

Vol. 9(7), pp. 297-303, September 2021

<https://doi.org/10.14662/ijarer2021.300>

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Full Length Research

Hybrid Teaching of Introductory Programming during the COVID-19 Pandemic – a Case Study

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Submission Date: 5 September 2021

Accepted Date: 15 September 2021

Abstract

The paper presents a case study of teaching an introductory computer science programming class in a hybrid flexible mode at a liberal arts college during the COVID-19 pandemic. The hybrid teaching and learning model provides face-to-face learning to in-person students and simultaneously distance learning to remote learners. Asynchronous online learning tools have been adapted to aid the unconventional teaching approach. To better assess the effectiveness of student learning in the hybrid mode, an exit survey was conducted. The paper discusses participants' responses regarding learning preferences and challenges faced in the hybrid learning mode.

Keywords: Introductory programming, First-year undergraduate, remote learning, hybrid teaching

Cite This Article As: Tian, T. (2021). Hybrid Teaching of Introductory Programming during the COVID-19 Pandemic – a Case Study. *Inter. J. Acad. Res. Educ. Rev.* 9(7): 297-303

INTRODUCTION

Manhattan College is a private, Lasallian Catholic, liberal arts college in New York City. This student-centered institution lays strong focuses on low student-faculty ratio and small class sizes. The college currently enrolls 3,894 students with the majority (3,316 students) being undergraduate. The student body represents 44 U.S. states and territories and more than 60 countries. 46% of our students are women and 31% are minorities. In January 2020, the World Health Organization (WHO) published the discovery of the new coronavirus, which later named as COVID-19. On March 11, 2020, WHO made the assessment to characterize COVID-19 as a pandemic¹. The virus spread all over the globe. New York City was particularly hit hard. In mid-March 2020, Manhattan College made the transition from face-to-face classroom teaching to remote teaching, and it lasted throughout the remainder of the spring semester.

For academic year 2020 - 2021, the college moved to a highly flexible teaching and learning model, which offered in-person, reduced-density learning. Classes were redesigned to accommodate remote learning for students that are immune compromised and for ones that did not feel comfortable returning to campus. The new hybrid teaching was a live dual-model that provided face-to-face learning to in-person students and simultaneously remote learning to students who were not able to be on campus.

¹<https://www.who.int/news/item/27-04-2020-who-timeline---covid-19>

Many higher education institutions across the globe have migrated some, if not all, teaching and learning activities online. Azlan et al. (2020) presented the implementation of e-learning in the Master of Medical Physics program at the University of Malaya during the COVID-19 pandemic. King Mongkut's University in Thailand adopted the concept of hybrid classroom, aiming to reduce the physical contact on campus (Triyason et al., 2020). In (Danjou, 2020), the author detailed an experience of teaching organic chemistry tutorials to a small class of first-year undergraduate students during the lockdown in France. Faculty at Davidson College shared examples of how department members collaborated with students to ensure a smooth transition to remote teaching while maintaining inclusive excellence (Anstey, 2020). (Sunasee, 2020) describes the challenges of teaching organic chemistry online at an undergraduate institution. In (Hamid and Rashid, 2020; Connolly and Mutchler, 2021; Seeling, 2020), educators share recent experiences of modifying entry-level computer science courses to transition from face-to-face learning to a fully online model. (Ahlin, 2020) compares two different modalities (traditional and hybrid) in teaching an undergraduate research methods class and evaluates student engagement and master of course content. (Smoyer et al., 2020) conducted a survey of undergraduate social work students regarding their experiences with remote learning. Results are particularly useful in studying how distance learning shapes the interpersonal relationship and communication.

In this paper, we present a case study of teaching an entry-level programming class in the hybrid flexible mode at Manhattan College. C++ was used as the programming language for the course. The introductory programming curricula include principal topics such as flow control, functions, and arrays. To assess the efficiency of the hybrid teaching approach, students were asked to complete a questionnaire at the end of the semester.

The rest of the paper is organized as follows. Section 2 describes the live dual-model teaching method, which enabled synchronous learning for on-campus students and remote learners. Asynchronous online learning tools were used to aid the unconventional teaching approach. In Section 3, we discuss the assessment of student learning and course evaluation. Results of the questionnaire are presented. Section 4 concludes the paper.

Teaching Method

CMPT-101 Computer Science I is an introductory programming course offered by the Computer Science Department at Manhattan College. The course aims to teach fundamental concepts of computer science and programming to audience with no related experience. Most of the students who enroll in the class are freshman students of Computer Science majors. This study is based on a class size of 23 students, which include 21 freshmen and two senior students. Their disciplines range from Computer Science to Mathematics, Mechanical Engineering and Finance. Figure 1 shows the enrollment percentage of each discipline.

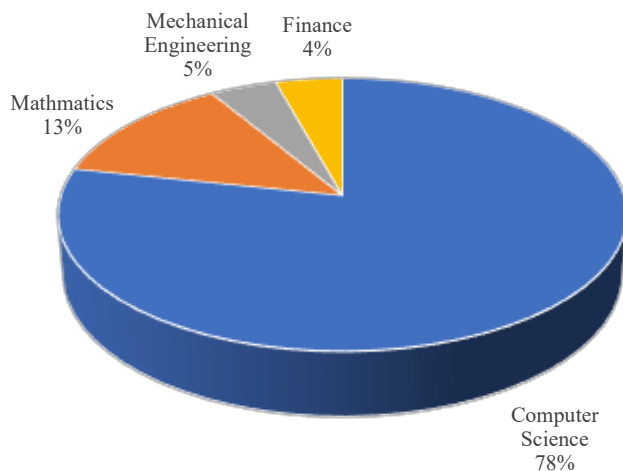


Figure 1. Percentage of enrollment by discipline

Before the academic year started, students had to declare themselves as a remote or in-person learner. In this class, 43% of the students registered their status as remote, while the rest 57% of the class attended the lectures on campus in the traditional face-to-face manner.

CMPT-101 is conducted in the computer lab, where each student has access to a desktop station for practicing and developing C++ programs. As novice programmers, they often encounter syntactic and compiling errors, where the instructor needs to step in to guide them with the debugging. Due to Covid-19 restrictions and social distancing guidelines, an alternative approach was needed in order for the instructor to view programs on individual computer stations and maintain a physical distance in the meantime. Our solution was LanSchool², a classroom management software supported by Lenovo that helps to guide digital learning in a school setting and promotes collaboration and connection between teachers and students. One of the key features LanSchool provides is screen monitoring, which enables the instructor to view all students' screens. Figure 2 illustrates an example adapted from lanschool.com. As a result, communication with the in-person students has been greatly improved while following the safety protocols.

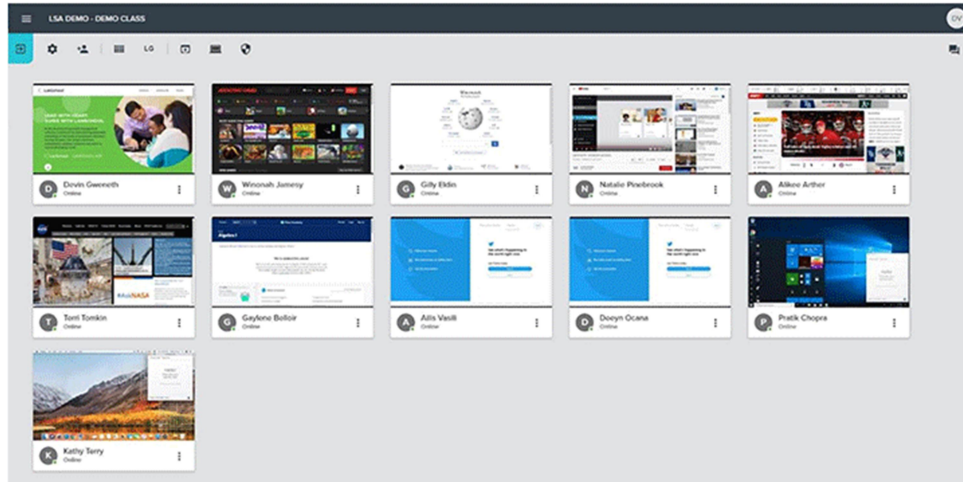


Figure 2. Example of screen monitoring with LanSchool (lanschool.com)

The remote teaching is facilitated through synchronous web-conferencing classes. Remote students are engaged in learning at the regular class hours through Google Meet³, which allows students and teachers to communicate in real-time. A meeting code has been shared with the students prior to the start of the semester. Among the many features provided by Google Meet, two of them are frequently used in the class. They are screen sharing and messaging. Screen sharing allows the instructor to present the entire screen or an application window to the audience. This is especially useful when presenting PowerPoint slides to the remote group. Moreover, it makes possible to share real-time code development with the class, which is an essential component in an introductory programming class. Reversely, the screen sharing feature can also be used for e-learning students to present their code to the teacher when they need assistance with debugging a program.

Google Meet's messaging feature makes classes more engaging with live chatting during calls. Remote students are able to ask questions in writing. Additionally, it allows the instructor to share files, links and other messages with the participants. The build-in messaging feature is sufficient when the chat contains mainly text. However, a different tool is required to illustrate visual contents and to share simultaneous drawings. Traditionally, the instructor uses a whiteboard or a chalkboard in a typical classroom setting. However, it is not an option in hybrid teaching mode when there is a group of distance learners. To better accommodate them, each classroom is equipped with an IPEVO V4K ultra high-definition USB document camera⁴, seen in Figure 3. It features an 8-megapixel camera that offers high-definition resolutions up to 3264 x 2448 for capturing details of live images without pixilation.

The document camera is specially designed for its fast-focusing speed, which helps minimizing interruptions when the presenter switches between different materials at high resolutions. The camera is compatible with a variety of software and applications. It can facilitate as a regular webcam when used with video conferencing software such as Google Meet. Alternatively, live streaming can be shared with Visualizer, a software developed by IPEVO that has an intuitive user interface and borderless window display.

²<https://lanschool.com/>

³meet.google.com

⁴<https://ipevo.com/>



Figure 3. IPEVO V4K document camera (ipevo.com)

Besides regular class meetings, the remote teaching is also supplemented with online component, such as discussion boards or learning management systems, to meet time-on-task requirements. Moodle⁵, an asynchronous learning platform has been adopted to provide materials, lectures slides, assignments and exams that can be accessed by students at any time. Homework assignments and exams are set up with a given timeframe that students are asked to complete. For fairness, distance examinations apply to all students, including both face-to-face participants and remote learners.

Discussion

To evaluate students' experiences with hybrid learning, an exit survey was conducted at the end of the semester. The survey contained five multiple choices and two open-ended questions. No identification or demographic information was collected in order to preserve participants' anonymity. In total, 22 responses were submitted, resulting a response rate of over 95 percent. This section presents the survey results and discusses participants' responses regarding learning preferences and challenges faced in the hybrid learning mode.

Which teaching method do you think is the best for an introductory programming class?

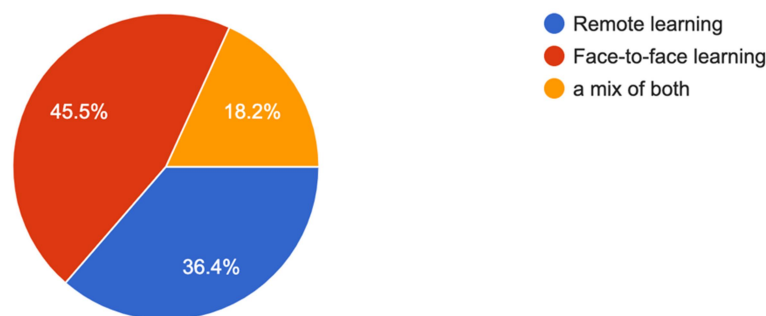


Figure 4. Survey question 1 – preferred teaching method

As shown in Figure 4, over 45 percent of the students described face-to-face learning as their preferred format in taking an introductory programming class. Meanwhile, 36 percent of the respondents preferred remote learning. The remaining 18 percent of the participants expressed desires for both learning methods.

⁵<https://moodle.org/>

What is your opinion regarding distance examinations?

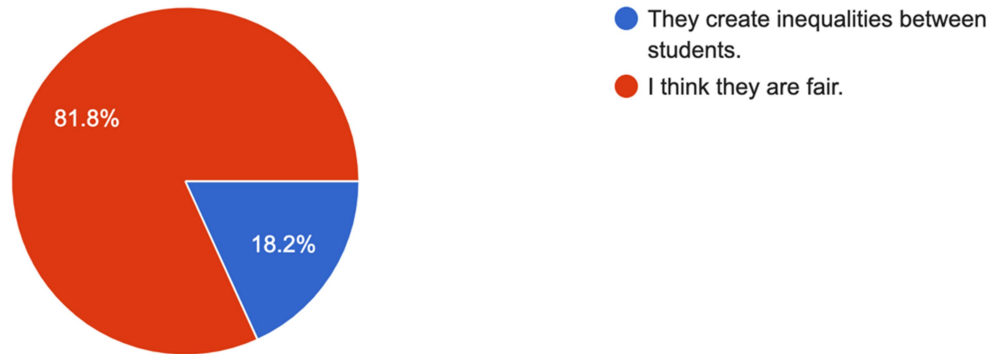


Figure 5. Survey question 2 – distance examinations

As mentioned in Section 2, distance examinations applied to both in-person and remote students. With exam questions uploaded on Moodle, students were required to turn in their solutions within a given time frame. The majority of the respondents thought they were fair, while a small group of students expressed the concern that remote exams may create inequalities among individuals.

Some colleges use pre-recorded videos for lectures. Would you prefer that over live sessions?

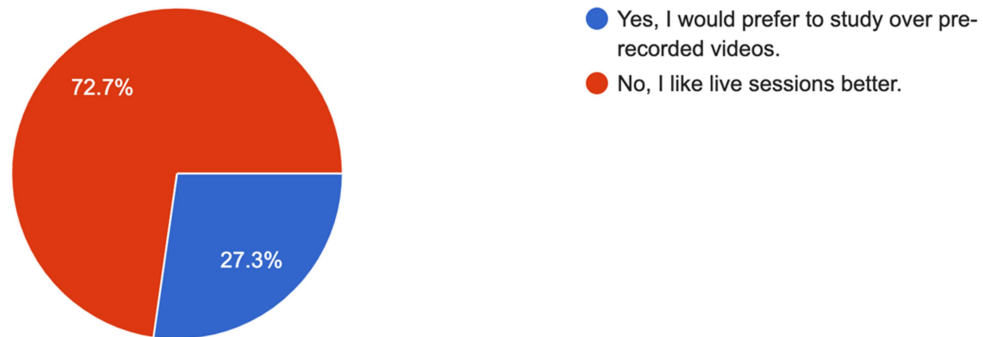


Figure 6. Survey question 3 – lecture mode

At Manhattan College, all lectures are delivered live. Both the instructor and remote students join the online conference at regular class hours. The instructor is able to pause lecturing during the live stream, ask questions, and collect real-time feedback from students before proceeding with the new material. Live sessions as such are flexible, dynamic and responsive. In our survey (shown in Figure 6), more than 70 percent of the respondents were satisfied with live lectures. The remaining participants, however, preferred to study over pre-recorded videos.

Do you have enough resources and technology support for remote learning?

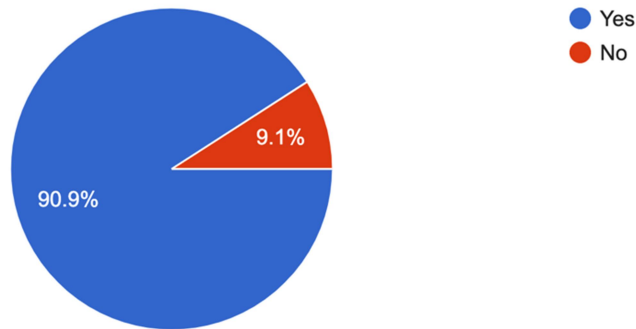


Figure 7. Survey question 4 – resources and technology support

Technology is the key to ensure effective distance learning. Without physical access to the computer labs on campus, remote students have to rely on their personal equipment to attend live lectures and complete assignments and exams. Minimum requirements include a computer that supports synchronous video conferencing and the programming software (Visual Studio) used in the class and fast and stable internet connection. The computer should be equipped with a microphone and a webcam for better communication. During our survey, most of the respondents claimed to have enough resources and technology support for remote learning (seen in Figure 7). Less than 10 percent of the participants stated that a better computer would enhance their learning experience.

What aspects of remote learning do you like the most?

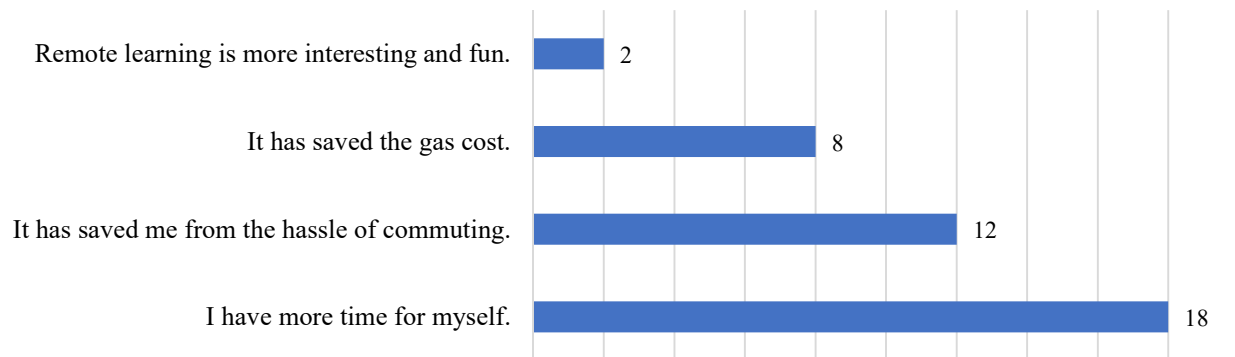


Figure 8. Survey question 5 – benefits of remote learning

When asked which aspects of distance learning are the most favorable, 90 percent of the respondents answered that remote learning allows them to have more personal time (shown in Figure 8). More than half of the participants expressed that the remote learning method frees them from commuting and 40 percent of the students benefited from it by saving the gas cost. About 10 percent of the survey participants described remote learning as more interesting and fun than the traditional teaching method.

The last part of the survey consists of two open-ended questions. Participants were inquired of the challenges faced during remote learning and how they overcame them. Answers are optional. Around half of the students participated in this part of the survey. Many respondents expressed the difficulty of staying focused during a lecture when they are not in a classroom setting. Other responses include challenges to balance personal wants and personal needs, and to keep pace with live lectures. As for approaches to overcome those challenges, we received some inspiring feedbacks, such as making plans ahead, taking notes during lectures, placing oneself in an empty room without distractions, and putting away phones and other electronic devices.

CONCLUSION

The paper presents a case study of teaching a freshman computer science programming class in a hybrid flexible mode at a liberal arts college during the COVID-19 pandemic. The hybrid teaching and learning model enables two groups of audience to engage in a live lecture simultaneously. One group is the face-to-face students in the traditional classroom setting, and the other group is the remote learners that cannot be physically present on campus. The paper discusses the live dual-model teaching method and introduces the tools and recourses that were used to assist the unconventional teaching approach. To better assess the effectiveness of student learning in the hybrid mode, an exit survey was conducted at the end of the semester. Based on the responses, we have learned that most participants favor the traditional face-to-face teaching method for an entry-level programming class. When remote learning is offered, the vast majority of the respondents prefer live lectures over pre-recorded sessions. Many students like the fact that distance learning has allowed them more personal time, while some also point out the challenges to stay concentrated not being physically present in a classroom.

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