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Applying Universal Design Fundamentals in a Technology Education Environment

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Abstract

This article provides technology educators with multiple methods for increasing inclusion. It defines Universal Design for Instruction principles, how they can increase accessibility in classes where they are applied, and gives examples for their application in technology-based coursework. Project Based Learning is the technique of choice for many technology educators, and while successful for the students that are capable of self-motivation and self-agency, students that perform poorly in groups and are unable to articulate their ideas can suffer.

Technology education classrooms are also often ill-prepared for students with disabilities when lab equipment is involved, stressing the need for more inclusive practices to be adopted in technology education, with UDI being a comprehensive series of principles that can significantly increase engagement and inclusion when implemented in the PBL pedagogy.

Keywords:

Project-based, education, engagement, pedagogy, technology, inclusion.

Definitions:

Universal Design of Instruction (UDI) – Universal Design of Instruction (UDI) is the design of instruction that can be used by all students without the need for adaption. This design includes instructional materials, facilities, and strategies (Burgstahler, 2010).

1.0 Introduction

As the technological abilities of our society continue to increase and become more complex, educating students in the varied fields of technology has become a topic of interest for the education community. Buzzwords like "STEM (Science, Technology, Engineering, and Math) and "Project Based Learning" are known to educators, students, and parents alike, and schools that offer a technology education are increasing in desirability as institutions parents want to send their children to and locations teachers are interested in working. With the rise of technology education, the question of how technology education can be made available to everyone also grows. Many education techniques, such as PBL, claim to increase understanding and retention amongst students with accessibility concerns, but do they truly make technology accessible to everyone? In this article, we will be exploring PBL's

application in technology education and the areas where inclusion can be improved. We will also be introducing Universal Design for Instruction, a set of core principles for increasing student inclusion in education environments and relate how its core mission aligns with that of Design for All. We will also be providing examples where UDI and PBL can coincide and work together to maximize student engagement and accessibility in an education environment that has historically been difficult to make inclusive: technology.

1.1 Universal Design for Instruction

Universal Design for Instruction (UDI) is a fundamental aspect of inclusive design frameworks and pedagogy. With many aspects and principles, UDI has grown to become an important tool for creating inclusive and inviting environments tailored toward a wide range of ability levels. With this in mind, what exactly is UDI and why should we as instructors focus on using it in our courses and pedagogy?

By exploring the 14 combined principles of UDI we'll understand how we can implement UDI principles in our pedagogy and classroom environments. UDI comprises the principles of Universal Design (UD), Universal Design for Learning (UDL), and Web Content Accessibility Guidelines (WCAG) (Burgstahler, 2020, p. 43). Examining these principles, we can see how they contribute to UDI as a whole, and how they individually affect learning outcomes. Sheryl Burgstahler in her book Creating Inclusive Learning Opportunities in Higher Education: A Universal Design Toolkit lists the 14 UDI principles as follows:

For Universal Design

1. ***Equitable Use***

2. ***Flexibility in Use***
3. ***Simple and Intuitive***
4. ***Perceptible Information***
5. ***Tolerance for Error***
6. ***Low Physical Effort***
7. ***Size and Space for Approach and Use***

For Universal Design for Learning

8. ***Multiple Means of Engagement***
9. ***Multiple Means of Representation***
10. ***Multiple Means of Action and Expression***

For Web Content Accessibility Guidelines

11. ***Perceivable***
12. ***Operable***
13. ***Understandable***
14. ***Robust (Burgstahler, 2020, p. 43)***

While each principle presents useful and important guidelines for inclusivity and adds important aspects to the overall UDI framework, this article will focus on the implementation of specific principles within technology pedagogy, though we will briefly overview each principle.

Equitable Use focuses on creating as similar of an experience as possible for all users, explained best in the words of Sheryl Burgstahler: "Provide the same means for use for all users: identical whenever possible; equivalent when not". (Burgstahler, 2020, p.37) Flexibility in Use focuses on creating an experience that is usable by users with different abilities and learning preferences. (Burgstahler, 2020, p.38) Simple and Intuitive Use focuses on ensuring that content is understandable and usable by

users with different experience levels, knowledge, and language skills among other aspects. (Burgstahler, 2020, p.38) Perceptible Information outlines providing essential information to users in an effective manner regardless of learning conditions or abilities (for example, using pictures in conjunction with audio). (Burgstahler, 2020, p.38) Tolerance for Error details predicting and accommodating for possible errors and unintended actions and consequences of use and minimizing hazards. (Burgstahler, 2020, p.38) Low Physical Effort outlines creating designs that "can be used efficiently, comfortably and with a minimum of fatigue". (Burgstahler, 2020, p.38) Size and Space for Approach and Use relate to creating spaces that accommodate and provide appropriate space for users of different sizes, postures, and mobility. (Burgstahler, 2020, p.38)

Multiple Means of Representation outlines providing multiple means to present content that accommodates users of different language, comprehension, and ability levels. (Burgstahler, 2020, p.42) Multiple Means of Action and Expression details giving users multiple opportunities to express themselves through their work, for example by allowing students to submit a video essay instead of a written one. (Burgstahler, 2020, p.42) Multiple Means of Engagement involves providing multiple ways for users to engage with content, such as providing video lectures alongside textbook readings. (Burgstahler, 2020, p.43)

Sheryl Burgstahler provides an excellent overview of the 4 principles of WCAG:

1. **Perceivable.** ***Users must be able to perceive the content, regardless of the device or configuration they are using.***

2. **Operable.** ***Users must be able to operate the controls, buttons, sliders, menus, etc., regardless of the device they are using.***

3. **Understandable.** ***Users must be able to understand the content and interface.***

4. **Robust.** ***Content must be coded in compliance with relevant coding standards to ensure it is accurately and meaningfully interpreted by devices, browsers, and assistive technologies. (Burgstahler, 2020, p.41)***

The importance of including UDI principles in pedagogy is to create inclusive environments and present equal opportunities for learners of all ability levels to achieve their educational goals. Creating environments in which a learner with a disability can succeed will broaden the educational reach and provide many benefits to both learners and educators, including higher enrollment rates and opening paths to success for everyone.

1.2 Comparison to Design for All

Universal Design presents many actionable guidelines that educators can follow to create more inclusive environments. Design for All builds upon this as well, presenting a vision for the overall goal of Design for All and Universal Design: creating inclusive environments for all. The Design for All Foundation describes Design for All as "Design for All is the intervention into environments, products, and services which aims to ensure that anyone, including future generations, regardless of age, gender, capacities or cultural background, can participate in social, economic, cultural and leisure activities with equal opportunities." (Design for All, 2022)

Where Universal Design provides the how, Design for All provides the why. Why are we using Universal Design principles in our pedagogy? Why should we care about Universal Design at all? Design for All focuses on the goal and the parameters that focus us on why Universal Design is fundamentally integral to inclusive practices.

1.3 Characterizing Technology Education

Due to its relevance to the professional community, technology education is often at the forefront of innovations in pedagogical approaches. In addition, due to its nature technology education does not lend itself to a standard classroom experience, with lecture-based teaching followed by at-home learning or self-study being difficult to apply to a field of study that is multidisciplinary and encompasses such a large range of Science, Technology, Engineering, and Mathematics (STEM) concepts during any given classroom period. This necessitates varied approaches in course work and instruction to maximize student learning and engagement.

In this context, we refer to Technology Education as the familiarization of students with professional fields including chemistry, mechatronics, software, hardware, and other technology fields in a classroom environment. Technology Education focuses on the application of STEM concepts in knowledge in the furtherment of a defined end goal. This can be a solution to a problem, an investigation into an outcome or result, or other applications that allow a student to use STEM concepts they have learned through other coursework or from personal experience, and usually includes factual, conceptual, and application-based learning techniques (South Dakota Department of Education, 2022).

Examples of a Technology course might include: Robotics, Integrated Circuits, Aerospace, Composites, and/or Prosthetics. They might be taught in a conventional classroom or a lab-based environment but could also be held on-location at a site relevant to the subject matter, like a manufacturing plant or water treatment facility. It is this ubiquity that makes technology education a challenging but rewarding study that requires non-standard teaching techniques to meet its instruction needs.

1.4 Project Based Learning

One of the many ways Technology Education addresses its need for non-standard teaching techniques is through the use of Project Based Learning (PBL). PBL is encapsulated as an "ill-defined task within a well-defined outcome" (Capraro et al, 2013) and focuses on applying knowledge as it is learned towards an end goal that is heavily emphasized to students throughout the course of the project. While PBL can be used for individuals, its broader applications (and true strengths) come from being utilized in small groups of students that collaborate on their solution. This approach mirrors the rotating project groups currently utilized in the tech industry, which contributes to its effectiveness and popularity in Technology Education.

PBL techniques usually involve a series of short-run projects based on a topic discussed in the course where the class is split into pairs or small groups and then given a task to complete together. The parameters of this project are intended to be vague to promote creative thinking and each group creating their own solution to the task based on the set of skills and ideas they possess. The project will usually culminate with a presentation to the rest of the students where the project group will describe

their final solution to the given task and the process they took to get there. Groups are encouraged to ask questions of the presenting group and compare and contrast their experience to that of the presenting team. In a PBL environment the instructor acts as guide rather than a strict teacher and keeps project teams on track and engaged with each other, allowing the process of the project and the experiences gained from working together to drive student learning on the subject matter.

PBL techniques could be implemented once during an otherwise classical lecture environment, periodically over the length of a course, or PBL could be used exclusively as the teaching technique of choice depending on the nature of the course and the intentions of the instructor. A class about advanced electronics could be taught exclusively with labs and projects based around the many kinds of integrated chips and electrical components, while a material class may require some lecture time to address the underlying mathematical concepts that support the course material. A teacher's experience or preference also contributes to the usage of PBL, as teachers who are not confident in their lecturing abilities may employ PBL more liberally than a teacher who has been using lectures and textbooks for the majority of their career. PBL draws strength from its adaptability in execution, increasing the chances that a technology student encounters it in the classroom.

PBL has rapidly gained traction since the beginning of its wide-spread adoption in 1965 after a long period of anonymity. High Quality Project Based Learning (HQPBL) is an organization that seeks to further PBL adoption in academic institutions and has tracked 3236 schools utilizing PBL principles as of the writing of this publication. (HQPBL, 2022). This rapid adoption is

unsurprising to educators that work within Technology Education, as it addresses a number of key issues that are systemic to the field. Broadley, these issues include:

- ***Technology concepts are difficult to teach in a conventional lecture-based classroom.***
- ***This is due to the large volume of technical knowledge that is a prerequisite for understanding certain technology concepts. The more STEM fields a subject encompasses only further compounds this problem, as there is an increase in prerequisite knowledge required to understand the subject at hand.***
- ***If the prerequisite knowledge of the students is unknown to the instructor this can result in limited advancement in the principles the course intends to teach.***

- ***A student's performance in STEM subjects does not always predict their success in a technology class.***
- ***Students that perform well in their STEM coursework could be expected to perform well in a technology class that utilizes STEM concepts. However, what is often the case is students struggle with applying the conceptual knowledge they have learned in a math or science class to an ill-defined problem, one that heavily diverges from the clear starting conditions normally provided by questions found in math and science coursework. These are the classification of problems the tech industry is built on solving, resulting in a disparity. Conversely, students that perform poorly in STEM classes can be more adept than their peers at framing these ill-defined problems depending on their background. Students that have never taken a STEM course may have applicable skills that allow them to define a problem in physical and measurable terms, especially for post-secondary***

education where the backgrounds and life experiences of students are more varied.

- ***STEM education has historically struggled to prepare students of different genders, races, learning ability, and socioeconomic backgrounds equally.***
- ***Due to the rigor involved with the coursework of STEM subjects, students with greater resources for studying, tutoring, and practicing outside of the classroom positively correlate with a better understanding of STEM subject matter (Nikischer, 2013). The same is true for Students with Disabilities (SWDs), where the large volume of information that is conveyed during a short period can create difficulties for students with learning disabilities, and the varied learning environment of Technology Education can pose problems for physically disabled students. Finally, STEM fields are dominated by men even after many social initiatives to rectify this disparity (Bloodhart et al, 2020). Non-male and LGTBQ students routinely feel like they have to fight for space in STEM education and work harder than their peers to get the same level of help and resources (Brinkworth, 2016).***

PBL techniques allow technology concepts to escape the confines of the classroom and allows students to apply their knowledge. By participating with peers on a project, students can combine their understanding of the concepts presented in the coursework with those of others, providing new perspectives to concepts that are well understood and those that require expanding. All students are directly engaged by having to interact with each other, and students with different backgrounds and experiences become assets to the group. PBL techniques also increase understanding by utilizing multiple means of engagement outside of textbooks and lectures, accommodating students that normally struggle

under the standard education model, such as students with attention issues.

These aspects of PBL make it an attractive teaching tool for technology teachers, with many successful applications such as this Microprocessor Course from Chitkara University (Singh & Singh, 2011), however, PBL is not limited to technology teachers or even teachers in STEM subjects. Utilizing PBL techniques have resulted in increases in information retention and self-efficacy in non-technology subjects, particularly those with learning difficulties (Filippatou & Kaldi, 2010). To technology educators, the value of PBL is clear. But is it really as inclusive as it claims?

2.0 Shortfalls of Project Based Learning

2.1 Engagement Problems with Project Learning

Project Based Learning (PBL) has many strengths over classical teaching techniques when it comes to engaging students that have difficulty in maintaining attention or sitting for long periods of time, reduced understanding from written or oral instruction, and students who are historically low-achieving and/or disengaged (Filippatou & Kaldi, 2010). But for all its strengths, PBL does not always engage every student due to social roadblocks fundamental to its project structure. During a project, students are expected to cooperate with their peers and contribute equally to their final solution. However, students who are not comfortable in situations that require them to talk, plan, or discuss ideas with their peers can be left out of the learning process. Students who are louder and more outspoken about their ideas are more likely to drive the direction of the group project and disproportionally utilize course resources. This results in the students who are already succeeding academically getting more

help, while the students who truly need it receive less. This disparity only compounds over time and can be difficult to correct, as antisocial students later in their educational career can be labeled "under-achievers" and "troublemakers" by teachers and their continued education can be affected by the stigma.

Students are not free of responsibility in the PBL environment either. Since PBL places the learning agency load upon the student, students who have difficulties self-motivating can struggle in a PBL course. The difference in teaching style in PBL can also make the transition in teaching styles difficult for students resistant to change. When these factors come together, especially if the application of PBL is inconsistent across a student's coursework, some students may choose not to put any effort into their projects at all and engage with teachers and peers only enough to maintain the appearance of engagement and learning. This behavior was coined in a study by Maastricht University as "ritual behavior" (Domans et al, 2001) and is an established frustration for anyone who has worked in a project group with a group member exhibiting ritual behavior. Even if only one student is failing to carry their weight in a project, it can affect the performance of the entire group, reducing their ability to make connections to new information and make an adequate attempt to research and analyze the problem assigned to them. This can affect their final evaluation for the course, depending on the grading method used by the instructor, which can, in turn, create a domino effect within the project group that further reduces the value of any learning outcomes that were produced. This can negatively impact a student's opinion of PBL, regardless of how effective the technique is.

2.2 The Onus of Education

In the previous section we discussed how students are responsible for the majority of their learning outcomes within a PBL model, but that does not mean that instructors are removed from the process. Teachers define the terms of the projects, the criteria that must be met for a project to succeed, the resources available to project groups, and are still expected to support each group and lead them towards making the concept connections and participating in the critical thinking that is a cornerstone for success in the PBL pedagogy. If an instructor does not actively support their project groups in their learning journey, the learning outcomes from PBL techniques are significantly degraded and can render the approach unsuccessful. This kind of inattentiveness can often be seen in novice or inexperienced teachers unfamiliar with the PBL pedagogy, even when all the materials for a PBL technology course are provided to them. (Brinkerhoff & Glazewski, 2004)

Regardless of the educational benefits of PBL, a transition between pedagogies results in an increase in workload on that of the instructor. While a project based approach can decrease the active workload of a teacher in the long-term due to its self-organizing approach, in the short term the conversion of materials from a classical course to that of a PBL course can be daunting for a teacher, especially if they are unfamiliar with the concept of PBL. As the popularity of PBL increases and school administrations take note of the attractive standardized grade increases and improved engagement from students it promises, many teachers are finding themselves pressured to adopt the PBL pedagogy without the resources to implement it properly. The engagement of an instructor as a facilitator and the set-up of the ill-defined problem that results in a well-defined outcome is necessary for

PBL to succeed, and without it the engagement benefits for at-risk and learning deficient students is largely lost.

2.3 Fixing the Non-inclusive Design of Technology Education

Many institutions today are unaware of the key pillars of PBL that must be maintained for it to succeed due to their inexperience with the pedagogy. The Dunning-Kruger effect, which describes how people with a minimal understanding of a concept can often overestimate their comprehension and be resistant to correction, affects many educational institutions as they begin to implement PBL.

There are many organizations, such as the HQPBL, that work hard to improve knowledge surrounding PBL and its counterparts and ensure that there are many resources available for would-be converts to provide a high quality and effective PBL lesson plan for their students. However, is this enough to guarantee that every student remains engaged in their learning and concludes a PBL course with comparable learning outcomes to their peers? How as educators can we ensure that our students accept responsibility for their education under the PBL model and are provided the resources they require to succeed, regardless of their physical, intellectual, or emotional needs? Enter Universal Design.

Universal Design (UD) helps ensure that PBL approaches are prepared to handle the needs of every student before they even enter the classroom. By considering UD principles in the creation of coursework, educators can address inclusion problems before they happen, and these principles can help drive classroom practices so students that are struggling to work with their group

or are engaging in "ritual behaviors" can be intercepted before their learning outcomes are effective. In the next section, we'll be presenting some guidelines and examples for integrating UD with PBL.

3.0 Universal Design for Technology

3.1 UDI Principles

The idea of 14 individual principles making up the framework for Universal Design for Instruction (UDI) can be daunting when first learning about and implementing UDI in your materials. However, many of these principles work together and build upon each other creating an intuitive structure that becomes easier the more you use it.

Breaking the UDI principles into their individual groups also helps prevent being overwhelmed and to understand the situations as well as the ways that each principle or group of principles are best implemented. Looking at the three groups of Universal Design (UD), Universal Design for Learning (UDL), and Web Content Accessibility Guidelines (WCAG), we can see what areas they were originally designed for.

For Universal Design, we can see that these principles were mainly designed for physical environments and physical manipulation, and while some principles can be applied to digital means, largely Universal Design is focused on the physical considerations of design. This is supported by the Rocky Mountain ADA (Americans with Disabilities Act) which explores the history of Universal Design and its original intentions for physical environments and architecture (Simmons, 2020).

With UDL, these principles were understandably created with pedagogy considerations in mind. While these principles are focused largely on pedagogical applications, they can also be applied in other areas and can be mixed with UD or WCAG principles to create accessible media outside their originally intended purposes.

WCAG principles, as indicated by its name, were created for digital use (Birney, 2020). As with UDL and UD principles these principles can function in areas outside of digital environments and can be used in conjunction with other UDI principles to bolster and improve materials.

Understanding the differences between these groups helps to tailor our materials and approaches to the situations in which they are necessary. This also helps us to employ the right tools for the job, using the right measurements and standards for each task we undertake.

When creating curricula for courses and deciding on teaching methods, placing special consideration into how each of the 14 principles of UDL will affect your teaching style and individual lectures will help to create an inclusive course. Further, placing thought into the situations and medium considerations you'll be making during the course will help to determine what UDL principles, guidelines, and frameworks will be needed for each aspect of the course. For example, in a technology course where your lecture may contain typing on a computer, consider UD principles in the physical aspects of the lesson. Ask questions such as "are the computer desks inclusive of users of different sizes, postures, and stances such as standing or sitting?" "does it require extensive physical effort for a user to interact with this

activity?" and "can users make some mistakes during this activity and not detriment themselves?" (Burgstahler, 2020, pp. 38-39).

This example also shows how UDI principles can intermingle with materials, as you can also benefit from considering UDL principles when creating this activity. Asking questions in this vein will help less with the user's experience of the activity, and more with ensuring that users understand the activity and are able to complete required goals in a satisfactory manner. Ask questions such as "are there multiple ways that the user can receive instructions and assignment goals, such as videos, written or typed hand-outs, and audio?" "could second-language users and users of different cognitive ability levels still understand these instructions" and "are there multiple ways that a user could reach the end goal of this assignment satisfactorily?" (Burgstahler, 2020, pp. 37-43).

3.2 Multiple Means of Engagement

An important part of UDl that is often underutilized and overlooked is multiple means of engagement. This principle focuses on using multiple mediums for presenting course content, such as using video lectures and textbook readings (Burgstahler, 2020, p.43). An important part of this principle is to ensure that whatever information is important is accurately represented in all the different forms of media you choose to use. Essentially, if you are using textbook readings and video lectures, ensure that the information the user is receiving is as equal as possible from both mediums (which relates to the UD principle of equitable use as well) (Burgstahler, 2020, p. 43). If important information is presented in one medium but not the others, the use of multiple means of representation is negated if the user still has to interact with all of the various mediums.

The purpose of this principle is to create opportunities for users to engage with content in ways that best fit their individual learning styles and preferences. Users may prefer and learn best from video lectures over textbook readings, or vice versa. A sight-impaired user may struggle to interact with printed media and may have an easier experience with digital media. Users may choose to interact with only one option that you provide, but providing multiple options ensures that all users can get the most out of your course materials.

While often underutilized, this principle can be fundamental to students' learning experience, gained knowledge, and understanding of course material.

3.3 Providing Examples of Desired Coursework

Another overlooked aspect of UDI is the principle of providing examples for your coursework, instructions, and lessons (Burgstahler, 2020, p. 43). Any user who has created instructional material may know the difficulty associated with explaining a complex concept to a learner. Creating instructions can be difficult, as the possibility of misinterpretation, missing important details, or creating a confusing piece of material becomes more likely the more complex the document and subject of the document becomes. It is for this reason that providing examples of what you’re looking for from your coursework can be so important.

Placing the principle of providing examples into a UD perspective, we see that this is important for all users, including users who may have comprehension disabilities. Providing examples for your coursework will not only help students better understand what you’re looking for from them but will also help students grow and

improve in their own work. By providing an example of what good (or even exemplary) work looks like, students get an idea of what they need to do to succeed and can compare the example against their own work. Providing examples, therefore, serves a dual purpose, by providing examples instructors provide a template for how a student should complete their work while also providing a secondary lesson on what a good response to the original lesson looks like, thereby cementing the learning goals of the original lesson and improving student skills in multiple areas through a single action.

What should we consider when providing our examples, then? Our examples should at the least exemplify the minimum requirements a student would need to meet to pass the assignment. Essentially, if a student took the example, replaced the content with their own, and submitted it they should be able to pass the assignment. This should not encourage plagiarism; the intention is to provide the students with a structured guide for what they need to complete. As an example of this, consider assigning an essay to a student. When providing an example of this essay, provide an essay that would meet the requirements, and show in your example how it meets the requirements. This may appear like an outline, where each section is separated by headers that explain what should be in the section. This may also appear like a submitted student assignment, where the contents aren't necessarily important, but the formatting and length are. The goal of providing these examples is to show the student exactly what you want (whether at a minimum or providing an example of what exemplary work would look like) to give them direction and bolster the instructional materials you have provided.

Providing these examples will help to eliminate, or at least minimize, misunderstandings and misinterpretations of your instructions. By providing exactly what you're looking for from your students, they will be less likely to become confused and will be more likely to perform the work you're looking for from them. They also won't miss important aspects of the paper such as formatting requirements, important questions to answer, or important steps to take. Often, students can struggle with things like citations or step-by-step instructions, so providing an example of what a good citation or execution of a step looks like provides the students with the tools they need to correctly execute important aspects of the assignment. Finally, students are less likely to be confused about the parameters of the assignment, like goals, length (if applicable), and concerns to consider if they have a tangible example of the end goal available to them.

4.0 Considerations for Universal Design in a Lab Environment

4.1 Challenges of Student Safety

UDL concepts strives to increase accessibility for any student that may wish to participate in a course, and their integration into PBL pedagogy can maximize the ability for students of all abilities to participate in the classroom equally. However, in an implementation with a technology focus, many environments that are necessary for teaching a technology or STEM course involve the use of lab classrooms. These classrooms typically contain toxic chemicals or dangerous machines that can pose safety risks to students if improperly handled. One drawback of technology education is that some of these materials cannot be safely handled by students with disabilities, especially physical disabilities. This creates a conflict with UDL principles, where

some lab environments can be made accessible for students with disabilities in order to complete the task required by the project but may place them in a dangerous or unsafe situation because of it. This creates a balancing act for the technology educator trying to maximize accessibility while still maintaining a safe environment, and when it comes to compromises concerning safety, safety normally wins.

Educators often run into the problem of old and outdated teaching facilities that were not designed for accessibility and are not Americans with Disabilities Act (ADA) compliant. Per Title II of the ADA, schools are not required to bring their buildings into ADA compliance, but if they do not, they may not offer programs that enroll students with disabilities in those buildings. Many schools will avoid updating their existing facilities by relocating programs to a different classroom that is accessible. For technology classes this is not always achievable, especially if the equipment is specialized or only exists in a specific room. This can greatly hamper PBL techniques especially if the class must be split for accessibility reasons. While every effort should be made to make lab environments accessible to everyone, educators do not usually get a say in the matter. There are some solutions we can implement as educators, however. The Wheelchair Woodworker Shop is a comprehensive article that details proper accommodations for retrofitting a wood shop to be accessible for wheelchair users (Stephano, 2011) and an investigation from the American Chemical Society lists recommendations for how to train visually impaired students to use existing chemistry laboratories. (Nepomuceno et al, 2016).

4.2 Compromises in Universal Design

Despite our best efforts as instructors, even when adhering to the UDL principles, there will be some course elements that cannot be adapted for all students. These are concerns that technology educators are not always cognizant of before considering UDL or until a student that requires specific facility requirements is encountered. UDL principles encourage educators to adapt their coursework to be usable by any and every student that may take the course, but in the process of applying them to your teaching materials, there may be some elements that cannot be effectively adapted to everyone. In these cases, adjustments should be made that accommodate the largest subset of the differently-abled population. UDI principles cannot always be implemented, and in some cases certain accessibility measures implemented to help one group of students can actually make the course more difficult for others.

4.3 Inclusion Is Not Zero-Sum

The biggest takeaway a technology educator should have from UDL principles is that while some compromises in inclusion cannot be escaped based on the nature of technology coursework, that does not mean that inclusion initiatives should be abandoned. UDL is not an all-or-nothing system, the 14 principles can be applied in any combination and to varying intensities. Even if your classroom is in a shop or lab environment that is unsafe for certain students to utilize and cannot be replicated in a digital environment, that does not mean there is no value those students can gain from the course and should not discourage you from trying to include them, even if you are unsuccessful. This examination by Zesski and Wedler shows how students with hearing and visual disabilities can still participate in chemistry laboratories and have successful

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learning outcomes even though they are not following the same process as their peers.(Zesski & Wedler, 2018) The PBL model allows students to contribute to their group in other ways, and encourages them to enhance the understanding of their peers through discussion and collaboration while also being exposed to experiences and conclusions they would not be otherwise able to, based upon their ability. There is always value for marginalized students when they are included in the learning process, even if they cannot fully experience everything in the course.

5.0 Universal Design Driven by Culture

5.1 Process vs Culture

Creating inclusive processes will help to make inclusivity and UD less of a job and more of a habit. UD practices seem daunting at first (especially since UDI contains 14 individual practices), but through practice and training to develop an inclusive mindset, inclusivity becomes second nature. As previously mentioned, and shown through this paper, many UDI principles work together or relate to each other, meaning that often when you make an inclusive consideration you begin to make several others simultaneously. Regularly striving to make your course materials inclusive leads to honing UD skills, causing your mindset to shift and helping you to start asking how you can make materials inclusive from their conception. The best thing you can do to make inclusivity part of your culture is to start using it. Even small steps towards inclusivity can have a large impact, and the more you engage with inclusivity and see how it helps your students the more motivated and experienced you'll become.

5.2 The Importance of a Culture of Inclusion

Creating a culture of inclusion is important for many reasons and to many individuals, opening doors and providing opportunities for many individuals to achieve their goals. Not only will a culture of inclusion increase opportunities for individuals with disabilities, but it will also create better conditions and environments for learning for all learners and instructors. Perhaps most importantly, a culture of inclusion tells learners and instructors of all ability levels and goals that they are welcome and that they can achieve their goals and will be supported and guided in the process.

5.3 Changing Culture with Faculty and Staff

Learning UDI principles and implementing them into your course materials is an important first step in changing the culture of faculty and staff (Burgstahler, 2020, pp. 184-185). Practicing what you preach and setting the example will show other instructors that UDI is possible, and the success in the classroom that results from implementing UDI principles will gather interest among other instructors and faculty members (Burgstahler, 2020, pp. 184-185). Also, learning UDI principles, practicing them, and becoming familiar with them, will help other instructors feel safer and more confident implementing them as they know they'll have someone to go to if they need help or support (Burgstahler, 2020, p. 184). This opens the door as well to implementing an inclusion department or organizing a group at the institution dedicated to training and supporting inclusion practices (Burgstahler, 2020, p. 184).

Framing UDI as beneficial to all students may also encourage apprehensive faculty members and instructors to investigate

principles. Alongside this, framing UDI as an easier approach to creating course materials and reducing the need to change (or remediate) course materials for possible accommodations (since materials will be made inclusive from inception) may help change the culture at institutions. A great way to change the culture and reduce apprehension about UDI is to be clear in the idea that UDI seems complex and difficult at first, but the more one uses UDI principles, the easier creating inclusive documents will become.

6.0 Conclusion

Education, at its core, is driven by a goal to increase the understanding and knowledge of anyone who wishes to learn. To further this goal as educators, we should make every effort to ensure our teaching practices consider every student that may enter our classroom, regardless of their physical, mental, or social ability. By adopting Universal Design for Instruction principles, it helps us make our coursework and lesson plans inclusive for every classification of student before they attend our course. By striving to make our learning environments cultures of inclusion rather than just as-needed accommodations, we promote education to students that have previously felt excluded, under-motivated, or under-valued in their education careers.

For technology educators specifically, we hope this assessment has shown that Project Based Learning (PBL) is an innovative and effective technique for the technology classroom. While there can be shortcomings in its inclusion for some students, PBL can be highly effective at keeping students engaged and learning who do not respond well to classical teaching techniques. With some adjustments and the application of UDI principles, PBL can be an effective lesson plan for adapting our learning environments for

students from every walk of life. The continued growth of our culture rests on the scientists, technologists, engineers and mathematicians of the future, those students we are educating right now. We should take every effort to make our courses inclusive, because everyone should have a chance to help build the future.

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