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Teaching in a time of pandemic: The case of the EMET Program at Pennsylvania State University – Fayette

Abstract

The author shares his experiences of university teaching during the time of restrictions imposed on teaching and learning modes due to a pandemic. The relative scarcity of literature analyzing the response in the fields of science and engineering to the pandemic served as motivation. After providing general background information about the pandemic's impact on educational systems worldwide, the article provides qualitative research with a narrative model for a case study of an engineering program at an American university. The analyzed case concerns the teaching and learning methodologies implemented in an electro-mechanical engineering technology bachelor's degree program at Pennsylvania State University – the Fayette campus in the academic years 2020-22. Pennsylvania State University's chosen teaching modes in the time of the pandemic to be used by instructors provide an example of adaptability of a higher education institution to the changing teaching and learning circumstances. The pedagogical approach to preparing, delivering, and assessment of learning effectiveness in engineering courses with a laboratory component is described. The article also shows how to use the learning management system, Canvas, with its analytical utility tool, to improve effectiveness and responsiveness of the teaching and learning process. The shortcomings and unexpected benefits of learning online pedagogy are shared and discussed. To assess the students' perception and the study mode and their preferences in this regard, an anonymous, closed-ended, nominal-polytomous questionnaire was conducted, and its findings are analyzed. Further, to compare the students' preferences as regards study modes depending on the academic discipline, engineering students were contrasted with students studying business as their major. The surveys also provide answers to trends in the longer term in students' expectations for delivery of programs by higher education institutions.

Keywords: educational system, teaching modes, online learning, pandemic, engineering program

Introduction

From elementary schools to university level, irrespective of the geographical location and country, education systems were impacted by pandemic-related restrictions with various levels of severity. The effects of COVID-19 on education worldwide have been described in various publications in economics, pedagogical, and educational literature. Even by April of 2020, the World Economic Forum (WEF, 2020) had reported that 1.2 billion students worldwide found themselves [locked] out of the classroom in 186 countries impacted by school closures. Countries worldwide, responding to the pandemic, established different policies and educational guidelines to follow, which consequently affected the educational processes and their outcomes differently (Bozkurt et al., 2020; Pokhrel & Chhetri, 2021). In the case of the USA, the individual states pursued their own policies, under the federal legal system, which had various implications for educational processes and measured outcomes. All fifty of the states closed schools for face-to-face or in-person instruction at some point at the beginning of the pandemic, in spring 2020 (Ballotpedia, 2022). While some states in the USA such as

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Florida, Montana, and Wyoming (Ballotpedia, 2022; Freeman, 2020) opened their schools earlier after some delays due to changing pandemic circumstances in late 2020 or early in 2021, the majority of states kept schools closed for much longer (Ballotpedia, 2022). As Ballotpedia (2022) reports, "by the end of the 2020–20021 academic year, about 66% of students were in states that left closure decisions to schools or districts (most of them were closed), 33% were in states with state-ordered in-person instruction, and 1% were in states with state-ordered regional school closures."

In August 2021, the U.S. Department of Education (U.S. Department of Education, 2021) released a "Return to School Roadmap" that provided "key resources and supports for students, parents, educators, and school communities to build excitement around returning to classrooms this school year", and outlined "how federal funding can support the safe and sustained return to in-person learning." Many states kept schools closed well into the 2020/21 school year and beyond, causing students' deficiencies regarding basic skills such as math and reading in K-12 education, which are either hard to make up or completely irreversible. In a report assessing student learning done remotely or via hybrid methods, throughout the pandemic, McKinsey& Company (Dorn et al., 2021) analyzed data for 1.6 million elementary school students across more than forty states in the USA, comparing students' performance in spring 2021 with the performance of students prior to the pandemic, and found that "students testing in 2021 were about ten points behind in math and nine points behind in reading." Translating this information into school-time or month of learning, McKinsey& Company (Dorn et al., 2021) reported that "students are five months behind in math and four months behind in reading."

Naturally, the negative impact encompasses both tangible and intangible losses, both being definitely intertwined. For the former, The Wall Street Journal (Chapman, & Belskin, 2022) reported that the "pandemic learning loss could cost students 70,000 (U.S. dollars) in lifetime earnings" due to a degraded skill set and consequently lower productivity in later years. Furthermore, a study by Stanford University economists (Hanushek & Woessmann, 2020) projects possible losses for the overall USA economy of USD 28 trillion over the rest of this century. Worldwide, according to the Stanford study (Hanushek & Woessmann, 2020) "For nations, the lower long-term growth related to such losses <due to closed schools> might yield an average of 1.5 percent lower annual GDP for the remainder of the century."

McKinsey& Company (Dorn et al., 2021) reported that the harm caused by the pandemic goes well beyond academics: "Roughly 80 percent of parents had some level of concern about their child's mental health or social and emotional health and development since the pandemic began" with "35 percent of parents very or extremely concerned about their child's mental health…social and emotional health."

School openings worldwide: the road back to in-person teaching

Worldwide, Denmark was one of the first countries to open schools, as far back as spring 2020, with some restrictions, which were only gradually relaxed (Kingsley, 2020). Many other countries pursued much more restricted policies well into the 2020/21 academic year (Bozkurt et al., 2020). As far as the USA is concerned, as mentioned, a U.S. Department of Education document from August, 2021 specified the guidelines for school districts to prepare for the academic year 2021/22 with its "Return to School Roadmap," which "will lay out actionable strategies to implement the Centers for Disease Control and Prevention's (CDC) updated guidance for K-12 schools, so that schools can minimize transmission and sustain in-person learning all school-year long." The guidelines focused on three priorities: "(1) prioritizing the health and safety of students, staff, and educators, (2) building school communities and supporting students' social, emotional, and mental health, and (3) accelerating academic achievement." Due to various levels of administrative and legal dependence of the states and their school districts on governmental mandates, the school districts and universities pursued different policies regarding the pandemic.

Learning technologies and COVID-19

Even prior to the COVID-19 breakout, countries worldwide were spending a substantial amount of money on educational technologies. The World Economic Forum (WEF, 2020) reported that prior to the pandemic "there was already high growth and adoption in education technology, with global edtech investments reaching USD 18.66 billion in 2019 and the overall market for online education projected to reach USD 350 billion by 2025." From the moment of COVID-19, expenditures on educational technologies and their usage only increased. These educational tools include virtual tutoring, video conferencing tools, online learning software, and language apps.

There are articles presently in the literature that describe in detail how different countries and their educational systems on different continents responded to the new challenge of adapting to a new online learning environment (Bozkurt et al., 2020; Rabiega-Wiśniewska et al., 2022; WEF, 2020). The education institutions responded to new requirements of remote learning [by prohibiting] face-to-face contact in classrooms. Consequently, education institutions have changed significantly, relying mostly on online learning, whereby teaching was undertaken remotely and on digital platforms (WEF, 2020). Many authors (Abdrasheva et al., 2022; Bakker & Wagner, 2020; Bozkurt et al., 2020; WEF, 2020) point out the "digital divide" among different countries and among different groups within specific countries and societies that affected the availability, access, and effectiveness of online learning processes.

Higher learning institutions' response to the pandemic: initiatives, online learning, challenges

Similarly to other parts of the educational systems, higher education institutions were forced to shift suddenly from the classroom to an online learning environment worldwide in spring 2020. To facilitate the transition, governments and higher education institutions developed initiatives to support students, including providing students with SIM cards, providing devices for online learning, [providing/enabling] direct cash transfers, [enabling] late payment for tuition fee or tuition cuts, and providing food vouchers, interest-free loans, etc. (Abdrasheva et al., 2022). The effectiveness of the transition to online learning was dependent, in general, on many factors, including the availability of the needed infrastructure for remote communication, technological support provided by institutions, and a faculty's level of familiarity and experience with online learning technological tools (Abdrasheva et al., 2022; Gapinski, 2020, 2023; Pokhrel & Chhetri, 2021; WEF, 2020).

Turnbull et al. (2021) provided an early report on higher education institutions' response to the pandemic with respect to educational technologies in use and the challenges encountered by staff and students. In their analysis, they considered only papers in English with empirical findings. They found that most papers were health-related or general in nature, and lacked specific academic discipline focus. A scarcity of papers on higher education institutions' response to the pandemic was reported for science and engineering.

The factors that the RAND Corporation determined as key indicators of pandemic preparedness and consequently efficient transition to online learning were: "1. Providing devices (such as laptops and tablets); 2. Training teachers on delivering online instruction; 3. Using an LMS; 4. Providing fully online or blended learning courses; 5. Establishing plans to deliver instruction during a prolonged school closure" (Eadens et al., 2022) higher education institutions seem to be much better prepared than K-12 education, due to having a longer period of experience in online learning, and academically much more mature students.

Does the selected dominant online learning mode chosen by higher education institutions restrict the development of vital skills of the receivers on the other end of communication links? Educational researchers (Bakker & Wagner, 2020; Lv et al., 2022; WEF, 2020) worry that new technology with online learning will lead to a return to less favorable pedagogy – transmission of knowledge at the expense of fostering analytical and critical thinking abilities. Bakker and Wagner (2020) noted that most of the challenges facing education due to the pandemic are transdisciplinary in nature, but "some have unique characteristics for mathematics learning." The same authors point out the consequences of the pandemic for research activities and the way the researchers are modifying their activities due to new circumstances, and also draw attention to the unexpected benefit and importance of forced pausing and reflection on scientific endeavor and discovery. They made an eloquent comparison between situations imposed during the pandemic of the [….] unknown to Dante's *Divina Commedia* scenario, written in the 1300s, and an inability "to find the right way '*la diritta via*'." Abdrasheva et al. (2022) reported that "roughly 58% of global researchers experienced significant disruptions and delays in their research projects since they had no access to laboratories and specialized equipment."

The ramifications of the changing educational environment in times of a pandemic go beyond the selection of proper and most effective teaching methodologies. In 2020, Erduran (2020) pointed out that the COVID-19 pandemic placed additional responsibility on science education due to "growing mistrust in science" in general due to misinformation or conflicting messaging disseminated by the mass media, online, or even by governmental agencies.

A World Economic Forum publication (WEF, 2020) points out the benefits of online study, citing evidence that online study is conducive to retaining 25–60% more information compared to 8–10% in a classroom environment, and that online study requires 40–60% less time to learn than traditional face-to-face settings (WEF, 2020). According to the authors (WEF, 2020), in online study, students learn at their own pace, retrieving the needed information whenever desired.

Pennsylvania State University: teaching modes

Similarly to other U.S. universities, Pennsylvania State University (PSU), commonly referred to as Penn State, switched fully to online mode after the academic Spring Break of March 2020. The initial teaching methodology of remote learning either in synchronous or asynchronous mode was enhanced, in the consecutive semesters, with a hybrid delivery method that combined online components with traditional face-to-face teaching but with strict distancing and mandatory mask procedures. At the PSU-Fayette campus, the electro-mechanical engineering technology program (EMET, n.d.) maintained the online, hybrid delivery method in the 2020/21 semesters, returning to face-to-face classes in spring 2022 in most classes. Pennsylvania State University responded to the pandemic by offering various options regarding the teaching mode early on in 2020, and for fall 2022, after some changes in the original settings, the following options were available to instructors (PSU-Registrar, 2022):

- In Person (P): the class meets in person on the days and at times listed. Instructors can offer up to 25 percent of an in-person class remotely (synchronously or asynchronously), and have flexibility to manage their own absences, whether due to illness or other unavoidable circumstances, during travel, or for pedagogical reasons.

- Hybrid: 25–50% Remote (H2): the class meets meet in person and remotely. 25–50% of the class will be taught remotely, synchronously or asynchronously.
- Hybrid: 51–74% Remote (H5): the class meets in person and remotely. 51–74% of the class will be taught remotely, synchronously or asynchronously.
- Hybrid: 75% and up Remote (H7): the class meets in person and remotely. 75–99% or more of the class will be taught remotely, synchronously or asynchronously.
- Remote Asynchronous (RA): the class meets remotely. 100% of the class will be taught remotely, asynchronously.
- Remote Synchronous (RS): the class meets remotely on the days and at the times listed. 100% of the class will be taught remotely synchronously. Instructors can offer up to 25 percent of a Remote Synchronous class remotely asynchronously, and have flexibility to manage their own absences, whether due to illness or other unavoidable circumstances, during travel, or for pedagogical reasons.
- Video-Receiving (VR): a shared class that a campus receives on the days and at the times listed. 100% of the class will be taught remotely synchronously. Instructors can offer up to 25 percent of a Remote Synchronous class asynchronously, and have flexibility to manage their own absences, whether due to illness or other unavoidable circumstances, during travel, or for pedagogical reasons. This only applies to the Digital Learning Cooperative (DLC).
- Remote Blended (RB): the class meets 100% remotely. The class will be taught remotely, combining asynchronous and synchronous (on days and at times listed) instruction. 50% or more of the class will be taught asynchronously.

Electro-Mechanical Engineering Technology program at Pennsylvania State University – Fayette

The electro-mechanical engineering technology (EMET) four-year degree program (EMET, n.d.), interdisciplinary by nature, combining electrical and mechanical engineering areas of study, prepares graduates for industrial and manufacturing environments in product design, development, and production. Penn State – Fayette (one of the campuses of Pennsylvania State University) EMET program learning objectives correspond to the Accreditation Board for Engineering and Technology (ABET) (ww.abet.org):

- an ability to apply knowledge, techniques, skills, and modern tools of mathematics, science, engineering, and technology to solve a broad range of engineering problems appropriate to the discipline,
- an ability to design systems, components, or processes meeting specified needs for a broad range of engineering problems appropriate to the discipline,
- an ability to apply written, oral, and graphical communication in a broad range of technical and non-technical environments; and an ability to identify and use appropriate technical literature,
- an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes,
- an ability to function effectively as a member as well as a leader in technical teams.

EMET pedagogy, teaching / study modes and technologies

The EMET courses were offered online in the middle of spring 2020, due to breakout of the pandemic and, after a few semesters of online and hybrid delivery, there was a return to mostly face-to-face activities in the fall of 2022. Naturally, throughout 2020, there were substantial difficulties, especially for instructors facing a heavy laboratory program component in multiple courses in their transition to delivery completely online. In particular, the author of the article was required to deliver EET 275 PLC Controls, EMET 230 Computerized I/O Systems (Introduction to concepts of structured programming, data acquisition, computerized interfaces, and graphical user interfaces), EMET 330 Measurement Theory and Instrumentation (Fundamentals of measuring, transmitting, and recording temperature, pressure, flow, force, displacement, and velocity; the laboratory component emphasizes systems used in manufacturing), EMET 410 Automated Control Systems (Introduction to analog feedback control theory and computer simulation and analysis using MATLAB; laboratory study of feedback systems), and EMET 403 Electromechanical Senior Design Project, among others, initially in spring and summer 2020 completely online, and later in hybrid, and face-to-face mode, subject to required distancing.

These courses with intensive laboratory components required from the author the preparation of rather extensive instructional material to be posted using the Learning Management System (LMS) Canvas. The materials included detailed instructional guides for the labs, video recordings for all laboratory assignments and material, and other class material with 24/7 access by students (see Figures 1 and 2 in the online version of the journal). In the case of laboratory assignments, the lab kits were provided by the campus to students, and the students [created, set up] labs at their home with guidance provided by the instructor in either synchronous or asynchronous mode, depending on the needs. The online delivery of lectures or laboratory activities was performed via a video-conferencing tool, Zoom (https://www.zoom.us). The Zoom sessions were accessed through LMS Canvas, which provided proper log-in authorization. The author's class sizes varied during the 2020–2022

semesters, between seven and seventeen. Despite the challenging teaching and learning environment, the EMET students were successful in completing their course work and finalizing their education senior design projects throughout the pandemic years 2020–22 (Milasi & Gapinski, 2023).

Based on the author's observations, online class delivery is more suitable for academically mature students, while academically weak students struggle, especially with more mathematically advanced content. This realization motivated the author, based on his long experience with either hybrid or online delivery modes (Gapinski, 2012, 2013, 2020, 2023) to create an extensive library of video recordings on dedicated topics of various duration for students to review asynchronously, as needed. Most of the recorded instructional videos were from twenty to thirty minutes in duration. In each of the classes taught by the author, well over sixty dedicated video recordings on specific topics were prepared by the author and posted on the LMS Canvas-Media Gallery for 24/7 access by students (see Figure 2). Figure 2 shows a sample of the author's video recordings made for the EMET 410 Automated Control Systems class, such as Process Control with PID, MATLAB Simulink, Manual PID Tuning with MATLAB simulations, Minimum vs Nonminimum Phase Systems, Solving ODEs, Wind Turbine PID Control System, and Stability of Closed-Loop Systems. The total number of instructional video recordings created by the author for this class reached over sixty. The author of the article received positive students' comments about the pedagogical approach that allowed students to review rather difficult material at their own convenience, 24/7. The following are samples of the comments given: "I liked the lab portion of the class. Because there was a lot of information, the lab helped me understand the lectures. He also made in-depth videos on each topic which was very helpful." (Fall 2022), "The notes were helpful, and the published material online was the most helpful." (Spring 2022).

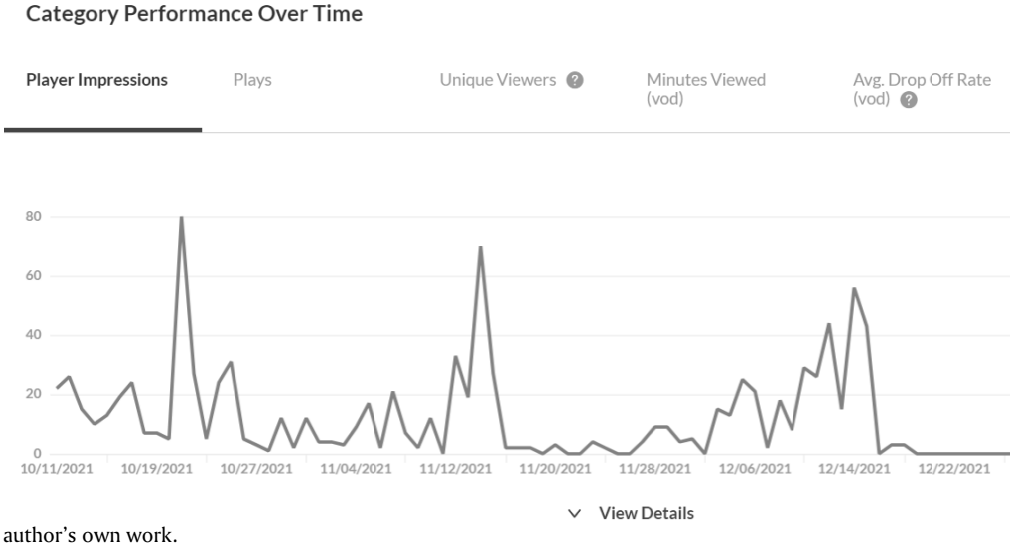
In courses that have pre-requisites, which is normal for engineering disciplines, the material posted on LMS Canvas played, in the author's eyes, an important role for a student's educational success. The LMS Canvas material, with its extensive instructional coverage, prepared by the author, allowed students to work and correct their own deficiencies, on their own time schedule, in the privacy of their homes. Naturally, the material posted on LMS Canvas enabled the instructor to provide the "flipped classroom" class format for students to learn material prior to classroom discussions and other related activities.

Pedagogy – taking advantage of the LMS Canvas Data Analytics

The Learning Management System (LMS), Canvas, has a built-in data analytics utility, which allows an instructor to monitor the access and usage by students of the instructional material posted on Canvas. This feature provides, in the author's view, a vital tool to monitor students' Canvas activity and provides information that can be useful when developing the right pedagogy in addressing specific topics. Furthermore, it provides the instructor with needed information on students to give specific students encouragement with a "gentle push" (see Figure 3 and 4). The Canvas monitoring feature, providing information on student usage, combined with the observed students' performance in class, allowed the instructor to adjust the lecture time devoted to specific topics as needed. Thus, the instructor was more nimble in addressing students' needs to better understand the material by tailoring class pedagogical methodologies that included engaging students in active learning individually or in groups.

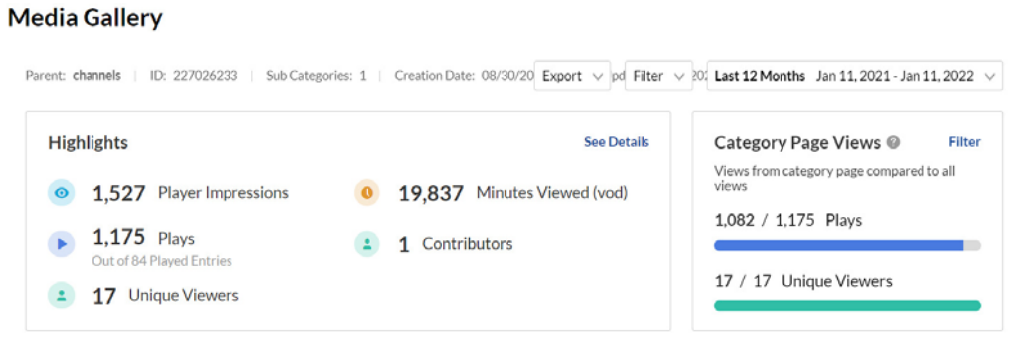
Figure 3

Canvas – Media Gallery. Data Analytics. Student usage time. Fall 2021. EMET 410 course



Source: author's own work.

Figure 4
Canvas – Media Gallery. Data Analytics. Student usage time. Fall 2021. EMET 410 course



Source: author's own work.

Figures 3 and 4 demonstrate the capability of the Canvas data analytics utility by showing data from the EMET 410 class, taught by the author in the fall of 2021. Namely, Figures 3 and 4 show the data collected for the EMET 410 course attended by sixteen EMET engineering students in the fall 2021 semester. As seen in Figure 4, the amount of time spent by sixteen students viewing the author's instructional video-recordings amounted to a total of 19,837 minutes (330 hours). This time does not include the time spent by students viewing other course instructional material posted on Canvas. This course, EMET 410, was a four-credit course, with five contact hours per week for lecture and associated laboratory activities. Figure 3 shows student usage of the video recordings prepared by the author during the semester with three clearly visible peaks before examinations, as one might expect. The assigned textbook for this course was *Modern Control Systems* by Dorf and Bishop (2017). Consequently, the instructional material posted by the author on LMS Canvas served as an additional resource available to students.

The Canvas data analytics utility allowed the author to monitor student usage of the Canvas resources on a weekly basis throughout the semester. As such, it provided vital information that enabled the author to formulate the pedagogical teaching methods to get more effective outcomes.

The author observed a strong positive correlation between the instructional viewing time, students' understanding of the material during the semester, and their final course grades. Students' understanding and comprehension of the material was assessed based on performance in examinations, pop-quizzes both online and in-class, homework assignments, laboratory work, student engagement, and class observations.

Quality assurance in the PSU-Fayette EMET program

As regards the issue of how to assure quality with the increasing number of online courses offered by universities and colleges, Swaak (2023) addressed this issue in a recent article that used a survey of college officials, performed by the nonprofit group Quality Matters and Encoura's Eduventures (Quality Matters, 2022). In the article, Swaak writes that while the "vast majority have quality standards, only a minority – 42 percent – reported that they always use them to evaluate new or heavily revised online courses."

Teaching at a higher learning institution naturally involves two parties: an instructor and a student. With a background in electrical engineering and computer science, the author participated in many pedagogical and instructional workshops and conferences throughout his academic career and has significant experience in using various software and educational technologies used in online and hybrid delivery methods. Students may initially have various levels of familiarity and knowledge of IT tools available on the campus, but at the junior level they are quite proficient in using them.

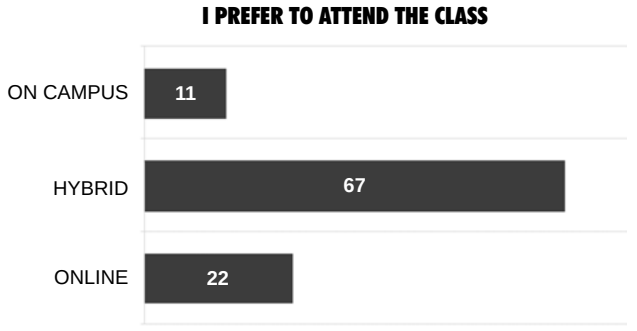
The discussed EMET program is ABET accredited, and as such has a detailed assessment protocol, which incorporates both qualitative and quantitative evaluation methods with performance indicators irrespective of the delivery method (face-to-face on campus, hybrid, online) to assess the meeting of designated learning outcomes. This involves the industry input on program contents and laboratory equipment, participation of industrial board members in senior project presentations, industry input about graduates' proficiencies, etc. Each EMET course has specific learning objectives and expected outcomes, and assessment rubrics listed by classes' syllabi. The assessment data are submitted by instructors for the comprehensive assessment reports. The reader is referred to ABET documentations and their assessment criteria.

The assessment of attainment of teaching and study objectives using the pedagogical methodologies described in the article in delivering EMET courses proved their educational utility value.

Student surveys: preferred teaching/study mode

To assess the students' perception and preferences as regards the study mode, an anonymous, closed-ended, nominal-polytomous questionnaire was administered and its findings are reported here. The EMET program students were asked about their

Figure 5
Engineering students' teaching mode preferences as a percentage. EMET 330 class. Spring 2021



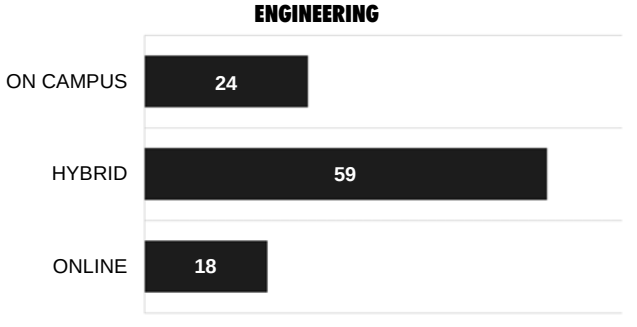
Source: author's own work.

preferred teaching/study mode with three options: on campus face-to-face, hybrid, or online. The survey was conducted among seniors of the PSU-Fayette EMET program in the spring of 2021 for seventeen students. Figure 5 shows the results of a survey among EMET senior students. The results show that students have a preference for the hybrid format due to the fact, in the author's view, that most students were adult students working either part time or even full time, so the time issue was essential for them, and they wanted to reduce travel time to/from campus. Many were working in the industrial park adjacent to the campus, in high-tech companies. The survey's online mode was understood as synchronous mode.

Does academic discipline affect the students' preferred teaching/study mode?

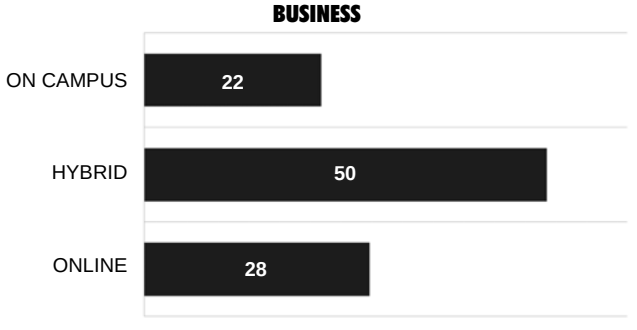
It was interesting for the author to check the students' preferences as regards the teaching and study mode (either on campus face-to-face, hybrid, or online) based on their academic major or discipline of study. Consequently, another academic discipline of business was chosen to compare and to contrast students' preference between the two different majors. Consequently, two academic disciplines were compared: the mentioned engineering program of electro-mechanical engineering technology at Pennsylvania State University – Fayette (EMET, n.d.) and business major at the University of Pittsburgh – Greensburg (UPG, 2022). The UPG Business program students were from general management, management information systems (MIS), and management accounting business majors. Most of the courses are quantitative in nature, in both the EMET program at PSU-Fayette and Business Management at UPG. However, as an engineering major, EMET has many more calculus-based courses. Both programs offered similar styles of teaching based on lectures delivered either on campus or online, instructional material posted on LMS Canvas for each course of comparable quality, and similar students' aids provided by campus IT staff assistance. The results of the anonymous, closed-ended, nominal-polytomous questionnaires are shown in Figures 6 and 7. On each campus, circa forty students were surveyed. The UPG campus was chosen due to the vicinity [due to proximity] and the fact that the research collaboration was already agreed with the UPG business faculty member.

Figure 6
Engineering students' preferences as regards the teaching mode as a percentage. PSU-Fayette. Spring 2022 semester



Source: author's own work.

Figure 7
Business students' preferences as regards teaching mode as a percentage. UPG. Spring 2022 semester



Source: author's own work.

In both cases, the Penn State University – Fayette and University of Pittsburg at Greensburg campuses, the students' preferred option was the hybrid teaching mode as of spring 2022, with 59% and 50% of responders, respectively. Furthermore, considering the second preferred option, while 24% of the surveyed PSU-Fayette students preferred campus face-to-face instruction, 28% of the surveyed UPG students preferred online delivery to instruction on campus. In the case of PSU-Fayette engineering students, based on the author's conversations with students, campus delivery was preferred to purely online mode due to the difficulty of mathematically-oriented contents of classes. Consequently, in the students' view, face-to-face sessions were more conducive to learning. In the case of UPG business students, based on the author's conversations with the UPG business faculty, most of the business students were working part-time, so travel time was a major concern for them. Consequently, their second preferred option was the online teaching mode. 18% of surveyed engineering students selected online delivery as the third option, while 22% of business students chose campus instruction as their third preferred option.

The results may be surprising, but the experiences of the students of the two programs during the years 2020–2022, during and after the COVID-19 pandemic, may provide some answers. It seems that the pandemic increased the level of anxiety about health issues in society in general, including within the student population. The combination of health-related concerns and the need for students to economize by reducing travel time to and from campus explains the selection by students of both programs of the hybrid format of class delivery as a mixture of on-campus and online instruction. Therefore, it is rather understandable that after the pandemic restrictions and difficulties students now expect more flexibility in class delivery methods.

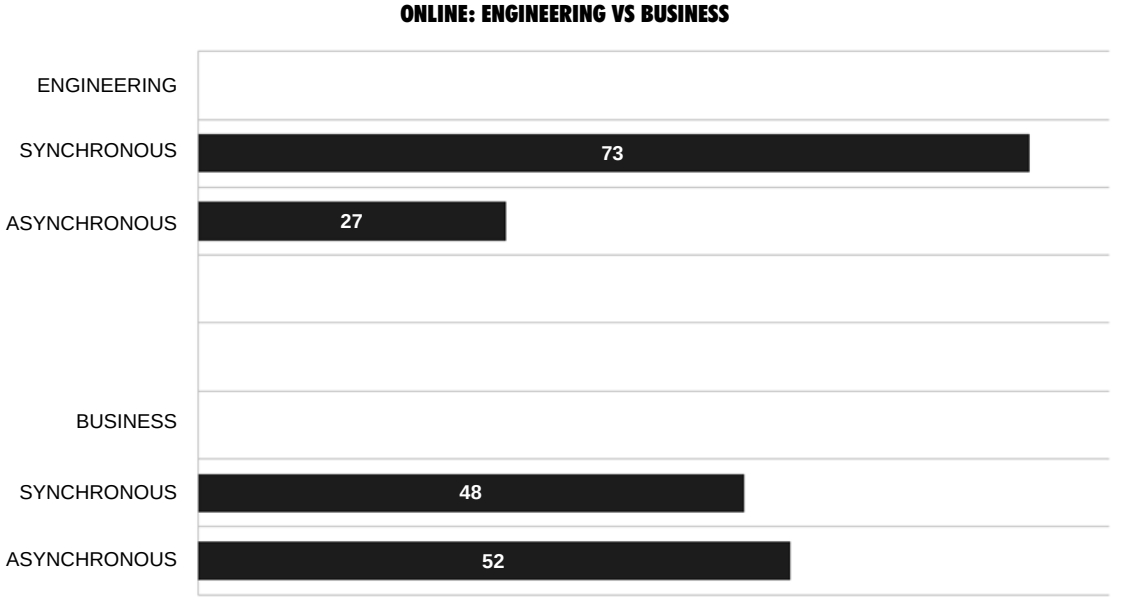
The survey results align with the subject of an article recently published by Hall (2023) in the Chronicle of Higher Education, where she reports that even with higher education institutions returning to campus face-to-face study, students, irrespective of age, expect convenience and flexibility in the courses offered online, and "didn't want online- and hybrid-learning options to disappear."

An interesting question for the author was what type of online format, whether synchronous or asynchronous, is the preferred choice of students of both [the two] majors. Consequently, the students of [the two] programs, engineering, and business, were asked about their preference between the online synchronous and online asynchronous mode of delivery. The results of the anonymous, closed-ended survey of students' preferences as regards online instructions in either synchronous or asynchronous mode are shown in Figure 8.

While the PSU-Fayette campus engineering students decidedly preferred a synchronous mode, with 73% of participants, 52% of the responding UPG business students preferred an asynchronous mode, see Figure 8. PSU-Fayette engineering students preferred the synchronous regular sessions with a video conferencing tool, Zoom, for two-way communication due, in the author's opinion, to rather difficult mathematical class content. Therefore, in the case of an unclear matter/issue, the synchronous online sessions allowed students to actively participate in the online sessions, and pose questions, in which case the unclear issue

Figure 8

Engineering vs business. Students' preferences as regards online teaching mode: synchronous vs asynchronous as a percentage. Spring 2022 semester



Source: author's own work.

was resolved almost instantly. In the case of business, based on a discussion with the business faculty member, the business students selected the asynchronous mode, with 52% responders preferring the synchronous mode, 48%, due mainly to the convenience of 24/7 access to the posted material.

The results of the surveys indicate longer-term trends in students' expectations regarding academic program delivery that have to be addressed by higher education institutions to provide viable options to students. Students expect and demand greater flexibility and convenience in teaching and study modalities, often involving online components, and other current learning technologies from higher education institutions, and these students' expectations are here to stay.

Conclusions

The goal of the article was to describe the ways the educational systems with higher education institutions responded to the challenges created by the pandemic worldwide and in the USA. In particular, the electro-mechanical engineering technology (EMET) program at Pennsylvania State University – Fayette was chosen by the author and a faculty member of the EMET program as a case study to explain the author's pedagogical journey undertaken for the last three years since the breakout of the pandemic to facilitate learning and meeting the teaching objectives in an ABET accredited program. The article provides qualitative research for the case of a U.S. engineering program using mostly narrative model [mostly using a narrative model/using a mostly narrative model] and consequently addresses the issue of scarcity of publications, as reported in literature, that focus on science and engineering during the pandemic. The implemented pedagogical methodologies that enable and support teaching and study in various modes in the engineering program are described. The article outlines the challenges the pandemic created for educational systems, and surprising if not unexpected benefits of the new ways of studying. The article also shows how to use the learning management system, Canvas, with its analytical utility tool to enhance pedagogical methodologies to improve effectiveness and responsiveness of the teaching and learning process. Furthermore, the paper analyzes the engineering students' perception and preferences as regards a teaching and study mode based on an anonymous, closed-ended, nominal-polytomous questionnaire. The article compares the students of different academic disciplines, namely engineering and business, in their preference as to teaching mode as well. It reveals the longer-term expectations of the post-pandemic generation of students, who require greater flexibility and convenience in program delivery methods offered by higher education institutions.

The long-term effects of the impediments to the teaching and learning environment due to the pandemic on students and graduates, changing preferences of students as regards teaching/study modes, and how higher education institutions and administrations at various levels can be better prepared for unexpected events are a few of the topics to be considered for further research.

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