Institutional Infrastructures for Open, Distance, and Digital Education

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Abstract

Infrastructure for open, distance, and digital education (ODDE) needs to have the capability to dynamically develop to accommodate varying models for the delivery of the curriculum and the changing needs of students and institutions. The capability to dynamically develop can be instilled within the institutional infrastructure for ODDE which includes areas such as information technology (IT), emerging technologies, marketing and recruitment, student prospect lead management, registration, educational materials, libraries, and student supports. Organizationally, infrastructures to support affordability, scalability, sustainability, and support must be developed. Open questions and directions for future research on institutional infrastructure for ODDE along with implications for ODDE practice that arise from this research are included.

Keywords

Online learning infrastructure · Distance learning information technology · Online marketing · Online user services

Dynamic Development of Institutional Infrastructures

While the core function of education remains unchanged, the needs of students and educational institutions are constantly evolving according to changes in sociocultural, political, demographic, and technological domains. It is essential that the infrastructure for open, distance, and digital education (ODDE) has the capability to dynamically develop to accommodate varying models for the delivery of the curriculum and the changing needs of students and institutions. This chapter will explore how the capability to dynamically develop services can be instilled within the institutional infrastructure for ODDE. It will review some of the evolution in the field such as structures to support affordability, scalability, sustainability, and support. An overview of institutional infrastructure and models for ODDE will be presented. This is followed by a discussion of evolving delivery approaches and institutional infrastructure and the need for IT infrastructure supports. The authors will produce open questions and directions for future research on institutional infrastructure for ODDE along with implications for ODDE practice that arise from this research.

Overview of the Institutional Infrastructure for ODDE

The institutional infrastructure for ODDE is complex and its core components include marketing and recruitment systems, IT and learning management systems, and administration platforms for student services, educational materials, and libraries including open education resources. The requirements for infrastructure depend

upon the institutional mission, strategy, and associated business models combined with the characteristics and size of the intended student audience, variety of academic programs, proposed learning outcomes, and other program development needs. The needs of infrastructure will differ for stand-alone open and distance programs offered in an online mode when compared with those which are more integrated into a traditional campus. Underlying the core components and associated requirements for institutional infrastructure for ODDE is the tension from competing strategic priorities, limited budgets, and staffing resources.

Standard Institutional Infrastructure Model for ODDE

Infrastructure as an area has been intensely examined as part of professional exchange at conferences. However, there has not been significant formal research particularly related to infrastructure in distance education. A special issue of the International Review of Open and Distance Learning (2001) presented case studies of seven different international institutions identifying the drivers of organizational and infrastructure models. Building the infrastructure for online learning has had significant open science or open scholarship exchange in many countries, as an example of that conducted in Ireland with the Irish Journal of Technology Enhanced Learning (Concannon, Costello, & Farrelly, 2019).

Figure 1 presents a model developed by Davis, Little, and Stewart (2008) to illustrate several of the areas of the institutional infrastructure for ODDE.

This model assumes starting with a business plan and the learning plan related to course content and teaching and learning strategies. Starting with the left-hand column, learning outcomes (i) must be developed by the faculty or instructional staff and ideas considered for pedagogy and course content. There is a development unit of instructional designers who share the responsibility with faculty to translate the pedagogical strategies and learning content into a learning management system (ii). There also needs to be an interface with registration and advising, library and other academic services, and digital or open resources (iii, iv, v). Attention must be paid to areas such as authentication and security, a student portal and interface, and the student information system (vi, vii, viii) and, finally, quality review (ix).

Evolving the Institutional Infrastructure Model for ODDE

A more recent evolution has been the creation of a unit and/or a chief officer for innovation. The responsibility for different components of the infrastructure for ODDE has typically been spread across multiple departments and vice presidents within an institution, especially in institutions where open and distance learning is only a part of the overall business model. The specialized position of chief officer for innovation has been developed to address the struggles between standardization and innovation and separation of control between academic and administrative computing. This position often straddles academic and administrative infrastructure and

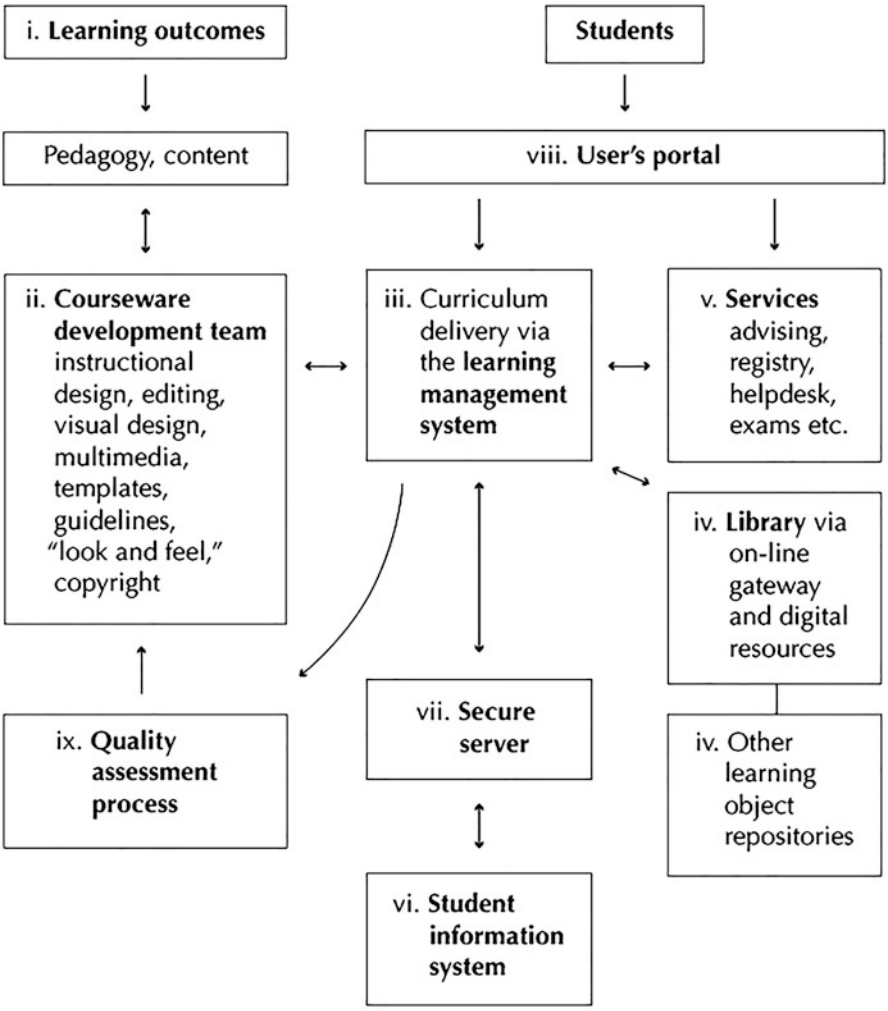

Fig. 1 Developing an infrastructure for online learning (Davis, Little, and Stewart, 2008, n.p)

serves as a conduit for promoting innovations in efficiency, improving learning and student retention, increasing scale, and reducing cost. Research conducted by Entangled Solutions (Selingo, 2018) showed at least 400 colleges in the United States having this title at the Vice President level or as a core role in either academic affairs or in IT. These positions balance priorities such as working with academic affairs on student success, working with finance on return on investment, and working with IT on data analytics and decision-making related to innovation and technology investments.

There are two important aspects related to infrastructure from the development of the innovation unit approach. Firstly, these units often have a greater external perspective and the capability to consider partnerships or shared service models.

Early open and distance programs often had a "build your own" infrastructure. As the field has matured, shared services with companies may be less resource intensive. Secondly, these innovation units often build systems that promote the review for innovation in academics, technology, or services. They help build more of a problem solving or design thinking approach (Selingo, 2018). Selingo (2018) did research on various approaches to support innovation and came up with three models. The most common model is a skunk works or autonomous entity which is in place at Southern New Hampshire University or Arizona State University. In this model, a separate innovation unit is resourced and staffed within the institution, having relatively less impact on the rest of the institution and more freedom to innovate. The second model was labelled by Selingo as the Internal Consultancy. This innovation unit stands alone but consults with willing departments across the university. The third is an integrated model that is more prevalent at a smaller institution, where innovation is integrated into the existing structure.

Considerations for an Integrated Institutional Infrastructure for ODDE

Infrastructure for Planning, Marketing, and Recruitment of Programs for ODDE

Once the institutional strategy for ODDE is developed, the institution needs to either create a stand-alone functional office for planning, marketing and recruitment, registration, and financing or to make sure that other functional offices embed the ODDE needs into those office functions. During the Covid-19 transition, many traditional dual-mode institutions moved quickly to the delivery of these types of services from their functional departments. Post-Covid-19, dual-mode institutions new to distance delivery need to more reflectively consider the need for infrastructure for these important functions. Other sections of this handbook explore organizational structures and change management, but there are infrastructure provisions to consider. The marketing approach for ODDE has matured into professional practices for generating leads related to potential students, lead generation, lead follow-up and management, research on the success of leads, and CRM integrated platforms to support the whole student life cycle. In the last decade, some institutions partnered with online program management companies (OPMs) as the institutions did not have the internal expertise. This can be quite successful when the institution has little experience with distance marketing and cannot build the infrastructure. The strategy of using an OPM can be effective for quickly ramping-up a program, but the revenue sharing process proved to be taxing for some institutions because the share is significant.

A more recent development has been insourcing these services with consortiums of institutions in more of a shared services model. The earliest developments in this area were for libraries and information technologies, often for shared purchasing to increase scale and get better pricing. Examples in the United States include NJEdge (https://njedge.net/) which works with school districts, colleges, and healthcare

systems to share high speed data for research, networking, cybersecurity, and other IT needs. In the United States, centralized infrastructure shared services for libraries, IT, instructional design, marketing, recruitment, registration, and student services exist in states such as New York (https://www.sunyonline.edu) and Georgia (https://ecore.usg.edu/about/how-does-it-work) for course delivery support. One such example of successful shared service for ODDE operating at a national level is HEAnet, which was established in Ireland in 1983 by the Irish Universities with the support of the Higher Education Authority and now serves as a national education and research network delivering "high-speed internet connectivity and IT shared services to all levels of the Irish education sector." An important aspect of this work is for institutions to be able to analyze the return on investment in lead generation but, correspondingly, to connect this to the learning analytics to make sure that students who are recruited to the institution are successful. Registration learning analytic platforms have emerged which assist institutions to better predict successful registration patterns for students. Of particular interest is systems to support less prepared or less historically advantaged students. Student services platforms to deliver academic supports and library systems should also be integrated. All of these systems require significant integration to best understand the profiles for a successful student life cycle from an operational perspective. The institution also needs to have a strategy related to the creating of these systems increasingly outsourcing or sharing these services.

Institutional Infrastructure for Libraries and Educational ODDE Materials

In the United States, the Association of College and Research Libraries has standards for distance delivery of library services which were developed in 2006 and updated in 2016 (American Library Association, 2016). Infrastructure for library provision and services requires a platform for delivery of educational resources and adequate financial support so that distance students and faculty get access to similar library services as any other student of the institution. Services are now delivered primarily through the web, either by the institution, a consortia of institutions, or a commercial provider. A physical library is not required; however, it is important that students have access to books, references, and journals databases and that any fees are similar to the provision for other students. Staffing for librarian research assistance and often librarian services are embedded directly in the programs or courses. Concerns that should be addressed by library infrastructure are the timeliness, ease of access by students, and the cross-cultural perspectives.

Historically, many distance learning institutions managed or partnered with commercial providers for the physical distribution of books or other instructional materials for students such as lab kits or other supplemental materials. Increasingly, institutions are providing open education or digitally delivered resources. Early initiatives were developed course by course, but more recently institutions have moved whole programs or the entire institution to open education. This was not only to save costs for the student, but institutions were finding that a portion of

the students do not actually purchase or use the books provided or purchased outdated materials. From an infrastructure perspective, this means that institutions investing in sharing low cost digital or open education resources need to create or outsource platforms to share these resources. Commercial providers and professional associations have emerged to share these resources. Data from these platforms allow faculty and staff to better track on usage, effectiveness, and improvements.

Institutional Infrastructure to Support Research in ODDE

The advent of the Covid-19 pandemic highlighted shortcomings in educational institutions in their ability to conduct timely research on students' experiences of ODDE. Research focused on the institutional infrastructure for ODDE is essential as institutions work through which aspects of blended and online delivery should be retained in the short term: What are the areas for longer term strategic development? How do institutions plan, fund, and operationalize these changes? It will be crucial that students and staff are engaged throughout the research process. Mc Vitty, Jackson, and Hutchens (2021) confirm that students are open to retaining the majority of elements of online delivery in some form but do not always know which modes will best support their learning. There is a need for further investigation in the infrastructural requirements for ODDE to provide a consistently engaging online learning experience. Most of the research on students experiences of ODDE takes place at an individual module or course level and is not used to inform institutional decision-making for the short-term or long-term investment in institutional infrastructure for ODDE. Individual faculty investigates delivery approaches or the use of a particular software or other technology. Multiple campus program research or multi-campus approaches could better inform the needs for investment in instructional infrastructure. Tyton Partners has tracked faculty adoption and use of digital software and tools and recommend developing common frameworks for evidence-based research and sharing (Fox et al., 2021, June 22).

One model for sharing research related to the infrastructure for open education is the COUP framework developed by the Open Education Group (2021). COUP allows researchers on open education to share findings related to costs, outcomes, usage and perceptions. The dimensions of cost and usage are particularly important to the area of infrastructure. This research group has developed a calculator application to look at a range of cost metrics for students and institutions such as:

- Costs of textbooks previously assigned
- OER support fee models
- Changes in campus bookstore revenue
- Changes in tuition revenue due to changes in drop rates
- Changes in tuition revenue due to changes in enrollment intensity
- Changes in tuition revenue due to changes in persistence
- Changes in access to performance-based funding due to changes in drop, enrollment intensity, and persistence

The adoption of open educational resources can impact a range of financial and cost metrics for students and institutions. Research shared using this model shows that the use of open resources will save K-12 school districts' money or in the case of higher education save students' money (Open Education Group, 2021). Correspondingly, however, there can be possible losses in institutions getting shared revenues from bookstores. The IT area needs to determine effective ways to share open education resources through repositories or other related services to promote ease of access for students.

Institutional Infrastructure to Support Evolving ODDE Course Delivery

The institutional infrastructure for ODDE naturally matured over the last two decades, but it has also changed due to significant disruptions in the ways in which courses are being delivered. One substantial disruption was the emergence of Massive Open Online Courses (MOOCs) which had both significant successes and expressed concerns. MOOCs have been an important development in ODDE, and their popular growth has demonstrated a possibility for informal and inexpensive or free education. MOOCs also were supported in ways that expanded the use of technology in online education; investments were made in higher-quality video and adaptive technologies which allowed for much larger technology-supported courses at less per person expense. The growth in MOOCs demonstrates how advances in information and communications technology encourage the move to online learning and are continually facilitating new modes of delivery. For example, MOOCs are being used as a method of disseminating key research findings from research projects. MOOCs demonstrate how the infrastructure for open and distance learning needs to have the capability to evolve with the changing needs of students, institutions, and models for the delivery of the curriculum.

Institutional IT Infrastructure for ODDE

Developing Institutional Infrastructure for ODDE

Large open universities in many countries were strategic in developing and harnessing the efficiencies of advanced technologies for more scalable and lower cost delivery (Guri-Rosenblit, 2019). Covid-19 and the evolution into online and other digital technologies have made the use of advanced technologies more ubiquitous throughout higher education. Guri-Rosenblit suggests that the large open universities may need greater investments as far as infrastructure to support digital and online, along with the more complex faculty and support needs. In many dual-mode institutions, IT infrastructures are merged with campus-based infrastructures. There is little literature related to specific IT infrastructure for ODDE. Instead, literature relies on models for traditional institutional IT infrastructure. One useful model for administrators to use for the institutional IT infrastructure for ODDE

comes from Broadbent and Weill (1997) that ties IT capabilities to help to achieve organizational goals. Broadbent and Weill define three areas of infrastructure services necessary to enhance business processes: the IT component, the human infrastructure, and shared IT services. The results of their study named 23 infrastructure services which may contribute in helping an organization to reach goals. In 1999, Broadbent, Weill, and Clair (1999) and Broadbent, Weill, and Neo (1999) refined these 23 services into application management, communication management, data management, research and development, services management, security management, standards management, and IT management. In distance education, additional crossover broad impact areas such as data analytics, knowledge management, and business process mapping have emerged as areas of practice.

Several models exist to support the integration of IT into teaching and learning, but these tend to operate at an individual course or module level. The ADDIE five step model (Dick, 2001), Laurillard's Conversational framework (Laurillard, 2002), SAMR (Puentedura, 2006), TROHA (Troha, 2007), and Salmon's Carpe Diem (Salmon, 2011) constitute a sample of the models that can be used to guide the implementation of IT in education. The ADDIE instructional design model involving five stages, namely, analysis, design, development, implementation, and evaluation provides a framework to implement IT into distance learning. Laurillard's conversational framework is both a learning theory and a practical framework for designing online learning environments and involves four main components: teachers' concepts, teachers' constructed learning environment, students' concepts, and the students' specific actions. The Substitution, Augmentation, Modification, Redefinition or SAMR model was developed by Puentedura (2006) to enable educators to identify different ways in which they could integrate technology within the teaching and learning portfolio. The SAMR model provides a continuum from novice to advanced level of technology integration to encourage educators to seek ideal ways to embed technology to support and enable the learning experience. The Troha model provides a more systematic experience, while Salmon's Carpe Diem model provides a framework to integrate technology while redeveloping an entire unit of study. The aforementioned models favor an approach where an instructional designer is working with an individual instructor on individual learning units or modules but provide limited guidance on a collaborative coordinated and strategic approach to the integration of IT across a program, faculty, or educational institution. This can result in a splintered approach with instructors at varying stages of technology adoption on a single program and/or across a faculty or academic department.

The Impact of Advancements in IT on the Institutional Infrastructure for ODDE

There are several significant developments and advancements in IT which have had a substantial impact on the institutional infrastructure for ODDE. These include cloud computing and software as a service; bring your own cloud; artificial intelligence, adaptive learning, and learning analytics; and mobile learning.

Cloud Computing and Software as a Service

The increasing availability of the Internet has facilitated the development of cloud computing where software and computing services are delivered over the Internet. This has allowed for greater integration of technology systems and sharing of data across systems resulting in the provision of Software as a Service. The data environment for ODDE has evolved to an ecosystem with the integration of customer relationship management systems, learning management systems, and the student information system. In Software as a Service, the databases and the software are accessible online through the cloud. New technologies and pilots can be implemented in a more agile and scalable way (Anderson, Marlaire, & Shean, 2020). Institutions no longer need to manage an on-premises data center to provide their own servers to store and process data as most of these activities can be outsourced to external providers. Varying capital expenses, often consumed with replacing aging physical IT hardware, have shifted toward predictable monthly or quarterly expenditure. Compared with on-premises data centers, additional resources can be easily deployed in a cloud infrastructure at peak times, e.g., during examination periods, etc. The costs are allocated through the cloud, and the institution is charged only if the services are used. These shared services provide an alternative to higher cost in-house IT infrastructure. Moving to a cloud computing infrastructure and utilizing Software as a Service can release the in-house computing team to concentrate on the long-term IT strategy. The overall support and development of the IT infrastructure requires specialist skills. Careful consideration needs to be given to the continuing development of the skillset of in-house computing team to ensure they have the expertise to adapt as required and redirect their focus to developing different areas of IT infrastructure.

Bring Your Own Cloud

Many institutions pre-Covid-19 were developing and implementing "bring your own device" (BYOD) policies to respond to the demands of users and facilitate those who were able to supply their own device to support their learning within both the traditional on-campus and online learning environments. Closures of campus and restrictions on the movement of people forced a radical change, almost overnight, in work and learning practices. Many educational organizations struggled to accommodate the needs of users who now required immediate remote access and support for a variety of software and services to support the learning environment. In response to restricted access to the physical and virtual campus during Covid, and as a workaround to difficulties accessing Institutional Learning Management Systems and/or virtual classroom technologies, many staff and students started to build their own clouds to support their learning and teaching. "Bring your own cloud" (BYOC) is a concept that can apply in an educational context as students and staff are piecing together institutional or third-party cloud software and services to perform certain tasks. Personal cloud storage solutions are being used to store and

share key learning resources. Academic staff are using free versions of virtual classroom technologies such as Zoom to facilitate their online engagement with their students independent of the institutional supplied systems. Widespread access to WiFi is improving, and students are willing to use personal mobile data plans to access the Internet both on and off campus. Much of this practice can be considered "rogue IT" where unsanctioned IT resources are being used to support the activities of an organization. Tensions can exist when users expect institutional support services to trouble between users and support services. Many institutions have invested heavily in installing WiFi networks on campus and on licenses for a range of software platforms to support distance learning. BYOD and BYOC practices pose serious risks to the security of student data. Responding to, and accommodating, BYOC and BYOD practices presents significant opportunities and challenges for institutional infrastructures for ODDE.

Artificial Intelligence, Adaptive learning, and Learning Analytics

Institutions are now moving forward to greater technology tools to support students. Artificial intelligence is being applied to personalize learning and services, particularly when working with students across multiple time zones. Software to support the development of academic writing and assist in detecting plagiarism are continuously integrating artificial intelligence to improve their offering. Chatbots are now available on many websites which can serve student with routine questions related to courses, financial aid, and registration or library or book services. Chatbots are replacing the first layer of end user troubleshooting and support for various IT systems such as the VLE and are also provided in courses to assist as a resource related to particular topics.

Adaptive learning platforms have emerged to better support learners on individualized pathways and to support scale. There has been significant investment in promoting success, particularly in first year courses. The Gates Foundation has funded research into the efficacy of proprietary adaptive learning platforms working with educational institutions to examine the cost/benefit analysis and the potential for improvements in learning (Yarnell, Means, & Wetzel, 2016, April). The results of these early projects were mixed, with four of fifteen projects indicating a positive return on investment related to the use of different adaptive platforms. More recent work at some institutions has shown improvement in learning and student success by combining adaptive courseware and learning analytics, particularly in first year or gateway courses (Dziuban, 2020). It is a maturing field with potential. Partnering with an adaptive partner for technology allows for algorithm-based routing of learners, and there are a variety of company software platforms available such as Realizeit, Aleks, MyLabs, etc.

Learning analytics is an area of significant growth in strategic importance in the past 5 years. "Technologies for improving analysis of student data" was listed as one of the top 10 strategic technologies in the 2019 EDUCAUSE Horizon report as were "learning analytics for student success (institutional level)," showing the importance

of this work to institutions (Alexander et al., 2019). As previously mentioned, cloud computing and Software as a Service are facilitating the continuing development of an integrated IT ecosystem. The data used in these systems can also be combined with teaching and learning software including video usage data. Educational providers now have the capability to better analyze if the use of technology is improving student performance or making the organization more efficient. Many of the newer IT systems include the ability to present user data in a visual way to indicate underlying usage patterns and trends in large or small user populations. Some systems allow for data to be amalgamated from multiple platforms. Institutions can use analytics from registration and learning platforms to predict successful registration patterns for students. Improvements in the visualization and use of data need to be balanced against the users, both students and staff, right to privacy. All staff with administrative access to these systems should be provided with training on the ethical and appropriate use of the data. Educational institutions need to ensure that the benefits of learning analytics are realized. Analytics need to be used to answer pertinent questions that will inform the evolution of the infrastructure for ODDE to underpin a consistent and engaging learning experience. The aforementioned role of the chief officer for innovation can be useful in integrating learning analytics into institutional decision-making in a timely manner.

Mobile Learning

Mobile learning refers to the use of mobile devices to access and engage with learning content wherever and whenever a student has a mobile device connected to the Internet. Many students own their own smartphone or mobile device, and most platforms incorporate a responsive design and/or have specialized apps to improve the user experience when accessed from a mobile device. The benefits of mobile learning are based on convenience, flexibility, and learning dependence. Mobile learning increases the availability of education as students can access the learning environment and associated resources once they have a suitable mobile device. The capital expenditure associated with the provision of computers on campus for students has shifted to implementing BYOD and BYOC policies and supporting staff in developing content that is also accessible on mobile devices. Many mobile devices incorporate push technology which can be used in the learning context to send notifications and reminders to students about key learning tasks. Learning analytics amalgamates a wide range of information from mobile devices that can inform decision-making around the institutional support needed for mobile learning. Software for learning analytics can collect data from mobile devices to detail usage patterns by mapping and comparing a range of data points including time of access, Internet service provider, geophysical location, type of device including make and model, duration and frequency of access, etc. The

addictive dimension brought about by the ubiquitous presence of digital devices and integration of push technologies poses a risk to the engagement of the learner (Pedro, Barbosa, and Santos, 2018). In a similar vein to remote working, institution infrastructure for ODDE may need to accommodate the rights of staff and students to disconnect from the learning environment. This will present a significant challenge as students and staff are using a variety of mobile devices to support their learning and teaching. There is a need for further research on the impact of mobile technologies on the engagement of the learner and the teaching and learning process.

The Impact of the User Experience on the Institutional Infrastructure for ODDE

The discussion of infrastructure services for ODDE must also consider the user experience. Determining how to assess the user experience has become more complex as technology and systems have moved into the cloud and as the systems have become more integrated. The effective use of learning tools is dependent on the perspective of the users, defined as students, faculty, and the institutions. In looking at the IT systems, the technology acceptance model has been used in studies to assess the impact of the user experience related to technology. The model has been updated to reflect some criticisms related to its inefficiency in justifying the social influence on the acceptance of technology (Straub, 1997). It incorporates other factors like "social influence" and "self-efficacy" (Al-Maroof, R., 2020 and "perceived enjoyment" (Salloum et al. 2019). Al Kurdi et al. (2020) expanded the model to include these influences. The critical factors were subjected to a statistical analysis which showed social influence, perceived enjoyment, and computer self-efficacy maintain a positive and strong effect upon, perceived ease of use, and perceived usefulness. Additionally, behavioral intention to use the E-learning system is significantly affected by the perceived usefulness and perceived ease of use. Various other research studies assessed the positive influence of social influence, perceived enjoyment, and computer self-efficacy on perceived ease of use, perceived usefulness, and E-learning acceptance. A continuing critical concern is the cross-cultural perspective related to the acceptance and use of education technologies and the integration in countries where there are issues related to bandwidth or other connectivity (Al-Maroof, 2020).

Institutions have also evolved as to how the students are supported through help desks, call-centers, and support services that are managed by the institution or outsourced partners. Analyzing the data on the user experience has become complex, including reviewing response times, dropped call rates, web statistics and other analytical tools to improve services. Similar to IT infrastructure acceptance models discussed, review of how diverse learners or learners with less access to resources get access to support services is important.

Impact of Covid-19 on Institutional Infrastructure for ODDE

The transitions after the worldwide Covid-19 pandemic has had institutions around the world looking at institutional infrastructure supports for ODDE. The impact of Covid-19 meant that many traditional institutions without experience immediately had change their course delivery models, student support services, and work practices to pivot to blended and fully online learning. Campuses around the world worked together to learn and deliver education.

Implementation of a national strategy for remote working will remove some of the barriers to engagement with ODDE and increase the demand for flexible and online learning. Institutions should be reviewing their infrastructure for ODDE, including their planning, marketing, and student recruitment systems, IT systems, and course delivery models and remote working policies for staff, to ensure that their organizations are evolving the institutional infrastructure to respond to the changes in work and study practices as a result of Covid-19. In Ireland, the recently published National Remote Work Strategy 2021 acknowledges the seismic shift in remote working and aims to legislate for the right to request remote working, review tax and expenditure for remote working, make home and remote work the norm for 20% of public sector employment, invest in a network of remote working hubs, develop a code of practice for the right to disconnect, and accelerate the provision of high-speed broadband to all parts of Ireland (Department-of-Enterprise-Trade-and-Employment 2021). Remote working hubs could easily become remote working and study hubs. Wonkhe and Pearsons' research on "Students' experiences of study during Covid-19 and hopes for future learning and teaching" confirmed that there are very few elements of online learning and teaching that the students surveyed in England and Wales would not like to see continue after the pandemic (Mc Vitty, Jackson, & Hutchens, 2021). Most agreed that they would like to see the continued provision of recorded lectures, core materials in the learning management system, online access to support services such as well-being and careers, and online tutorials or check-ins with tutors. Students have experienced and recognized the benefits of a more flexible approach, and the institutional infrastructure for ODDE will have to evolve and purposefully draw on the best of both online and face-to-face learning. Many will return to classroom-based learning, but many will continue in online and will need to build more solid infrastructures and student services. A survey of attitudes to upskilling conducted by the Irish Higher Education Authority reported that more than one-third of people (37%) are considering upskilling or reskilling due to the Covid-19 pandemic, and almost half the respondents would like to retrain to work in a more progressive and evolving sector (HEA, 2021). There is emergent work to share insights from building shared services for infrastructure post-Covid, one such example from China related to open education repositories (Huang et al., 2020) and infrastructure systems for both higher education and regular schools (Xue, Li & Xu, 2020).

Infrastructure Supports for Emergent Areas

It is important that institutional infrastructure for ODDE can support emergent areas. Educause conducts research through Horizon reports on IT trends in education, a number of which are related to infrastructure. The 2019 report identifies multiple areas related to open and distance learning infrastructure (Alexander et al., 2019). Short-term trends indicate the increased interest in mobile and adaptive learning. Midterm trends include mixed reality, artificial intelligence, virtual digital assistants, and block chain. Open education resources and digital courseware also are innovation developments which continue to be expressed by IT representatives from around the world.

Since 2012, the Open University has produced an annual Innovating Pedagogy report to "explore new forms of teaching, learning and assessment in an interactive world to guide teachers and policy makers in productive innovation." Each report proposes innovations that are due to become more widespread and have the potential to provoke a shift in educational practice. Several of the pedagogies singled out in the 2021 report will have a significant impact on the institutional infrastructure for ODDE if the adoption of these pedagogies become widespread (Kukulska-Hulme et al., 2021). "Best learning moments" and "enriched realities" with the use of technologies such as augmented reality and virtual reality top the list.

Concluding Remarks: Open Questions and Directions for ODDE Practice

Despite innovations in parts of higher education, the traditional models of distance delivery in higher education have remained substantially similar. In order to scale innovations, infrastructure needs to be flexible and adaptive to support these innovations. The profession is also actively interested in infrastructure models and particularly ways to increase scale, improve student success, and reduce costs. This has been particularly driven by new entrants to the market.

Questions remain for how the institutional infrastructure for ODDE can evolve:

- How can personalization and customization for users continue to advance through developments in adaptive learning, mobile, and artificial intelligence?
- How can data analytics be used more effectively to support learner success through identifying just-in-time support services?

Further research is required in the following areas:

- Sharing models for effective deployment and training of technology staff to support the ecosystem for ODDE

- Sharing models linking ODDE strategy with organizational structures, infrastructure, and any shared services
- The cross-cultural implications related to technology use, support services, and learning environments
- The infrastructural requirements for ODDE to provide a consistently engaging online learning experience
- The cost/benefit analysis related to the decision to use a third-party service to share costs for infrastructure, particularly when these services are proprietary
- Adaptive and artificial intelligence to examine the possibilities of changing the pace of education and improving learning
- The impact of mobile technologies on the engagement of the learner and the teaching and learning process
- The investment needed to make sure that there is a seamless experience for users, particularly related to infrastructure for IT, library, educational materials, and other academic services

The state of infrastructure models in ODDE are poised for new developments, particularly as software and other services have moved to the cloud and new technologies have emerged. In addition, the developments of shared services and outsourced models will influence future practices. Also, most importantly, user influence and the capability to make greater choices regarding opportunities post-Covid-19 will impact models for services and academic programs.

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