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Universal Design for Learning **in** **Higher Education**



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Universal Design for Learning

Universal Design for Learning (UDL) originates from Universal Design (UD), which is a set of principles that guides the design of architecture and products that can be used by the widest range of individuals possible: all ages, abilities, characteristics and life stages (Institute for Human Centered Design, 2016). Both UD and UDL share a common objective of universal access, but in different contexts; UD focuses on the “built” environment whereas UDL is expressed in learning environments (Pisha & Coyne, 2001).

Proponents of UDL recognize that overly rigid educational approaches can create fundamental obstacles to learning. UDL involves incorporation of a variety of approaches in order to engage learners in an inclusive curriculum that values diversity.

At its foundation, UDL prompts us to consider the complex factors of learning, including the instructor’s decisions in course design, students’ motivations for learning, and the learning environment. The UDL framework emphasizes flexibility in how instructional material is presented, how students demonstrate their knowledge and skills, and how they are engaged in learning.

Why use UDL?

Neurobiological research shows the importance of emotional engagement in shaping life-long learning, application, and memories (Immordino-Yang, 2016). Also, students’ educational outcomes can improve when the three principles of UDL are implemented in course design, learning experiences, teaching practices, learning environments, and student assessments (Al-Azawei, Serenelli, & Lundqvist, 2016). Further, using a variety of appropriate entry points and levels of challenge can improve learning for all students while maintaining a high level of academic integrity.

The post-secondary student population is increasingly diverse and our institutions embrace students who have different points of view, experiences, abilities, backgrounds, interests, histories, stories, and socioeconomic status to name a few (Buzzard, Crittenden, Crittenden, & McCarty, 2011; National Center on Universal Design for Learning at CAST, 2017). When traditional instructional approaches such as lectures and readings are used exclusively in a course, they do not address the diversity of learners that are likely to be in that course. To reduce barriers to education and increase student engagement, instructors could consider the needs of all learners through course design, learning experiences, and the learning

Universal Design for Learning (UDL):

A framework that guides the design of courses and learning environments to appeal to the largest number of learners.

Why UDL?

It allows instructors to design a learning environment that maximizes the learning outcomes for the widest range of learners without lowering standards or expectations

environment. UDL offers a framework for considering diverse student populations in higher education (Institute for Human Centered Design, 2016).

For example, 1% of undergraduate students at the University of Calgary were under the age of 18 in the 2016-2017 academic year (Office of Institutional Analysis, 2018). Seventy-nine percent of undergraduate students that year were between the ages of 18-24, which leaves 20% of undergraduate students aged 25 and older (Office of Institutional Analysis, 2018). Two percent of the undergraduate student population were Indigenous students in the Fall 2016 term, while 1.8% of graduate students were Indigenous (Office of Institutional Analysis, 2018). In 2016-2017, seven percent of the undergraduate and 28.9% of the graduate student population were full-time international students (Office of Institutional Analysis, 2018). These statistics are just a few examples to illustrate that students bring different experiences and perspectives to their learning.

A number of strategies can help meet diverse learner needs, including learning communities for students (Tinto, 2003), peer tutoring (Topping, 1996), and supplemental instruction (McGuire, 2006). These approaches aim to increase retention, improve student performance, and, more importantly, shift the educational paradigm from one that is teacher-centred to a student-centred learning environment. These strategies are sometimes offered outside of the course or rely on student agency to seek assistance from the institution's student academic centre. UDL is a complementary approach that instructors can use proactively when designing courses.

Implementing UDL involves consideration of both accessibility to information and pedagogical approaches as essential to the learning experience. Put simply, UDL is intended to provide flexible curriculum (Pace & Schwartz, 2008). Incorporating UDL does not eliminate educational barriers to learning for some students (Zeff, 2007). However, it provides a new standard and mindset for instructors to reduce those barriers for all students.

Examples of Diversity in our Classes (2016-2017)

Undergrad students:
Under 18: 1%
18-24: 79%
25+: 20%

Indigenous students:
Undergrad: 2%
Grad students: 1.8%

International students:
Undergrad: 7%
Grad students: 28.9%

UDL and Beliefs About Teaching

Although much work needs to be done in understanding UDL in higher education, it holds a great deal of promise and potential. Instructors who incorporate UDL principles into their courses tend to hold certain beliefs about teaching and learning, such as the following:

- They acknowledge that there is probably a diversity of students in the courses.
- They believe that all students have the same right to higher education.
- They aspire to creating equitable access to learning for all students in their courses.

Criticisms of UDL

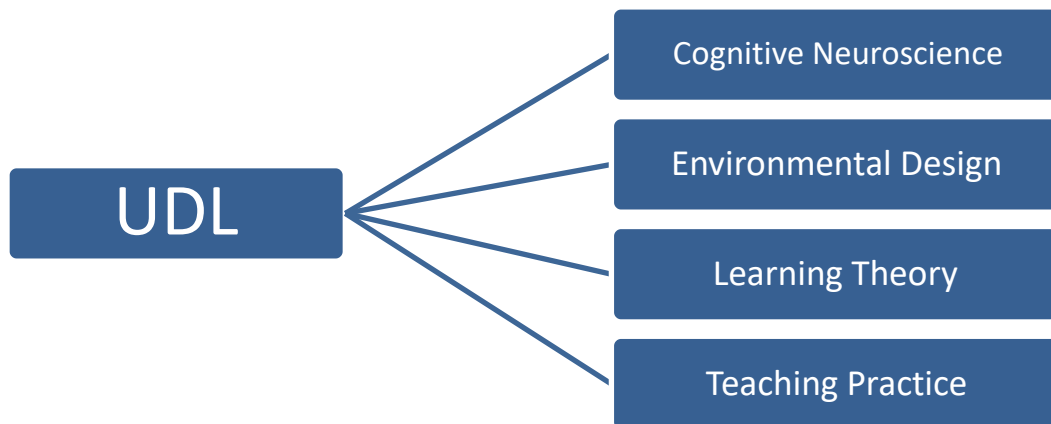
Research to support the efficacy of UDL principles is, unfortunately, in the nascent stages (Al-Azawei et al., 2016; Mangiatordi & Serenelli, 2013; Rao, Ok, & Bryant, 2014; Roberts, Hye Jin, Brown, & Cook, 2011). As noted by Davies, Schelly, and Spooner (2013), there has been limited research on the larger-scale impact of UDL on student performance, or of the value of UDL professional learning development for instructors. Recently, Dean, Lee-Post, and Hapke (2017) were among the first to examine learning gains on undergraduate students as a result of UDL-inspired strategies in a large lecture hall setting. In this study, instructional tools that were accessible both inside and outside of the classroom (e.g. MindTap®) had more of a positive gain on actual and perceived learning than tools that were accessible in-class only (e.g. clickers).

Rao et al. (2014) noted that the literature lacks a clear explanation of how the UD principles should be applied. They have questioned the extent to which UDL principles and guidelines must be implemented in a course to be considered accessible and equitable. A cross-cultural examination on the influence of UDL-inspired curricula is also missing and is currently limited to a few countries that are similar in culture and socioeconomic conditions (Al-Azawei et al., 2016).

A major limitation to the application of UDL themes across post-secondary settings is the amount of time that would be required to fulfill the three principles (Kumar & Wideman, 2014). Further limitations, such as class size, may limit the application of UDL strategies in large classes (Dean et al., 2017). However, as noted by Poore-Pariseau (2013), a well-designed rubric will help in ensuring students are fairly graded in UDL-designed assessment formats.

What informs UDL?

The UDL framework has been informed by a number of different areas, including:



Several are discussed in the following sections.

Progression of Novice Learners to Expert Learners

Novices and experts approach learning differently. An expert instructor may skip steps unconsciously, potentially causing learners to have a difficult time interpreting concepts and making connections between steps. Additionally, the instructor who can perform complex tasks in an efficient manner may underestimate the amount of time it takes for learners to perform an assignment or learn the material. Novice learners may not witness the impacts of their learning at the beginning and therefore may feel that they are not making any learning gains (Middendorf & Pace, 2004).

One example of a process that can enhance our teaching practice and help instructors recognize how their expertise might potentially complicate student learning is called Decoding the Disciplines (Middendorf & Pace, 2004). The decoding portion happens in an interview process: instructors and educational developers collaborate to make an expert's thinking processes visible, asking that expert provocative questions to help bring their unawareness to the surface. The questions are based on addressing a student "bottleneck" that the instructor has identified as an obstacle to learning. The expert's shared stream of consciousness provides clues as to why a novice might find it difficult to engage or express their learning at a level the instructor expects.

To demystify the discipline's complexity and narrow the gap between expert and novice thinking, Middendorf and Pace (2004) suggest that experts engage in a decoding process to uncover, observe, and interpret the tacit knowledge of the expert through a series of seven steps:



1. Identify a bottleneck to learning
2. Uncover the mental tasks needed to overcome the bottleneck
3. Model these tasks
4. Give students practice and feedback
5. Motivate and lessen resistance
6. Assess student mastery
7. Share what has been learned through the decoding process

Miller-Young and Boman (2017) interviewed seven faculty members across disciplines. Their research revealed that an expert has access to multiple ways of knowing, practicing and being, making it easier for instructors to: deconstruct and reconstruct their learning, recognize patterns, value provisionality, expand their thinking, be attentive to what is happening in the world, take agency, and apply an ethical and authentic understanding to their profession and practice (Miller-Young and Boman, 2017, p. 23). In connection to UDL principles and guidelines, the expert learner's implicit knowledge must be made explicit in order to be accessible to the novice learner. The novice learner can then share the expert lens and begin to develop multiple ways of knowing, practicing and being in collaboration.

Neural Networks and Principles of UDL

Taking a UDL approach, the instructor embraces learner diversity. Informed by cognitive neuroscience, UDL was formed by the Center for Applied Special Technology (CAST) to encompass three broad networks of cognition associated with learning (Kolb & Whishaw, 2015; Rose, 2005; Rose, Harbour, Johnston, Daley, & Abarbanell, 2006):

1. ***Affective neural networks*** – responsible for emotion and affect, located at the medial regions of the brain (e.g., extended limbic system). These networks represent the ‘why’ of learning (i.e., responsible for evaluating the significance or importance of the information being perceived).
2. ***Recognition neural networks*** – situated at the posterior half of the brain’s cortex and can be described as the ‘what’ of learning (i.e., responsible for recognition and perception of information).
3. ***Strategic neural networks*** – situated in the anterior regions of the brain’s cortex (e.g., frontal lobes), these networks represent the ‘how’ of learning’ (i.e., responsible for planning, organizing, and execution).

Recognition network:

recognizing information

Strategic learning network:

organizing and expressing information

Affective network:

engaging with information

These neural networks roughly correspond to the three principles of UDL, which inform accessible pedagogy and establish a framework for course planning and learning experiences (National Center on Universal Design for Learning at CAST, 2017; Rose, 2001):

1. ***Multiple means of engagement*** – connect with learners’ interests, supporting self-reflection of learning, fostering collaboration and varying levels of challenge (e.g., open class discussion, question and answer period, applied problem-solving, goal-setting). This principle corresponds with the Affective neural network.
2. ***Multiple means of representation*** – provide learners with multiple ways to engage and comprehend information and experiences (e.g., video, audio, graphics, symbols, tactile objects). Representation is associated with the Recognition neural network.
3. ***Multiple means of action and expression*** – provide learners with alternative methods of demonstrating what they comprehend and different ways of managing information (e.g., assignments, multimedia presentations, concept maps). This principle aligns with the Strategic neural network.

Figure 2 is a graphical representation of the three learning neural networks and the associated principles of UDL that are used to tap into the learning brain. The Center for Applied Special Technology (CAST) developed nine guidelines, accompanied by 31 checkpoints that illustrate the three UDL principles: <http://udlguidelines.cast.org>

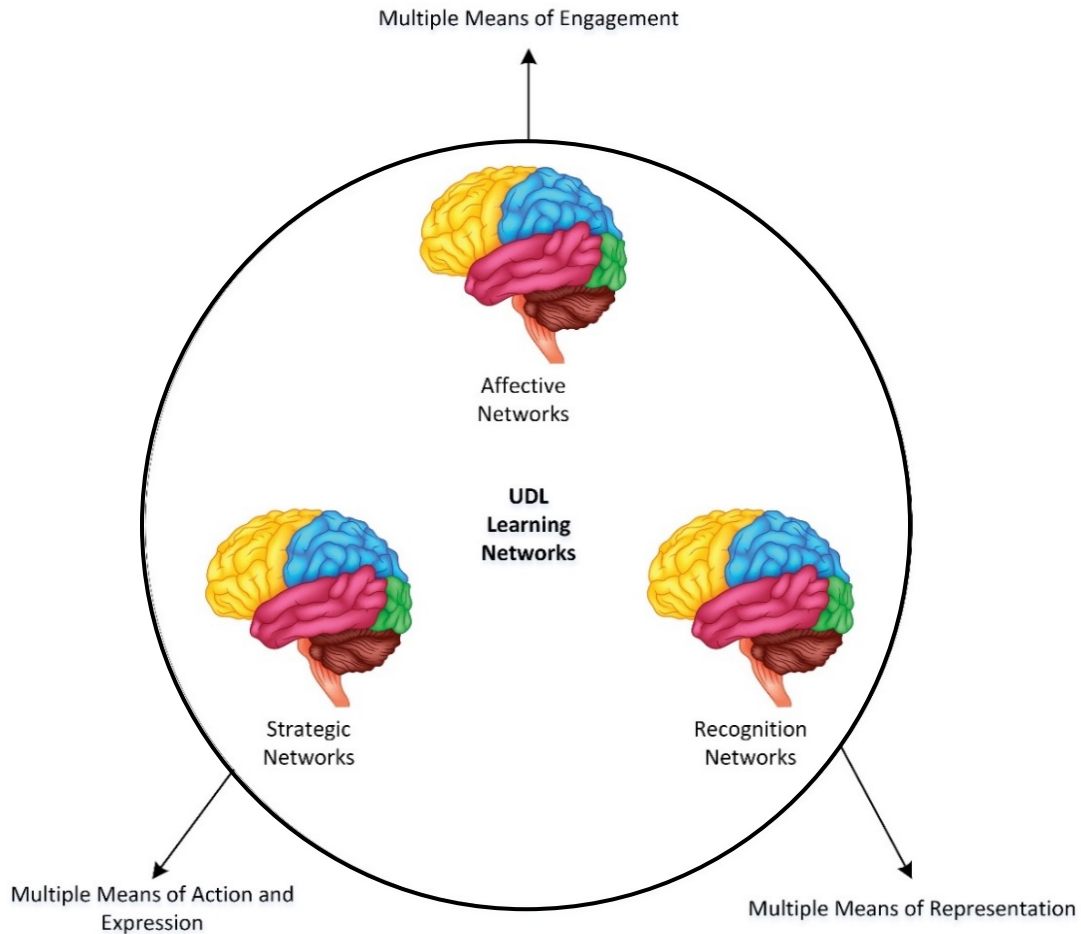


Figure 2. Application of the three UDL principles and the learning brain (National Center on Universal Design for Learning at CAST, 2017).

Impact of UDL in Higher Education

Davies and colleagues (2013) conducted a study in which students reported that UDL intervention strategies increased their understanding of concepts in postsecondary courses (Davies et al., 2013). Further, UDL strategies can increase student interest and engagement, with multiple means of representation having the greatest perceived value (Black, Weinberg, & Brodwin, 2015; Smith, 2012). In a study on post-secondary students with at least one diagnosed disability (e.g. cognitive, psychiatric, and visual impairment), students emphasized the importance of being offered various options for receiving

learning materials (including instructor prepared notes, notes prepared by student volunteers, recorded class lectures, alternative media, and hard-copy textbooks) (Black et al., 2015). In particular, lecture notes permitted students to focus on retaining information, lowering the pressure of making adequate notes in class. This helped increase students' perceived engagement level during the lessons. Recently, Dean et al. (2017) demonstrated that engaging students both in-class and outside of class using accessible instructional methods (interactive multimedia such as interactive electronic textbooks, flashcards, practice quizzes, activity lists, video lectures, personalized instructor content, etc.) has a positive impact on learning, especially for large class settings that are typical of introductory university courses.

In addition to benefitting students, the process of incorporating UDL principles can have a positive impact on instructors. For instance, at the University of Southern Maine, STEM (Science, Technology, Engineering, and Mathematics) faculty members who participated in a UDL development program reported a positive impact on their teaching experience, as evidenced by an increased engagement and commitment to improving student learning. It also had a positive impact on their professional relationships with peers, in that it encouraged faculty members to observe each other's course instruction and discuss the ways they applied UDL principles toward making their courses more accessible (Langley-Turnbaugh S. J., Blair, & Whitney, 2013). UDL principles motivated instructors to think about active learning and plan their lessons strategically to engage students by using demonstrations, simulations, models, and examples. Less emphasis was placed on theoretical foundations, offering students more ways to demonstrate competence. At the Metropolitan State University of Denver, a team of instructors sent out weekly UDL-inspired tips for other instructors to try in their classrooms (Herring, Morrison, Young, Kleinfeld, & MacDonald, 2017). The response was positive, and as a result, a website was developed to archive all instructional tips and offer a library of UDL resources, providing faculty the opportunity to comment and offer new tips.

For more information on UDL evidenced-based research on post-secondary environments, please see the annotated bibliography.

UDL Principles

In addition to giving an overview of the three UDL principles, this section covers question prompts for instructors to consider when implementing each principle. Tables 1 - 3 provide introductory examples for implementing UDL strategies to promote the three principles in postsecondary classrooms.



Principle 1: Multiple Means of Engagement

Multiple means of engagement refers to different opportunities for student involvement (e.g., interactive activities, group discussions, online discussion boards). This principle reflects the idea that students have different motivations to engage in learning. For instance, some students are highly motivated by spontaneity and innovation while others may be uncomfortable in such learning environments. Some students may seek active social learning forums while others will retreat from such environments. Students who are fully engaged in learning will be enthusiastic about applying their knowledge and will have a desire to learn more on their own. This principle also refers to offering varying levels of challenge, fostering community and collaboration, and supporting students in self-regulating their learning.

I am engaged in multiple ways. I can see where I am going and am encouraged to reflect on my process as I push the boundaries of my own learning.

~Susan (undergraduate student)

I engage students in multiple ways. I design collaborative environments for students to make sense of their learning with their peers and build community.


~Undergraduate instructor

Questions for Considering Multiple Means of Engagement

How can you incorporate variety in your teaching approaches and student learning activities?
How might you incorporate student interaction and collaboration into your course?
How might technology be used to engage students in authentic learning?
What opportunities exist to incorporate student choice?
How can you encourage student self-regulation and personal coping skills?

Table 1. Examples of multiple means of engagement

This table provides some examples for implementing multiple means of engagement in a postsecondary classroom. Categories are listed on the left, with ideas for implementation on the right.

 Multiple Means of Engagement	Putting it into Practice
Variety in teaching and learning activities	Incorporate discussions and small group activities into lecture classes Embed engagement materials in lecture notes, such as sample exam questions or puzzles
Interaction with others	In-class and online discussions Problem-based learning Inquiry-based learning Study groups and TAs
Use of technology	Use the online learning environment for small group work, discussions, links to news articles, practice exam questions, videos, student and instructor profiles
Student choice of course content	One optional unit or topic after standard units have been addressed Each group researches and presents on a different topic
Self-regulation and motivation	Goal setting Rubrics given at the beginning of an assignment to prompt self-assessment Checklists for students to track their own progress Online quizzes, not for marks but rather for immediate student feedback



Principle 2: Multiple Means of Representation

Multiple means of representation is about providing learners various ways to access and engage with course materials and information. In its simplest form, this could mean offering textbooks in audio or multimedia formats. This principle also refers to how students comprehend information in different forms, such as decoding syntax, vocabulary, notation, symbols, and disciplinary language. The goal is to support students in using multiple representations and developing fluency in traversing across them. Offering flexibility in presenting information also acknowledges differences in how learners comprehend and perceive information. For example, students with visual impairment may find print materials inaccessible, and students with diverse language, cultural backgrounds, and perceptive abilities may encounter barriers to information when instructors assume common background.

The principle also includes pedagogical approaches to a topic or concept. An instructor could decide to give a concept overview (lecture) followed by an example and an application of the concept through an in-class exercise. Other examples include statistics, case study, and expert opinion. If one approach is ineffective, a different approach may work better.

I seek information in multiple ways. I use concept maps to connect big ideas and search hashtags to sift through current topics and trends in my field.

~Owen (First year undergraduate student)

I organize and represent information in multiple ways. I create presentations with interactive components and use student conversations as entry points to introduce concepts and build understanding.

~Undergraduate instructor

Questions for Considering Multiple Means of Representation

How can you ensure that your course materials are accessible to as many students as possible?

How might you present main course concepts in more than one format?


Does your course offer opportunities to encourage student agency?

What learning activities could emphasize comprehension of key concepts?

How might you informally gauge student understanding of course concepts?

Table 2. Examples of multiple means of representation

This table provides some ways to implement multiple means of representation in a postsecondary classroom. Categories are listed on the left, with ideas for implementation on the right.

 Multiple Means of Representation	Putting it into Practice
Accessible course materials	Use common file formats such as .doc and .pdf documents compatible with text-to-speech software Put a copy of the course text on reserve in the library Provide links to Creative Commons resources Use Open Education Resources (OER) Post slides, readings, and course materials online in advance if appropriate
Multimodal sources of information	Include captions for graphics and transcripts for videos Video recordings of lectures if allowed Provide models and graphics in addition to text Use animations
Pedagogical approaches	Use different pedagogical approaches to topics or concepts, such as logic, statistics, narrative, case study, multiple perspective, and testimonial
Student-created materials	Graphic organizer summary created by students Concept maps, metaphors, illustrations, storyboards Students post their class notes to the course site (perhaps in small groups) Students create their own glossary of terms throughout the course
Comprehension and key concepts	Study guide: outline and list of key concepts Key concepts overview at the beginning of each class Practice exercises and solutions Highlight patterns and themes between ideas Post a list of Frequently Asked Questions (FAQs) and responses online
Check for understanding	Online discussion forums Q & A in class Student response systems (Top Hat™) to check for comprehension and guide further discussion



Principle 3: Multiple Means of Action and Expression

Multiple means of expression encourages students to demonstrate their learning through various forms (e.g., exams, multimedia, concept maps, papers, projects). This principle highlights executive functioning, where students apply what they learn strategically. That is, it involves finding, creating, using, and organizing information. This process can include graduated levels of support, and using tools and technology. Students may find that they are able to express themselves more proficiently in one medium than in another. It may be possible to incorporate graded assignments into a course that allow students to select alternative formats. Other opportunities for multiple means of action and expression include note-taking, in-class assignments, and feedback from different sources.

I follow my interests and use my strengths to express what I have learned in creative ways. I seek feedback and modify my work to strengthen it and reach my goal.

~Jennie (graduate student)

I keep learning outcomes in mind and provide options for students to express their learning in multiple ways. I model new approaches or tools so that students can see them in action.


~Graduate instructor

Questions for Considering Multiple Means of Action and Expression

How might you incorporate multiple means of expression on exams?
What opportunities exist to incorporate multiple means of expression in assignments?
How might you provide opportunities for feedback?
What choices might you offer students regarding assignments, communication, and content delivery?
What course design decisions can you make to mitigate student anxiety regarding assessment?

Table 3. Examples of multiple means of action and expression

This table provides some examples for implementing multiple means of action and expression in a postsecondary classroom. Categories are listed on the left, with ideas for implementation on the right.

 Multiple Means of Action & Expression	Putting it into Practice
Exams	Variety of question types on exams: multiple choice, matching, short answer, fill in the blank, equations, label a diagram Exam questions that assess various ways of understanding: remember/ comprehend, analyze/ apply, and evaluate/ create (Bloom’s Taxonomy) Incorporate graphics into some questions
Assignments and demonstration of skills	Presentations in class or online Different methods of demonstrating skills, such as role-play, debate, discussions Provide opportunities to develop skills in real settings
Opportunities for feedback	Use question sets from the textbook as practice In-class peer feedback Use rubrics Student-led study groups Cumulative assignments with feedback at various stages Office hours
Student choice	Choice of due date or topic Choice of assignment format: paper, presentation, website, poster, etc. Incorporating social media as a communication tool Offer tools and technologies to support learner needs and reduce barriers (assistive technology, spelling/grammar checkers, dictation software, typing vs. writing by hand)
Assessment anxiety	Use assignment guidelines to outline your expectations Provide templates or outlines if appropriate Option to write final exam as a take-home exam if appropriate Give sample assignments showing feedback and how they were graded if appropriate

Worksheet A: Current UDL Practices

How do you currently design learning experiences for students using the three UDL principles?



Multiple Means of Engagement



Multiple Means of Representation

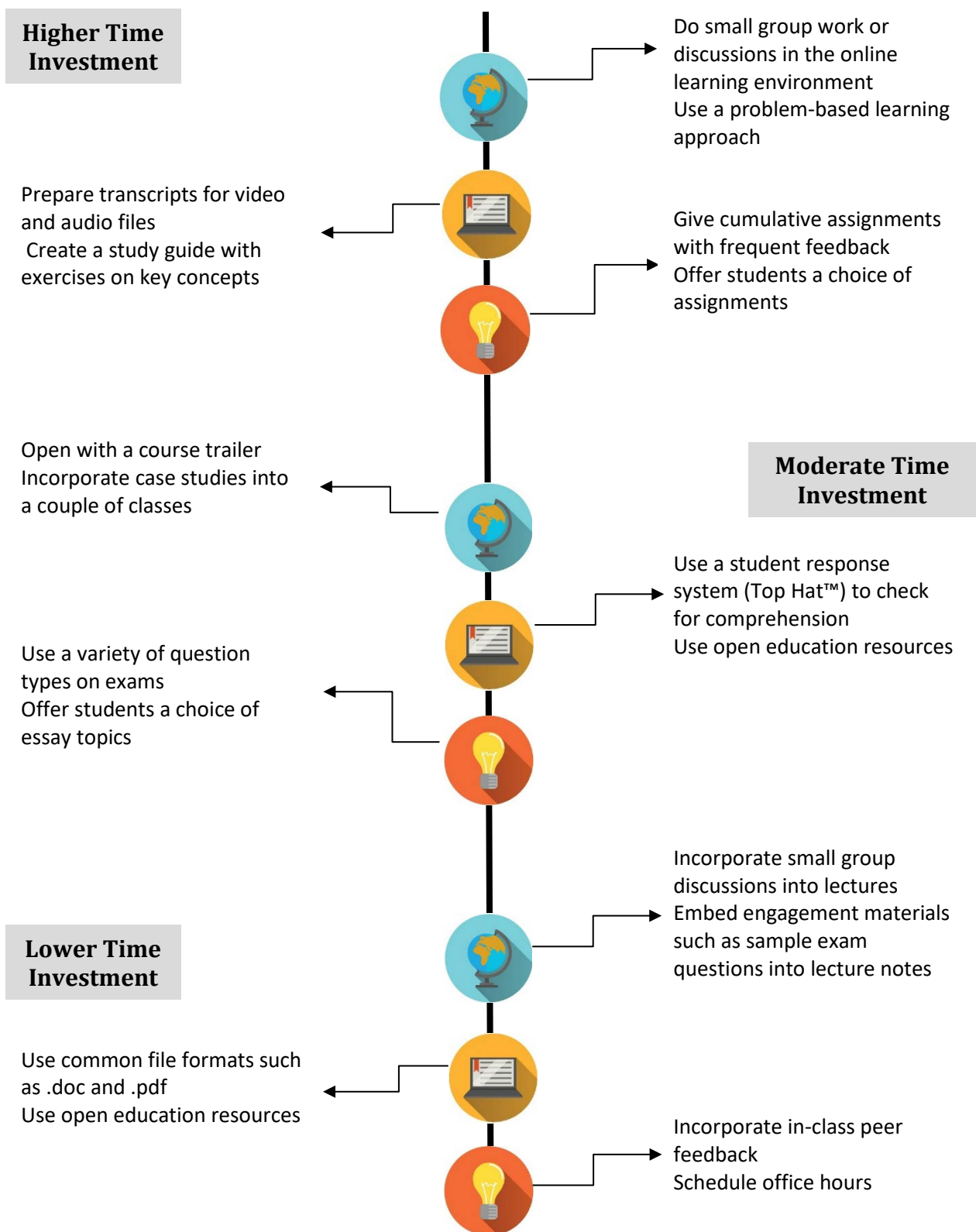


Multiple Means of Action and Expression

Implementing UDL in Your Course

You do not have to do a major course redesign in order to increase flexibility and accessibility for students. Rather, you can get started by implementing UDL principles in small ways. The following chart gives an example of UDL based on each of the principles for small, medium, and large time investments. If you have limited time to devote to preparation and implementation of UDL, you could look for strategies that require a lower time investment. Other times, you could invest more time in strategies with the potential for a huge benefit for all learners.

Examples of Strategies to Implement UDL in Your Course



Worksheet B: UDL Planning Activity

What UDL strategies would you like to try when designing your next course?



Multiple Means of Engagement



Multiple Means of Representation



Multiple Means of Action and Expression

Incorporating UDL Principles into a Lecture Class: Example

In this example, the instructor is delivering a lecture in a 50-minute class to a group of about 100 students. Given the practical constraints, she has incorporated the following elements to add UDL connections in the 50-minute session.

Elements	UDL Connections
<p>Teaching Approaches: Start each lecture with an overview of key concepts. Break up the lecture at the 15-minute mark to incorporate a discussion question and at the 30-minute mark to have students work through an example.</p>	<p>Multiple means of engagement: fosters collaboration, variety in teaching and learning activities, encourages learning and increases motivation</p> <p>Multiple means of action and expression: facilitates information management, demonstration of skills and knowledge</p>
<p>Learning Activities: Discussion: students pair up to discuss a new concept and add a definition to their course glossary Exercise: students work through an example and compare to the rubric.</p>	<p>Multiple means of representation: comprehension and key concepts, student-created materials, check for understanding</p> <p>Multiple means of action and expression: demonstration of skills and knowledge, opportunity to practice</p>
<p>Resources: Examples, visual models, detailed comments in a PowerPoint™ slide, alternative format textbook (e-books), video lectures, podcasts.</p>	<p>Multiple means of representation: accessible course materials, multimodal sources of information</p> <p>Multiple means of engagement: choice of learning materials</p>
<p>Learning Environment: Students in the lecture hall will turn to one another for impromptu discussions. When doing the sample problem, they can refer to resources in the online course. Top Hat™ will be used to poll the students' answers.</p>	<p>Multiple means of engagement: interaction with others, use of technology</p> <p>Multiple means of representation: accessible course materials, check for understanding</p>
<p>Assessment: The activities are not formally assessed. Students get informal peer feedback during the discussion. After working through an example, they compare their notes to the instructor's.</p>	<p>Multiple means of engagement: choice of activities</p> <p>Multiple means of representation: comprehension and key concepts, check for understanding</p> <p>Multiple means of action and expression: demonstration of skills and knowledge, opportunities for feedback</p>

Conclusion

UDL originated in the physical environment, but can be applied to a learning environment with the potential result of enhancing learning for all students. The principles of multiple means of engagement, representation, and action and expression comprise an instructional design model that allows instructors to strive for equitable access for all students. That is, these principles offer options, flexibility, and goals to accommodate diverse learners, regardless of discipline. In addition, UDL prompts instructors to consider how they might improve their own teaching practices by considering diversity in the classroom, student voice and agency.

Annotated Bibliography

Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal design for learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning, 16*(3), 39-56.

A literature review of evidence-based UDL studies is presented here and complements prior reviews performed by Mangiatordi and Serenelli (2013) and Rao et al. (2014). A total of 12 papers were selected for review. Empirical research examined supported the assertion that UDL-based curriculum alleviates learning barriers for students and special accommodations for students with disabilities were minimized.

Black, R. D., Weinberg, L. A., & Brodwin, M. G. (2015). Universal design for learning and instruction: Perspectives of students with disabilities in higher education. *Exceptionality Education International, 25*(2), 1-16.

The perspectives of university students with disabilities were investigated to determine how well UDL and UDI principles aligned with their learning preferences. A comparison group of students without disabilities was also included in the study. Both groups of students benefited from the application of UDL/UDI principles. Hands-on learning opportunities were ranked highly. Students of disability did not want to be treated differently from the other students as it made them feel that they are their disability; therefore, the multiple means of presenting the instructional material provided for equity in learning. Highest rated instructional modes were class and small group discussions. Permission for students to hand in project components for feedback before incorporating them into the final project was rated highly as well as preparing laboratory reports.

Burgstahler, S. (2013). *Universal design in higher education: Promising practices*. S. Burgstahler (Ed.) Seattle: DO-IT, U of Washington. Retrieved from www.uw.edu/doi/UDHE-promising-practices/resources.html

This is an online book of compilation of peer reviewed articles demonstrating the application of UD in post-secondary education. The first article by Langley-Turnbaugh S. J. et al. (2013) summarizes a 5-year program of UDL implementation involving STEM (science, technology, engineering, and mathematics) faculty members at the University of Southern Maine. The second study incorporated UID principles to online courses offered to the geographically dispersed student body attending the University of Hawaii (Rao, 2013). Other articles speak about the DO-IT initiative at the University of Washington.

Davies, P. L., Schelly, C. L., & Spooner, C. L. (2013). Measuring the effectiveness of universal design for learning intervention in postsecondary education. *Journal of Postsecondary Education and Disability, 26*(3), 195.

This paper compares data collected from two independent groups of student surveys on their perception of teaching practices for a group of instructors who received UDL training and a control group that did not receive training, respectively. The participatory undergraduate course is *Introduction to Psychology*. In this study, the UDL strategies that observed the most significant impact as a result of UDL training for the instructors were the following (i) presenting material in multiple formats, (ii)

relating key concepts to the larger objectives of the course; (iii) providing an outline at the beginning of each lecture, (iv) summarizing material throughout each class session; (v) highlighting key points of an instructional video; (vi) using instructional videos; and (vii) using well-organized and accessible materials.

Dean, T., Lee-Post, A., & Hapke, H. (2017). Universal design for learning in teaching large lecture classes. *Journal of Marketing Education, 39*(1), 5-16.

In this study, four instructional tools (PowerPoint™, lecture notes, clickers, and Mind Tap™) are examined for their effectiveness in actual student learning, in addition to perceived learning, within a UDL-inspired introductory marketing class. These four instructional tools were selected to benefit the large class size of more than 600 students. Learning was assessed using average scores on three administered exams. Student perception on beneficial learning was attributed to instructor-generated course content, namely through the use of PowerPoint™ and the provision of lecture notes. Both perceived and actual learning was enhanced through the use of instructional tools that were accessible inside and outside of the class (i.e., digital learning tools administered through the institution's learning management software).

Kumar, K. L., & Wideman, M. (2014). Accessible by design: Applying UDL principles in a first year undergraduate course. *Canadian Journal of Higher Education, 44*(1), 125-147.

This paper presents a case study of the impact of implementing UDL principles to a first year undergraduate class of 50 pupils at an Ontario university by examining the perspective of the instructor, the students, and the disability service provider. The student demographics for this course tended to be mature female students from diverse backgrounds (country of origin, first language, university experience, and age). At least one student required disability services from the university for academic accommodations. The instructor designed the course through several iterations by offering maximum flexibility to course material delivery, use of external learning aides and how students can convey their understanding.

McCabe, D. B., & Meuter, M. L. (2011). A student view of technology in the classroom: Does it enhance the seven principles of good practice in undergraduate education? *Journal of Marketing Education, 33*(2), 149-159. 10.1177/0273475311410847

In this study, guidelines from the Seven Principles for Good Practice in Undergraduate Education were used to assess the impact of incorporating technology—specifically Blackboard—into the classroom. Of the seven principles, Blackboard™ enhanced student-faculty contact and active learning. Students rated earning better grades in class and staying interested in the topic of study during the semester as the top two most important learning objectives. However, student perception indicated that Blackboard™ did not enhance these learning objectives. Generally, students found value in the seven principles but did not necessarily feel that Blackboard™ enhanced those principles in the classroom experience. Some principles are inadequately addressed through course management platforms such as communicating high expectations and may need to be addressed through other means.

Pace, D., & Schwartz, D. (2008). Accessibility in post-secondary education: Application of UDL to college curriculum. *US-China Education Review*, 5(12), 20.

In this study, the individual perceptions of four university professors on the effects of electronic clickers on accessibility and engagement were studied over one semester. The technology was utilized in four different graduate-level courses within the special education teacher preparation program. PowerPoint™ presentations were inserted with questions that allowed the students to engage by responding through the use of clickers. Students perceived the clickers enhanced the depth of in-class discussion of lecture topics and, therefore, ensured that they were active participants rather than passive recipients. However, technical problems associated with getting software to work in class was an overall source of frustration for the instructors and students.

Rao, K., Ok, M. W., & Bryant, B. R. (2014). A review of research on universal design educational models. *Remedial and Special Education*, 35(3), 153-166. doi: 10.1177/0741932513518980

The authors of this paper performed an empirical literature review on the application of UD principles in educational settings including primary, secondary, and post-secondary. Thirteen articles were identified: eight in a pre-K to 12 setting and five in post-secondary environments. Advances in student academic attributes were noted in math, science, literacy, and social skills with students reporting an increase in engagement as a result of UD implementation. These interventions were especially positive for students who possess learning disabilities. The authors also critiqued the inconsistencies of how UD-based research is currently being performed and reported in the literature and noted the lack of empirical research. For instance, they recommended increasing the transparency of a study by including details on the study setting (e.g., effects on different demographic groups, how study is implemented, etc.) linking UD-based principles to the interventions reported in a study so that it may be replicated in a classroom setting.

Roberts, K. D., Hye Jin, P., Brown, S., & Cook, B. (2011). Universal design for instruction in postsecondary education: A systematic review of empirically based articles. *Journal of Postsecondary Education & Disability*, 24(1), 5-15.

An empirical review of the literature on UD principles as it is applied to postsecondary education is presented in this paper. Only 8 articles were found that fit the search criteria and reflects the nascent stage of UD evidenced-based research in post-secondary environments. Utilizing technology in higher education classrooms was found to be a critical instrument in developing and promoting inclusiveness.

Rose, D.H., Strangman, N., 2007. Universal design for learning: Meeting the challenge of individual learning differences through a neurocognitive perspective. *Universal Access in the Information Society*, 5, 381-391.

Rose and Strangman (2007) described the neuropsychological and psychological basis for the UDL framework which identified three broadly distinct functions in learning: recognition, strategic, and engagement. The three learning networks are described in detail. Individuals who exhibit differences in these learning networks may suffer from deficits and disorders (e.g. color blindness, dyslexia) or simply as a result of prior exposure or training (e.g. level of skill). Recognition networks enable the perception, memory, and reconstruction of information. Strategic networks facilitate in responding to the

information physically and cognitively including setting goals, identifying strategies, focusing, progress monitoring, and making modifications to these activities. Affective networks assist in interpreting the information based on emotional importance and thereby influences the level of motivation and engagement in learning.

Shaw, S. F., Scott, S. S., McGuire, J. M., & ERIC Clearinghouse on Disabilities and Gifted Education, A. V. (2001). Teaching College Students with Learning Disabilities. ERIC Digest.

S. F. Shaw et al. (2001) provides 9 principles in UDI to guide faculty members in designing a course that is accessible to diverse learners. These principles include (i) equitable use instruction; (ii) flexibility in use-instruction; (iii) simple and intuitive instruction; (iv) perceptible information; (v) tolerance for error; (vi) low physical effort; (vii) size and space for approach and use; (viii) a community of learners; (ix) instructional climate.

Smith, F. G. (2012). Analyzing a college course that adheres to the universal design for learning (UDL) framework. *Journal of the Scholarship of Teaching and Learning*, 12(3), 31-61.

This study considered the reflective practice of an instructor who redesigned a post-secondary course using the UDL framework and studied the perspectives and engagement level of the graduate students, undertaking the course, as a result of UDL implementation. Students felt that they benefited from the employment of UDL approaches by increasing their interest and engagement level with the course content. Additionally, the multiple means of representing the course content were perceived most beneficial by the students.

Resources

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