



Using design-based research to gauge the impact of an open educational resource repository to support online teaching and learning

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Abstract

Despite vast experience in face-to-face teaching, faculty and graduate teaching assistants (GTAs) still have a need to develop an online teaching skill set. Emergency remote teaching resulted in an avalanche of professional development opportunities. Post COVID-19, very few faculty can say that they have not been challenged by the need to teach online. Unfortunately, reacting to emergency situations in higher education comes at the expense of online pedagogy. Furthermore, instructors and GTAs prefer online resources over face-to-face training because of time constraints. This demonstrates a critical need to offer easy-access, on-the-job, self-paced, and theoretically-sound support to instructors who struggle with teaching online courses. This study reports on the results of a design-based research project to create and implement Purdue Repository for online Teaching and Learning (PoRTAL). Our guiding research questions focused on faculty and GTAs need for support, the affordances needed for PoRTAL, its effectiveness, and the barriers for implementation, replication, and escalation. The research process included four major phases and each phase comprised two development steps. The four phases were: 1) needs analysis and exploration, 2) internal evaluation, 3) expert evaluation, and 4) implementation. Each phase resulted in design principles to contribute to theory. Six design principles were identified: accessibility of open educational repositories, human performance technology principles for faculty training, attainable universal design for learning guidelines, online pedagogy vs technology training, content and design balance, and cultural and institutional barriers for project replication. Recommendations for practice and limitations of implementation are given.

Keywords Design-based research · Digital repository · Human performance technology · Online teaching · Open educational resource

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Introduction

The sudden move to Emergency Remote Teaching (ERT; i.e., “temporary shift of instructional delivery format;” Hodges et al., 2020) in 2020 catapulted the already increasing number of students enrolled in distance learning courses, which had reached seven million in the USA alone by 2019 (National Center for Education Statistics, 2022). Post COVID-19, very few faculty can say that they have not been challenged by the need to teach online (Hodges et al., 2020). However, while offerings have increased, many instructors have little to no training in how to do so effectively (AbuZayaad-Nuseibeh, 2017; Hurtado et al., 2012). Pre-COVID instructors received little professional development in online teaching (AbuZayaad-Nuseibeh, 2017; Magda, 2019; Martin et al., 2019) and post-COVID has shown a large variation in types and quality of professional development (Salajegheh et al., 2022). During the ERT era of COVID, initial training in online teaching focused on tool management and technology like navigating learning management systems, video production, and videoconferencing (Ní Fhloinn & Fitzmaurice, 2021). Although technical skills are valuable when teaching at a distance, facilitating a meaningful online learning experience is essential and requires strong pedagogical skills. Providing appropriate support to instructors enables them to adapt to the changes in teaching in addition to preparing higher education institutions to offer quality online courses (McGee et al., 2017; Mohr & Shelton, 2017).

Despite vast experience in face-to-face teaching settings, faculty and graduate teaching assistants (GTAs) still have a need to develop an online teaching skillset (Adnan et al., 2017; Frass et al., 2017). Reactively addressing online learning issues can result in unsatisfactory results (Besser et al., 2022; Burke, 2005) and a stressful experience for instructors teaching online. Further, professional development initiatives have been shown to improve attitudes and self-efficacy toward online teaching (Northcote et al., 2015). Providing support, including professional development to instructors, aids higher education institutions in delivering effective online courses (McGee et al., 2017; Mohr & Shelton, 2017) eventually leading to successful institutional implementation of online programs (Baran, 2018; Hinson & LaPrairie, 2005; Jackson, 2018).

Moreover, research has shown that instructors prefer online resources over face-to-face training because of time constraints (Poderi et al., 2024), especially for instructors teaching in research-intensive institutions who prioritize research more than teaching and service (Brew et al., 2022; Chen, 2015; Reid & Gardner, 2020; Scott & Scott, 2011; Taylor & McQuiggan, 2008). Faculty perceive one-on-one consultations with mentors or instructional designers to be more effective (Evanick, 2023; Taylor & McQuiggan, 2008; Williams et al., 2014). Yet, sustained one-on-one support is expensive for institutions. It also implies a considerable time investment from faculty members (Carroll-Barefield et al., 2005; Poderi et al., 2024; Shreaves et al., 2020). Thus, it is necessary to offer comprehensive, timesaving, and more economic resources to assure that no instructor is left behind.

Taken together, this demonstrates a critical need to offer easy-access, on-the-job, and self-paced support to instructors who struggle with teaching online courses. With that intention, we adopted a design-based research (DBR) approach (Wang & Han-

nafin, 2005) for the creation of PoRTAL (Purdue Repository for online Teaching and Learning), an open educational resource (OER) digital repository that provides strategies and resources for both novice and experienced instructors teaching online. The “open” in OER denoted that the “materials are licensed with copyright licenses that provide permission for everyone to participate in the 5R activities—retain, reuse, revise, remix, and redistribute” (Wiley & Hilton, 2018). Rooted in the free-software movement, Open Educational Resources (OERs) are “technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes” (UNESCO, 2002). An *open* approach to framing our research allowed us not only to increase access to our OER digital repository beyond institutional borders, but also enhanced transparency, allowing others (e.g., peer institutions) to replicate and validate our findings. While increasing the impact and visibility of our work, an open approach in our research also promotes efficiency in educational research by allowing others to build on our efforts and learn from our challenges. DBR guided us through iterative cycles of revision and improvement involving perspectives from multiple stakeholders, or co-designers. We analyzed the challenges experienced by new instructors or instructors having less online teaching experiences from a Human Performance Technology (HPT; Dessinger et al., 2012; Van Tiem et al., 2012) perspective resulting in a “HPT-OER model” (Richardson et al., 2023). According to Pershing (2006), “Human Performance Technology (HPT) is the study and ethical practice of improving productivity in organizations by designing and developing effective interventions that are result-oriented, comprehensive, and systemic (p. 6).” This paper is the second in a series that reports on the PoRTAL project’s intervention informed by an HPT perspective and focuses on the co-design process and resulting research, our design principles, from the DBR process.

The professional development of instructors and GTAs for online teaching and learning: a human performance technology approach

ERT resulted in an avalanche of professional development opportunities for faculty and GTAs. Unfortunately, reacting to emergency situations in higher education comes at the expense of online pedagogy. Much of professional development time is focused on acquiring technical skills like learning management systems, video conferencing software, or video editing (Ní Fhloinn & Fitzmaurice, 2021; Walsh et al., 2021). Given the urgency of remotely delivering instruction that was designed to be in-person, institutions and instructional designers were in “survival” mode that needed to focus on keeping courses afloat (Moreno et al., 2022). This might have prevented them from guiding faculty and GTAs in the effective facilitation of online teaching and learning using evidence-informed practices. Ní Fhloinn and Fitzmaurice (2021) reported that in previous ERT situations, like the SARS in 2003, only instructors who already have strong technology skills were prepared to shift their efforts to improve their online pedagogy. ERT led to increased technical training for faculty and GTAs but neglected online pedagogy, suggesting that resources supporting effective online teaching strategies are just as crucial as technical guidelines.

Even before the pandemic, faculty and graduate students received little training on how to perform an essential element of their jobs—teaching (Schroeder, 2022). Lack of pedagogical training was true for in-person instruction and even more dire for online teaching—which faced resistance even before the pandemic. As is the case with most first time in-person teaching experiences, instructors may teach their first online course with minimal guidance. Hebert et al. (2022) surveyed faculty in four higher education institutions and reported that 36.5% of them had no previous online teaching experience prior to the pandemic. Yet, much of the training that faculty and GTAs receive is included in packed welcome weeks and introductory sessions in the midst of a transition to a new job place (Schroeder, 2022). Instructors' subject matter expertise includes unrealistic expectations that faculty have to master the pedagogical decisions to lead a successful learning experience (Robinson & Hope, 2013), let alone an online learning experience. Yet, lack of training does not imply lack of knowledge which leads instructors to continue reproducing the way they were taught, strategies they used when learning (Oleson & Hora, 2014), and potentially the misconceptions about online teaching and learning acquired.

Moreover, despite the vast resources that are available in institutional centers for teaching and learning (Schroeder, 2022), instructors face competing priorities between their research and teaching that prevent them from focusing on their pedagogical professional development and resources (Carless & Winstone, 2023; Reid & Gardner, 2020). Institutions also provide one-on-one support through instructional designers. However, Mueller (2021) reported that tensions between faculty and instructional designers might prevent a successful relationship; for example, tensions were felt when faculty sense a loss of autonomy and when faced with a perceived incongruency between recommendations by instructional designers and faculty's teaching philosophy or pedagogical strategies. Finally, professional development time for teaching is unpaid and this is especially true for contingent faculty whose salary is paid based on the number of courses taught. Given the multiple constraints on resources and competing priorities for faculty and GTAs as workers in higher education institutions, higher education institutions need to offer efficient training entry points that overcome time constraints and circumvent competing priorities.

Theoretical perspectives supporting the creation of digital repositories

Digital repositories can share best practices and knowledge in the form of resources that are readily available, leading to more discovery, knowledge creation, and use (Allan, 2009; Liu et al., 2021; Okon et al., 2020; Rahaman, 2018). With the ever-increasing amount of online information sometimes reusing knowledge compiled by others is easier to accomplish tasks compared to searching for information alone (Fisher et al., 2012; Kittur et al., 2014; Liu et al., 2021). In order to be useful, these resources need to be sustainable, trusted, and well managed (Seckler et al., 2015; Thielsch & Hirschfeld, 2019) and also relevant and thorough (Liu et al., 2021).

A digital repository can consist of online teaching best practices in the form of learning objects that provide procedural knowledge or knowledge about how things

are done (Allan, 2009; Okon et al., 2020). Sometimes such knowledge warehouses that are cataloged and stored for reuse result in large amounts of non-reusable knowledge (Yacci, 2008) because of concerns related to credibility (Seckler et al., 2015; Thielsch & Hirschfeld, 2019). Before reusing knowledge it is imperative for knowledge consumers to evaluate the context, relevance, trustworthiness and thoroughness of content they want to reuse (Liu et al., 2021). This will reveal how the knowledge artifacts were constructed (Liu et al., 2021). To optimize the use and reuse of these resources, the development of digital repositories or knowledge warehouses should be guided by instructional theories and models. Most importantly they should meet users' needs (Fisher et al., 2012; Liu et al., 2021; Markus, 2001).

Knowledge reuse can be defined as the application of existing materials and shared best practices to solve common problems (Liu et al., 2021). The theory of knowledge reusability (Markus, 2001) identifies four types of knowledge reusers or consumers: shared work producers, shared work practitioners, expertise-seeking novices, and secondary knowledge miners. Considering online instructors as knowledge reusers, they could fall under shared work practitioners or expertise-seeking novices. Further, online resources should meet open access criteria with regards to accessing resources and distributing resources (Huang et al., 2020). In a study about reuse of Open Educational Resources (OERs) like digital repositories, Pegler (2012) found three factors associated with knowledge reuse activity: technical issues, quality, and motivation. Where technical factors include copyright issues, quality includes usability, and motivation is connected to the purpose of reusing the knowledge in the repository. Users are encouraged to use online educational resources that meet certain standards: they should be current, openly licensed, of high quality, ensure fast search, relevant to the users and suitable for dissemination (Pegler, 2012).

Digital repositories are OERs in which *openness* indicates that materials are licensed that provide users access to engage in the 5R activities: retain, reuse, revise, remix, and redistribute (Wiley & Hilton, 2018). The resources within PoRTAL were designed and developed to serve as OERs, keeping in mind the above theoretical implications. Currently users are allowed to retain, reuse, revise, and remix but not redistribute remixed resources; our team is in the process of updating the creative commons license to allow for this broader approach.

Role of open educational resources in online teaching and learning in higher education

Aiming to meet the United Nations premise that “everyone has the right to education” (1948), the purpose of OERs is to provide access to educational materials of the highest quality (Caswell et al., 2008; Wiley & Hilton, 2018). The primary intended audience of OERs were instructors and teachers who needed to update their teaching practices or improve course materials (Irvine et al., 2021; UNESCO, 2002; Wiley, 2021). Wilson et al. (2018) conducted a small study in the Southern Cross University in Australia that demonstrated the usefulness of OERs in a self-paced professional development program regarding time flexibility and accessibility. Therefore, asynchronously delivered professional development programs were demonstrated to be

a unique tool to provide credentials for new instructors and update the teaching and learning skills of more experienced instructors (Wilson et al., 2018). Honoring its name, The Open University UK invested in OERs through The OpenLearn initiative obtaining positive results and benefits for the institution. Some of the advantages were: enabling staff to engage in new forms of information and support; improving external web presence in the market; achieving a cutting-edge recognition of web-based learning and open education; and attracting learners to online courses that gained nearly £2.7 million in teaching income (Gourley & Lane, 2009). Similar results were found regarding student enrollment in three other higher education research institutions (i.e., MIT, Johns Hopkins School of Public Health and the Open Universiteit Nederland) (Carson et al., 2012). Kimmons and Irvine (2023) argue that the role of OERs in education goes beyond impact as measures in revenue and enrollment, but also on how educators are enabled through OERs to rethink and reimagine how education takes place in a more equitable world.

OERs have also been key for the development of faculty online teaching skills in cases of emergencies like natural disasters, pandemics, and political situations that call for a change in teaching practices. For instance, in face of a political crisis, Rapp et al. (2016) explained the implementation of an OER platform called e-Tutor developed at Ankara University's Distance Learning Centre in Turkey. The e-Tutor OER platform was licensed under the Creative Commons License and translated into multiple languages to increase its reachability. The Turkish developed e-Tutor supported Ukrainian faculty who were forced to transfer their classes from face-to-face to online education. Their OER platform included 14 modules on topics such as online learning theories, virtual classroom management, and online instructional methods. Taking a hands-on approach, the e-Tutor program asked faculty to become online learners prior to teaching online, and consequently, understand what *feels* to be on the other side of the screen and the potential barriers that they, as well as their learners, might feel. This is an example of an OER that is crucial to support faculty in times of crisis and assure continuity in education to learners (Rapp et al., 2016). An evaluation of the e-Tutor program recommended that similar programs balanced theory and practice; increased the duration of courses to decrease pressure on faculty; include collaborative projects; and have responsive facilitators (Adnan et al., 2017).

Systematic reviews and meta-analytical evidence highlight key areas in which OERs support instructors and students in higher education, such as implementing open textbooks to reduce costs and supporting disadvantaged students without compromising achievement. Mullens and Hoffman (2023) synthesized two decades of research on OERs adoption by analyzing the results of 97 peer-reviewed journal articles published between 2002 and 2023. While both faculty and students have positive views about OER adoption and consider them comparable to traditional instructional materials, faculty particularly value the prestige of OER's authors and the reputation of the institution that produced them. Further, OER adoption comes at no expense to students' achievement and retention and could significantly help disadvantaged students. Yet, Tlili et al. (2023) and Tlili et al. (2025) meta-analytic evidence showed that OERs and OER practices have a positive but negligible effect on students' learning performance ($g = 0.10$; $p < 0.05$). Otto et al. (2021) emphasize that although much research on OER adoption has been done in terms of cost-saving opportunities

and retention, there is a noticeable research gap regarding OER usability. Altogether, reviews on OER adoption invite researchers to further examine issues like technological and copyright support (Mullens & Hoffman, 2023) and usability testing (Otto et al., 2021).

A more recent emergency experienced at a worldwide scale is the COVID-19 pandemic. The COVID-19 pandemic has created serious social, economic, and education system disruptions globally. According to UNESCO (2020), at least 191 countries shut down educational institutions, affecting over 90% of students at all education levels. Prior to COVID-19 pandemic, instructors received little professional development on teaching (AbuZayaad-Nuseibeh, 2017; Magda, 2019), in particular, online teaching (AbuZayaad-Nuseibeh, 2017; Magda, 2019; Martin et al., 2019). After the COVID-19 pandemic, the vast majority of instructors and GTAs were challenged by the need to teach or mentor online (Hodges et al., 2020). Some of the challenges that were encountered include: teaching bigger online classes; ensuring that students stayed engaged and motivated; ensuring accomplishment of the learning outcomes by the students including the intended knowledge, skills and attitudes; course completion and also learning to adapt existing processes to respond to unprecedented operational challenges in the future (Hodges et al., 2020). In such a scenario many instructors continued education via ERT using OERs such as Teachers Pay Teachers and OER commons (Huang et al., 2020; Van Allen & Katz, 2020).

Conducting a design-based research study: Purdue repository for online teaching and learning

This study reports on the co-design process and our research results and subsequent design principles, of our design-based research process to create and implement the *Purdue Repository for online Teaching and Learning* (PoRTAL). PoRTAL was created as an open educational resource (OER) digital repository that is available 24/7 to provide strategies, tips, and resources for instructors struggling to teach online. To ensure the success of a digital repository like PoRTAL, involvement and cooperation from multiple stakeholders like administrators, staff, faculty peers, and instructional design teams are essential (Bennet & Lockyer, 2004; Covington et al., 2005; Frey & Donehue, 2002; Hoffmann & Dudjak, 2012). PoRTAL was launched as a joint initiative of several units across a university, where this research study was conducted. The research team from the academic unit consisted of faculty and graduate researchers who spearheaded the design process while the other units contributed to content and expert evaluation in their capacity as co-designers and subject matter experts.

DBR is an iterative process that systematically improves practice (Wang & Hannafin, 2005) resulting in contextually-sensitive principles or theoretical contributions (McKenney & Reeves, 2019). Researchers use DBR to distill theoretical design principles from the process of solving real-world educational problems in close collaboration with practitioners and the community they are serving. Using a generic DBR model (McKenney & Reeves, 2019) we moved through iterative cycles of revision and improvement involving perspectives from multiple stakeholders.

Based on the DBR approach and to improve the PoRTAL OERs, we collected evaluation data at various intervals from faculty specializing in instructional design, instructional designers, potential faculty users, and GTAs; and then, revised the PoRTAL OERs accordingly. At present PoRTAL contains 31 resources on topics grouped into: Strategies for *online teaching and learning*, *Thinking about your course design*, *Upping your game*, and *Policies and procedures*. This paper focuses on the research conducted during the development of PoRTAL. We also discuss the contributions of PoRTAL to the instructors and GTAs' professional development, the identified affordances and barriers, and recommendations for improvement. Our guiding research questions were: RQ-1. What was the perceived need for online teaching resources for faculty and GTAs?

RQ-2. What affordances can make PoRTAL resources accessible to a diverse and broad population?

RQ-3. How practical were the PoRTAL resources in supporting faculty and GTAs in their online teaching practices?

RQ-4a. How effective were the PoRTAL resources in supporting faculty and GTAs in their online teaching practices?

RQ-4b. What were the affordances and barriers to implementing the PoRTAL training materials (e.g., content, format, localized context)

Figure 1 shows the alignment between the process followed for the development of PoRTAL and our research process. The research process included four major phases and each phase comprised two development steps. The results of each phase are theoretical insights which we have expressed as design principles (McKenney & Reeves, 2019), the primary contributions of this study. Practitioners can find a thorough description of each step of the DBR process we engaged in by reviewing Richardson et al. (2023). Briefly, our phases were comprised of the following steps:

- Phase 1
 - Step 1: Needs Analysis. Grounded in the literature on instructor training in online learning and analysis of peer-institutions approaches to online

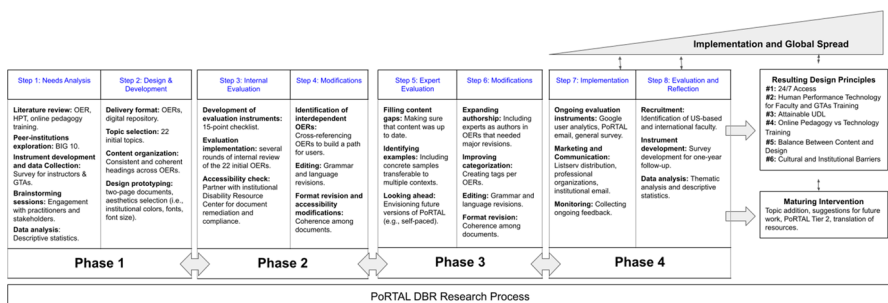


Fig. 1 Design-based research process for the development of PoRTAL. *Note.* A thorough description of development process steps 1 through 7 can be found in Richardson et al. (2023)

teaching/ training, resulting in the design and implementation of surveys for instructors and GTAs

- Step 2: Design & Development. We developed a prototype for our intervention choosing an OER 2-page format and identified the topics necessary per the needs analysis survey results.
- Phase 2
 - Step 3: Internal Evaluation. We developed a 15-point checklist for evaluation and implemented it across the OERs. Accessibility issues were checked with the help of Disability Resource Center.
 - Step 4: Modifications. Based on internal evaluation we identified cross-referenced OERs, edited and revised the format.
- Phase 3
 - Steps 5: Expert Evaluation. Reached out to experts in the field for feedback on topics and content coverage.
 - Step 6: Modifications. We reworked current and added new OERs to fill content gaps based on experts' insights, improved content with examples, and included experts as part of the co-creation of the OERs.
- Phase 4
 - Step 7: Implementation of P[Anon] digital repository.
 - Step 8: Evaluation and Reflection. We used Google analytics and a follow-up survey including international faculty for ongoing evaluation of individual OERs and to inform a one-year follow-up of PoRTAL implementation.

Research process

The research process of this DBR study is divided into the corresponding four phases and eight steps depicted in Fig. 1. The first development step of each phase focuses on data collection and analysis (e.g., needs analysis, evaluation instruments, user analytics, accessibility analysis), which led to an evidence-informed development step in which theoretical design principles were distilled as results of each phase and theoretical contribution of the study. Each proposed principle is discussed considering relevant theory. As DBR is an iterative process there was often a step back to refine each OER with each level of data collection as indicated by the arrows in Fig. 1 at the Phase level.

Phase 1 - Needs analysis and design & development

RQ 1. What was the perceived need for online teaching resources for faculty and GTAs?

Step 1: Needs analysis and data collection

Implementations of online teaching and learning support for faculty and GTAs from comparable institutions (i.e., Big 10) were inspected to identify existing resources and a literature review about OER, HPT, and online pedagogy was conducted to inform instrument development for data collection. A survey was sent to all instructors and graduate students at the institution's main campus via listserv, regardless of their experience teaching online. The survey had four sections: 1) prior online teaching and learning experience, 2) level of interest in online pedagogy topics, 3) level of interest in technological skills and specific software, and 4) additional topics or tools not included in our proposed list. Respondents were also asked open-ended questions to indicate what their perceived barriers were to teaching online and what was their preferred format to receive support when teaching online (i.e., in-person workshop vs self-paced module vs just-in-time resources). We could not use a validated instrument due to the lack of an available one in the literature on needs analysis on online teaching resources. However, the instrument we developed was informed by our team's review of existing repositories and literature and was reviewed by four experts before administering. The instrument served as a diagnostic tool that evidenced the instructors' concerns, expectations, and experiences when changing their teaching environments. Respondents were 174 faculty members and 435 graduate students. This needs analysis and data collection process reflects a co-design process with practitioners in shaping the design and development of our resources.

Step 2: Design & development

Resulting Theoretical Contribution, Design Principle #1: 24/7 Access Digital Repository and Open Educational Resources

A significant advantage of OERs is cost savings from knowledge reuse (Hilton et al., 2014; Martin et al., 2019; Yacci, 2008). However, producing high-quality digital repositories that meet users' needs requires a lot of effort and motivation from knowledge producers and the availability of resources to complete the task (Markus, 2001). In addition, maintaining the credibility and trustworthiness of the knowledge (Seckler et al., 2015), considering the subjective perceptions of content that may influence user evaluations, and attitudinal and behavioral outcomes (Thielsch & Hirschfeld, 2019), and identifying knowledge management tools to ensure accessibility and visibility of recorded knowledge (Rahaman, 2018) requires a lot of effort from the knowledge producers.

Building on Step 1 Needs Analysis and Data Collection, PoRTAL has been designed intentionally to provide easy-access, on-the-job, and self-paced support to instructors who are teaching online courses. Specifically, 22 initial OER topics were identified for development (Richardson et al., 2023, Table 1) by including a definition, examples, resources, and other pertinent information to help instructors implement pedagogical practices (Yacci, 2008) and to provide easy access to them (Huang et al., 2020; Pegler, 2012). The initial 22 OER topics were grouped into four cat-

Table 1 Integrated results from faculty and GTAs recommendations for PoRTAL

Faculty	GTAs
1. Incorporating worked examples from instructors with experience teaching online	1. Improving the overall design and layout of the PoRTAL site by making it more user friendly
2. Recategorize resources based on instructors' experience (i.e., beginner, intermediate, advanced) teaching online to create a personalized learning path	2. Incorporating the most relevant and focused resources on the front page. For example, the most viewed
3. Provide specific recommendations for large class size online teaching	3. Including more practical tips with examples from external resources
4. Provide recommendations for diverse contexts. Specifically, rural areas	4. Including more visual representation with images and videos
5. Incorporate an open Q&A discussion that resembles public comments in a blog	5. Improving the visual design of the OER by reducing words and number of bulleted lists
6. List institutions' responsibilities regarding online teaching	6. Incorporating video guidelines of how to implement a particular concept/principal
7. Introduce experiences from non-US based faculty (e.g., testimonials)	7. Incorporating job aids for relevant software
8. Shared examples should use easily accessible software (e.g., PowerPoint) instead of paid software (e.g., Camtasia)	8. Creating a list of mistakes to avoid for each resource
9. Include examples on how to introduce social media (e.g., Facebook) and chatting platforms (e.g., Slack).	9. Incorporating more examples of online tools and their applications (i.e., software)
10. Provide translations to other languages to improve outreach of resources	10. Including real case experiences of GTAs facing specific challenges
11. Include a section in the documents called "Potential Challenges and Possible Solutions."	11. Including lesson plan templates and sample lesson plans for online teaching
12. Include extra topics: self-regulation, engagement vs presence, overuse/abuse of videos, transactional distance, synchronous vs. asynchronous environments, social media integration	12. Including a sample course incorporating the essential components of effective online teaching and learning
We integrated faculty and GTAs insights to provide a more comprehensive description of the type of professional development expected from both groups	

egories: instructor strategies (e.g., discussion board facilitation), course design (e.g., Universal Design for Learning (UDL), course enhancement (e.g., gamification) and policies & procedures (e.g., accessibility). Although OERs are user-friendly, instructors may require higher skill levels to use digital repositories (Pegler, 2012). When reusing OERs there is the need for "educator-led decision-making within a technical-mediated system" (Pegler, 2012, p. 6). Additional technical skills are required in cases where resources are modified, when classifying and describing the resources, and when trying to identify the best licensing options for sharing OERs (Pegler, 2012). However, PoRTAL's OERs are available as downloadable PDFs from an open website that can be accessed and used based on individual context. For example, some users have considered translating the OERs to other languages as well (e.g., Turkish). Translations fit with the 5Rs guideline that provides license for anyone to retain, reuse, revise, remix, and redistribute (Wiley & Hilton, 2018) that was found to be helpful to users. We believe that the methods we followed to create PoRTAL involving a design based research (DBR) approach where design, research, and prac-

tice (Wang & Hannafin, 2005), guided us through iterative cycles of revision and improvement that considered perspectives from multiple stakeholders (Richardson et al., 2023) will be helpful for creators of OERs in the future.

Resulting Theoretical Contribution, Design Principle #2: Human Performance Technology for Faculty and GTAs Training

We framed the need for faculty and GTAs development in online learning as a human performance issue and investigated it further through an established HPT model. We adopted Van Tiem et al.'s (2012) HPT model in our DBR process to (1) perform a need, gap, and cause analysis to identify challenges faced by faculty and GTAs in the context of online teaching and why they occur, (2) develop and implement an intervention (i.e., PoRTAL) to address these challenges, and (3) concurrently and iteratively evaluate all these steps to improve our intervention (See Richardson et al., 2023 for details). Some of the major findings through our need, gap, and cause analysis were that faculty and GTAs did not have access to adequate tools, resources and training programs, and they had limited time to develop or upgrade their skills on online teaching. The solutions that emerged through this process were to develop just in time resources (PoRTAL tier 1) and develop self-paced training (PoRTAL tier 2). HPT is aligned with the DBR process as it provides an iterative way of analysis, design, development, and evaluation (Richardson et al., 2023). The application of the HPT model in our DBR process helped us make sure that training and faculty resources on online learning are crucial to address the current gaps and prepare faculty and GTAs to effectively teach online.

The comprehensiveness and systematicity of the HPT-OER model gave us freedom in each step to perform ongoing analysis for meaningful change management within our institution. In the beginning, as part of the needs analysis, we conducted an environmental analysis to determine what the current status of online learning is in the world, what is the direction workplaces are taking in terms of online teaching, and what skills are expected of workers (i.e., instructors) to teach online. The environmental analysis included world analysis (e.g., rapid increases in online courses), workplace analysis (e.g., high demand for online instructors in next 12–18 months), and worker analysis (e.g., demand for evidence-based practices). This analysis led to a gap analysis that further revealed that although the desired performance for instructors was to apply best practices in online teaching and learning, the reality was that instructors did not effectively integrate best practices. This insight led to the cause analysis of this gap, which consisted of environmental factors (e.g., inadequate tools and resources to support online teaching and learning) and individual factors (e.g., not having the skills and knowledge to effectively design, develop, and conduct online courses). These multi-phase analyses through the HPT-OER model helped our decision making in creating PoRTAL as an intervention to address the skill and knowledge gaps of instructors. Partnering with relevant departments across the campus gave us the opportunity to utilize varied expertise and resources and promote PoRTAL more widely. Collaboration was instrumental in implementing and maintaining PoRTAL. Evaluation was part of each step of the process, and it went through multiple iterations based on formative, summative, confirmative, and meta

evaluation. For a more detailed explanation of the model and alignments between different components, please refer to Fig. 2 in Richardson et al. (2023).

Phase 2 - Internal evaluation & modifications

RQ-2. What affordances can make PoRTAL resources accessible to a diverse and broad population?

Step 3: Internal evaluation

The internal iterative evaluations used a 15-item checklist for OER development to ensure format consistency and content quality in initial prototypes (Richardson et al., 2023). Two members of the research team evaluated each OER prototype independently and then compared results before sending the OERs for expert evaluation. Several rounds of internal evaluation (designers and content-experts) were in place to improve content quality and maintain design uniformity of the resources. We also consulted with the Institutional Disability Resource Center to review our resources for any accessibility-related issues as part of our co-design process.

Step 4: Modifications

Resulting Theoretical Contribution, Design Principle #3: Attainable Universal Design for Learning Guidelines

We addressed accessibility from the Universal Design for Learning (UDL) perspective. UDL changes “the design of the environment rather than to change the learner” (CAST, 2018) by providing nine guidelines that foster multiple means for learners' engagement, representation, and action and expression. During PoRTAL Step 4: Modifications in Phase 2, we addressed users' engagement (UDL guideline #7) by recruiting interests through the refinement of the guiding questions that outlined individual OERs (i.e., why this is important, Richardson et al., 2023). We also focused on identifying missing OERs and topics that supported users' self-assessment and reflection (UDL Guideline #9), such as the Online Teaching Persona OER.

Then, we focused on providing multiple means of representation by editing each OERs' language to promote understanding across disciplines and institutions (UDL Guideline #2) by highlighting the relationships among OERs through cross-referencing and hyperlinks (UDL Principle #3). Finally, we partnered with our Institutional Disability Resource Center to individually review each OERs to ensure that they were accessible to users who needed to use text-to-speech software and to provide options for physical action (UDL Guideline #4). We acknowledge that it is still challenging to address all UDL guidelines comprehensively.

For example, we could not incorporate much of the action and expression component of the UDL framework, which includes three sub-components: providing options for 1) physical action, 2) expression and communication, and 3) executive functions

(CAST Consortium for UDL, n.d.). The nature of the resources (e.g., two pagers, limited space) did not allow us to include all components. However, the CAST Consortium for UDL (n.d.) clarifies that the UDL framework serves as checkpoints to reduce learning barriers and that some guidelines may not be relevant to specific learning goals. Then, our predominant mode of providing perceptions is through reading. We based our decision of designing reading resources on our phase 1 needs analysis. The insights gained from the UDL framework led us to incorporate more options for perceptions and action and expressions in our second stage of PoRTAL (e.g., self-paced modules with videos). Since these resources are meant to be self-paced and learned, theories related to self-directed learning could be consulted to guide researchers and practitioners' work in the future.

Phase 3 - Expert evaluation & modifications

RQ3. How practical were the PoRTAL resources in supporting faculty and GTAs in their online teaching practices?

Step 5: Expert evaluation

Expert evaluation participants

A pool of 10 experts were recruited to evaluate the resources for content accuracy, depth, and breadth. We developed a one-page evaluation instrument with eight open-ended questions for experts to review each OER. This also signifies our constant focus on co-design with practitioners and experts. Sample evaluation questions included:

- Does content appear up to date?
- Is there enough/too much overlap between topics (e.g. twenty-first century skills and information literacy; social presence and CoI)?
- We've used limited direct citations within documents because of length. However, within the PORTAL docs there are a few things that should be cited at the spot- quotations and definitions (as applicable). Are these items appropriately cited at the spot? Other comments regarding citations?
- Are resources provided for users outside of P[anon] and/or Blackboard?
- "Based on this particular PORTAL document do you believe you have enough information to (1) understand the basics of the topic, and (2) move forward using the resources and references provided?"

The responses from the experts to these questions not only filled the content gaps but also identified new examples and generated ideas for future versions of PoRTAL. Evaluation data from experts was categorized as feedback that could be addressed during the next Modifications step and feedback that recommended other future interventions. For a more in-depth description of the expert evaluation design process please refer to Richardson et al. (2023).

Step 6: Modifications

Resulting Theoretical Contribution, Design Principle #4: Online Pedagogy vs Technology Training

Many instructors might fear online teaching and learning, thinking that they might not have the necessary technological skills to meet the challenges (Boettcher & Conrad, 2016). When starting to teach at a distance, instructors might place a greater emphasis on technological skills (e.g., video editing) rather than their online pedagogical strategies. Technical skills are useful in teaching distance learning, but facilitating meaningful online learning requires strong pedagogical skills. The provision of appropriate support to instructors enables them not only to prepare higher education institutions for quality online courses, but also to adapt to change in teaching (McGee et al., 2017; Mohr & Shelton, 2017). Addressing this issue, we invited content experts from relevant fields like special education and problem-based learning as well as “process” experts, instructors who had 5+ years in the design and facilitation of online teaching to provide further insights on the OERs. Experts were highly involved in the reviewing process providing formative feedback and, in some cases, becoming co-authors of OERs. In this way, our research process involved multiple perspectives to critique our design resulting in valuable feedback that influenced our theoretical approach (Barab, 2014). Our experts reported a need for more practical recommendations and worked examples, as a result, we included examples that instructors could use as templates for their own design and facilitation. For example, as part of the “Facilitation your Online Discussions” OER, we included two sub-OERs that provided recommendations ready to implement. Specifically, the sub-OER “Varying your Discussion Boards as Instructional Strategy” integrates online learning theory (i.e., cognitive presence) with a variety of sample questions to guide instructors on writing discussion board props targeting various cognitive processes. We also included a sub-OER providing a sample discussion board rubric and examples for each criterion.

Finally, to ease instructors' navigation within PoRTAL, we implemented a tagging system for all OERs. Rather than using technical descriptors, we classified resources using tags that describe their pedagogical value and application context. Sample tags included “discussion boards” or “policies and procedures.” Our pedagogically-oriented tagging system aims to bridge the gap between how instructors conceptualize their online teaching needs and how resources are cataloged, potentially increasing resource discovery and adoption rates (Cox & Trotter, 2017). Additionally, we maintained consistency in tag application across all materials to avoid the fragmentation often seen in larger repositories where similar resources may be tagged differently, making them difficult to find through standard search functions.

Phase 4 - Implementation and evaluation & reflection

RQ4a. How effective were the PoRTAL resources in supporting faculty and GTAs in their online teaching practices?

RQ4b. What were the affordances and barriers to implementing the PoRTAL training materials (e.g., content, format, localized context)

Step 7: Implementation

Following the previous steps, PoRTAL was launched in 2019 and hosted within the university's "Innovative Learning" website under the Tools and Resources section. The resources were accessible from anywhere in the world. "Innovative Learning" promotes effective teaching and learning by offering quality resources and services to instructors within the university. PoRTAL was marketed across the university through social media and campus news sources, to professional organizations via list-serv notices (e.g. AERA SIGs, AECT), and through professional presentations. Additionally, during this period, several feedback mechanisms were in place to inform us about the quality of the implementation.

Ongoing evaluation instruments, monitoring, and global spread Google Analytics data was collected from 2019 to 2021 to gain insights into the number of views and downloads of each OER as well as users' location. A link to a feedback survey is provided at the end of the PoRTAL web page. This includes three questions: was the PoRTAL resource useful?; was navigation through the PoRTAL website intuitive?; and will you recommend PoRTAL to a friend or colleague? Comments and feedback are also solicited in the survey along with two prompts about respondent demographics. Users were able to share brief comments about PoRTAL's role in their work. Some examples are: "Finally!! An excellent resource for us "long time" teachers to utilize and keep up with the "changes!" - Anonymous

"This is a great project for academicians/lecturers who work out of the US and do not have access this kind of online teaching materials in their countries. Especially this project became more important after Covid-19 pandemic making online teaching ability more and more necessary across the world" - Anonymous

A PoRTAL email was created to gather feedback from the audience as well. Based on the feedback that was received after the project was completed we created several more OERs to meet specific needs. The new OERs include: Authentic learning, Case-based learning, Journaling with students, Posting with intentionality, Use of technology to enhance language teaching, Getting students ready for peer reviews, Interactive synchronous sessions in online courses, Copyright, Accessibility 101, Course management strategies, and Strategies for online academic integrity. The ongoing data collection helped us identify which resources needed further development and to design an evaluation strategy for the one-year follow up. All these initiatives to continually collect data from users represent our co-design process with practitioners to improve our resources.

Since all the OERs included several hyperlinks we wanted to make sure that the links were always active. To facilitate this process an excel sheet with the OER titles and all the hyperlinks that it contained was created. If any link was found to be deac-

tivated we immediately made sure that it was updated. A team member was appointed to monitor these links regularly.

Step 8: Evaluation & reflection

One-year follow up evaluation Targeted evaluation data was collected one year after the launch (implementation) of PoRTAL. Participating instructors and GTAs received a list of the ten most-viewed OERs based on analytics data indicating number of hits and downloads of the OERs. Further, we listened to anecdotal evidence and submitted feedback that indicated that the OERs were not always as relevant for an international audience. As such we invited international instructors to this phase of the evaluation process. International faculty (n = 19), US faculty (n = 10), and GTAs (n = 45) were asked about the effectiveness of PoRTAL as an Open Educational Resource (OER) to support their online teaching and learning practices and the potential barriers that instructors faced during the implementation. US Faculty came from across program areas like Career and Information Studies, Language Literacy and Socio-cultural Studies, Instructional Systems Technology and Learning Sciences (n = 5), Educational Leadership (n = 1), and Counseling and Learning Sciences (n = 1). All international faculty were seasoned instructors from across disciplines and included curriculum and instruction (n = 6), English (n = 5), engineering (n = 4), business (n = 2), medicine (n = 1), and statistics and actuarial sciences (n = 1) and were based in countries like Colombia (n = 2), Bangladesh (n = 4), India (n = 5), Nigeria (n = 1), Saudi Arabia (n = 3), South Africa (n = 1), and Turkey (n = 3). In addition, the survey was sent to GTAs both in the university where this study was conducted (n = 38) and in other universities (n = 7) located in the United States. The GTAs also represented varying program areas including curriculum and instruction (n = 6), educational studies (n = 3), educational technology (n = 13), computer science (n = 4), biological sciences (n = 1), philosophy (n = 1), mathematics (n = 1), Design, Art, & Performance (n = 1), educational psychology (n = 1), business management (n = 1), engineering (n = 6), and languages and cultures (n = 6).

Data collection one-year follow-up—instructors vs GTAs insights on implementation challenges

Participants were asked to review any three of the ten OERs through a Qualtrics survey that contained questions about their online course training, design and teaching experience, and effectiveness of PoRTAL providing both quantitative (5-point Likert scale—strongly disagree to strongly agree) and qualitative (open-ended questions) data sources. Participants evaluated each OER based on six user experience items related to online teaching content (e.g., “This PoRTAL resource covered the essential aspects of this topic”) or future application (e.g., “This PoRTAL resource will help me teach online effectively”). Examples of open-ended questions included “How can this resource support your online teaching/online course design practices?” and “Please provide some specific examples (e.g., designing and facilitating online dis-

cussions, better able to manage my course).” Appendix A shows the user experience quantitative results of both faculty and GTAs.

We used deductive and inductive coding approaches to analyze our evaluation data (Saldaña, 2016). We analyzed data from each OER independently and differentiated data from instructors and GTAs. Our initial round of coding was deductive. We focused on 1) perceived usefulness and benefits of the resources, 2) potential implementation challenges, and 3) suggestions for improvement. In the second round of coding, we used thematic analysis as an inductive approach to identify themes across OERs that synthesize practical recommendations for online teaching training and digital repository development. Appendix B shows the qualitative synthesis of faculty and GTAs recommendations per OER reviewed.

Faculty’s navigation challenges, general recommendations and other comments

Challenges regarding navigation focused on accessibility and web design. Four out of 10 US faculty reported difficulties with navigation. Issues reported were accessibility (e.g., need for full hyperlinks), filters and tags on the main website (i.e., occasional failure), and organization (i.e., content in one page is overwhelming). Only three out of 19 international faculty reported navigation issues in the areas of accessibility and website design. On the one hand, hyperlinks were reported to be problematic for users with vision problems ($n = 1$). On the other, tags were reported to look like bottoms ($n = 1$). Furthermore, one US based faculty suggested new topics for future OERs like self-regulation, engagement vs. presence, and overuse/abuse of videos. Finally, US faculty recommended a reorganization of the PoRTAL resources to avoid overwhelming users. For example, suggesting a reading order using a roadmap indicating readings based on expertise level. One international faculty highlighted the need for translating the OERs, yet another faculty reported having translated the OERs into Turkish to share with colleagues.

GTAs’ navigation challenges, general recommendations and other comments

All GTAs asserted that the 10 OERs that they reviewed were very useful. One GTA said, “If you can somehow market these resources to all schools and universities, I think everyone will love it. Perhaps the Board of Regents and Superintendents of School Districts would be a good starting point for marketing.” Most GTAs found the navigation in PoRTAL easy while others felt it was not user friendly enough although functional. They recommended improving the design and layout, adding practical tips with examples, visual representations like images and videos, making the display more attractive, and having more focused resources on the first page.

Resulting Theoretical Contribution, Design Principle #5: Balance Between Content and Design

Recommendations from faculty and graduate students

GTAs and faculty both agreed that the OERs should provide potential challenges in online learning and recommendations on what not to do. Likewise, both groups suggested incorporating worked examples, case studies, and practical recommendations. Nonetheless, faculty asked for examples with higher complexity than GTAs. For example, scenarios on how to handle larger classes, diverse audiences, and examples specific to rural contexts, whereas graduate students centered on lesson plan templates. Similarly, graduate students demanded examples of various educational technologies. Conversely, faculty asked for examples with mainstream applications (e.g., PowerPoint) to improve ease of use. Altogether, we observed how novice instructors (i.e., GTAs) were concerned with visual aspects of PoRTAL while expert instructors (i.e., faculty) gave recommendations on the content and pedagogical approaches.

Through the open-ended questions, faculty and GTAs shared their views on the effectiveness of PoRTAL resources and barriers to applying them in their work. Both faculty and GTAs found the resources particularly useful for novice instructors in online teaching. Faculty found the resources useful or felt they would be useful to enhance their or their colleagues' online teaching. Furthermore, they indicated that the OER format supports practicing instructors who cannot attend in-person professional development training for online teaching. Likewise, GTAs found the resources very helpful especially during the COVID-19 crisis. They thought that these resources provided them with important and innovative ideas that would help them build confidence. One drawback GTAs identified was about implementing these ideas easily because most often courses are designed by faculty. Furthermore, barriers to implementing some inputs from the resources in online teaching practices included: large classes, technology availability issues for students, student resistance to constructivist approaches to teaching, difficulty in introducing new formats as GTAs, time constraints, inflexibility of the syllabus, extra workload for students, change mindset from instructors, and increased planning time. International faculty were concerned about whether all strategies could be incorporated into their lessons for cultural reasons.

Resulting Theoretical Contribution, Design Principle #6: Cultural and Institutional Barriers for PoRTAL Implementation

Faculty who transition from traditional face-to-face to online teaching can display negative and resistant attitudes towards online education. However, professional development initiatives improve attitudes and self-efficacy toward online teaching (Northcote et al., 2015). Reactively addressing online learning issues might produce unsatisfactory results (Burke, 2005) and stressful experiences for faculty members. Therefore, providing as much support as possible to faculty members might aid institutions in their quest to provide online courses at a large scale and faculty to adapt to the changes in teaching. It is not a surprise that offering sustained professional development to faculty members can be a success factor for institutions that are transitioning to online teaching (Hinson & La Prairie, 2005).

Nonetheless, one might infer that such “sustained” support might be expensive for institutions. Furthermore, it implies considerable time investment from faculty members (Carroll-Barefield et al., 2005). Taylor and McQuiggan’s (2008) study on faculty development concluded that instructors prefer online resources over face-to-face training possibly because of time constraints. However, it is necessary to offer comprehensive, less time-consuming, and more economic resources to ensure that no instructor is left behind. Hinson and La Prairie (2005) recommended using examples of other institutions as guidance to foresee and address faculty needs when moving from traditional teaching to online teaching. Another strategy for a successful transition is assuring involvement and cooperation from multiple stakeholders like administrators, staff, faculty peers, and instructional design teams (Bennett & Lockyer, 2004; Covington et al., 2005; Frey & Donehue, 2002; Hoffmann & Dudjak, 2012). Regardless of involvement or delivery form, Adnan et al. (2017) recommends offering professional development opportunities focusing on online teaching strategies and pedagogies as well as creating learning environments instead of only technology training.

Limitations

This study’s highly collaborative and iterative process implied that we faced exponentially more limitations than in other research studies regarding the lack of exemplary studies, the feasibility of feedback implementation, data synthesization, and generalizability. During Step 1: Needs Analysis, we realized that there were no existing DBR studies on open repositories or online teaching and learning published. Nonetheless, we deeply explored the literature on faculty and GTA training, and OER integration in higher education. Also, we partnered with practitioners and subject matter experts to collect enough data to overcome this challenge. Therefore, despite the lack of examples to guide our inquiry, we are confident that our work can serve as a pioneering guide on implementing DBR for online pedagogy of faculty and GTAs. Another limitation was the feasibility of feedback implementation during Steps 5 and 7. The mismatch between the changes in the design that users recommended (i.e., obtaining a certificate and hands-on experiences) and our team’s capacity was challenging. Nevertheless, users’ recommendations served as the basis to secure stakeholders’ buy-in and funding for a second tier of PoRTAL that will guide faculty and GTAs to more in-depth and self-paced training that exposes them to more practical experiences. We also faced challenges synthesizing the qualitative data collected in Step 7 in a way representative of instructors and GTAs’ experiences due to the large number of graduate students involved. Specifically, GTAs’ insights could overpower US-based and international faculty suggestions. We analyzed instructors’ and the GTA data separately to address this issue and drew general suggestions for PoRTAL improvement. Finally, despite PoRTAL being open access, our study faces generalizability challenges because other institutions might face structural (i.e., infrastructure, budget) and cultural (i.e., language) barriers when replicating. This limitation reminds us that open access does not equal inclusion and that future developments based on PoRTAL should emphasize inclusivity.

Conclusions

There has been an increasing trend in learner preferences towards online learning that surged further after COVID-19. To meet this need, post COVID-19, educational institutions have made a move towards offering more online courses. However, our study found that, while offerings have increased, many instructors are not trained well to teach online due to the lack of professional development opportunities. In addition to technical skills instructors require training in online pedagogical skills. Furthermore, professional development initiatives must empower faculty to teach online and improve their attitudes and self-efficacy toward online teaching. Our needs analysis indicated that faculty generally prefer online resources as just in time resources when compared to face-to-face trainings owing to lack of time. Sustained training facilities might be expensive for institutions, and in such cases, faculty rely on resources created by other educational institutions.

Following an extensive learner needs analysis, the PoRTAL Open Educational Resources (OERS) were created by taking a DBR approach. This paper highlights the iterative process that followed the DBR methodology involving multiple phases of evaluations and revisions to ensure the quality and sustainability of the OERs. Most importantly the final evaluation phase that was conducted after one year of implementation allowed the research team to collect feedback data from a wide audience of faculty and GTAs. From the end user perspective, the effectiveness of the PoRTAL resources in supporting users' online teaching practices were perceived as successful. The practical implications and challenges that the faculty and GTAs experienced were leveraged to revise some resources and also create more resources. The interest also spurred Tier 2 of the PoRTAL project that resulted in online self-paced workshops that are hosted on the D2L Brightspace learning management system that can be accessed for free.

Perhaps the most valuable contribution of this DBR study is the six design principles, our theoretical contributions, resulting from each phase of our research process. The results of our DBR study propose evidence-informed theoretical contributions pertinent to digital repositories, OERs, faculty and GTA training, and online pedagogy. Our six theoretical design principles indicate that a successful open digital repository to support online instruction should offer 24/7 access and understand faculty and GTAs as workers from a human performance technology perspective. Furthermore, it should strike a careful balance between online pedagogy and technology training on the one hand, and between pedagogical content and website design on the other. Finally, the major barriers to development and implementation were the attainment of UDL guidelines and cultural barriers within institutions. Altogether, these theoretical design principles can guide peer institutions in their creation of digital repositories, as well as researchers on how to conduct DBR in online settings.

Appendix A

See Tables 2 and 3.

Table 2 Faculty's user experience ratings per resource (n = 29)

OERs		Items				
	This PoRTAL re- source covered the essential aspects of this topic	This PoRTAL resource will help me teach online effectively	I am confident about imple- menting what I learned in this PoRTAL resource into my online teaching practices	The external links included in this PoRTAL resource were useful	I will use this PoRTAL resource again in the future	I will recom- mend this PoR- TAL resource to my colleagues
1. Discussion Board Facilitation (n = 12)	4.58 (0.51)	4.58 (0.67)	4.67 (0.49)	4.75 (0.45)	4.75 (0.45)	4.83 (0.39)
2. Principles for Online Teaching (n = 13)	4.15 (1.28)	3.92 (1.44)	4.31 (0.95)	3.92 (1.19)	4.08 (1.32)	4.08 (1.26)
3. Instructor Role Adjustment (n = 11)	4.82 (0.40)	4.73 (0.65)	4.64 (0.67)	4.91 (0.30)	4.55 (0.69)	4.91 (0.30)
4. Online Teaching Persona (n = 3)	4.67 (0.58)	4.67 (0.58)	4.67 (0.58)	4 (1)	4.67 (0.58)	4.67 (0.58)
5. Social Presence Student Engagement (n = 10)	4.8 (0.77)	4.4 (0.81)	4.6 (0.78)	4.4 (0.86)	4.1 (0.82)	4.7 (0.48)
6. Readiness to Teach Online (n = 15)	4.2 (1.21)	4.13 (1.19)	4.2 (1.21)	4.33 (0.72)	4 (1.51)	4.4 (1.83)
7. Community of Inquiry Framework (n = 5)	4.8 (0.45)	4.4 (0.55)	4.6 (0.55)	4.6 (0.89)	4.8 (0.45)	5 (0.00)
8. Gamification in Online Teaching (n = 6)	4.16 (1.17)	3.83 (1.17)	4 (1.26)	3.83 (1.17)	4 (1.26)	4 (1.26)
9. Student-Centered Teaching (n = 7)	4.29 (1.50)	4.14 (1.46)	4.29 (0.76)	3.86 (1.35)	3.86 (1.35)	4 (1.41)
10. Teamwork (n = 5)	4.8 (0.45)	4.6 (0.55)	4 (0.71)	4.8 (0.45)	4.8 (0.45)	4.8 (0.45)

Standard deviations are presented in parentheses. Means and standard deviations should be interpreted in light of specific sample sizes per OER

Table 3 Graduate Students' user experience ratings per resource (n = 45)

OERs	Item	This PoRTAL source covered the essential aspects of this topic	This PoRTAL resource will help me teach online effectively	I am confident about implementing what I learned in this PoRTAL resource into my online teaching practices	The external links included in this PoRTAL resource were useful	I will use this PoRTAL resource again in the future	I will recommend this PoRTAL resource to my colleagues
1. Discussion Board Facilitation (n = 19)	4.63 (0.50)	4.53 (0.61)	4.53 (0.61)	4.53 (0.61)	4.37 (0.90)	4.47 (0.77)	4.53 (0.84)
2. Principles for Online Teaching (n = 23)	4.74 (0.45)	4.52 (0.73)	4.52 (0.73)	4.61 (4.99)	4.70 (0.47)	4.57 (0.79)	4.78 (0.52)
3. Instructor Role Adjustment (n = 14)	4.36 (0.63)	4.43 (0.76)	4.43 (0.76)	4.14 (1.10)	4.36 (0.63)	4.07 (1.21)	4.5 (0.76)
4. Online Teaching Persona (n = 9)	4.56 (0.53)	4.56 (0.53)	4.56 (0.53)	4.56 (0.53)	4.67 (0.5)	4.67 (0.5)	4.89 (0.33)
5. Social Presence Student Engagement (n = 12)	4.75 (0.45)	4.67 (0.49)	4.67 (0.49)	4.58 (0.67)	4.5 (0.78)	4.42 (0.79)	4.5 (0.67)
6. Readiness to Teach Online (n = 15)	4.4 (0.63)	4.33 (0.98)	4.33 (0.98)	4.33 (0.90)	4.47 (1.06)	4.13 (1.19)	4.53 (0.92)
7. Community of Inquiry Framework (n = 4)	4.25 (1.5)	4.75 (0.5)	4.75 (0.5)	4 (1.41)	4.75 (0.5)	4.25 (1.5)	4.25 (1.5)
8. Gamification in Online Teaching (n = 14)	3.86 (0.95)	3.79 (0.89)	3.79 (0.89)	4 (1.11)	4.5 (0.65)	3.57 (1.40)	3.64 (1.01)
9. Student Centered Teaching (n = 11)	4.45 (0.93)	4.18 (0.98)	4.18 (0.98)	3.82 (1.25)	3.73 (1.10)	3.73 (1.01)	4.27 (1.01)
10. Teamwork (n = 14)	4.5 (0.52)	4.36 (0.63)	4.36 (0.63)	4.57 (0.65)	4.5 (0.65)	4.43 (0.65)	4.57 (0.65)

Standard deviations are presented in parentheses. Means and standard deviations should be interpreted in light of specific sample sizes per OER

Appendix B

See Table 4.

Table 4 OER specific feedback from faculty and GTAs

Resource	Faculty	GTAs
Discussion Board Facilitation	Contextual examples with hyperlinks to practical resources provided best practices and met institutional needs. <i>Challenges</i> : time management, gaining student participation, application in large classes, and technology issues. <i>Suggestions</i> : Update references, more examples for accessibility, LMS specific management strategies	Provided new ideas to engage and motivate student participation, giving constructive feedback, promoting critical thinking, and assessing student engagement with topic. <i>Challenges</i> : Difficult to implement in large classes, time management. <i>Suggestions</i> : Provide best practices for large classes, tips to grade discussion posts
Principles for Online Teaching	Suitable for faculty new to online teaching. Tips and tricks section was practical and succinct. <i>Challenges</i> : Technology issues, high expectations that may demotivate learners, time management. <i>Suggestions</i> : Modify research focused language, provide sample rubrics, and worked examples	Offers practical examples for novices to improve online communication, teaching presence, and teach diverse students. <i>Challenges</i> : Good for higher education not K-12, technology issues, requires planning. <i>Suggestions</i> : Provide tips to deal with defaulters, engage students, online class management, and samples. Improve format
Instructor Role Adjustment	Concise for implementation, well-defined concepts, helped understand their role, and supported novice instructors. Excellent discussion board rubric. <i>Challenges</i> : Providing feedback in large classes, time management, supporting at-risk students. <i>Suggestions</i> : Provide examples per role type, examples to teach diverse students, and monitor class participation	Offers tips for content organization, individual feedback, transitioning to online teaching, demonstrating availability, and alternate types of activities. <i>Challenges</i> : Change in mindset, meet students' expectations for direct answers. <i>Suggestions</i> : Tips to be flexible, examples for hard sciences, and to show instructor cares
Online Teaching Persona	Supported to be intentional as an online instructor and establish a teaching persona. <i>Challenges</i> : May require much time and heavy pre-work. <i>Suggestions</i> : Adding more links, adding more contexts to links and connecting to pedagogy, adding more examples	Builds confidence for novice instructors, helps understand the importance of a teaching persona, helps institutes to train grad students. <i>Challenges</i> : extra workload for students, students' lack of skills in using tools. <i>Suggestions</i> : video examples, list of common mistakes, job aids
Social Presence Student Engagement	Adds human elements to online teaching, decreases feelings of isolation. <i>Challenges</i> : video-related practices are time consuming, cultural challenges, privacy concerns, out of context for international faculty, translations not available. <i>Suggestions</i> : Implementation could be supported with more worked examples, adding potential challenges and solutions	Tips to implement student-centered learning activities, encourages active participation. <i>Challenges</i> : time-commitment, student resistance, technology unavailability, large classes. <i>Suggestions</i> : visual examples, tips for social engagement with differently able students, more examples of online tools, more tips based on self-determination theory and student-centered teaching

Table 4 (continued)

Resource	Faculty	GTAs
Readiness to Teach Online	Helpful for new faculty, supports the design and delivery of instructions, reduces anxiety towards online teaching, supports international faculty. <i>Challenges</i> : network and infrastructure, need of training, being unsure about implementation. <i>Suggestions</i> : Avoid dichotomizing in person vs online instruction, examples in diverse contexts	Practical tips to gain confidence in online teaching, evaluating online teaching, helpful for transitioning to online teaching. <i>Challenges</i> : lack of organizational support and appreciation, busy schedules of graduate students <i>Suggestions</i> : More focus on practical strategies, tips for synchronous interactions, real case experiences
Community of Inquiry (COI) Framework	A comprehensive and succinct account of the CoI framework, a reminder of the concept of presences. <i>Challenges</i> : providing formative feedback due to time constraints, students' resistance to constructivist methods. <i>Suggestions</i> : adding illustrations, examples or external links, adding case studies or practitioner stories	Practical tips on implementing CoI, enhances social learning, very helpful for online teaching. <i>Challenges</i> : requires additional time, establishing CoI using technology may be difficult. <i>Suggestions</i> : A sample course based on CoI, real-world examples, more on how instructors can support student interactions
Gamification in Online Teaching	Supports student engagement, participation, and motivation and potential tool to increase attendance. <i>Challenges</i> : Institutional barriers (e.g., lack of TA support), students' resources (e.g., limited digital devices) and classroom size. <i>Suggestions</i> : Worked examples focused on <i>when</i> and <i>when not</i> to implement gamification	Introduces emerging technologies to increase student engagement and reduce academic stress. <i>Challenges</i> : Gamification might promote grade driven behaviors, require extensive practice and preparation time. <i>Suggestions</i> : Videos demonstrating gamification practices and promoting faculty buy-out through training
Student Centered Teaching	Promotes student engagement, diverse instruction, and change from the traditional teacher-centered perspective. <i>Challenges</i> : Terminology can be overwhelming to new instructors (e.g., formative assessment). Instructors may face resistance from students and colleagues used to hierarchy in education. <i>Suggestions</i> : Include examples from diverse cultures	Promotes reflection on teaching style and formative assessment and feedback. <i>Challenges</i> : Implementing feedback demands, high time investment. Disciplinary differences (e.g., software programming). <i>Suggestions</i> : Provide scenarios in which instructors changed their instruction based on reflection and provide tips to improve relatedness and students' autonomy
Teamwork	Useful to prepare students for twenty-first century skills and promote collaboration. <i>Challenges</i> : Unclear guidelines for peer-assessment and difficulty of implementation in large classes. Resistance from students and higher time demands. <i>Suggestions</i> : Address class management issues and guide when teamwork is appropriate	Encourages innovative teaching practices and clarifies instructors' role on teamwork (e.g., Team agreement resource, guidance with unengaged students). <i>Challenges</i> : Creating teams in interdisciplinary classes and maintaining diversity. <i>Suggestions</i> : Expand on diversity and teamwork assessment. Clarify differences between collaboration and cooperation

We integrated faculty and GTAs insights to provide a more comprehensive description of the different expectations from both groups

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Declarations

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Ethical approval The questionnaire and methodology for this study was approved by the Human Research Ethics committee of Purdue University (Ethics approval number: 1205012267).

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