63. A) Pie chart depicting the distribution of students who felt that the synchronous classes were interactive and encouraged active discussion; B) Student responses about perceived effectiveness of recordings of live synchronous lectures

Asynchronous mode of teaching

Previous work has shown that flipped classroom and the use of pre-recorded videos can be an effective strategy in undergraduate education in various sciences and engineering (9, 10). As a result, I decided to employ this

asynchronous mode as a part of my teaching strategy for this online forensic science course during the pandemic. I recorded short (~15 minutes) videos on various topics in forensic science such as criminal liability, mapping a crime scene, presumptive and confirmatory tests for blood and analysis etc. These recordings were done in a lucid manner to ensure ease of understanding from the student's perspective and were posted on the learning management system prior to the scheduled class. The students were asked to watch the pre-recorded videos (98% of students indicated they watched these recordings) and come prepared for further discussions and analysis.

Students engaged in class discussions to clarify any lingering questions on this material. In addition, students were expected to participate in an online quiz (conducted on the learning management system) on the content of the pre-recorded videos to assess their understanding of the learning material. Overall, a flipped class style technique of pre-recording videos followed by quizzes and discussions was deployed to ensure an effective teaching methodology for this online forensic science course.

The success of this technique is borne by the student survey results in which 91% of students agreed or strongly agreed that the pre-recorded videos were clear and easy to follow **(FIGURE 2A)**. In addition, 86% of students felt that the quizzes conducted on this pre-recorded material was helpful in testing their understanding of the topic under discussion **(FIGURE 2A).**

Overall, a majority of the class (86%) felt that this method of watching pre-recorded videos followed by active discussion and quizzes was an effective learning strategy for this forensic science course **(FIGURE 2B)**.

b. Use of a Learning Management System (Canvas)

A learning management system (LMS) can be used as an effective tool of communication for online education (11, 12). For the forensic science course at IISER, I utilized Canvas as the LMS in order to provide an efficient and organized system to deliver all content related to the course (13). On Canvas, the course was organized into various modules such as introduction to forensics, legal aspects in forensics, crime scene investigations, time of death, blood and blood spatter analysis, DNA fingerprinting, toxicology etc. All class material pertinent to that particular module including links to recorded live classes, pre-recorded videos, PowerPoint slides, reference material and class notes were posted on these modules providing access to all class information. This ensured that the course content was well organized which in turn would make it efficient and easy to use at the student's end.

Lack of in-person communication is a hindrance to effective learning in an online mode. As a result, it becomes necessary for an instructor to maintain a constant

line of communication with the students. During synchronous classes, the students had the opportunity to directly ask questions or engage in communication either
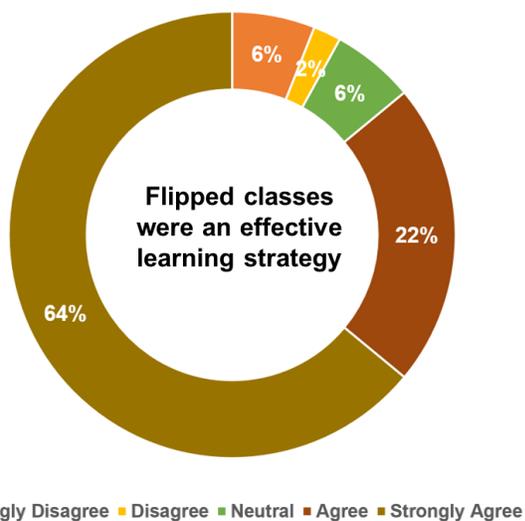
A
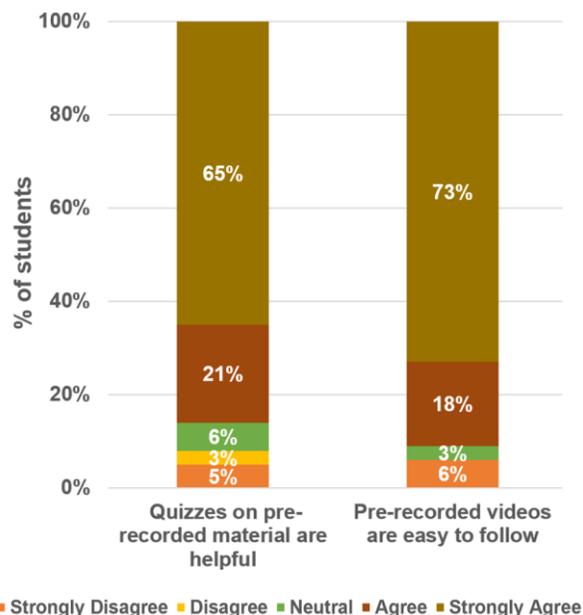
B

FIGURE 2 Student responses on asynchronized mode of teaching, N=63. A) Student responses on the perceived effectiveness of the pre-recorded videos in their learning; B) Pie chart depicting the distribution of students who felt that the flipped class technique was an effective learning strategy

with me or their peers through the chat box feature of GMeet. However, in order to continue this line of

communication beyond the classroom, I utilized Canvas as a tool to encourage further interaction with the students. Important information or announcement pertaining to assignments, quizzes and other reminders were posted on the announcements tab on Canvas and this immediately alerted the students ensuring constant communication. As part of the continuous assessment, students could also participate in online moderated quizzes conducted each week on the Canvas platform. In addition, I utilized the discussion forum on the Canvas platform to encourage interaction amongst the students on various forensic case studies. I would ask the students to read the literature on a well-known forensic case such as the O.J. Simpson trial or the Aarushi Talwar murder case. Then, in order to moderate the discussion on the forum, I provided the students with a couple of discussion points and questions pertaining to the case under study. This provided a launch pad for their interactions and encouraged them to express their thoughts, reply to other students' suggestions and questions and kept the conversation going beyond the classroom.

Overall, I used Canvas as a tool for communication with my students in the online mode and the effectiveness of this methodology is reflected in the student survey results discussed below. A majority of surveyed students agreed or strongly agreed that Canvas as an LMS was easy to use (86%) and well organized (92%) **(FIGURE 3)**. In addition, 76% of the students agreed or strongly agreed that analyzing case studies on the discussion forum on Canvas was interactive thus providing a great platform for effective communication beyond the classroom **(FIGURE 3).**
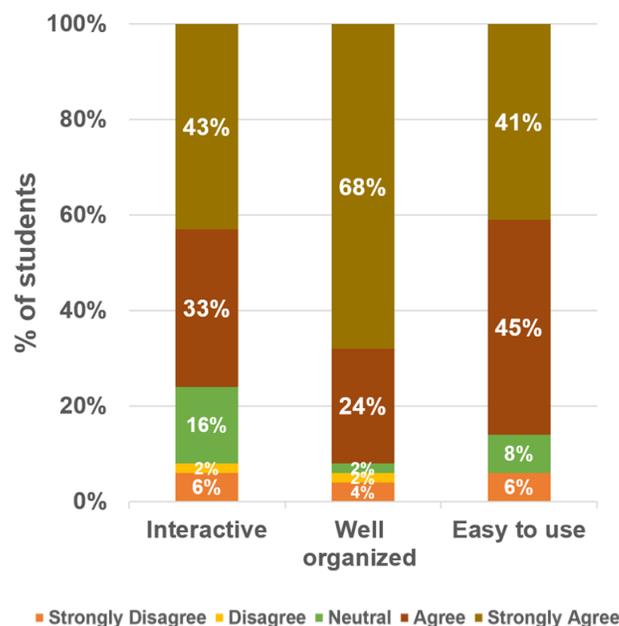

FIGURE 3 Student perceptions on the use of Canvas as an effective learning tool, N=63

c. Individual and group assessments

Previous work has shown that there are several challenges to designing an effective assessment pattern for online courses (14, 15). This is exacerbated by the fact that students feel less prepared to participate in assignments and assessments when face-to-face teaching is limited (16). As a result, it is imperative to find an efficient strategy for assessment of student performance in an online course. The assessment model for this forensic science course involved continuous monitoring of student performance all through the semester. Students were expected to participate in both individual and group work assessments. The individual assessments included weekly quizzes, mid-semester and end-semester exams while the group assessment involved participation in either a group presentation or a group project. While mid-semester and end-semester exams were part of the assessment of the lecture-based course, the weekly quizzes, presentations and projects were specifically designed for this online course.

Individual assessments

For the individual assessments, the students were expected to participate in online quizzes and exams spread through the semester. The online quizzes were conducted on an almost weekly basis on Canvas and included quizzes on the pre-recorded videos or on material taught during the live lectures. In addition, the students had to take a mid-semester and end-semester exam organized by the Institute on an online platform called CodeTantra (17). This is a comprehensive AI assisted assessment platform with live remote human proctoring which helped minimize any malpractice issues with online exams. The platform also enabled the instructor to grade the questions and provide feedback to the students.

One of the major challenge to effective online learning in a developing nation like India is the lack of an uninterrupted access to Wi-Fi and broadband connectivity. This issue is especially exacerbated during live, timed online exams and assessments. In fact, 67% of our surveyed students reported that issue with internet connectivity was the major challenge while taking proctored online exams. However, despite this, a majority of the students agreed or strongly agreed that the online quizzes (86%) and proctored exams (76%) were effective in testing their learning and understanding of the course material (**FIGURE 4A and 4B**).
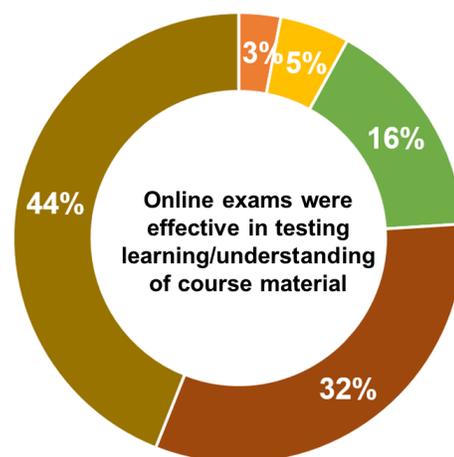
Group assessments

Previous research has shown that small group work in science promotes favorable attitudes towards learning (18, 19). In order to encourage team learning, the students in this forensic science course were asked to participate in
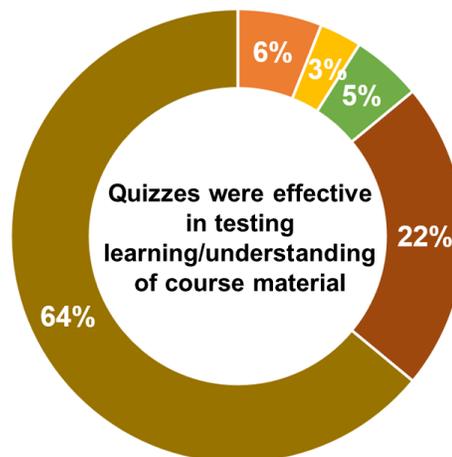
A

Quizzes were effective in testing learning/understanding of course material

6% 3% 5% 22% 64%

■ Strongly Disagree ■ Disagree ■ Neutral ■ Agree ■ Strongly Agree

B

Online exams were effective in testing learning/understanding of course material

3% 5% 16% 32% 44%

■ Strongly Disagree ■ Disagree ■ Neutral ■ Agree ■ Strongly Agree

FIGURE 4 Pie charts depicting student perception on the effectiveness of assessments in their learning/understanding of course material, N=63. A) Student responses on the perceived effectiveness of the online quizzes in their learning; B) Student responses on the perceived effectiveness of the online exams in their learning

either a group presentation or group project (2-3 members per team). Of the students who responded in the survey, 52% worked on the presentation while 48% participated in the group project.

In the group presentation, students had to choose a forensic case study based on topics related to course content (see **Appendix B** for the complete list). The students were then expected to research the case study and give a twenty-minute PowerPoint presentation describing the background of the forensic case, the crime layout, the events after the crime, detailed forensic evidence, steps undertaken to finding the suspect, trial in a court of law and the role of media.

The group project, on the other hand, involved a Do-It-Yourself crime scene in which the students had to set up and document a crime scene. The crime scene (homicide) was staged in either their home or in the dorm room complete with a weapon of choice, several forensic evidences and the deceased individual (pillow, soft toy, dummy etc.). The students were then asked to document the scene with sequential photographs, a sketch of the crime scene with mapping details and a note with a list of evidences collected and packaged. They also had to record a short video with a crime scene walkthrough and evidence collection.

The students clearly displayed a high degree of creativity and enjoyed the challenge and experience of working as part of a team. The student survey results indicated that a majority of the students agreed or strongly agreed that it was clear what was expected to be done in the group work (presentation: 82% and project: 77%) **(FIGURE 5A and 5B)**. The students also enjoyed working with their peers both for the group presentation (70%) and group project (81%). A majority of the students who chose the project also agreed/strongly agreed that the idea behind the project was interesting (84%) and helped in their understanding of analyzing a crime scene (87%) **(FIGURE 5B).**

General student comments about the course

As part of the survey, students were also asked closed and open ended questions in which they shared their background in forensic science and the experiences in the course **(Appendix A)**. Survey results showed that many of the students who registered for this introductory level course in forensic science had no previous experience or familiarity in forensic sciences. Only 35% of the respondents of this survey mentioned that they were familiar with the basics in forensic science techniques and reported they had gained this mainly through movies, crime series and books. As a result, it was essential that the course should kindle an interest in the area of forensic sciences and this was done through the various pedagogical approaches described herein. As part of the survey, students were asked on what was the most enjoyable part of the course. Perusal of this open ended question in the survey reveals that 40% of students found discussions about the various forensic case studies as the most enjoyab-
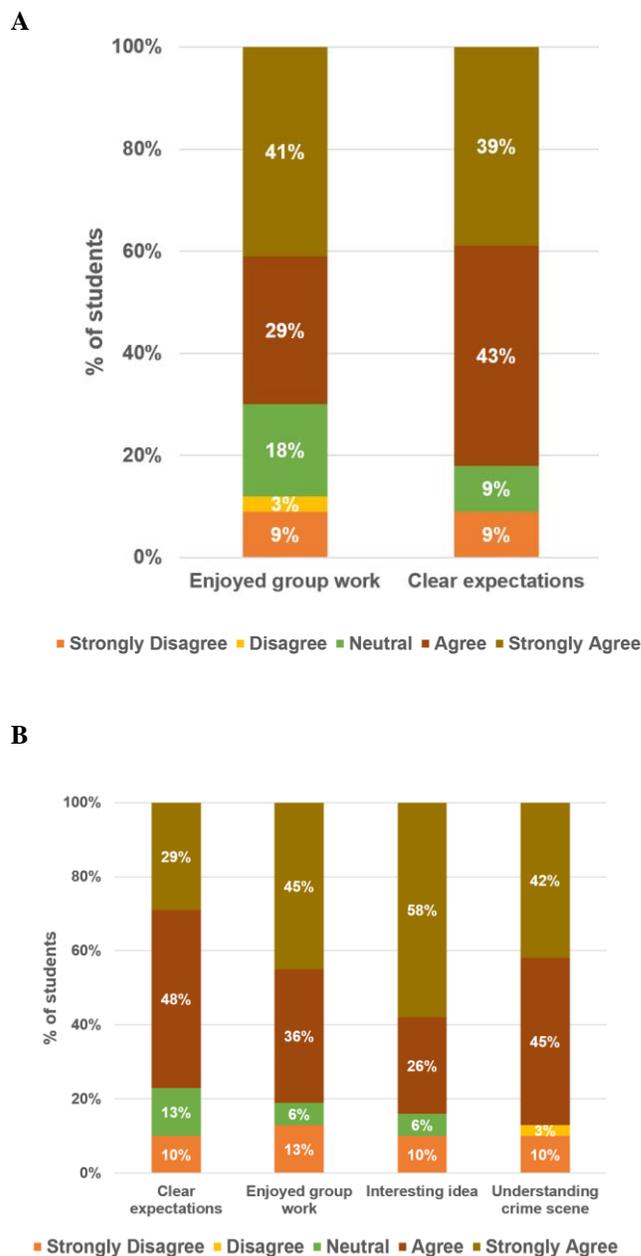
A

B

FIGURE 5 Student responses on group assessments, N=63 A) Student responses on the perceived effectiveness of group presentations in their learning; B) Student responses on the perceived effectiveness of group projects in their learning

-le part of the course. 38% of students mentioned that they enjoyed the interactive course style and the various pedagogical methods adopted to teach this online course. The remaining 22% of students mentioned that they enjoyed specific topics such as crime scene investigations, forensic aspects in law, blood analysis etc. Interestingly, at

the end of the semester, 95% of students surveyed mentioned that the course stimulated their interest in the field of forensic science. In addition, 76% indicated that they would be willing to attend an advanced course in forensics if offered at IISER Tirupati. The main suggestion for change from the students was to include some hands-on experience in forensic science techniques and to restore the face-to-face experience in the future.

Conclusion

Teaching an online class, especially during the pandemic, has been a daunting task for educators all over the globe. This work shows the strategies that were successfully adopted to teach a forensics science course online to students in India during the pandemic. A combination of live classes, pre-recorded videos, usage of a LMS interspersed with online chats, discussion forums and group work was adopted to teach this course. While live classes and LMS have been previously used to navigate through online forensic science courses (11), this work provides a unique student perspective on the effectiveness of these strategies. Our students at IISER Tirupati felt that the various learning resources provided to them such as videos (both recorded live and pre-recorded), interactive polls, chats, discussion forums, group projects and presentations helped them as they navigated learning in this online forensic science course. In addition, they felt that the online quizzes and exams were effective in testing their understanding of the subject. Overall, a majority of the students felt that the class stimulated their interest in the subject and they enjoyed the interactive style and the pedagogical methods deployed in this course.

This study is limited by sample size and the number of survey respondents from the forensic science course at IISER Tirupati. As this is a voluntary, anonymous student survey, it only indicates student perceptions on the effectiveness of the various strategies deployed in the course and is not indicative of any other larger scenario.

Overall, this work highlights the importance of understanding student perceptions and gaining insights into their opinions and concerns. Over the last two years, the pandemic has brought major changes to the field of higher education and there is a distinct possibility that online and hybrid courses are here to stay. This study provides information on the various strategies that could be effectively deployed in the teaching of online forensic science courses. In addition, these techniques can also be used to supplement a face-to-face learning in order to make it more effective. As a result, it is necessary for forensic science educators to learn to be flexible and adapt to provide an enriching learning experience to students in an ever-changing scenario.

References

1. World Health Organization. Coronavirus Disease (COVID-19) Pandemic. https://www.who.int/health-topics/coronavirus/ (accessed 2022-22-06).
2. Sun L, Tang Y, Zuo W. Coronavirus pushed education online. Nat Mater 2020;19(6):687.
3. Khare A. IISERs: new initiative towards excellence in science. Curr Sci 2016;110(5):763-765.
4. Krishnan MS, Brakaspathy R, Arunan E. Chemical education in India: addressing current challenges and optimizing opportunities. J Chem Educ 2016;93: 1731-1736.
5. Shukla RK. A new systematic approach of teaching and learning of forensic science for interdisciplinary students: A step towards renovating the forensic education system. Forensic Sci Int:Synergy 2021;3: 100146.
6. Coticone S, Garcia C, Van Houten LB. Pivoting remote: techniques for teaching forensic science utilizing virtual student-led case studies in a blend flex mode. J Forensic Sci Educ 2021;3(2).
7. *Google Meet* (GMeet: premium video meetings). https://apps.google.com/meet/ (accessed 2022-22-06).
8. *Mentimeter* (Interactive presentation software) https://www.mentimeter.com/ (accessed 2022-22-06).
9. Fautch JM. The flipped classroom for teaching organic chemistry in small classes: is it effective? Chem Educ Res Pract 2015;16:179.
10. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP. Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci USA 2014;111: 8410-8415.
11. Londino-Smolar G. Remotely teaching a large enrollment introduction to forensic science course. J Forensic Sci Educ 2020;2(2).
12. Londino-Smolar G, Hansel C. Let's solve it: designing an interactive online forensic science lab. JHETP 2021;21:73-88.
13. *Canvas* (Canvas by instructure). https://canvas.instructure.com/. (accessed 2022-22-06).
14. Krishnamurthy N. Teaching freshmen chemistry in India during the COVID-19 pandemic: Student

perspectives and challenges. J Chem Educ 2021; 98(12): 3884.

15. Connon CC, Greenspoon SA, Simmons T. Crafting an effective virtual classroom in the COVID-19 pandemic. J Forensic Sci Educ 2020;2(2).

16. Jackson A. The Expectation Gap: Students' Experience of Learning During Covid-19 and Their Expectations for Next Year. https://wonkhe.com/blogs/the-expectation-gap-students-experience-of-learning-during-covid-19-and-their-expectations-for-next-year/. (accessed 2022-22-06).

17. *CODETANTRA*. https://www.codetantra.com/ (accessed 2022-22-06).

18. Taylor A. Top 10 reasons students dislike working in small groups…and why I do it anyway. Biochem Mol Biol Educ 2011;39(3):219-20.

19. Springer L, Stanne ME, Donovan SS. Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. Rev Educ Res 1999;69(1):21-51.

Appendix A

Student Survey Questions

1. What was your knowledge of Forensic Science at the beginning of the course?
- No previous experience /familiarity with the subject
- Familiar with some of the basics of the subject
- Have experience with advanced material in the subject.

2. If you answered that you are familiar with the forensic sciences (either with the basics or the advanced level) please explain from where have you gained this information?

As part of this course, you were expected to attend live synchronous lectures twice a week.

Likert scale: Strongly disagree, disagree, neutral, agree, strongly agree

3. Questions on live lectures
A. The classes were interactive and encouraged active discussion.
B. Recorded videos of live lectures helped me catch up on things I did not understand during class.
C. Recorded videos of live lectures helped me in preparation for assessments and exams.

As part of this course, you were expected to watch short pre-recorded videos posted on Canvas. You were then expected to participate in in-class discussions and short online quizzes based on the pre-recorded material.

4. Did you watch the full versions of the pre-recorded videos posted on Canvas from start to finish? Yes/No

Likert scale: Strongly disagree, disagree, neutral, agree, strongly agree

5. Questions on Pre-recorded videos
A. Pre-recorded videos posted on Canvas were easy to follow and understand.
B. Short in-class quizzes on pre-recorded videos were helpful in testing my understanding of the material discussed.
C. I believe the flipped class model (watching pre-recorded videos followed by in-class discussion of material) is an effective learning strategy.

6. Learning Management System
A. The learning management system for the course (Canvas) was easy to use and efficient.
B. The content was well organized on Canvas through various modules.
C. The discussion forum on Canvas was interactive and helpful in analyzing case studies.

7. Assessments
A. Graded quizzes were effective in testing my learning/understanding of the course material.
B. On-line exams were effective in testing my learning/understanding of the course material.

8. What challenges did you face while taking online exams?
- Issues with internet connectivity
- Issues with scanning and uploading the exam on the exam portal
- Issues with maintaining time/following instructions in an online setting
- Distractions at home/living space

Group work:

The course was designed to accommodate one of two group activities: a group presentation OR a group project.

9. Which one did you choose to work on for the course? Please check one.
- Group presentation
- Group project

If you chose presentation, please answer Q10. If you chose project, please answer Q11.

Likert scale: Strongly disagree, disagree, neutral, agree, strongly agree

10. Questions on group work: presentation
A. It was clear what was required to be done in the group presentation.
B. I enjoyed working as part of a group.

11. Questions on group work: project
A. The idea behind the group project was innovative and interesting.
B. The project helped my understanding of analyzing a crime scene.
C. It was clear what was required to be done in the group project.
D. I enjoyed working as part of a group.

12. Overall, do you believe that the course stimulated your interest in the subject. Yes/No

13. Would you be interested to participate/register for a second semester of a course in forensic science focused on advanced topics? Yes/No

Open ended questions

14. What was the most enjoyable aspect of the course?

15. What additional features/changes would you suggest be incorporated in the future for this course?

16. Gender:
- Male
- Female
- Prefer not to say

Appendix B

List of forensic case studies for the group presentation

1. Murder of Pradyuman Thakur
2. Sheena Bora murder
3. Murder of Krystal Beslanowitch
4. The Lindbergh kidnapping
5. Lynette White case
6. Joseph Kappen: The Saturday Night Strangler
7. Neeraj Grover murder
8. The Green River killer
9. Pamela Shelley murder case
10. Jeffrey MacDonald case
11. Richard Rogers: The Last Call Killer
12. Casey Anthony case
13. Richard Ramirez: The Night Stalker
14. Golden State killer