Chapter 83

Educational Technology in Higher Education:
Online Teaching and Learning

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ABSTRACT

This article covered the trends in educational technology in higher education primarily pertaining to online teaching and learning. It begins by discussing the background information. A review of the current technology trends was presented with a brief overview of the technology. The last portion of the background information contains a survey conducted during COVID-19 at a state college in the northeastern United States, which asked faculty about their instructional and technical needs during remote teaching and learning. Given the rapid changes in technology in the higher education arena, there are four major issues that arrive causing challenges that need to be addressed. The chapter concludes by discussing the solutions and recommendations for effectively implementing and maintaining the trending technology in higher education. When discussing new technologies there are additional requirements, such as handling uncertainty in higher education and a decrease in funding which influences the budget for these new technologies.

BACKGROUND

The background information includes the projected new technologies expected within the higher education environment. The technologies included learning analytics, artificial intelligence, hybrid learning spaces, micro-credentials and skills-based requirements, and professional development for college teaching. Also, a brief overview of online teaching and learning was reviewed. Next in the background information, this section included a summary of what happened during COVID-19 and what we learned from COVID-19. The last portion of the background information contains a survey conducted during COVID-19 at a state college in the northeastern United States, which asked faculty about their instructional and technical needs during remote teaching and learning.

New Technologies in Higher Education

The new technologies in higher education are addressed in this portion of the background information. Each of the new technologies in higher education are introduced providing introductory information. In addition, the technologies are discussed introducing the benefits for application within the higher education environment. Later in the chapter, in the recommendations and solutions, the technical trends are discussed pertaining to the recommendations regarding funding, use of technology, and the best practices.

The newest technology developments consisted of six areas, as explained in the EDUCAUSE Horizon Report (Pelletier et al., 2022). Panelists were asked what were the newest developments in technology within the higher education teaching and learning arena (Educause Horizon Report, 2022). The Horizon Report (2022) mentioned six areas which included: learning analytics, AI learning tools, hybrid learning, hybrid/remote learning, micro credentialing, and professional development for hybrid/online learning. The pandemic helped facilitate swift movement towards AI, data collection and analytics, online learning, hybrid learning and micro-credentials (2022).

Learning Analytics

According to the Society for Learning Analytics Research (SOLAR), learning analytics is "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (https://www.solaresearch.org/about/what-is-learning-analytics/). SOLAR lists five goals for learning analytics:

1. Supporting student development of lifelong learning skills and strategies
2. Provision of personalized and timely feedback to students regarding their learning
3. Supporting development of important skills such as collaboration, critical thinking, communication and creativity
4. Develop student awareness by supporting self-reflection
5. Support quality learning and teaching by providing empirical evidence on the success of pedagogical innovations (SOLAR, 2022)

Student data can be collected and analyzed to assess the effects of certain types of teaching which reflect student learning. Also, student data can be used to provide feedback to help improve learning, as well as predict whether a student might drop a course or fail. Linden et al. (2022) wrote that analytics could be used to catch students at the earliest stages of their first year in university before they fail out of class(es). Students are monitored and data is collected based on assignments turned in, engagement with the Learning Management System (LMS), and whether they have reached out to tutoring or other help on campus. If a student misses the first assignment in the first three weeks of class, the student receives a phone call offering assistance in completing the missed coursework (Linden et al., 2022). This type of predictive analytics can make the difference between a student failing or passing a course.

Artificial Intelligence (AI)

Artificial Intelligence (AI), another emerging technology in higher education, can be used in a number of ways to assist students and faculty with learning and teaching (Alam, 2022). AI tutors, for example, can help students learn the basics of a subject, preparing them for success as the subject matter gets more complicated. Tlili et. al. (2021) found that AI can be used to discern between high- and low-quality Open Educational Resources, thereby saving faculty time and effort as they identify course materials. Tlili et al. (2021) commented that:

AI can be applied to classify the quality of OER based on different factors, including users' feedback, number of downloads, or ratings by applying ranking algorithms. This means that the users (e.g., learners or educators) will get to see more highly valued OER ahead of poorly published OER. (Tlili et al., 2021, p. 523)

More uses for AI in higher education are already in use, and even more will be identified in the coming years.

Hybrid Learning Spaces

Hybrid learning spaces can refer to more than one type of space. It can mean an instructor teaching from home and having students learn from home, while at the same time both instructor and students are "in class." This means they are arguably in two "places" at the same time (Cohen, et. al. 2020). The course modality can also be a learning space where some students are in the classroom with the instructor, while others are at home and watching via video camera and microphone, as well as on screen in the classroom (sometimes also called "HyFlex"). Either way, there is a crossing of spaces, a hybridity of some participants in the learning process being virtually in two places at once.

At the beginning of the COVID-19 pandemic, institutions of higher education moved swiftly from in-person to remote or hybrid teaching and learning. Even as this switch occurred, pedagogy scholars began to realize the importance of hybrid learning spaces. Cohen, et. al. (2020) wrote that

Education systems are beginning to recognize the potential of hybrid learning spaces in promoting significant learning, and increasingly use pedagogical hybrid learning models. Recent work has begun exploring the nature of hybridity from an educational design perspective. (Cohen et al., 2020, p. 1040)

When many higher education institutions began to return to in-person teaching, students demanded more flexible ways to access courses. They had become accustomed to learning from home, which helped them meet the demands of work, family, and other obligations while still engaging in learning. Institutions had to be flexible in order to keep students engaged – and enrolled. In 2022, faculty at many higher education institutions are teaching more online courses in order to accommodate the needs and demands of their students (Pelletier et al., 2022).

Educational design has to keep up with these changes. Classrooms are being outfitted with better cameras, microphones, and other technology to create better hybrid learning spaces than had been in existence before the pandemic. Designs of future learning spaces include physical and technological tools

through which instructors and students interact (Cohen, et. al, 2020). These designs allow for greater flexibility in teaching and learning.

Micro Credentials and Skills Based Requirements

Another area where flexibility comes into play are micro-credentials and skills-based requirements. Employers are starting to look for skills and micro-credentials rather than college degrees, and institutions of higher education must offer these in order to remain viable (van der Voet & Vermeeren, 2017). Micro credentials and skill-based learning can be part of the path to a degree for students, thereby increasing their return on investment for their education. Students might simultaneously feel more accomplished and feel that they have a step up in their job search, whether they graduate or not. Healy (2022) discovered 45% of the students completing a degree expressed interest in certifications or micro-credentials to obtain additional skills for employment.

A challenge to institutions of higher education offering micro credentials is making sure the student is aware of how a micro credential will help them gain employment or support their existing career (Healy 2022). "Education providers have a responsibility to ensure that career information and support is actively offered to micro credential learners, just as it is for students in degree programs" (Healy, p. 22). In addition to offering micro credentials, universities have to offer support around them to make sure students are being set up for success.

Professional Development for College Teaching

While there is a great deal of teacher training in the K12 arena, the same becomes sparingly for aspiring faculty members in graduate education. Professional development mainly happens once obtaining a faculty position, by Centers for Teaching Excellence or other similar entities. When Dooley et al. (2019) reviewed a collaborative online course design effort across nine institutions, faculty professional development was examined. One of the focuses of the study was on professional development of faculty with respect to instructional design. While the primary focus of the study was on the content modules, another piece was faculty professional development as described above (Dooley et al., 2019).

Dooley et al. (2019) found that there were improvements in faculty knowledge and use of instructional design. When compared to the beginning of the study, "the competence gained in instructional design showed growth from 6.5 to 8.0 in instructional design" (Abstract) In this study, professional development was proven in a quantitative way.

SHIFTS IN TECHNOLOGY AFTER COVID

During the COVID-19 pandemic, the United States shutdown all businesses with the exception of hospitals and many health care facilities switched to telehealth options, while universities and colleges globally and nationally closed down campuses. Tang (2022) stated that there was tremendous growth of educational technologies because of COVID.

Garcia-Penalvo et al. (2021) mentioned the primary goal was to finish the spring 2020 term. Colleges shifted to emergency remote teaching and learning. Face-to-face institutions were required to offer a distance learning modality in order to finish the term and maintain social distancing (Coman et al., 2020).

Garcia-Penalvo et al. (2021) stated that faculty who were falling behind in acceptance of distance technologies were forced to learn new technologies and complete the term applying these new technologies.

The influence of COVID shifted many aspects of college business. There are studies concluding what we learned from remote learning during COVID which we need to continue practicing.

Brown (2022) discussed what we learned through the experience of teaching remotely during COVID. Brown (2022) also stated the importance of access for students and modifying the course knowing that access could be a problem. Ni Fhlonin and Fitzmaurice (2021) commented that facilitating interactions with students needed to become a priority. While Valencia and Rincon (2022) stated the importance of developing a rapport between students and faculty, Manturuk and Reavis (2022) suggested that students appreciate the opportunity to chat in the video platform and participate in discussions.

Pelletier et al. (2022) mentioned that COVID helped us realize the benefits of hybrid and online learning. There is a need for developing effective practices and pedagogy for hybrid and online learning (Pelletier et al., 2022). There is a need for focusing on instructional design, enhancing pedagogy, investing more time and money to help further facilitate hybrid and online learning. Lastly, Pelletier et al. (2022) mentioned that it remains essential to strengthening access and engaging nontraditional students.

There were various disadvantages arising when the world switched to online learning. Coman et al. (2020) reported the obstacles and challenges included: teachers not knowing how to adapt teaching strategies, lacked knowledge of online learning, and minimal teaching experience with online modalities. Coman et al. (2020) discussed the university challenges as:

keeping an equilibrium between online courses, that could affect students health, them spending many hours in front of a screen, and non-digital activities, analyzing and focusing on student's emotional health—providing them with support throughout the process of learning, taking into account the fact that not all students have access to the internet, and managing and monitoring their access to devices in order to effectively collaborate with them. (para. 5)

Students were faced with their unique trials, Aboagye et al. (2020) mentioned the following as challenges for students:

administrative issues, academic skills, social interactions, technical skills, learner motivation, time and support for studies, cost, and access to the internet and technical problems were some of the challenges associated with online learning (p. 2).

Overall, Aboagye et al. (2020) discovered that accessibility to the internet and mobile devices were the most prevalent challenges for students.

Another realization that appeared during and after COVID-19 were the inequities in remote learning (Barber et al., 2021; Tang, 2022; Tucker-White, 2021; Xafis, 2020). Garcia-Penalvo et al. (2021) discussed that education is a human right and through the 'United Nations' (2019) fourth Sustainable Development Goal (SDG), everyone must have access to an inclusive, equitable quality education because education enables socioeconomic mobility upward and is key to escaping poverty (para. 2).

While Barber et al. (2021) discussed the health disparities amongst minority and first generation students (Xafis, 2020), there remain educational inequities within higher education which need to be

further addressed (Tang, 2022). Tang (2022) also stated that there remain inequities in higher education, in addition there are further recommendations, such as a call for student-centered learning, and collaboration amongst multiple departments or divisions.

FACULTY SURVEY RESULTS – ASSESSING FACULTY TECHNICAL NEEDS DURING REMOTE TEACHING AND LEARNING

Introduction

Literature supports the importance of communication and collaboration during a transitioning time, such as the COVID pandemic and swiftly changing to remote learning. There are various studies describing successful online instruction, yet we needed to wait for studies describing the remote learning experiences for students and faculty. This was the primary reason for facilitating the faculty survey, to discover the needs of faculty during this new phase of remote teaching and learning. Faculty were asked questions concerning their comfort or confidence level with various aspects of teaching remotely. Faculty were also asked questions pertaining to the faculty's perspective regarding their students' experience.

Survey Results

A survey was distributed to all faculty at a state college located in the northeastern United States. The purpose of the survey was to assess faculty technical needs related to moving to remote learning during the Spring 2020 semester, when the university closed because of COVID in March 2020. The Instruction and Research Technology department wanted to help support the faculty during remote learning. Yet, it was unknown how the faculty were progressing and if the faculty were experiencing technical challenges.

A twenty-four question survey was created and administered through Qualtrics. The surveys were sent through email to faculty teaching during the Spring 2020 semester. Approximately 750 faculty were sent an email invitation to participate in the survey. Three hundred fourteen faculty responded to the survey, with a 42% response rate. Forty-five percent were full-time faculty and 53% were considered adjuncts. The respondents were across colleges with the largest percentage, 36%, from the College of Humanities and Social Sciences. The next largest population was 23%, from the College of Health and Sciences.

When faculty were asked how challenged, uncomfortable or unfamiliar they were with the required technologies or applications, 46% expressed a low challenge level (See Figure 1). 38% expressed a moderate challenge with the technologies or applications. The remaining 15% responded with either a high challenge or a very high challenge. Thus, 54% (n=140) of the faculty expressed feelings of being uncomfortable with the required technologies or applications.

A similar question was asked of the faculty, but looking for the student perspective. Faculty responded that their students seemed challenged by the technologies or applications of remote learning. Thirty-one percent of the faculty responded that their students experienced a low challenge response to technology and applications (See Figure 2). 43% percent of the faculty responded that their students experienced a moderate challenge. Twenty percent responded with a high challenge, and 4% very high challenge with technologies and applications.

The next question asked about access to the Learning Management System (LMS), Blackboard, and video conferencing (Webex, Teams, Blackboard Collaborate). Fifty-seven percent of the respondents

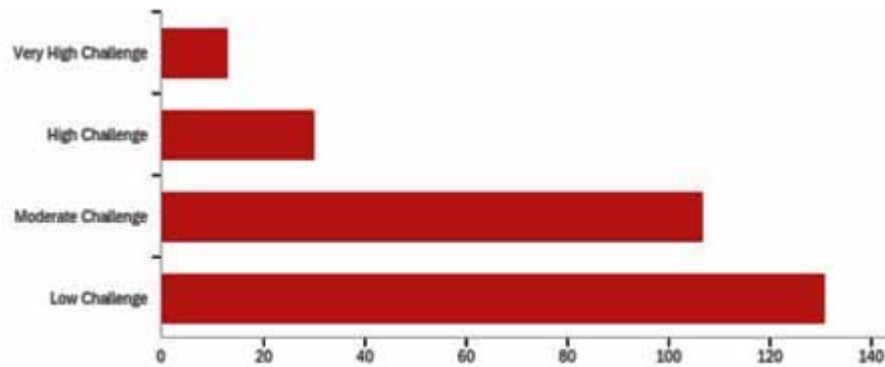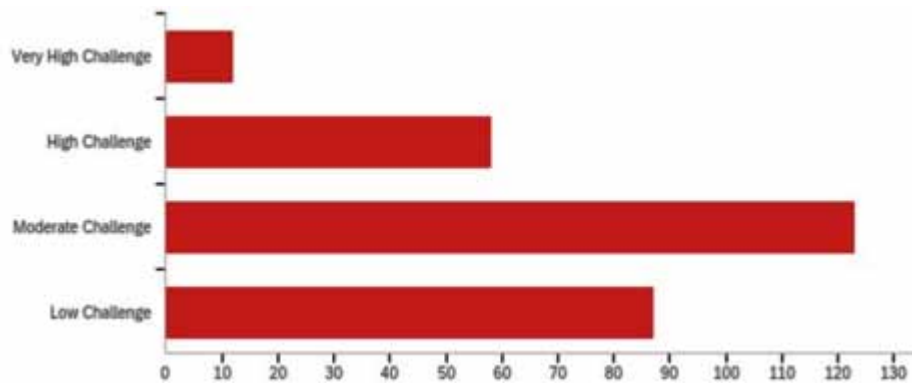*Figure 1. Q2 - Discomfort or lack of familiarity with required technologies or applications for me*

Figure 2. Q3 - Discomfort or lack of familiarity with required technologies or applications for my students


selected a low challenge for accessing LMS and video conferencing. Twenty-one percent expressed a moderate challenge. The open text responses requested purchasing Zoom before the university had an account.

When faculty were asked about their students' access to LMS and video conferencing, 38% responded that the students experienced a low challenge for accessing technology. And 33% selected a moderate challenge regarding access to technologies. Within the open text portion of the question, several faculty expressed students not having computers and internet access at home. Additionally, students had to use their smartphones for classes. Also, 87% of faculty stated they had access to a reliable digital device. While the faculty expressed that their students lacked access, 47% selected their students expressed a moderate challenge in accessing a reliable digital device.

When faculty were questioned about internet access, 80% selected a low challenge for themselves (See Figure 3). Yet, when asked about their students, 25% chose a low challenge for students' access to the internet. 46% chose moderate challenge, and 20% chose a high challenge.

When asked about students challenge with accessing the library, 55% chose a low challenge. Faculty expressed students were unable to access specialized applications for Music, Art, Physics, Spanish, Communication, SPSS, and Zoom were noted as a challenge for students to access. When a course was initially offered as hybrid, transitioning to remote learning was less challenging for the faculty and students.

Figure 3. Q9 - Access to reliable and sufficient Internet connectivity service for my students
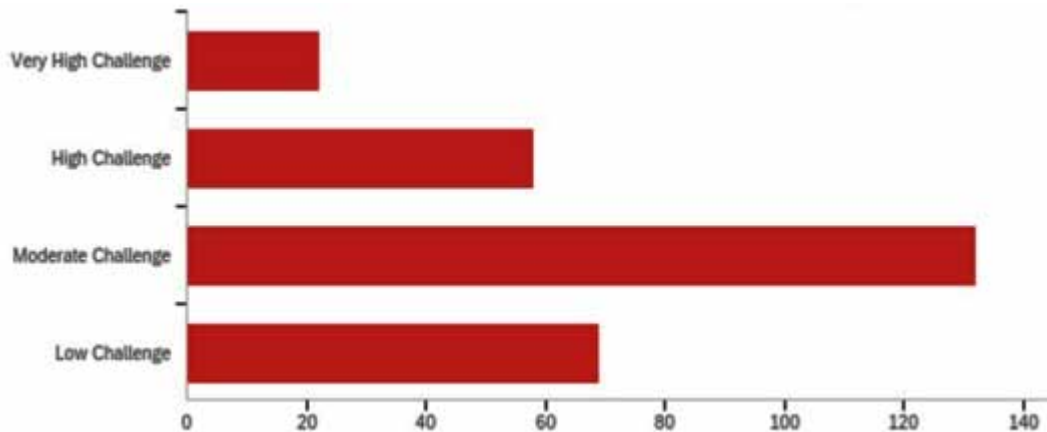
When faculty were asked about the needs for knowing distance teaching pedagogy, there were ten differing aspects asked. The respondents were able to check all that applied (See Figure 4). The three highest categories selected remained a challenge for the following semester, including: stimulating student engagement in an online course, how best to assess student learning in the online context, best online teaching practices for clarity and achievement of learning objectives.

Faculty were asked through open text to contribute to additional areas of challenge regarding remote teaching. Several faculty mentioned the difficulty of transforming previous on-paper materials into online resources. Faculty were challenged on how to teach hands-on courses online. Other challenges mentioned included access to the internet and equipment for students. Lastly, a faculty member commented that "students face a variety of challenges at home. Lack of space, demands on their time, unreliable internet access, domestic troubles."

The survey concluded by asking how the faculty would categorize their skills with distance learning. Forty-four percent of the respondents identified their technical skills were stronger than when remote instruction started. 28% selected somewhat stronger than when the shift was made to remote learning. Eighteen percent chose much stronger, and 9% chose no better than before the change.

The final survey question asked how satisfied the respondents were with their performance as an online instructor (See Figure 5). Fourteen percent chose extremely satisfied, 63% very satisfied, 21% not satisfied.

Post-Survey Discussion

During COVID-19 when the universities around the world shut down the on-campus environment and offered emergency remote learning, technical initiatives were developed to best serve the institution's students (Delgado, 2021). Overall, Delgado et al. (2021) discussed how COVID-19 "accelerated the emerging information technologies" (p. 4). Especially during this time, communication and collaboration became a necessity (Cicco, 2020). Based on the results of the faculty survey, included in this chapter, and the literature, the institution determined the importance of communication and collaboration (Cicco, 2020).

Figure 4. Q16 - What remain as particularly needs for you now with distance teaching pedagogy in anticipation that the pandemic may necessitate at least some degree of distance teaching this fall? (check all that apply)
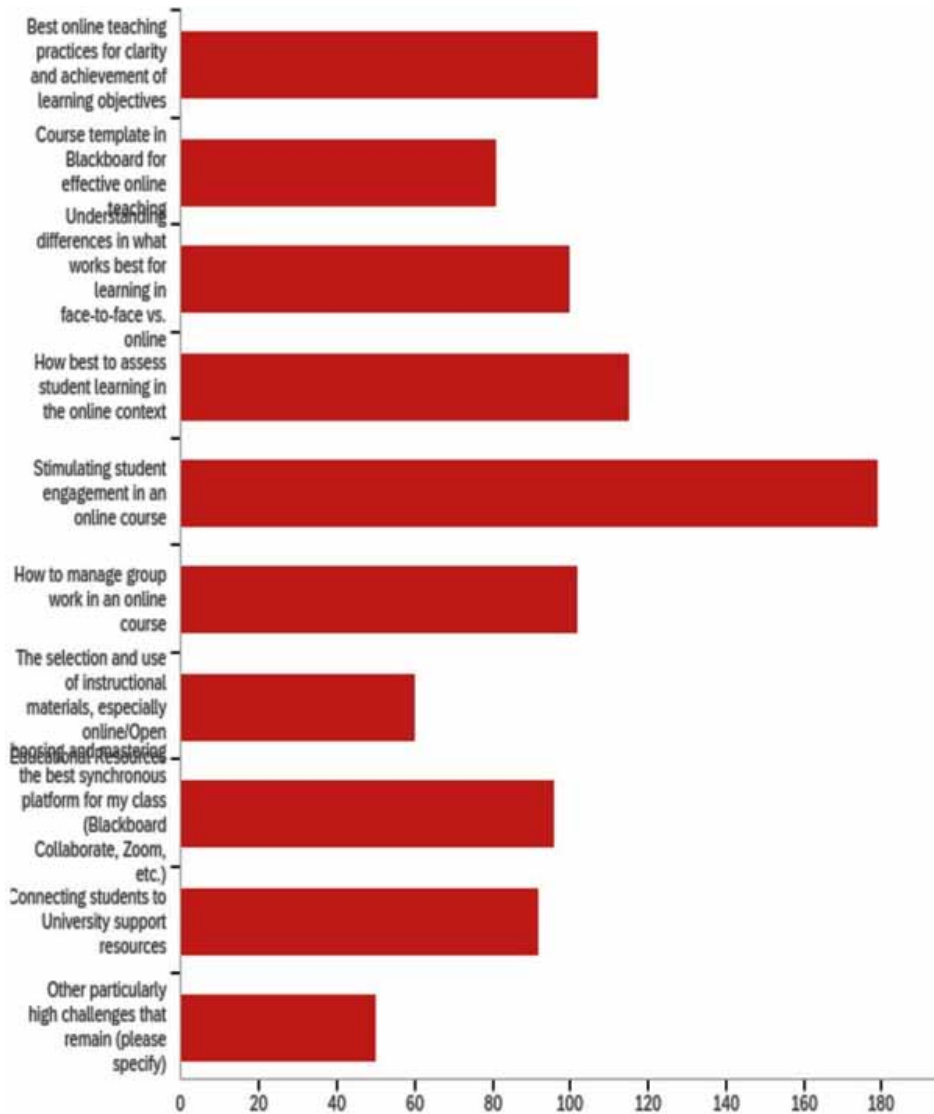
There were six action items put into place once feedback from faculty survey was analyzed. The six steps taken included purchasing an institutional Zoom account, greater WIFI access (Hernandez et al. 2019) within the campus parking areas, a website with resources for both students and faculty, opportunity for laptop rental, the collaboration of three departments and the development of an annual conference.

Based upon the survey results the institution implemented six initiatives. The first action item implemented because of the survey results was adding Zoom as a university video conference application. The Zoom application was easily accessible to faculty, staff and students. The second initiative involved additional WIFI access around the parking areas of the campus. This allowed students to park

Figure 5. Q21 - Overall, how satisfied were you with your performance as an online instructor?
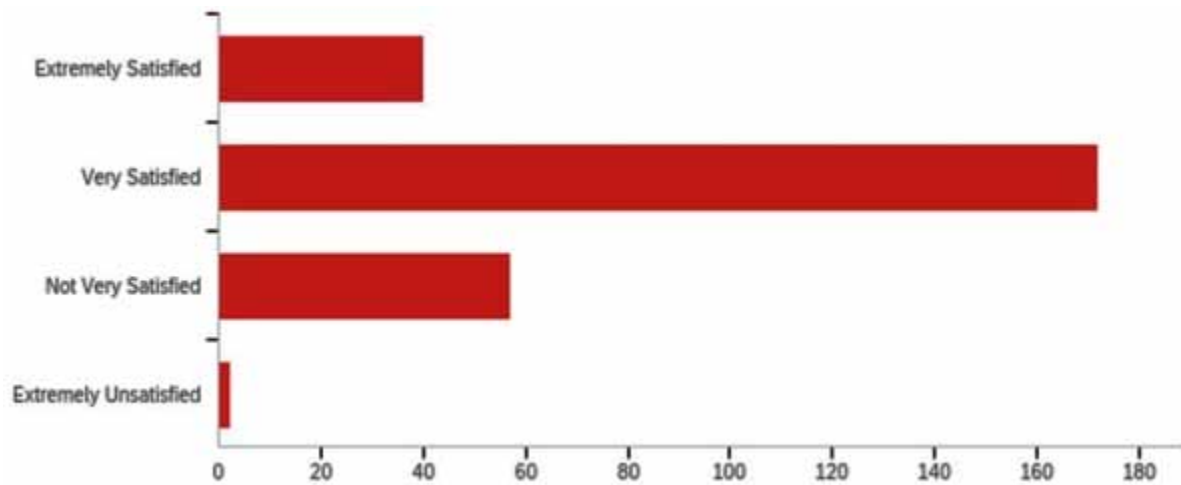
their cars in the parking areas to gain access to their online courses. The third item implemented was the opportunity to rent laptops. Cicco (2020) confirmed there was a national trend that many students were without a laptop or needed to share a computer within the home. The fourth initiative provided faculty and students with additional remote resources. Websites were created to offer faculty and students resources for successfully teaching and learning remotely.

The next item involved collaboration and communication. Three departments worked together to provide various support mechanisms aligning resources for both students and faculty regarding remote learning and teaching resources. These three departments included instruction and research technology, center for teaching excellence, and the provost's office. The final action was implementing an on-campus conference providing opportunity for faculty to share what worked during remote learning. Both of these action steps facilitated continued communication and collaboration amongst the faculty at the institution.

The survey results helped reveal the need for collaborative practices and additional communication at the state college. This information was advantageous concerning the time of the pandemic and remote teaching and learning. Moving forward, learning analytics and further data collection is needed. Primarily, data needs to be collected in order to create data informed decisions. Thus, higher education requires the data to be collected, analyzed, and a strategic action plan require development and implementation. These practices can further guide the institution towards more effective teaching practices. The final recommendation includes following Talyn et al. (2021), who led by strengthening a community of practice which will support all modalities of teaching and learning.

ISSUES

Given the rapid changes in technology in the higher education arena, there are four major issues which arrive causing challenges that need to be addressed. First, because AI allows for predictive data and additional data collection opportunities, collecting data and making data informed decision-making strategies. The second issue developed because of the new technologies. This issue involves the pace

of new product versions and companies buying out other applications or software products. Next, there is a greater need for effective communication with all stakeholders and a continued need for personnel with new skills. The final issue which occurred involved the technical trends appearing in the field of higher education. The issues are influenced by the technical product, service, and implementation. EDUCAUSE (2022) mentioned the importance of visualizing the technical trends within the social, political, environmental, and technical aspects influencing higher education. Thus, looking at the big picture and involving stakeholders with communication became important.

Collecting Data and Data Informed Decisions in Higher Education

Gasevic et al. (2019) discussed the appearance of learning analytics in higher education. Through the collection of data the institution can move towards "data-informed strategic decision making" (Gasevic et al., 2019). Several studies have researched the benefits of data informed decision making, as a high stakes practice in higher education (Means et al., 2009; Murray, 2014; Shen et al., 2012). Higher education has turned towards effective technologies to reach the goals of the diverse students greater adaption and flexibility. Digital tracing allows for a documented path a student follows providing the institution with valuable learner information (Gasevic et al., 2019).

Gasevic et al. (2019) mentioned the three themes in the area of learning analytics in higher education. One theme was gathering data for a predictive value. Another theme involved visualization which provided visual presentations of information. While the third theme allows for review of various interventions and instructional strategies offering information on the success of the strategy. Goldstein and Katz (2005) discovered approximately 70% of the US colleges applied data to decision making. Yanosky and Arroway (2015) expressed disenchantment with the use of analytics in preemptive retorts. Gasevic et al. (2019) concluded that there needs to be a culture change accepting the collection and application of data.

The Pace of Product Versions and Company Buyouts

Technology has influenced the world of work and how quickly job responsibilities need to become adapted to new technologies. We are living in an era of company product buyouts, leaving unclear who owns the applications used for curriculum management, learning management tools, learning analytics, video conferencing, and financial/human resources. The company buyouts may or may not require a migration of data.

An example of a recent dramatic change in the EdTech ecosphere is the October 2021 merger of Blackboard, a learning management system company, with Anthology, "a leading provider of higher education software solutions that support the entire learner lifecycle" (Press Release on Anthology/Blackboard Merger). This merger created a mega-company combining the learning management system with technologies for assessment, learning analytics, as well as enterprise resource planning, all of which, according to their press release, will "enable institutions to remove the historical barriers between administrative and learning ecosystems and drive learner and institutional success" (Press Release on Anthology/Blackboard Merger)

This company can now deliver virtually all of the technology tools an institution of higher learning needs to do business, including teaching and learning. There may be more, similar mergers or buyouts to create similar mega-companies that will compete with Anthology/Blackboard. No one knows for sure. What is sure, however, is that the business of higher education is evolving to make student education

more personalized, based on learning analytics and other technologies being linked to learning management systems. This is an important development in EdTech.

New versions of software and platforms also bring disruption and change to institutions of higher education. Staniec et al. (2022) discussed how changes in technology can cause staff to become anxious. Blackboard's relatively new version, Ultra, is an example. It is a major change to the platform, which had remained virtually the same for years before Ultra was introduced. This kind of change can be disliked by faculty who are accustomed to the older system. It can be said that Ultra is more student-centered than the old version, which was more instructor-centered. While teaching in person has evolved from "sage on the stage" to "guide on the side," Blackboard Ultra has brought a similar change to the technology side of teaching and learning.

Technical Trends

Colleges need to be best prepared for the technical trends: AI for data collection, AI for learning, defining instructional modalities, micro-credentials and skills-based requirements. These technical trends require continued funding, management of the system, strategic planning for implementation and sustainability of the technologies. Salam et al. (2022) suggested technical management for institutions to apply as a strategic method for implementing and maintaining the technical application. The new technologies require monies for overall benefits for students, faculty and the colleges. Overall, all of these trending technologies require both funding and personnel to help collect data, interpret the data, and make data-informed decisions.

AI for Data Analytics

Artificial Intelligence (AI) was first mentioned in the 2017 EDUCAUSE report as a new trend in technology for American colleges and universities (Alexander et al., 2019). Alexander et al. (2019) described AI as using:

computer systems to accomplish tasks and activities that have historically relied on human cognition. Advances in computer science are creating intelligent machines that functionally approximate human reasoning more than ever before. (p. 27)

EDUCAUSE (2022) also mentioned the availability of big data that is now available to colleges, yet institutions need to better use and apply the big data to help with student outcomes. Another tendency within the higher education landscape are silos of data. Departments need to share information gained with other departments. Data sets are available, yet typically not shared across the university system (Pelletier et al., 2022). Therefore, careful considerations are imperative when creating the managing team to aid in the process. Collaboration and communication are also imperative throughout the process of applying and maintaining the technology.

AI as a Learning Tool

AI for learning tools is another trend happening or continuing to happen in higher education teaching and learning. AI was often applied to simulate reality with the medical and healthcare practitioners

(Issenberg, 2006; Owen, 2016; Shepherd & Burton, 2019). AI was also included as a virtual writing assistant, providing students with immediate feedback (Pelletier et al., 2022).

Additional funding and personnel are needed to facilitate AI. Whether AI is used as a learning tool or for data purposes, the institution would need to make institutional decisions to purchase and support the new technologies. The institution would also need to support individual departments for funding, for example enrollment management could benefit from AI data analytics. A nursing department needs the personnel who understand and know how to apply simulations for instruction. Overall, in order to effectively implement the AI technology requires funding, personnel, strategic management, collaboration and communication with all stakeholders.

Defining Instructional Modalities

EDUCAUSE (2022) discussed that there are a wide variety of instructional terms being applied which require a unifying definition for departments to better understand the technical instructional terms. Such terminology being used includes: HyFlex, blended, hybrid, flipped, synchronous, hybrid online and virtual learning (p. 9). Creating a unifying definition for the instructional modalities can help with research, designing courses, and communicating best practices for instructional strategies. Once the technical terms are defined, colleges can move forward with a strategic management, collaboration, best practices, research, and communication.

Micro-Credentials and Skills Based Requirements

Wheelahan and Moodie (2022) described "micro-credentials as moving curriculum of education from knowledge to skills" (para. 16). Micro-credentials also "reorient higher education from educational purposes to employment purposes" (Wheelahan & Moodie, 2022, para. 16). EDUCAUSE (2019) Strategic Technologies reported, "only 2% of institutions have deployed digital micro-credentials (including badging) institution-wide, but 29% are expanding or planning their use" (Alexander et al., 2019, p. 8). There are technical applications available for tracking the micro-credentials and badging.

EDUCAUSE (2022) also mentioned how large technology companies are moving away from requiring a bachelor's degree and instead seeking skills. EDUCAUSE (2022) commented that:

Major technology companies are removing four-year – degree requirements from their job postings and choosing to focus instead on the actual skills and competencies job candidates are bringing with them to the work. These changes signal to institutions a need to realign education and business models to better fit these consumer and industry trends and to develop more attractive and flexible, skills-based courses and credentialing options for educating, training, reskilling, and upskilling the current and future workforce. (p. 7)

This shift in companies requiring skills instead of education could feasibly change the outcomes and expectations of colleges. Instead of becoming an educated citizen through a liberal arts education, the goals for college learning could become strictly skills-based for finding employment (Wheelahan & Moodie, 2022).

SOLUTIONS AND RECOMMENDATIONS

The previous section discussed issues related to new technologies in higher education. These issues included: the pace of new product versions company buyouts; the need for communication and personnel with new skill sets; and the issues centered around the technical trends. When discussing new technologies there are additional requirements, such as handling uncertainty in higher education and a decrease in funding which influences the budget for these new technologies. Since COVID, a multitude of universities have addressed new strategies for online teaching and learning. The final recommendation requires additional communication and collaboration within the institution.

Handling Uncertainty in Higher Education and Decrease in Funding

Currently, higher education is experiencing a high level of uncertainty and disruption (Horizon Report, 2022). Coming out of the pandemic, higher education as a whole is searching for a new normal, pedagogically and in the way it does business (Churchill, 2022). To compound the disruption, a dearth of college-age students as well as potential students who are going straight from high school to work are combining to decrease enrollments at many institutions. These institutions are pressed to explain the employment benefits of a college education to potential students who can make $20-plus an hour at warehouses and other jobs. State institutions are suffering from lower enrollments, decreases in income based on tuition, housing, and board, as well as decreased state funding.

Handling such uncertainty and decreases in funding requires resilience and strong strategic thinking. Creative ways to attract students must be implemented, as does the strategic implementation of technologies that create efficiencies across institutions. As layoffs and voluntary separation plans become the norm at many institutions, those remaining administrators, faculty, and staff have to do more with less, all the while making sure that students don't notice any deficiencies. Technology can help with some of this, for example switching from an older, outdated enterprise resource planning system to a newer, more automated one that works better for the entire university community can make up for some of the lost positions.

Some institutions of higher education will close due to these disruptions, such as Lincoln College in Illinois. Lincoln closed after the pandemic wrought havoc on its enrollment, as well as a cyber-attack that brought down its technology infrastructure (Forbes, April 1, 2022). Others, those that are resilient and have solid strategic planning resources, will survive and continue to educate students into the future.

Online Teaching and Learning

Shahzad et al. (2021) mentioned that during the outbreak of the COVID-19 pandemic almost 120 countries switched to remote online learning. This shift further reenforced the dependency on learning technologies. Alam (2022) commented that "as a consequence of the advent of new technologies, teaching and learning methods have evolved dramatically" (p. 395). Technology based learning was instituted throughout the world. Shahzad et al. (2021) included the following as technology-based learning, "technology-based learning through websites, learning portals, video conferencing, YouTube, mobile apps, and a thousand types of free available websites for blended learning tools" (para. 2).

During COVID changes in technology pushed the envelope in requiring additional information about our students' needs when learning remotely. In addition, colleges also discovered from the faculty what

is needed to address the students' needs related to the course design and instructional strategies for teaching online.

1. Students Remain Interested in Traditional Classroom with Adjustments
2. Flexible Course Instruction
3. Suggested Changes

Honnurvali et al. (2022) mentioned suggestions on how to move forward with technology in higher education. The recommendations included,

1. Effective online teaching skills, assessment methods, teaching styles, content creation, and mapping learning outcomes
2. Building and maintaining necessary infrastructure, provide training of technical skills for both faculty and students
3. Establish a student support center and have effective student engagement as a KPI
4. Fund research on effective online learning and environment
5. Effective workload and time management
6. Offer rewarding incentives in online teaching and learning (Honnurvali et al, 2022, p. 34-35).

Dumford and Miller (2018) discussed the importance of discovering effective online strategies to engage the online learner. Engagement amongst students, faculty and content remain a topic being addressed, and with COVID, the topic of engagement within online learning was rejuvenated. Valencia and Rincón (2022) also discussed the importance of maintaining student engagement in the online classroom.

Collaboration and Communication

As two of the top skills employers seek in an ideal candidate, interpersonal or for our purpose, collaboration, and communication skills are top requirements (NACE, 2022). Higher education is no different. When handling new technologies, change management or migration of technology, the process of changing technology requires collaborative and interdisciplinary teams for communication and collaboration of the anticipated changes to be managed more efficiently and effectively. Collaboration will first be discussed pertaining to the benefits of collaborating as an interdisciplinary approach. Talyn et al. (2021) suggested the development of faculty learning communities. Talyn et al. also recommended weekly opportunities for discussing instructional strategies with other faculty during the shift to remote learning. The institution became more open to learning from other departments' expertise and knowledge.

In addition to Talyn et al.'s recommendation for facilitating faculty collaboration to prosper during the COVID-19 pandemic. When reviewing the literature on collaboration amongst college personnel, there were limited research studies conducted. There was literature encouraging educators to collaborate with other teachers to strengthen the profession and instructional practices (Castano et al., 2021; De Jong et al., 2021; Ismail et al., 2018). Druken et al. (2021) discussed the importance of cross-departmental collaboration and findings which suggested improvements in curriculum and instruction. Alocar et al. (2022) recommended that collaboration amongst universities and industry were imperative to the continuation of higher education in North America. Thus, whether the collaboration would support industry (Alocar

et al., 2022), the profession, or instructional practices (Druken et al., 2021), or even improvements in curriculum, collaboration remains a solution to best practices. Lastly, Zuo and Zhao (2018) encouraged collaboration amongst interdisciplinary sectors to improve research.

Reimers and Marmolejo (2021) reinforced the importance of collaboration among universities and schools during the COVID-19 pandemic. Reimers and Marmolejo (2021) discussed the entrepreneurial culture which helped facilitate the development of innovative practices, "these seven innovations include products, solutions, processes, and managerial improvements, and for the most part they are evolutionary innovations and, in some cases, revolutionary" (p. 337). Collaboration among faculty would offer a win-win situation. Students, curriculum, instruction, and industry would all benefit from the collaboration of faculty.

Mustafa and Paçarizi (2021) encouraged collaboration among faculty through professional development opportunities. Sanches (2022) recommended that faculty learning communities be developed in colleges to enhance teaching and learning. Hontvedt et al. (2021) commented on the importance of collaboration among faculty in the form of teacher support teams. Faculty from various disciplines came together to reflect on teaching practices. De Simone (2020) stated that collaborative professional development for faculty had great advantages for student learning. Overall, collaboration among the institution's departments can help facilitate research, teaching, learning, curriculum, and industry. Valencia and Rincon (2022) encourage faculty to collaborate and communicate with other faculty on what is working and what does not work. Professional development was supported as a way for faculty to continue learning about instructional strategies (Valencia & Rincon, 2022). Antoniou (2022) also encourage continuous professional development for faculty to attend sessions both internally and externally.

CONCLUSION

Because of shifts in technology, budgets, and COVID, higher education continues to evolve as potential changes force a new face-lift. Higher education has introduced the new technologies of Learning Analytics and Data, Defining Instructional Modalities and Simulation and Artificial Intelligence. During the last five years state and national budgets and funding have also shifted. Along came COVID to shake up the environment even further. These immediate and rapid changes ushered in additional issues. Three issues arrived which increased the challenges in higher education. The stride of technical changes continues to increasingly change the higher education environment. Communication with stakeholders becomes imperative and the need for personnel continues.

The good news centers on solutions and recommendations which preclude successful strategies for implementing and managing new technologies. First, institutions need to be well prepared for handling uncertainty in higher education and the decrease in federal and state funding. We have learned from COVID to address best practices for online teaching and learning. Change management becomes a key term and process for the higher education arena. Communication and collaboration continue to become commanding practices towards the success of the new era in higher education (Cicco, 2020). A final thought requires institutions to work together as an organization with the intention of sustainability (Rieg, 2021).

REFERENCES

Aboagye, E., Yawson, J.A. & Appiah, K. N. (2020). COVID-19 and E-Learning: The Challenges of Students in Tertiary Institutions. *Social Educational Research*, 1–8. doi:10.37256/ser.212021422

Alam, A. (2022). Employing Adaptive Learning and Intelligent Tutoring Robots for Virtual Classrooms and Smart Campuses: Reforming Education in the Age of Artificial Intelligence. In *Advanced Computing and Intelligent Technologies* (pp. 395–406). Springer. doi:10.1007/978-981-19-2980-9_32

Alcocer, S. M., García, F. L., Eighmy, T., & Ono, S. J. (2022). Higher Education Collaboration in North America: A Review of the Past and a Potential Agenda for the Future. *Forging a Continental Future*, 157.

Alexander, B., Ashford-Rowe, K., Barajas-Murph, N., Dobbin, G., Knott, J., McCormack, M., . . . Weber, N. (2019). Horizon report 2019 higher education edition (pp. 3-41). EDU19.

Anthology Press Release on Merger with Blackboard. (2021). https://www.anthology.com/news/anthology-completes-merger-with-blackboard-launches-next-chapter-in-edtech

Antoniou, S. (2022). Emergency Remote Teaching in Tertiary Education: Issues Raised, Solutions Given, and Lessons Learned. In Transferring Language Learning and Teaching From Face-to-Face to Online Settings (pp. 47-66). IGI Global.

Barber, P. H., Shapiro, C., Jacobs, M. S., Avilez, L., Brenner, K. I., Cabral, C., Cebreros, M., Cosentino, E., Cross, C., Gonzalez, M. L., Lumada, K. T., Menjivar, A. T., Narvaez, J., Olmeda, B., Phelan, R., Purdy, D., Salam, S., Serrano, L., Velasco, M. J., ... Levis-Fitzgerald, M. (2021). Disparities in remote learning faced by first-generation and underrepresented minority students during COVID-19: Insights and opportunities from a remote research experience. *Journal of Microbiology & Biology Education*, *22*(1), ev22i1–2457. doi:10.1128/jmbe.v22i1.2457 PMID:33884088

Brown, L. (2022, March). Lessons Learned from Pandemic Teaching. In *Proceedings of the 2022 ACM SIGUCCS Annual Conference* (pp. 51-53). 10.1145/3501292.3511582

Candrasari, R., Dewi, R., Rizki, D., Meliza, R., Al Usrah, C. R., & Fasya, T. K. (2021, January). Learning Communication Strategy at Colleges During the Covid-19 Pandemic and the New Normal Phase. In *International Conference on Social Science, Political Science, and Humanities (ICoSPOLHUM 2020)* (pp. 18-23). Atlantis Press. 10.2991/assehr.k.210125.004

Castaño Muñoz, J., Vuorikari, R., Costa, P., Hippe, R., & Kampylis, P. (2021). Teacher collaboration and students' digital competence-evidence from the SELFIE tool. *European Journal of Teacher Education*, 1–22.

Churchill, C. (2022). An examination of business professors' experiences with remote teaching under COVID-19: Lessons learned for the future. *Dissertation Abstracts International Section A: Humanities and Social Sciences*.

Cicco, G. (2020). Online Instruction during a Pandemic: Faculty Collaboration and Self-Care. *Journal of Educational Technology*, *17*(3), 1–5. https://imanagerpublications.com/article/17545/

Coman, C., Țîru, L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability (Basel)*, *12*(24), 10367. doi:10.3390/su122410367

Delgado, F.; Enríquez-Flores, M.; Jaimes-Nájera, A. (2021). Lessons in the Use of Technology for Science Education during COVID-19 Age under a Teachers' Collaboration Cluster. *Educational Science, 11*, 543. https://doi.org/11090543 doi:10.3390/educsci

Dooley, K., Edgar, L. D., Dobbins, C. E., Mackay, W. A., & Davis, T. D. (2019). Faculty professional development and instructional design for an interdisciplinary graduate-level online course. *NACTA Journal*, *63*(1A), 27–34.

Druken, B. K., Marzocchi, A. S., & Brye, M. V. (2021). Facilitating collaboration between mathematics methods and content faculty through cross-departmental lesson study. *International Journal for Lesson and Learning Studies*, *10*(1), 33–46. doi:10.1108/IJLLS-06-2020-0033

Dumford, A. D., & Miller, A. L. (2018). Online learning in higher education: Exploring advantages and disadvantages for engagement. *Journal of Computing in Higher Education*, *30*(3), 452–465. doi:10.1007/s12528-018-9179-z

Ebner, M. (2022). *2022 EDUCAUSE Horizon Report| Teaching and Learning Edition*. EDUCAUSE.

Flores, M. A., Barros, A., Simão, A. M. V., Pereira, D., Flores, P., Fernandes, E., Costa, L., & Ferreira, P. C. (2022). Portuguese higher education students' adaptation to online teaching and learning in times of the COVID-19 pandemic: Personal and contextual factors. *Higher Education*, *83*(6), 1389–1408. doi:10.1007/s10734-021-00748-x PMID:34493877

Forbes. (2022, April 1). *Lincoln College In Illinois To Close After 157 Years*. https://www.forbes.com/sites/michaeltnietzel/2022/04/01/lincoln-college-in-illinois-to-close-after-157-years/?sh=5623cdc63fa3)

Fulford, A. (2016). Higher Education, Collaboration and a New Economics. *Journal of Philosophy of Education*, *50*(3), 371–383. doi:10.1111/1467-9752.12152

García-Peñalvo, F. J., Corell, A., Rivero-Ortega, R., Rodríguez-Conde, M. J., & Rodríguez-García, N. (2021). Impact of the COVID-19 on higher education: an experience-based approach. In *Information technology Trends for a global and Interdisciplinary research community* (pp. 1–18). IGI Global. doi:10.4018/978-1-7998-4156-2.ch001

Gasevic, D., Tsai, Y. S., Dawson, S., & Pardo, A. (2019). How do we start? An approach to learning analytics adoption in higher education. *The International Journal of Information and Learning Technology*, *36*(4), 342–353. doi:10.1108/IJILT-02-2019-0024

Goldstein, P. J., & Katz, R. N. (2005). *Academic Analytics: The Uses of Management Information and Technology in Higher Education*. ECAR.

Healy, M. (2022). Microcredential learners need quality careers and employability support. *Journal of Teaching and Learning for Graduate Employability*, *12*(1), 21–23. doi:10.21153/jtlge2021vol12no1art1071

Hernandez, L., Balmaceda, N., Hernandez, H., Vargas, C., Hoz, E. D. L., Orellano, N., ... Uc-Rios, C. E. (2019, July). Optimization of a WiFi wireless network that maximizes the level of satisfaction of users and allows the use of new technological trends in higher education institutions. In *International Conference on Human-Computer Interaction* (pp. 144-160). Springer. 10.1007/978-3-030-21935-2_12

Honnurvali, M. S., El-Saleh, A. A., Sheikh, A. M., Goh, K., Gupta, N., & Umar, T. (2022). Sustainable Engineering higher education in Oman-lessons learned from the pandemic (COVID-19), improvements, and suggestions in the teaching, learning and administrative framework. *Journal of Engineering Education Transformations*, *35*(3), 52–69. doi:10.16920/jeet/2022/v35i3/22088

Hontvedt, M., Silseth, K., & Wittek, L. (2021). Professional Collaboration in Teacher Support Teams—A Study of Teacher and Nurse Educators' Creative Problem-Solving in a Shared Space for Professional Development. *Scandinavian Journal of Educational Research*, *65*(2), 240–257. doi:10.1080/00313831.2019.1665098

Ismail, S. N., Kanesan, A. G., & Muhammad, F. (2018). Teacher Collaboration as a Mediator for Strategic Leadership and Teaching Quality. *International Journal of Instruction*, *11*(4), 485–498. doi:10.12973/iji.2018.11430a

Issenberg, S. B. (2006). The scope of simulation-based healthcare education. *Simulation in Healthcare*, *1*(4), 203–208. doi:10.1097/01.SIH.0000246607.36504.5a PMID:19088590

Linden, K., Hicks, B., & Teakel, S. (2022). *Weathering the Storm: Targeted and Timely Analytics to Support Disengaged Students.* EDUCAUSE. Retrieved from https://er.educause.edu/articles/2022/9/weathering-the-storm-targeted-and-timely-analytics-to-support-disengaged-students

Manturuk, K., & Reavis, G. (2022). Pedagogical implications of COVID-19: A case study of what faculty learned about teaching well by teaching remotely during the COVID-19 pandemic. In J. S. McKeown, K. Bista, & R. Y. Chan (Eds.), *Global higher education during COVID-19: Policy, society, and technology* (pp. 154–166). STAR Scholars. https://starscholars.org/product/global-education/

Means, B., Padilla, C., DeBarger, A., & Bakia, M. (2009). *Implementing data-informed decision making in schools: Teacher access, supports and use*. US Department of Education.

Murray, J. (2014). Critical issues facing school leaders concerning data-informed decision-making. *Professional Educator*, *38*(1), n1.

Mustafa, B., & Paçarizi, Y. (2021). Exploring teachers'' perceptions of professional development: The case of Kosova. *Journal of Language and Linguistic Studies*, *17*(3), 1210–1224. doi:10.52462/jlls.86

Ní Fhloinn, E., & Fitzmaurice, O. (2022). Any advice? Lessons learned by mathematics lecturers for emergency remote teaching during the COVID-19 pandemic. *International Journal of Mathematical Education in Science and Technology*, *53*(3), 566–572. doi:10.1080/0020739X.2021.1983049

Owen, H. (2016). *Simulation in healthcare education: an extensive history*. Springer. doi:10.1007/978-3-319-26577-3

Pelletier, K., McCormack, M., Reeves, J., Robert, J., Arbino, N., Dickson-Deane, C., . . . Stine, J. (2022). 2022 EDUCAUSE Horizon Report Teaching and Learning Edition. EDUC22.

Reimers, F. M., & Marmolejo, F. (2021). Conclusions: What Innovations Resulted from University–School Collaborations During the COVID-19 Pandemic? *University and School Collaborations during a Pandemic*, 333.

Rieg, N. A., Gatersleben, B., & Christie, I. (2021). Organizational Change Management for Sustainability in Higher Education Institutions: A Systematic Quantitative Literature Review. *Sustainability (Basel)*, *13*(13), 7299. doi:10.3390/su13137299

Rybnicek, R., & Königsgruber, R. (2019). What makes industry–university collaboration succeed? A systematic review of the literature. *Journal of Business Economics*, *89*(2), 221–250. doi:10.1007/s11573-018-0916-6

Salam, R., Rahmawati, S., Novita, N., Satria, H., & Rafi'i, M. (2022). Management of Technology in the Higher Education Sector in Aceh Adoption and Measurement during the Pandemic Covid-19. *Sinkron: jurnal dan penelitian teknik informatika, 7*(1), 214-221. doi:10.33395/sinkron.v7i1.11276

Sanches, T., Duarte, C., Batista, M., & Miranda, J. P. (2022). Lessons, discoveries, challenges, and results in an interdiciplinary learning community of higher education teachers. In *14th International Conference on Education and New Learning Technologies* (pp. 1198-1206). IATED. 10.21125/edulearn.2022.0319

Shahzad, A., Hassan, R., Aremu, A. Y., Hussain, A., & Lodhi, R. N. (2021). Effects of COVID-19 in E-learning on higher education institution students: The group comparison between male and female. *Quality & Quantity*, *55*(3), 805–826. doi:10.1007/s11135-020-01028-z PMID:32836471

Shen, J., Cooley, V. E., Ma, X., Reeves, P. L., Burt, W. L., Rainey, J. M., & Yuan, W. (2012). Data-informed decision making on high-impact strategies: Developing and validating an instrument for principals. *Journal of Experimental Education*, *80*(1), 1–25. doi:10.1080/00220973.2010.550338

Shepherd, I., & Burton, T. (2019). A conceptual framework for simulation in healthcare education—The need. *Nurse Education Today*, *76*, 21–25. doi:10.1016/j.nedt.2019.01.033 PMID:30739876

SOLAR. (2022). *What is learning analytics?* Retrieved from https://www.solaresearch.org/about/what-is-learning-analytics/

Talyn, B., Callori, S. J., Cerwin, K., Chao, M., Cousins, K. R., Hood, C., McGill, S. F., Metcalf, A. E., & Woodney, L. (2021). Faculty Learning Communities Facilitated the Rapid Pivot to Online Teaching and Learning. *Journal of College Science Teaching*, *51*(1), 19–26. doi:10.1080/0047231X.2021.12290538

Teng, W., Ma, C., Pahlevansharif, S., & Turner, J. J. (2019). Graduate readiness for the employment market of the 4th industrial revolution: The development of soft employability skills. *Education + Training*, *61*(5), 590–604. doi:10.1108/ET-07-2018-0154

Tlili, A., Zhang, J., Papamitsiou, Z., Manske, S., Huang, R., Kinshuk, & Hoppe, H. U. (2021). Towards utilizing emerging technologies to address the challenges of using Open Educational Resources: A vision of the future. *Educational Technology Research and Development*, *69*(2), 515–532. doi:10.1007/s11423-021-09993-4

Tucker-White, D. J. (2021). Recognizing the Inequalities in Remote Learning Education. In *Handbook of Research on Inequities in Online Education During Global Crises* (pp. 77–96). IGI Global. doi:10.4018/978-1-7998-6533-9.ch004

Valencia, M., & Rincón, M. (2022). What Have We Learned After One Year of Remote Teaching and Learning? A Critical Conversation between Two. *Language and Education*.

van der Voet, J., & Vermeeren, B. (2017). Change Management in Hard Times: Can Change Management Mitigate the Negative Relationship Between Cutbacks and the Organizational Commitment and Work Engagement of Public Sector Employees? *American Review of Public Administration*, *47*(2), 230–252. doi:10.1177/0275074015625828

Verhulst, E., & Lambrechts, W. (2015). Fostering the Incorporation of Sustainable Development in Higher Education. Lessons Learned from a Change Management Perspective. *Journal of Cleaner Production*, *106*, 189–204. doi:10.1016/j.jclepro.2014.09.049

Wheelahan, L., & Moodie, G. (2022). Gig qualifications for the gig economy: Micro-credentials and the 'hungry mile'. *Higher Education*, *83*(6), 1279–1295. doi:10.1007/s10734-021-00742-3 PMID:34366441

Xafis, V. (2020). 'What is Inconvenient for You is Life-saving for Me': How Health Inequities are playing out during the COVID-19 Pandemic. *Asian Bioethics Review*, *12*(2), 223–234. doi:10.1007/s41649-020-00119-1 PMID:32427219

Yanosky, R., & Arroway, P. (2015). *The Analytics Landscape in Higher Education*. ECAR.

Zhang, L., Carter, R. A. Jr, Qian, X., Yang, S., Rujimora, J., & Wen, S. (2022). Academia's Responses to Crisis: A Bibliometric Analysis of Literature on Online Learning in Higher Education During COVID-19. *British Journal of Educational Technology*, *53*(3), 620–646. doi:10.1111/bjet.13191 PMID:35600420

Zuo, Z., & Zhao, K. (2018). The more multidisciplinary the better? The prevalence and interdisciplinarity of research collaborations in multidisciplinary institutions. *Journal of Informetrics*, *12*(3), 736–756. doi:10.1016/j.joi.2018.06.006