

Rethinking Higher Education Unit Design: Embedding Universal Design for Learning in Online Studies

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Abstract

Inclusive education in Australia has resulted in a concerted push for the differentiation of pedagogical teaching approaches by educators across Kindergarten to Year 12 (K-12) learning environments. Such approaches have been shown to meet a diverse range of learner needs found in today's classrooms. While progress is evident at the primary and secondary levels of education, implementing effective inclusive practices in higher education appears stagnant. Utilising the principles of Universal Design for Learning (UDL) in a fully online pre-service teacher training unit, multiple means of representation of the learning content and multiple means of engagement were explicitly incorporated into the online unit design. This approach aimed to proactively support the engagement of all students in an online teaching and learning environment. This study provides preliminary evidence that the application of UDL principles resulted in higher levels of student engagement and lower rates of student attrition.

Keywords: Higher education; instructional design; pre-service teachers; professional development; universal design for learning.

Introduction

Universities are increasingly attracting candidates from varied cultural and linguistic backgrounds, age ranges and socioeconomic backgrounds, inclusive of students with disability (Burgstahler, 2015; McCall et al., 2020). In response to the needs of non-traditional students or diverse learners, universities globally have increased their online course offerings, transforming the face of higher education (Stone, 2019). Despite the continued evolution of post-secondary education from traditional paper-based teaching methodologies to the use of flexible digital technologies, high online learning student attrition rates persist (Coussement et al., 2020). Several reasons have been posited for this phenomenon, including poor course design, low levels of facilitation of learning, and students' ineffective engagement (Eliasquevici et al., 2017; Hammond & Shoemaker, 2014; Pinchbeck & Heaney, 2017). Nevertheless, proactive frameworks can support the engagement, access, and facilitation of students' learning in an online environment, ensuring equity and inclusivity (Florian & Linklater, 2010).

Online Learning in Higher Education Environments

The term online learning is synonymous with e-Learning, web-based learning, internet learning, and computer-assisted learning, to name just a few. All these terms have a commonality: online learning is characterised as a flexible mode of learning that involves the use of information and communication digital technologies and electronic media for educational purposes (Rodrigues et al., 2019). Developments in digital technologies have allowed for greater degrees of flexibility in



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information representation, expression and engagement. However, it is crucial to appreciate that access to educational materials through digital technologies does not guarantee learning barriers are automatically overcome. Simply transforming traditional materials into electronic or digital resources does not directly address diversity; instead, it simply transfers the barriers associated with traditional print materials to the online learning environment (McGhie-Richmond & Howrey, 2014). Online learning environments are most successful when intentional instructional design decisions are made to maximise access to learning for students in a way that has not been possible in previous decades due to advances in digital technology (Hiltz & Goldman, 2004). For instance, digital technologies have allowed for greater control and manipulation of written text factors such as font size, colour, and contrast settings. The ability to embed hyperlinks, additional multimedia components and screencasts have helped support learners in their comprehension and ability to reach learning objectives. The creation of documents and textbooks accessible as text-to-speech enables ease of access and availability of such resources and diminishes the need for transcript services. These advances have helped enhance the learning opportunities of distance students in a fully online environment as they enable lecturers to provide multiple modes or representations of the course materials and provide students multiple pathways and flexibility to engage in their learning.

Universal Design for Learning (UDL) is one such framework for supporting the planning and implementation of such efficacious approaches. UDL in education evolved from the principles of Universal Design in architecture, which became popular towards the latter end of the 1990s by promoting readily accessible buildings for individuals of all abilities (Rose & Meyer, 2002). As Universal Design in architecture works to remove or lower access barriers to physical spaces, UDL works to remove or lower barriers to access curriculum content and increase participation in learning to meet students' varying learning needs. In education from early childhood through to higher education studies (Ashman, 2010; Fovet, 2020; Hayward et al., 2020; Lowrey et al., 2017). The UDL instructional framework is a proactive approach to support the facilitation of today's diverse learners, including, but is not limited to attributes such as age, ethnicity, socioeconomic status, ability, and gender (Edyburn, 2010; Meyer et al., 2014)

Developed and updated by the Center for Applied Special Technology (CAST, 2018), the UDL framework encompasses three core dimensions: limiting or reducing barriers to learning, multiple means of engagement, multiple means of representation, and multiple means of action expression. Multiple Means of Engagement address the "why" of learning, recognising that learners differ significantly in how they are motivated or can be engaged in the learning process. This includes intrinsic and extrinsic motivational factors such as individual neurological capacities, cultural expectations, interests and background knowledge, and the degree to which they engage in or avoid social constructivist learning environments. Multiple Means of Representation focuses on the "what" of learning, the ability to access information in formats that appeal or are relevant to them. Sometimes these approaches might be dictated by specific needs, such as students with sight impairment. Students might also demonstrate a preference for learning, such as students who learn through visual means rather than reading a text. The provision of multiple forms of representation reinforces within and between concepts and increases the likelihood that one or more representations will be accessible for the learner. Multiple Means of Action and Expression addresses the "how" of learning, which requires flexibility or choice in how learners can apply the newly acquired information and demonstrate their learning. For instance, students who may struggle to construct formal written texts due to language barriers may be capable of an oral examination on content, providing them with the ability to express their learning. It is important to note, that while the aims of the UDL framework may infer success in these areas, one must not assume it to be so. Research into UDL is ongoing and its application to different contexts and demographic groups is a growing area of study.

Previous research has examined the impact of different aspects of UDL implementation across educational contexts. For example, examining UDL efficacy across formal educational levels from the pre-school years through to high school in inclusive education environments (Lieber et al., 2008; Rappolt-Schlichtmann et al., 2013). Research has focused on the positive social and academic outcomes of students with a range of disability in inclusive education environments (Marino, 2009; Marino et al., 2014; Rappolt-Schlichtmann et al., 2013). Examination of the impact of UDL within specific curriculum contexts such as literacy and numeracy for learners from diverse backgrounds (Kennedy et al., 2014; Kortering et al., 2008). The recorded benefits to date for UDL in higher education have shown it is a sustainable and efficacious framework for supporting students' engagement and outcomes with disabilities, Indigenous students, and those who are the first-in-family (Fovet, 2020). However, there is a paucity of research in the area of online learning in higher education environments in Australia (Cumming & Rose, 2021), and as such, exploration of a broader application of UDL for the engagement of students in the online higher education context is still required to confidently promote uptake of this approach.

To explore the potential impact of UDL in an online, higher education context, intentionally planned strategies and resources were embedded in the course delivery features of an existing academic module on inclusive education. Within the module, the three core dimensions of UDL (Multiple Means of Engagement, Multiple Means of Representation and Multiple Means of

Expression) aimed to minimise barriers to accessibility of learning to increase student engagement and lower student attrition rates within the unit.

Method

Following approval from the Human Research Ethics Committee of The University of New England (HE21-003), student cohorts for the academic module were separated into pre-UDL and post-UDL depending on the year in which the module was studied. The study used a pre-test–post-test quasi-experimental design to examine differences between the pre-UDL, and post-UDL student cohorts. Cleaned Learning Management System (LMS) and Business Intelligence data on student satisfaction, student engagement and retention were analysed.

Participants

The learning analytics data from 107 undergraduate, initial teacher education students enrolled in a 4-year Bachelor of Education program at a regional Australian university were examined. Data was not examined until the unit was completed and all grades were submitted. Student usernames were replaced with anonymous identifiers.

Module Design

Post-UDL unit design elements included pre-recorded lecture materials (i.e., teacher-made videos) created to teach key course concepts. All pre-recorded lectures included oral narration accompanied by a Prezi presentation, graphic elements (e.g., images, diagrams), and videos that further illustrated the concepts covered. Pre-recorded lectures were made available through an embedded link to YouTube to provide students with the opportunity to access English closed captioning services. Lecture videos were also compressed through a readily available web program to minimise the recordings' file size. File sizes were reduced to ensure students in low internet bandwidth areas could access the recordings, or students could download the recordings easily to watch and review “offline” where required.

The pre-recorded lectures could be viewed in full, in part, and repeatedly for review, clarification, supporting the comprehension of the core concepts, and study aid for topic quizzes and the written assessment pieces. Also, downloadable lecture resources were made available to students. These included lecture transcripts (in both Word and Adobe PDF formats), an audio-only recording of the lecture, and a copy of the Prezi presentation slides. Providing text documents meant that students could self-customise the content by manipulating the font size, font type, layout or any other aspect that enhances accessibility for the individual. Multiple text formats also enable the use of text to speech software for greater accessibility to the unit materials. These design elements worked to address the core UDL dimension of Multiple Means of Representation (the way in which students are offered information and resources). All students had access to the required software for each design element.

In addressing the core dimension of Multiple Means of Engagement (a students' affective connection to and with the content of instruction), flexibility was addressed through access to the LMS from any device, at any time, from any place. The flexibility of engagement was extended using online quizzes as a mechanism for self-pacing of study (hurdle quizzes). Students could log in at any time to complete the topic module quizzes. To unlock the next topic in the learning sequence, students needed to achieve a passing grade set at seven out of 10. Students could take the quiz as many times as required to meet the passing grade. This allowed post-UDL students to work through the unit at a pace that suited them, without waiting for the release of content. By contrast, the pre-UDL cohort had new materials made available on a weekly schedule.

The core dimension of Multiple Means of Representation was addressed in several ways. Students were provided with the choice of the focus and context of their assignment. This included choosing one out of four psychological theories that impact learners to explore in the first assignment. Students could also contextualise their reflections based on the context of their future or prospective teaching environment; early childhood, primary, middle or high school. Choice was provided in the second assignment of the unit where students could select any one of 27 defined efficacious intervention practices (see (Wong et al., 2015) that could be employed to meet diverse learners' needs in classroom environments. In addition, students could choose to submit a formal written essay, a PowerPoint Presentation or a recorded oral presentation.

Table 1*Pre and Post-UDL Unit Design Elements*

Pre-UDL	Post-UDL
Pre-recorded lecture of oral material	Pre-recorded lecture including supplementary materials such as subject videos and visuals Lecture slides Lecture transcript (MS Word & Adobe PDF) Closed captioning Video compression Audio only version of the lecture
Weekly release of unit materials	Self-paced learning Hurdle quizzes at topic completion
Two written assessments on a single pre-defined topic	One written assessment with a choice of four foci One assessment with a choice of 27 foci Choice of educational education context Choice of presentation format and style

Data Collection Procedure

Moodle, a Learning Management System (LMS) platform, was used to support the organisation and delivery of an online learning space hosting the unit materials (Moodle.org). This LMS platform enabled the storing and administration of the digital instructional resources and track and monitor individual student's interactions with the instructional resources. The log files produced in Moodle were used to examine student engagement with the course's digital components and included the frequency of access and student actions on the course site (e.g., resource and information views, lecture views, and downloads). Learning analytics are commonly used to discern patterns in the collected data from an LMS to explore the number of time students spend online, amongst other considerations (You, 2016).

Measures

Students engaged with various access and content learning features that specifically address the modelling of the three core UDL dimensions; Multiple Means of Representation, Multiple Means of Engagement and Multiple Means of Expression. Student engagement was operationalised as the number of times students logged in and interacted with the specified unit's digital content. This included accessing resources, completing quizzes, viewing lecture materials and participating in online discussion forums (Henrie et al., 2015). This was determined through the LMS log file that records student behaviours allowing for the examination and measurement of the regularity of engagement with the online learning environment.

At the end of each teaching period students are encouraged to complete a unit evaluation form online. A number of factors were analysed that aligned with the unit design elements addressing UDL. These included the provision of resources, levels of intellectual stimulation, the efficacy of the unit in supporting students to achieve the learning outcomes and overall satisfaction levels. Ratings are collected against specific statements on a five-point Likert-scale ranging from 1 (strongly disagree) to a maximum of 5 (strongly agree).

Student attrition is the difference between the number of students who commence a unit of study and those who complete the study unit. Student attrition is calculated as the ratio of commencing and completing students.

Data Analysis

A one-sample t-test comparing login rates over the trimester between the pre-UDL engagement and post-UDL design individual student engagement was undertaken to examine the impact, if any existed, between the UDL unit design and student engagement rates. This approach was deemed the most appropriate given that the university's LMS data cleaning process restricted data collection of historical individual student engagement calculations.

Unit evaluation scores were compared pre- and post-UDL. Overall engagement rates were available for the unit's previous year, and individual student engagement rates remained accessible for the current year. Descriptive data are reported for the overall percentage of student attrition.

Results

Engagement

A one-sample t-test was used to compare the engagement rates post-UDL unit design of a cohort of 104 undergraduate teacher education students ($M=701.45$, $SD=14.80$) against the pre-UDL ($n=102$) average of 2973.90. The post-UDL unit design students interacted with the unit resources 2272.0, 95% CI [2301,2243] more times than the pre-UDL unit design cohort. The difference was found to be significant, $t(103)=-153.60$, $p<.001$. $d=3.02$.

Unit Evaluation Outcomes

Overall, there was a notable increase in the mean unit satisfaction factor scores collected as part of the unit evaluation. The mean satisfaction score for pre-UDL was 3.91/5.00 compared to 4.91/5.00 in the post-UDL cohort (Table 2). Students were asked to evaluate the unit and lecturer with a set of predetermined questions. Lecturers have no input to the question selection.

Student Attrition Rates

Student attrition rates more than halved between the pre-UDL and post-UDL cohorts (15.73% and 7.09% respectively).

Table 2

Comparison of Student Evaluation Scores between Pre- and Post-Universal Design for Learning (UDL) Student Cohorts (1.00=highly unsatisfied-5.00=highly satisfied)

	Pre-UDL	Post-UDL
The learning outcomes of this unit were made clear to me	4.09	4.88
The unit enabled me to achieve the learning outcomes	4.00	4.75
The unit was intellectually stimulating	3.91	4.88
I found the resources provided for the unit (e.g., online, print) to be helpful	3.64	5.00
The overall amount of work required of me for this unit was appropriate	3.70	4.88
The lecturer made effective use of teaching aids and media where appropriate	3.73	4.88
Overall, the lecturer was highly effective in facilitating my learning	4.18	5.00
Overall, I was satisfied with the quality of this unit	3.73	4.88

Discussion

The implementation of UDL as the unit design framework in an inclusive education unit resulted in a significant increase in student engagement rates, unit satisfaction factor ratings and a noticeable decrease in student attrition when compared to the pre-UDL cohort. As such, this is an encouraging framework for implementation to improve students' engagement in learning and retention rates of students in higher education online learning environments. The difference in engagement rates was significant given that pre-UDL students logged into and interacted with the unit resources a total of 29,739 times compared with the post-UDL total of 72,951. It is insufficient to draw too heavily on LMS data alone. Not all clicks translate to meaningful engagement. Similarly, the ability to draw on multiple modes of engagement might reduce the number of clicks. For instance, students might download materials once for the trimester so they can study offline at their own pace. Future studies will benefit from interviews specific to their experiences studying a unit with embedded UDL principles.

In the post-UDL unit design, student engagement was increased by using multiple means of representation of the unit materials. Informal feedback from students throughout the teaching period indicated that the ability to download audio recordings resulted in greater student accessibility of the lectures during drive time, including to and from their usual place of employment. Students were also able to download the lecture transcripts, which they commented helped them to take notes and follow the recorded lecture materials, highlighting key points and concepts more easily than taking handwritten notes.

These outcomes speak to a more meaningful translation and accessibility of learning materials through digital technology (McGhie-Richmond & Howrey, 2014). This was further reflected in the unit satisfaction evaluation ratings with an increase from 3.64 to a maximum rating of 5.00 concerning the unit resources made available to the students. In addition, students rated the effective use of teaching aids and media by the lecturer at 4.88 compared with the pre-UDL rating of 3.73.

Multiple Means of Engagement were represented through the accessibility of the LMS at any time, housing the unit resources and the summative topic quizzes. The students highly valued the ability to self-pace. As previously discussed, the demographics of 21st Century online higher education students has shifted significantly (Stone, 2019). At this university, a large proportion of the student cohort balances work, family, and study, including part-time enrolment. Having the ability to self-pace through units of work means students can better accommodate the workload of the unit at a time and place that suits individuals' schedules and competing responsibilities. Rather than having to wait for a weekly schedule of accessible topic materials, the hurdle quizzes allowed students to complete the topic in their time. The hurdle quizzes did not contribute to the unit's overall grades; instead, they ensured students had engaged with the lecture materials and readings before commencing to the next topic in the learning sequence. Students needed to gain a passing grade of seven out of 10 to unlock the unit's next topic. Informal feedback was highly positive. Students enjoyed the flexibility offered by self-pacing and also having the opportunity to check their understanding of the content as they progressed. Some students reported taking the hurdle quiz at the beginning of the topic and then at the end of the topic to compare their progress and understanding. There was also a considerable increase in the unit satisfaction rating by students reflecting their engagement as recorded in the intellectual stimulation (3.91 to 4.88) and the overall satisfaction ratings for the unit (3.73 to 4.88).

Measuring the impact of Multiple Means of Expression was problematic. Informal feedback indicated that students enjoyed a level of flexibility in being provided with a choice of topics to address in the unit's written assessment components. However, there was no direct unit evaluation factors to compare. Correspondence and face-to-face discussion elicited informal comments around the ability to choose a focus topic supporting greater relevance with students' proposed teaching contexts and interests. Students felt that the approach supported greater motivation throughout the assessment writing process and such strategies were likely to have contributed to the high overall satisfaction rating from the unit (4.88). To address this aspect in future studies, a short survey could be embedded in the LMS to collect ratings on the aspects addressing flexibility to better explore the impact of Multiple Means of Expression.

Student attrition decreased by 8.64% from 15.73% pre-UDL to 7.09% post-UDL. According to the Tertiary Education Quality Standards Agency (2020) the Australian national attrition average stands at 15.18% in higher education. The unit attrition rate of 7.09% is therefore substantially lower than the national rate. Given the comparison in unit satisfaction ratings between the pre- and post-UDL unit design intervention, it is plausible that the enhancements that impacted on increased student engagement, also decreased student attrition rates. Students rated the ability of the lecturer to effectively facilitate learning as 5.00, compared with the 4.18 in the pre-UDL design unit offering. The correlative relationship between attrition and UDL remains insufficient to claim causation. However, given it was the same lecturer teaching during the two unit offering timeframes, this would support the impact of UDL in supporting greater student engagement, higher levels of overall unit satisfaction ratings and the lower attrition rates. Further research is needed to improve our understanding of student attrition and how UDL may influence it.

It was not practicable to create a true experimental scenario, and so the statistical viability of the conclusions are not without their limitations and must be interpreted with caution. However, as a preliminary study into the impacts of UDL on an online, higher education cohort, there is sufficient evidence to warrant optimistic speculation for the success of UDL while stressing the importance of future study in this area. Future Studies will benefit from purposeful interviews and surveys specifically embedded into the project.

Conclusion

Overall, after the use of UDL, this study saw a statistically significant increase in student engagement rates, increased unit satisfaction ratings and lower levels of student attrition compared to the pre-UDL teaching period. However, given the limitations of the study, it would be highly beneficial to replicate this research project through embedding the same UDL design principles into a unit outside of the School of Education to measure the impact, if any, of such an approach across different disciplines. Replication of the unit design would allow for comparison of outcomes between the three aspects of students' engagement rates, student satisfaction ratings and student attrition rates. This study supports the increasing importance of UDL across multiple contexts and highlights the importance of further investigation into UDL in the higher education context.

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