



## OPEN ACCESS

## EDITED BY

Louis S. Nadelson,  
University of Central Arkansas, United States

## REVIEWED BY

Elisabeth De Schauwer,  
Ghent University, Belgium  
Sujata Bhan,  
SNDT Women's University, India

## \*CORRESPONDENCE

Rachel Lambert  
✉ rlambert@ucsb.edu

RECEIVED 16 January 2023

ACCEPTED 25 July 2023

PUBLISHED 16 August 2023

## CITATION

Lambert R, McNiff A, Schuck R, Imm K and  
Zimmerman S (2023) "UDL is a way of  
thinking"; theorizing UDL teacher knowledge,  
beliefs, and practices.  
*Front. Educ.* 8:1145293.  
doi: 10.3389/educ.2023.1145293

## COPYRIGHT

© 2023 Lambert, McNiff, Schuck, Imm and  
Zimmerman. This is an open-access article  
distributed under the terms of the [Creative  
Commons Attribution License \(CC BY\)](#). The  
use, distribution or reproduction in other  
forums is permitted, provided the original  
author(s) and the copyright owner(s) are  
credited and that the original publication in this  
journal is cited, in accordance with accepted  
academic practice. No use, distribution or  
reproduction is permitted which does not  
comply with these terms.

# "UDL is a way of thinking"; theorizing UDL teacher knowledge, beliefs, and practices

Rachel Lambert<sup>\*✉</sup>, Avery McNiff<sup>1</sup>, Rachel Schuck<sup>1</sup>, Kara Imm<sup>2</sup> and  
Sara Zimmerman<sup>3</sup>

<sup>1</sup>Gevirtz Graduate School of Education, University of California, Santa Barbara, Santa Barbara, CA,  
United States, <sup>2</sup>Hunter College, City University of New York, New York, NY, United States, <sup>3</sup>San Leandro  
High School, San Leandro Unified School District, San Leandro, CA, United States

Using design research methodology, we explored changes in experienced educators' beliefs, knowledge, and practices related to Universal Design for Learning (UDL) following a professional development course for in-service teachers and teacher leaders on UDL and design thinking. Data included analysis of focus groups 9 months after the summer professional development course. Findings indicated shifts in educators' beliefs about UDL, moving from conceptions of UDL as a static, inflexible framework to a "way of thinking" – moment-to-moment responsiveness to students' access needs. Another finding was the importance of empathy interviews as a practice to learn about students and build relationships. Participants stressed the importance of questioning one's own deficit thinking about students with disabilities. We call for more investigations into teacher knowledge, beliefs, and practices on UDL.

## KEYWORDS

universal design for learning, inclusive education, design thinking, teacher knowledge, empathy, UDL math

## Introduction

The promise of Universal Design for Learning (UDL) lies in its revolutionary reframing of a core problem in education. Instead of learner variability being a problem, the problem is reframed as inaccessible curriculum, interactions, and spaces (Meyer et al., 2014). UDL can be understood as a "way to move" (Dolmage, 2017), as a "form of activism" (Hamraie, 2017), and as a way to create access as understood through the perspective of disabled students (Titchkosky, 2011). These flexible ways of understanding disability are not typically taken up in schools; schools are designed to classify disability and to segregate those students into the bureaucratic system of special education. How then do teachers learn to apply UDL within systems that are designed to limit experimentation? We argue that UDL must be instantiated through a shifting set of teacher beliefs, new forms of teacher knowledge, and an emergent set of teacher practices that are quite different from business as usual in schools. In this paper, we explore what it means to learn to teach using UDL. What is the goal of our work developing teachers in the practice of UDL? What belief systems need to be shaken up? What are the mechanisms through which change occurs? And how do beliefs and knowledge interact with the practice of being a classroom teacher and/or a teacher leader?

Not all understandings of UDL focus on the revolutionary potential that we see in the initial work of CAST (Meyer et al., 2014) and in subsequent analysis through disability studies (Dolmage, 2017) and critical access studies (Hamraie, 2017). To the contrary, both researchers

and teachers have often narrowly interpreted UDL as a set of strategies that can be made into a checklist; the “checklistification of UDL” (Dolmage, 2017). Research on how teachers develop their understanding and use of UDL is still in an emergent phase and has most often narrowly defined teacher knowledge of UDL as knowledge of the guidelines created by CAST (2018). When teachers’ understanding of UDL is limited to a checklist of strategies, the possibilities for how they might design experiences for students is similarly constrained. In this paper, we interrogate what we see as a limited conception of teachers’ knowledge, beliefs, and practices of and about UDL, and provide one example of what an expanded model might look like. In doing so, we hope to restore/reclaim some of the more radical aspects of UDL as it was originally intended.

To do so, we explore findings from our empirical project to better theorize teacher knowledge in UDL. Our empirical project was a design research study on professional development (PD) for in-service teachers and teacher leaders on UDL (Lambert et al., 2021; 2022a,b). The PD was a six-week virtual course on UDL that integrated Design Thinking and UDL, specifically in the area of K-12 mathematics (UDL Math; Lambert, 2021). The course occurred in the summer of 2020, during a challenging phase in educators’ lives as they shifted between in person and virtual instruction because of the COVID-19 pandemic. Participants needed a way to envision and redesign mathematical learning experiences to re-engage students in challenging conditions. This moment posed a real dilemma for teachers, requiring something bigger than the “UDL-as-checklist” approach that many had experienced previously. In our view, the challenge of re-engaging marginalized students was essentially a design problem and therefore required a new approach. In order to support teachers to use their understanding of UDL to design new experiences for students, we combined UDL with Design Thinking. Design Thinking provides a collaborative process that helps teachers address persistent challenges within their practice by beginning with empathy for users, then carefully defining the problem and generating a diverse set of innovative solutions (City et al., 2009). Using data from two focus groups, we detail shifts we saw in educators’ beliefs about disability and UDL, shifts in their knowledge about UDL, and shifts in their practice. We will then discuss what this might tell us about research into teacher knowledge, beliefs, and practices in UDL.

## Conceptual framework

Universal Design for Learning (UDL) is an approach to understanding classrooms and pedagogy grounded in the learning sciences and neuroscience (Meyer et al., 2014). UDL emerged from the Universal Design (UD) movement in architecture and product design (Hamraie, 2017). Universal Design sought to find elegant and effective ways to maximize the use of buildings and products by designing them from the outset as accessible for disabled users. UD was created by the disabled architect Ronald Mace. In their analysis of the development of UD, Hamraie (2017) described the importance of *access knowledge*, or designing from the perspective of disabled people. They wrote, “access knowledge emerged from interdisciplinary concerns with what users need, how their bodies function, how they interact with space, and what kinds of people are likely to be in the world” (p. 214). To design for the diversity in bodies and minds that actually exist in the world, the designer must develop their

understanding of this human diversity. Disabled people possess this access knowledge based on their embodied experiences living in the world. Designing for difference is best done through developing deep understanding of how oneself and others move through the world (Hendren, 2020).

UDL was developed as educators from CAST were faced with the problem of creating accessible spaces for disabled children who were moving from a hospital environment to a school environment (Meyer et al., 2014). They theorized that the problem was not the students re-entering schools, but the rigid ways of doing things in schools that were inaccessible and inflexible. Thus, UDL allows for this radical reimagining of schooling. Rather than focusing on the deficits of individual students, UDL refocuses on designing educational spaces and curriculum to include a wide range of learners from the outset. UDL aligns with the social model of disability (Oliver, 2009). Instead of locating disability within individual students, UDL locates disability in inaccessible classrooms, curriculum, and spaces. This reframes disability from a medical to a social model (Waitoller and King Thorius, 2016). UDL is a useful and radical framework because it places the power in the work of educators to redesign classrooms, curriculum, and systems for students with disabilities.

Yet, UDL is taken up, understood, and “packaged” to educators quite differently. Ironically, despite the word “design” in its title, UDL lacks a design process. There is little designing work when it is conceived of primarily as a checklist. Smith et al. (2019) identified the tension between seeing UDL as passively following the UDL guidelines versus seeing UDL as a design process: “UDL is not simply a *listing* (emphasis added) of various flexible options and strategies; rather, it is a *process* (emphasis added) of designing intentionally to reduce cultural, cognitive, behavioral, and physical barriers” (Smith et al., 2019, p. 177). Moore (2017) similarly noted that there are two general ways of approaching UDL: first, seeing it as passive alignment with the guidelines and, second, as a design process. Smith and colleagues also noted a need to understand UDL beyond curriculum design, to consider systems and policies that are barriers for students at the margins. Some professional texts addressed this issue by proposing specific processes related to lesson planning (e.g., Ralabate, 2016) or curricular design (Basham et al., 2016). Others, such as Edyburn (2010), noted that UDL must be recognized as a design process, but assigned the design work of UDL to external instructional designers, not teachers themselves. Across our work, we see teachers as designers and attempt to position and support them as such. Even when using a curriculum, teachers are still designing routines, habits, interactions and space.

One reason we do not see alignment with the guidelines as sufficient is learner variability (Meyer et al., 2014). Disability is complex, multifaceted, and differs in context. What teachers might consider the “needs” of students with disabilities and students’ actual “needs” (according to students themselves) are likely very different (Naraian, 2019). Experiences of those with disabilities vary, and teachers cannot assume that what works for one student will work for all. Similarly, there is no set of UDL guidelines that allows teachers to understand the needs and lived experiences of students who are Black, Indigenous, and People of Color (Indar, 2018), although the UDL guidelines are currently being revised to better address racial equity.

This problem also connects to a problem of scale: how large or generalizable is the item being redesigned? For example, texts like Ralabate (2016) focused on the redesign of lesson plans. However, the

disabling aspects of school go well beyond the unit of lesson plans. The UDL framework does as well. For example, the emphasis on engagement and motivation suggests the need to make larger changes in schools than in lesson plans. A “lesson plan” is too small a design space. It does not take into consideration the effect of sequences of experiences, systems, or patterns that exist within schools, such as segregated classrooms for students in special education. These are exactly the types of “wicked problems” (Buchanan, 1992) that Design Thinking is well-poised to address.

In a paper presented in 2015 at UDL:IRL, a major conference of UDL attended both by academics and educators, Loui Lord Nelson described the importance of teacher beliefs in UDL. She proposed three underlying philosophical ideas of UDL and asserted that educators must interrogate their own beliefs around these issues. The first is *access*, or the deliberate design of curriculum so that all students can engage. She connected access to beliefs about who can learn; “there must be a palpable belief that all students are able to learn and all students must have access to learning” (Nelson, 2015, p. 7). The second underlying philosophy that Nelson addressed is *inclusion*, the belief that all students, no matter their disability status, can be included in schools and classrooms with their peers. Inclusion, meaning that all students belong together, is a core principle of UDL. The final underlying philosophy is *learner variability*. She described the harmful effects of sorting and ranking students based on disability, and instead stated that disability emerges from the interaction between the learner and the learning space (defined broadly as curriculum, interactions, space, and emotions).

Some of these beliefs warrant further discussion. For example, inclusion is not the end goal for all disabled communities, particularly in the Deaf community, for which inclusion often means loss of access to language. Focusing on learner variability and disability as only emergent in contexts can be problematic for disabled people who value their disabled identity (Dolmage, 2017). And as Hamraie (2017) explored in their work on access-knowledge, understanding what access means to an individual is complex knowledge work that is best undertaken by those who understand those access needs. How then can teachers provide access when they may not be disabled themselves, or in the same way as a student? Nelson’s work outlining teacher beliefs related to UDL provides an excellent starting point for further theorizing on UDL teacher knowledge.

## Teacher learning: knowledge, beliefs, and practices

Throughout this section we reference research in mathematics education, as mathematics education has a long history of debate on the use of these terms, and decades of research using them to understand teacher learning. Horn and Garner (2022) described how theory on teacher learning remains “thin,” and how their research aimed to “thicken up theory” on teacher learning (p. 2). We share similar intentions for theory on teacher learning and UDL. In order to do so, we define three terms: teacher beliefs, teacher knowledge(s), and teacher practice, both how each is used generally to understand teacher learning, and how they are used specifically in the context of UDL. Each of these terms can be defined in a static way located within an individual. Beliefs, for example, can be understood as fixed, unchanging in teachers, or can be conceptualized as complex and

dynamic, shifting across time and contexts (Skott, 2015). The latter understanding emerges from sociocultural and situated theory about teacher learning.

Teacher practices as a term refers most simply to what teachers do, their activities. It can be used to describe a list of instructional strategies (e.g., using visuals during lecture or assigning open-ended problems). Practices as a term is more complex when situated within sociocultural theory, as practices is used for activities, but those activities are always understood as co-developing with knowledge and in and through relationships and community (Rogoff, 2003). In this sense, practices are developed through participation in particular communities of practice (Wenger, 1999). Teachers tend to engage in particular forms of math teaching because they have experienced them as students, and therefore re-enact the practices they know well.

Teacher knowledge refers simply to what a teacher knows, but what counts as knowledge remains complex and contested. Knowledge can be defined from an individualist, more positivist viewpoint as a score on an assessment. For example, much research in mathematics education has used written assessments to measure teachers’ mathematical content knowledge. In mathematics education, there has been significant discussion of what kind of knowledge is needed to teach math well (Hill et al., 2008). Content knowledge is the understanding of mathematics itself. Pedagogical content knowledge is the understanding of how learners develop mathematical understanding. It can also include using what we know about how learners develop understanding to design learning experiences for students. Research has documented how pedagogical content knowledge is more predictive of student learning than content knowledge (Hill et al., 2005). Political knowledge (*conciimiento*) is a developing understanding of how mathematics teaching and learning is embedded in political systems, such as colonialization (Gutiérrez, 2013). Given this terrain, teacher knowledge itself is analogously complex, contested, and political.

Teacher beliefs have been studied in mathematics education for decades, bolstered by the presumed relationship between teacher beliefs about mathematics (and who can do mathematics) and teachers’ own pedagogical practices. However, there have been multiple indications that teacher beliefs (as measured by what teachers say in interviews or mark down in surveys) do not always match what they do (Skott, 2015). Other studies have found consistent links between teacher beliefs and teacher practices (Polly et al., 2013). Another way to conceptualize beliefs is through a participatory, or sociocultural, lens. Beliefs, as expressed, do not exist in a pure state, but are influenced by the context and the goals of the actors. And beliefs shift not only over time, but across contexts as teachers engage in particular practices (Skott, 2015).

One example of how we might theorize teacher learning (including knowledge, beliefs, and practices) can be found within Horn and Garner’s (2022) recent work, in which they discussed the importance of understanding not only the teacher and their relationship to context, but how they learn, and the mechanism of learning. Like our research, they study in-service teachers, theorizing how conceptual change for teachers is situated within schools which are generally resistant to change and have longstanding models about how teaching and learning should be arranged. To “thicken up theory” we would need to better understand not only how teacher practices, beliefs, and knowledge of UDL are interrelated, but how they change.

In fact, seeking to better understand the mechanisms of change is critical to shifting toward more inclusive schools.

## Current state of research on teacher knowledge, beliefs, and practices in UDL

Previous research in UDL has mainly conceptualized teacher knowledge as an understanding of the UDL framework and how to apply this framework to teaching practices (Smith et al., 2019). The framework provided by CAST refers to UDL's three principles (engagement, representation, action and expression), nine guidelines, and 31 checkpoints (CAST, 2018). Some research has documented how to create lessons and lesson plans that integrate the UDL guidelines and concepts (Kurttis et al., 2009; Rao and Meo, 2016). Research looking at preservice teachers' understanding of UDL has focused primarily on preservice teachers' application of the UDL framework to lesson plans before and after receiving instruction on UDL (Spooner et al., 2007; Courey et al., 2013; Owiny et al., 2019; Lee and Griffin, 2021).

Prior research on teacher beliefs surrounding UDL has focused mainly on teachers' beliefs about the barriers to implementation and inclusion (Lowrey et al., 2017; LaRon, 2018). Additionally, the research has tied teacher beliefs to the guidelines. Capp (2020) conducted a survey to understand Australian teachers' perceptions of their own confidence in implementing the UDL principles, guidelines, and checkpoints. Griful-Freixenet et al. (2021) explored preservice teachers' habits of mind (e.g., growth mindset, self-efficacy, and self-regulation) and their connection to the implementation of UDL principles. A study by Lanterman and Applequist (2018) looked at teacher beliefs more broadly by exploring preservice teachers' beliefs surrounding disability before and after UDL training. They found that a module in UDL impacted preservice teachers' beliefs that disability/ability are affected by classroom conditions and are not fixed (2018). They also found a modest correlation between participants' understanding of disability and their beliefs that their own actions as teachers can create conditions for students with disabilities to improve.

Ostrowdun (2020) conducted a study that looked closely at preservice teachers' beliefs about inclusion, assessed not through a survey measure but through drawings. The initial conceptions of inclusion were then compared with the teacher candidates' IEP and UDL lesson design assignments. For most of these teacher candidates, there were different "figured worlds" (Holland et al., 1998) in play. For example, the "inclusion world" was framed as idyllic and almost impossible to reach. In contrast, the "schools world" was pragmatic, deficit-focused, and where teacher candidates operated as required by their student teaching. When asked to reflect on their drawings, again, teacher candidates saw a difference between the utopia of inclusion and the reality that they were facing in their field placements. For example, one teacher tried to implement UDL in her placement, using social media as a way for students to express what they knew. But she faced pushback from her cooperating teachers and was told that she needed to focus on traditional genres of writing because that was what was on the standardized exam. This example illustrates the disconnect and potential conflict between a developing teacher's knowledge and beliefs of UDL and their instantiation of UDL in practice.

Some work on UDL in teaching has looked at the connection between knowledge of UDL and implementation, in this case, teacher practices. Existing studies have assessed teacher knowledge of UDL and teacher practice by measuring how well teachers implement the guidelines in their teaching, curriculum, and lesson plans. For example, Craig et al. (2022) evaluated teachers' implementation of UDL using a rubric for observation that assessed goals, barriers, and the three principles. Basham et al. (2020) presented the development of an observational tool for measuring UDL implementation. They discussed difficulties in measuring how UDL is applied in practice due to varying teacher understandings of UDL and the flexible and iterative nature of its application. As noted, UDL teacher practices can be understood in a more static sense as the implementation of UDL guidelines, as a checklist of certain strategies.

Conceptualizing knowledge, beliefs, and practices of UDL as a mastery of the principles and guidelines omits other important elements of practicing UDL. For example, it reinforces the notion that UDL is a static framework to implement, rather than a process to engage with over time. It seems to support a formulaic interpretation of UDL rather than viewing it as a flexible approach to designing instruction and curriculum. Finally, we note that research on UDL and teaching has not incorporated the importance of listening to and designing for the variety of users, the students. We assert that all three—teacher knowledge, beliefs, and practices—matter in how we develop an understanding of UDL. Belief matters in UDL because it is really a revolution, asking teachers to (in some cases) completely overturn their ideas about who belongs in a classroom and what to do when things aren't working. Yet beliefs do not occur in a vacuum, they co-develop with knowledge and practices. In this work, we seek to learn more about this process for the teachers in our study.

## Design Thinking

Design Thinking is a tool for designing that originated in the late 1980s within the context of architecture and art (Rowe, 1987). Though there are various approaches to Design Thinking, most versions consist of the following iterative phases: defining the problem, understanding user experiences, ideation of solutions, and prototype development and testing (Waloszek, 2012). These stages are flexible in that designers will often not move through the steps linearly, instead going back to earlier stages depending on what the design process tells them (Brown, 2008).

The Design Thinking approach has been applied in other fields beyond architecture, such as education, where the "product users" are most often students and the "design products" range from materials, to experiences, to routines and systems. Since teachers often face complex, seemingly intractable problems, education is particularly well suited to the iterative process of Design Thinking where multiple potential solutions are interrogated and revised (City et al., 2009). Additionally, design thinking reinforces and expands teachers' positioning as designers. While it is neither novel nor radical to think of teachers in this way (teachers do "design" learning experiences), there is tension when considering that teachers are often seen as "doers" or implementers and not creatives. Usually, design implies that something needs to be *created*, whereas when one implements something, that thing already exists (Carlgren, 1999). In this way,



teachers can be viewed as both designers and implementers, two intersecting key roles in the design process (Kirschner, 2015).

Emerging research on Design Thinking with in-service teachers suggests the framework can change how teachers think about teaching. For example, teachers have emphasized the importance of the empathy stage of Design Thinking in their teaching (Retna, 2016; Henriksen et al., 2020). Furthermore, teachers in Henriksen et al.'s (2020) study reported seeing themselves as designers after participating in a course focused on Design Thinking.

## Empathy interviews

In our use of Design Thinking we highlighted the importance of the empathy phase and specifically of the empathy interview, a tool designers use to elicit a series of stories and feelings from the user about a particular experience (e.g., being a 7<sup>th</sup> grade student of mathematics). Empathy interviews are meant to feel like natural, informal conversations between designers and users that uncover the users' experiences in a particular setting, their feelings about those experiences, and ultimately, their unmet needs within that context. The goal, in a way, is to understand a person's thoughts, emotions, and motivations, so that designers can design for them. When leading an interview, the strategy is typically to get the user to tell stories, because stories allow designers to better understand how a person makes sense of their experiences and the worlds they live in. In our project, empathy interviews were part of the Design Thinking process for participants, not a data collection tool.

Because the empathy interview can be rich, detailed, and complex, designers often work in teams to better capture the important ideas and moments. The detailed notes from an interview can be synthesized into a few broad categories and codified into an *empathy map*. By synthesizing the most salient aspects of the interview, and noting the unmet needs or "pain points" within the user's experiences, designers move beyond the empathy phase into the define phase, where two goals emerge: to develop a deep understanding of the user and develop an actionable problem statement, or point of view. While not specific to mathematics education, empathy has been found to be a critical feature in teaching. Teachers' ability to empathize with their students shapes the teachers' response to problem behaviors (Wink et al., 2021). In fact, one meta-analysis of student-teacher relationships found that empathy by the teacher was the strongest predictor of positive outcomes for students (Cornelius-White, 2007).

Thus we came to this work on UDL using both Design Thinking as a process for the participants and for our own methodology. Given that our course took place during the first months of the COVID-19 pandemic, we saw the course as an opportunity for teachers to develop new, innovative ways to reach students. By envisioning "what might be" as opposed to "what is" (Owen, 2005), teachers would ultimately take up the mantle of "teachers as designers." Design research on teaching can be generative when the process being studied is not clearly understood (Friesen, 2016).

We engaged in a collaborative design research project that was intentionally comprised of experienced mathematics and special educators highly interested in UDL, both in our participants and in our research team. Through our work with this group, we hoped to gain clarification on what UDL could be, how to integrate Design

Thinking with UDL, and the role of beliefs around disability in teachers' work. Our research question was: After participation in an on-line course and months of work as educators after the class, how do participants understand UDL? To them, what is UDL? How do they *do it*?

## Methods

Our primary methodology is Design Research. Design research studies are iterative, process-focused, and designed to create new theory through innovative design (Cobb et al., 2003). They are iterative as they use cycles of inquiry. They focus primarily on understanding a process or phenomenon, such as a teacher's shifts, and are poised to capture how these processes or phenomena change over time (Horn and Garner, 2022). Finally, design research is theory-driven: hypothesizing, testing, and ideally advancing theory about instructional design. Given our interest in studying the development of teachers' understanding of UDL and Design Thinking within the context of mathematics, we found that a design research study provided the best method to investigate these complex interactions while exploring emergent theories. Our work is not designed to create generalizable data, but to create and expand on theories of learning, here on how educators learn UDL.

This article builds on a larger empirical study of a teaching experiment. That larger study included pre- and post-course participant surveys, artifacts, and recordings. As a design research study, we also engaged in iterative and concurrent analysis during the course. Our focus in this article is what participants took into their practice almost a year after the course. Our main data source for this article is then the focus groups. We will summarize methods from the summer teaching experiment and then provide details on the analysis most relevant to this paper.

## Teaching experiment procedure

Our teaching experiment was a 6-week course for educators in the state of California in summer 2020 (Lambert et al., 2021). The class was primarily designed by the first author, a researcher and professional developer in UDL and mathematics, and the fourth author, a researcher and professional developer in mathematics and Design Thinking. Activities included explorations of Disability Rights, neurodiversity, and UDL. The focus of the course was collaborative design teamwork. All participants were assigned to a Design Team based on who they hoped to design for (users) and what they hoped to re/design (curriculum, spaces, interactions, or systems) using the theory and practices of UDL as they understood them. Each team was supported by one of the course facilitators who provided feedback and guidance along the way: helping to develop a problem of practice, analyzing empathy maps, or joining them for ideating or "wild brainstorming." In the final session, each Design Team presented their prototype for feedback from other teams. Prototypes included redesigns of classroom curriculum, engagement with families, and professional development for teachers. Consistent with design research, our team of facilitators met frequently, before and after each class to debrief and plan. More information on course content is available in Lambert et al. (2021).

## Participants: summer teaching experiment

Participants in the summer course included both out-of-classroom professional development educators and in-service teachers. To recruit professional development educators, a study advertisement was emailed to all members of a state-wide mathematics education organization. Educators were also encouraged to invite in-service classroom teachers to the course. Classroom teachers from a different UDL research project were also invited to join. No participants were excluded from the course.

A total of 45 educators participated in the study. In terms of gender, 35 identified as women, three as men, and seven did not indicate a gender. Participants identified as White ( $n=17$ ), Latinx ( $n=8$ ), Asian-American ( $n=7$ ), African-American ( $n=1$ ), Native American ( $n=1$ ), Middle Eastern ( $n=1$ ), and “mixed” ( $n=1$ ) (9 did not indicate their race). Four identified as disabled. Most participants (93%) had over 5 years of K-12 special education and/or mathematics teaching experience; 75% had over 10 years of experience. About half ( $n=23$ ) worked as district or county administrators or as curriculum developers, six were mathematics coaches, and 16 were in-service teachers. Twelve participants held a special education teaching credential. We purposefully recruited participants with classroom teaching and leadership experience, as we were hoping that participants would help us better generate knowledge about UDL in the context of mathematics and Design Thinking.

## Participants: focus groups

Two focus groups were conducted nine months after the PD course ended. One group was comprised of classroom teachers, the other was comprised of a particular Design Team. Participants in the classroom teacher focus group were recruited through an email to all course participants. The four participants in the classroom teacher focus group all identified as women, three as white, one as Latina, and one as disabled. Two were high school special educators, and two were elementary school general education teachers at a dual language school. All teachers had students with disabilities in their classes during the 2020–2021 school year, with majority Latinx classrooms. For the other focus group, we emailed a particular Design Team and asked the entire team to do an interview with us; four out of five members of the team agreed. All members of this focus group worked in mathematics education at the county or district level. Of the four who participated in the focus group, one identified as a White woman, one as an Asian American male, one as a Latina, and one did not identify themselves. None of these participants identified as disabled.

## Data collection and analysis

We discuss here both the data collection done before, during, and immediately after the course [Round 1, as presented in Lambert et al. (2021)] as well as the two focus groups which occurred 9 months later (Round 2).

### Round 1 data collection

Round 1 data consisted of course development data, course artifacts, and a survey. Course development data included facilitator emails, field notes, and meeting transcripts. Course artifacts included records of in-class activities, recordings of course sessions, and design

team prototypes. Participants also completed a survey pre- and post-course. Surveys included multiple choice questions about participants' familiarity with course topics and the degree to which they felt that they grew with regard to the course outcomes. Participants were also asked open-ended questions about course topics.

### Round 1 data analysis

Round 1 data analysis included both a case study of a particular Design Team's design process and analysis of survey data (Lambert et al., 2021). The design team case study was conducted using course artifacts. Descriptive statistics were used to analyze quantitative survey questions. Answers to open-ended survey questions were analyzed using open and axial coding with both inductive codes derived from the data (Corbin and Strauss, 1990) and deductive codes (DeCuir-Gunby et al., 2011) based on UDL and Design Thinking. One author conducted all the coding; codes and theme analysis were discussed in team meetings with all authors. See (Lambert et al., 2021) for more details about Round 1 data analysis.

In this paper, we also present visual analysis of participants' open-ended survey responses, which complements our initial qualitative coding. Specifically, we used Voyant Tools (<https://voyant-tools.org/>) to create word clouds from the pre- and post-survey responses to the question, “What is Universal Design for Learning?” Word clouds are visualizations of frequently used words in a corpus of text. This question was also analyzed for active and passive interpretations of UDL in our initial analysis (Lambert et al., 2021).

### Round 2 data collection

Focus groups were conducted remotely via Zoom approximately nine months after the conclusion of the professional development course. We specifically designed each of our two focus groups to be an optimal size (between 4 and 5 people). We created two separate focus groups with different participants. One group was restricted to classroom teachers. The second focus group was one particular design team, which was all educators working in non-classroom roles.

Two members of the research team participated in each focus group, with one facilitating and one listening for follow-up questions. The focus groups followed a semi-structured format so that facilitators could deviate from the interview guide if needed. The first set of questions explored experiences teaching in the 2020–2021 school year; the second set focused on UDL and Design Thinking (see the Appendix A for a full list of questions for each focus group). In addition to asking questions and facilitating conversation, we also showed focus group participants study findings (e.g., graphs showing course outcomes, and word clouds presented below based on open-ended survey questions) in order to elicit their feedback about the results.

### Round 2 data analysis

After the focus groups, all members of the research team completed individual *in vivo* coding of the focus groups transcripts (Miles et al., 2013) in order to develop initial codes. After a meeting to discuss those initial codes, three team members then applied these codes to the entirety of the two transcripts. Each of the three also wrote an analytic memo with analysis across the focus groups. The first author synthesized the analyses for this article. The first author presented the final thematic analysis to the writing team for feedback, at which point it was finalized. Any responses that were coded differently were discussed and consensus was reached.

As part of our iterative analysis process, the research team asked one of the classroom teacher participants to join the team writing this paper. This served as an additional member check on our findings, and also allowed for more expansive theorizing. This participant did not code data, but read the analysis and made comments on the draft.

## Findings

In this section, we first review our initial findings immediately after the course was finished in August 2020 (Round 1). We discuss our questions at that time, which led to another round of data collection in the form of two focus groups in April 2021 (Round 2). Our analysis focuses on the following research question regarding our two follow-up focus groups: *After participation in an on-line course and months of work as educators after the class, how do participants understand UDL? To them, what is UDL? How do they do it?*

### Findings from summer course (round 1)

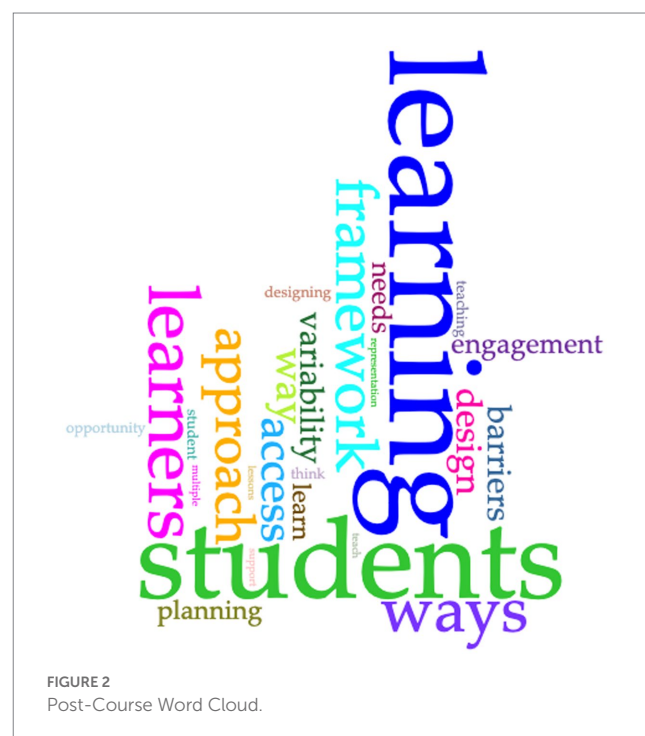
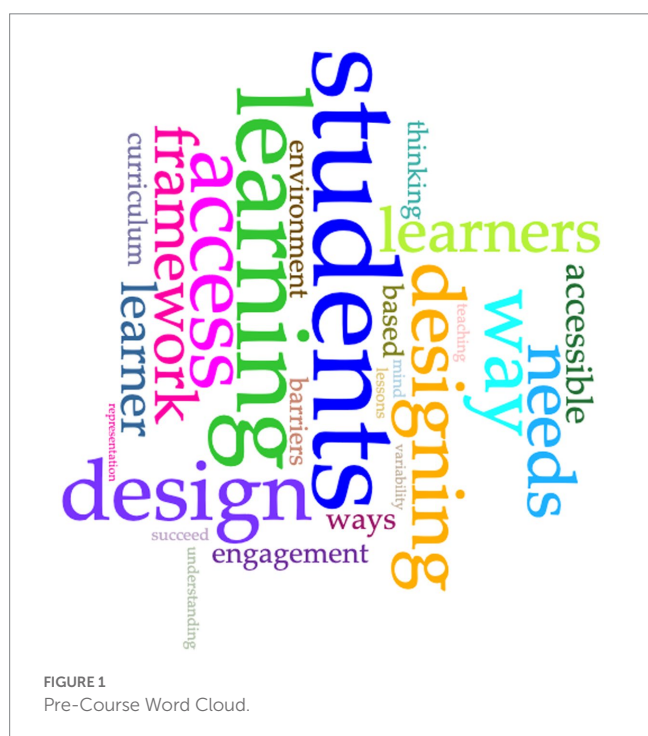
Findings from pre- and post-survey data (Lambert et al., 2021) indicate shifts in participants' conceptualization of UDL as a set of guidelines to an active design process, moving from a noun to a verb. Our initial findings also indicate that empathy became a guiding principle for participants' understanding of designing for disability (Lambert et al., 2022b). We also found that participants reported change in the way they conceptualized disability, with most participants reporting shifts away from medical and deficit models (Lambert et al., 2021; Lambert et al., 2022a). We illustrate these findings with word clouds (Figures 1, 2), an analysis tool not included in the earlier paper.

These word clouds are visualizations of frequently used words from these survey questions (after removing “Universal design for learning”; “UDL”; “Universal design in learning”; “UD in Learning”), with the most frequent words appearing larger and at the center of the cloud. The visuals show that pre-course responses frequently defined UDL as an “approach” (10 occurrences). Following the course, participants used “approach” fewer times (three occurrences) in their definitions. In the post-course responses, the use of the word “design” increased from seven occurrences in the pre-survey to 14 in the post-survey, and “designing” increased from five to 14 occurrences. This increase in the terms “design” and “designing,” suggest a more active interpretation of UDL following the course. Finally, the occurrence of the word “access” increased from eight to 14 occurrences. These shifts, as seen in the word cloud, imply that educators were more likely to define UDL as a structure to *follow* (i.e., how to make a lesson plan) prior to the course, and viewed UDL as a design process in which to *engage* after the course. The following responses from one participant highlight this potential shift:

Pre-Course Response: “Universal Design in Learning is a flexible learning framework that can be accommodated to individual learning differences.”

Post-Course Response: “Universal Design in Learning is designing learning so that the needs of all students are met.”

We notice a shift from the actor in the pre-course responses being the framework itself, to the actor being the educator in the post-course responses. The findings in the word cloud echo our thematic analysis of all responses, pre and post, of the summer course (Lambert et al., 2021). Again, we noted that participants shifted from a passive





conception of UDL to a more active one. We hypothesize that this shift may have been because of the integration of Design Thinking.

Our major goal with the course was to learn how Design Thinking could be integrated with UDL. We found that engaging in the Design Thinking process with the goal of creating more accessible mathematics teaching practices appeared to be very successful, as documented in the sizeable number of participants who discussed how the Design Thinking process allowed them to actually engage in UDL beyond just looking at the guidelines (Lambert et al., 2021). As one participant noted, “UDL is designing from the margins. Design thinking is a process that we can use to design from the margins if we are intentional about the process.” This was our main intention with the course, to provide a design process for Universal Design for Learning.

We now highlight a finding we found to be surprising: the centrality of empathy and empathy interviews in participant learning. When asked in the post-course survey, “What connections do you see between UDL and Design Thinking?” many participants highlighted the importance of empathy and centering the user experience. We were struck particularly by how empathy appeared to be important in the implementation of UDL, as empathy is a feature of DT but not UDL. When we asked participants in the post-course survey, “How might this course impact your work as an educator?” the most pronounced theme was empathy (17/33), with participants noting how starting with empathy interviews could positively impact their practice.

## Findings from focus groups (round 2)

After this analysis of pre- and post-surveys, we wanted to know how the course would impact the participants’ work as educators, particularly in the challenging year of 2020–2021. We were particularly interested in how the course impacted the work of classroom teachers, so we organized a focus group of four classroom teachers. We also wanted to understand the design process for one particular Design Team, called the PD Design Team as they planned to design PD around UDL for classroom teachers. This group continued their work together well into the fall, working on designing a way to engage teachers. We decided to do a focus group with this team to learn more about why they had engaged so deeply in the process. This design team was made up of all out-of-the-classroom educators (since the design challenge that had brought them together was designing PD for teachers). We thus had one focus group of all classroom teachers and another of all out-of-the-classroom educators.

The focus group questions are in [Appendix A](#). In both groups, we wanted to learn what had impacted their practice from the course, if anything. At the end of both focus groups, we also planned a member check where we presented some of the Round 1 findings discussed above, using the word clouds as a visual support and artifact for discussion.

Our findings were that (1) participants understood UDL as a “way of thinking,” as a moment-to-moment responsiveness to students, providing access in the moment that was in contrast to deficit thinking about students, and (2) empathy continued to be a critical, central practice of UDL in the work of both groups. Empathy interviews gave educators a practice for learning about and building relationships with

students (seen as complex and multidimensional) and responding to students (differences, failure, and needs) in the moment of instruction. Empathy was connected to the rejection of deficit thinking, and a way to design from the student’s point of view. We will first describe the way UDL was understood across both groups.

## Shifting understandings of UDL: from a framework to a “way of thinking”

Practitioners shifted their understandings from UDL as a static framework, to a “way of thinking” or a “mindset” that was more often discussed as in-the-moment than in pre-planning. The shift was an explicit part of the conversation for multiple participants. One participant narrated a journey metaphor:

I almost feel like we all kind of had this journey of thinking one way and thinking that we understood UDL in this fashion, but as we continued through it, as we’ve grappled with it, as we try to balance out the course work with our regular day job, and I can see how it has shifted into this new language of really design thinking, really looking at the needs.

We begin by noting that participants in both focus groups repeatedly qualified their descriptions of UDL as potentially incorrect, and that they were possibly not doing it right. We see this as important, as they were identifying a tension between different ways of understanding UDL, between different forms of teacher knowledge about UDL. When asked directly about their use of UDL in the school-year, the classroom teachers initially made comments about how they did not feel they did UDL completely, or in a way that felt “correct.” When pressed to explore how they actually used UDL, the teachers described a flexible “process,” one that they adapted to the situation. They described UDL as a way of thinking about accessibility, of beginning with students rather than standards, and lastly, as a process that extends to in-the-moment teaching moves.

High school mathematics special education teacher Haley described it as a questioning process around accessibility, “at the front of my mind like, is this going to be welcoming for everybody?” Classroom teacher Bella described it as a shift from focusing on standards to focusing on the students. She connected her thinking process to the novel situation of the pandemic: “how do I make it accessible to everyone and just really stretching my thinking far beyond maybe what I would have done in the classroom?” Zelda, who also worked in high school special education setting, said,

Design thinking and UDL are an active process...not like an approach or sitting out here and doing something a certain way, but it’s in those moments, in a teaching moment, even in your live-on-your-feet lesson, as you shift and adjust, that...is UDL.

Haley also insisted that her understanding of UDL was not about any specific way of teaching or teaching practice. She said, “[UDL is] like a process for us to like think through and make sure that it’s, that everybody’s able to access it, but it does not actually tell us how to teach.” For Haley, UDL meant incorporating student choice into assignments, as she began to allow students to turn in videos to explain their mathematical thinking. She saw that students who struggled with documenting their thinking on paper could explain complex mathematical thinking on a video.



So how does this moment-to-moment understanding of UDL work? After being asked, “So do you think you are using UDL in your current work? Is that something you think about or not? Please you can be totally honest. Are there parts that you have sort of held on to that sort of, you think about as you plan?” Zelda went first, immediately jumping not to planning with UDL but this in-the-moment work. What follows is a lengthy quote, but we preserve it as an example of how a teacher narrated her process of teaching, a representation of teaching (Horn and Garner, 2022).

I think one of the things, uh, as I plan, I'm not necessarily thinking UDL, UDL, but I think one of the things that also UDL...revealed to me some of my deficit thinking that I wasn't aware was necessarily there. This is only my second year teaching math. I come from, teaching a humanities background...and some of my old math baggage came with me to teaching math for example...last week I used a Jamboard and some Open Middle problems and my students really struggled with it, and I found myself thinking, ‘Maybe we can't do this,’ you know, ‘Maybe, maybe they can't do this,’ right? And I caught myself that I was like, ‘Okay,’ you know? And I also--I didn't want to over-scaffold it, you know? But we worked on it, I thought about it. You know I scaffolded it a tiny bit by giving them one number, and you know just talking about it. And then this week, I was like, ‘We're going to do it again.’ You know, as opposed to being like, ‘Oh, I think that just didn't go how I wanted it to go, so they can't do it.’...I asked them at the end, ‘How do you think this went?’ And they were like, ‘You know, I think we're getting it, I think we're getting it like at the end.’ Where I was like, ‘ooh this is taking a long time!’

Zelda narrates how she uses UDL as a way to process a challenging lesson, and how UDL influenced her to not assume her students cannot do this mathematics, but that they may just need more time. She ends the narrative by asking her students about the activity, and they respond positively, even as she narrates her own thinking about how it was “taking a long time.” Her story highlights how beliefs about student competence influence how teachers allow for opportunities for students to engage in challenging work. She then immediately turns to a more general description of what UDL is.

It's not just like oh, this [UDL] is different curriculum, but, I just, it's just like, I can catch myself and adjust my practice. You know, I can catch that thought and be like, no it's not that they can't do it, it's like – what, do we need to try again? Does it need more time? You know, and also asking them, like, ‘How is this going?’ So I think, for me, I feel like the course like has hugely impacted my practice.

The problem is not with her students and their capacity. UDL is about “catch that thought,” or an active way to interrupt the deficit thinking that she might have. We see how teachers connected UDL to their own shifts away from deficit thinking. Zelda's narratives particularly call attention to how deficit thinking can intrude on the work of a teacher, and her internalized challenge to “catch that thought.” She ends with the idea that this way of UDL in practice, this “way of thinking” has “hugely impacted my practice.”

This narrative gets at something that all the classroom teachers spoke about - the connection between UDL and beliefs about their students' capacities. In the PD design team, Amara described how she saw UDL:

I think, for me it is the understanding that UDL is not just a technique or system or the strategy. It is a way of thinking. You know, as a teacher coming in and really look at the classroom and how you're going to actually access every students' learning through your instruction, but it is by planning and organizing it in a way that is universal, you know, as if every single student will benefit.

In this initial response we see an emphasis on planning to achieve universal access. She continued, connecting UDL to beliefs:

[UDL] is really changing your mentality of how you're going to incorporate that approach within every single student in the classroom. And I think that the mind shifting is something that goes with...the guidelines...but at the same time how that is going to be benefiting every single individual regardless of their cognitive ability or academic levels...I really feel that has to be conveyed as much as you do, A, B, C, D this way, is you come in, and you look at your classroom and you adapt that mentality about giving everybody the instruction. I don't know if that makes any sense.

We note how Amara contrasts this way of thinking about UDL with a passive following of the guidelines (“A, B, C, D”), instead that it is about a “mentality.” We also note the last sentence here, “I do not know if that makes any sense.” We found that the participants used qualifiers throughout their descriptions of UDL, which may indicate their shifting notions of UDL or the concept of a “right way” to enact UDL.

Immediately after this comment by Amara in the PD design team, Lucy added her own description of UDL, echoing Amara's idea of the tension between following the guidelines and something more fluid. To understand this comment, one must know that the UDL guidelines are in three colors: green for *engagement*, blue for *expression*, and purple for *representation* (CAST, 2018);

It's hard to take the UDL framework for like a teacher or anyone to be like here's the framework. Now you choose number one in the purple color, the green column, and then number five and then, and then the results will be right. It's not a formulaic process unfortunately or fortunately. I would say, myself included, you know, sometimes we need those kind of like clear directions, but when you have those clear directions, like a recipe... You lose your agency in it, you don't have your autonomy in it, because you're just kind of following a sequence of events. So how do you get someone to take...the framework...or the UDL principles and apply them in a very organic and meaningful way that's pertinent to the situation? That's not an easy transfer.

She highlights the difficulty here of working with teachers, of this tension between a more passive use of the guidelines versus what she terms “very organic and meaningful way that is pertinent to the situation.”

Lucy then discussed, as a “side note,” her history as both a math and a dance teacher. She described how creating dances for her class was an organic process, one that did not follow a set procedure. She then returned to UDL, describing how she saw connections between dance and UDL. The connection is “holistically...embracing this idea of engagement.” Through engaging in a design process, she saw their group engaging in the UDL frameworks, but not in a passive but an organic and responsive way. We also notice the connection that she narrated between empathy and engagement, that their engagement in the project began with empathy. Like Amara, Lucy ended with a disclaimer, “I do not know if that’s right or wrong, but that’s how it is for me at least.” Again, as with many participants, we see their uncertainty about enacting UDL “right,” or having the “right” interpretation.

One discussion in the PD Focus Group was the difference between the Design Thinking process and improvement science cycles. Bernice noted that it was Design Thinking as a flexible process that made this experience so different from her previous improvement science work in education:

I felt like with improvement science, it was a very almost kind of rigid process that you work through whereas design thinking seems more organic and it seems like there was more room to just go where your questioning was taking you.

We call attention to this quote because it relates to the question about how the professional development we offered became untethered to a rigid process, and to the UDL guidelines. Through the Design Thinking process, the participants developed problems of practice that were meaningful to them, conducted empathy interviews with participants, and then designed new solutions to these problems of practice that incorporated user perspectives. Many approaches to UDL begin with the standards, and not with empathy for users (where the design process begins). The process starts with the standards, then thinks about barriers (often in general and not specifically), and then implements the guidelines as a way to design. This is a way to make instruction more accessible, and more inclusive, but our findings suggest that a more passive approach to UDL will never be organic, flexible, and robust enough to tackle the problems of inclusion.

## Empathy as a central principle of UDL

Both focus groups brought up empathy early in their sessions and insisted on the relevance of both empathy (as a feeling or belief) and empathy interviews (as a practice) in their day-to-day work during the 2020–2021 school year. All four classroom teachers reported that empathy was the most important idea that they took from the course and that they used empathy interviews in their practice during the school year, with one teacher describing empathy interviews as “the anchor for my practice.” We note that empathy was brought up organically by one teacher, and then expounded upon by all four. As it was a focus group, we were not able to see if each participant would have brought up empathy in individual interviews on their own, without the influence of others.

All four classroom teachers reported using empathy interviews as a consistent practice during the school year, with modifications. Both secondary special education math teachers described themselves as “case managers” and both did empathy interviews with all or most of the students on their caseload. Both elementary inclusive teachers also

did a version of empathy interviews. One interviewed all her students at the beginning and then at the end of the year, over Zoom. The other elementary teacher also did empathy interviews with all of her students, as well as with each family. The focus was on developing understanding of the student’s perspective and experience learning mathematics, with the teacher positioned as the listener. While the empathy interviews began with questions about students’ experiences learning math, the teachers reported that the conversations became about their students’ lives more broadly, and that they gained invaluable perspectives about how elements of their lives affected their learning. Teachers also described these interviews as critical for building relationships.

In the focus group of classroom teachers, participants described that the course affected a shift away from deficit thinking and toward a more complex, strengths-based understanding of students. They attributed this shift to their new focus on empathy. Discussing a shift away from deficit thinking, Bella said, “I think empathy has a lot to do with that too, because once we put ourselves in the place of a child with a disability it has to change our thinking. So I think empathy is a gateway for that.” Zelda noted that the course “revealed to me some of my deficit thinking that I wasn’t aware was necessarily there.”

The members of the PD Design Team intended to design a PD experience for teachers on UDL during the pandemic. As they narrated their design process in the focus group, however, they came back again and again to the importance of their empathy interview. According to the participants, this interview changed how they understood the perspective of classroom teachers during the pandemic:

That’s when we realized many of our teachers are going above and beyond just in instruction. And we know that for the experiences that we have with teachers, but when we talked to [the interviewee], she mentioned times when she would answer phone calls at 10 o’clock at night, at 11 o’clock at night, just to make that connection with the students.

They described this interview as transformative, as they listened with attention to the emotional experience of being a teacher during this time. Multiple participants noted that this had created a shift in their work designing for teachers, as they questioned their own assumptions about what teachers “need.” One noted,

I’m always going to go back to this idea of starting with this empathy interview, and starting with [teachers] instead of thinking, ‘I know what they’re thinking and what they’re struggling with’ -- starting with asking them.

In both focus groups, there was attention to how empathy could be transformative not only in designing classroom instruction and professional development, but more broadly in creating transformative social change. One county-level leader on the PD Design Team said,

If we’re going to make any social impact, social justice change, we have to listen to the stories of the people that are in our community. And so you know, instead of relying on my general tendency to look at large sets of data, we need to listen to the voices. And so I feel like just in my personal position, I’ve been challenged to think of storytelling--creating empathy by talking to individuals, especially in my position now at the county.

UDL as a “way of thinking” also extended beyond the classroom. One discussion in the classroom teacher focus group was about grading practices during the pandemic. Zelda noted that for her, as a case manager of high school students with disabilities, she brought to the math department’s attention the high number of students with disabilities who were failing math over Zoom. She reported that the math department was “rigid” and lacked empathy. She described a feeling of “rage” toward other educators who do not seem to connect with the students.

It’s – there’s been moments of rage, I’m not gonna lie ...there’s such a lack of empathy, right? There’s such a lack of empathy with – and rigidity. Like if there’s no other time for you to like rethink your grading like – this isn’t going to do it for you? What’s gonna do it?

Empathy seems, for these educators, to link the core values of social justice with relationships, and a more relational approach to the teacher-student relationship. Participants in both groups also explicitly connected empathy and UDL to social justice movements of the moment like Black Lives Matter that were particularly important to these educators. One noted, “the empathy really is like, it’s like the center of the pandemic, for me, and also the racial justice work that has needed to happen and it’s like cracked open in this new way.”

## Discussion

Universal Design for Learning (Meyer et al., 2014) reconceptualizes learners as variable, not broken, and shifts the focus from “fixing” students to rethinking the accessibility of classrooms. However, UDL is often implemented with only a passive role for teachers and a lack of a design process (Smith et al., 2010; Dolmage, 2017). Our theory of action was that when educators merge the *principles* of Universal Design for Learning with the *process* of Design Thinking, more accessible designs for curriculum, routines, tools, and spaces will result. We hoped that PD in these areas would allow for teachers to reconceptualize both UDL and Design Thinking, away from passive implementation toward active and creative engagement.

Indeed, in our initial analysis (Lambert et al., 2021) we found shifts in participants’ conceptualization of UDL, away from a set of rigid guidelines and toward an active design process (Lambert et al., 2021). These findings were also supported by our analysis of word clouds. We wondered how educators who participated in the PD would take up these ideas during a year of pandemic teaching. This paper described findings from two focus groups of educators nine months after the PD.

Our findings indicate that the participants in the course conceptualized UDL as a “way of thinking” and contrasted it with inflexible application of the guidelines. This resonates with the critiques across UDL to move beyond “checklistification” (Dolmage, 2017) of UDL. Their understanding of UDL seemed to privilege in-the-moment classroom decision making, and also was interrelated with disrupting their own deficit thinking about students. UDL is typically discussed at the planning phase, as a core idea of UDL is planning for learner variability, rather than retrofitting for it. Yet the narratives of our participants were about their thinking *during*

teaching, such as when Zelda described her thought processes when teaching a challenging math lesson. We wonder about this focus on in-the-moment UDL.

We also found that the empathy interviews themselves were impactful in the work of the teachers after the course, as an “anchor” for practice. All four classroom teachers reported using them in their practice, despite how much work these interviews can be. They reported doing so because of the importance of understanding the student perspective and building a relationship with each student. We wonder if the practice of doing an empathy interview allowed the teachers to decenter themselves, and to center student experience. To sit down with each of one’s students and ask them about their experiences learning math appears to be such a powerful experience that all four teachers incorporated it into their work. We also note that they modified the practice to make it work in their settings. For example, there was little mention of making empathy maps, which though time-consuming and detailed, are often part of the design thinking process. Teachers also shortened the duration of the empathy interviews and made them more informal, one keeping one student back each day after their zoom math class to chat about how they were feeling about math.

There is a tremendous difference between feeling empathy for one’s students and doing empathy interviews. Empathy as a generalized emotion is important in education— as we noted, empathy was the strongest predictor of positive outcomes for students in a meta-analysis (Cornelius-White, 2007). But empathy can be constrained to what one believes the other is feeling. In the case of disability, empathy can be simply assuming that, as a teacher, one knows the “needs” of one’s students (Naraian, 2019). An empathy interview is a powerful practice because we do not guess what the other is thinking – we ask, and we carefully listen. It is a tangible practice that appears to offer intangible benefits for teaching and designing learning experiences.

We notice that in both focus groups, the same sequence for learning about UDL through empathy was presented. First, there was an empathy interview about the user/learner. Second, the empathy interview shifted the designers’ way of thinking about the user/learner. In the PD Design Team, the participants described rethinking how they understood teachers’ work during the pandemic. In the classroom focus group, teachers described shifts away from deficit thinking about their students because of the empathy interviews. Lastly, there is a description of UDL as a way of thinking, as providing access that works for the learner. It was at this point that members of both groups brought up the UDL guidelines. These were useful to think about in providing access, not as a starting point, but as a resource. The starting point of this process was the empathy interviews.

What does this suggest about models of teacher knowledge, practices, and beliefs for UDL? We see a close relationship between questioning deficit beliefs and engaging in UDL practices in the moment as a teacher. Beliefs and practices appeared to be intertwined and emergent. We also saw the participants questioning what they had been taught about UDL. Some participants both rejected the dominance of the guidelines in their previous knowledge of UDL, while at the same time being hesitant to claim a different understanding of UDL. We begin to see a theory of access-knowledge (Hamraie, 2017) for UDL emerging, where teachers learn more about what kind of access students really need by asking the students themselves.

We see echoes of the work of Nelson (2015), who proposed access, inclusion and learner variability as core beliefs of UDL. Nelson noted that providing access to all students was connected to believing that all students can learn; access comes through when we question deficit thinking. We saw teachers narrating this process in our focus groups, such as when Zelda thought of UDL as a “check” to make sure she held high expectations of her students. We hope in future research to explore how UDL in combination with Design Thinking might shift teacher beliefs on inclusion and learner variability.

We acknowledge that our study was designed to be exploratory, to help us create theory through careful analysis of the experiences of a few educators. This is the goal of design research in teacher education (Horn and Garner, 2022): to create new theory based on close study of teacher change. We hope that we have created new understandings of teacher knowledge of UDL, particularly how the combination of Design Thinking and UDL can create shifts in teacher beliefs and knowledge of UDL that, in turn, affect teacher practice.

Our research was a design research study, and we intentionally sought out participants who were highly experienced. We wonder how our findings might have been different with less experienced participants.

These complex understandings, and interconnections between beliefs, knowledge, and practices, emerged in part because we designed the course for experienced educators. The iterative nature of our research design was vital - we learned so much from the focus groups because they occurred *after* participants had spent time away from the course and after we had already engaged in data analysis. These kinds of design methodologies are necessary as we begin to develop understanding of what UDL can be, and its radical potential.

We end where we began, with the radical potential of UDL. Perhaps our work to understand how teachers understand UDL comes before there is a clear understanding of UDL in the field, yet perhaps it is educators who will define (and continually redefine) the beliefs, practices, and knowledge of UDL.

## Data availability statement

The datasets presented in this article are not readily available because Full copies of interview answers or video artifacts would identify participants. Requests to access the datasets should be directed to [rlambert@ucsb.edu](mailto:rlambert@ucsb.edu).

## References

- Basham, J. D., Smith, S. J., and Satter, A. L. (2016). Universal design for learning: scanning for alignment in K-12 blended and fully online learning materials. *J. Spec. Educ. Technol.* 31, 147–155. doi: 10.1177/0162643416660836
- Basham, G., Gardner, J. E., and Smith, S. J. (2020). Measuring the implementation of UDL in classrooms and schools: initial field test results. *Remedial Spec. Educ.* 41, 231–243. doi: 10.1177/0741932520908015
- Buchanan, R. (1992). Wicked problems in design thinking. *Des. Issues* 8, 5–21. doi: 10.2307/1511637
- Brown, T. (2008). Design thinking. *Harv. Bus. Rev.* 86, 84–92, 141. Available at: [https://www.researchgate.net/publication/5248069\\_Design\\_Thinking](https://www.researchgate.net/publication/5248069_Design_Thinking).
- Capp, M. J. (2020). Teacher confidence to implement the principles, guidelines, and checkpoints of universal design for learning. *Int. J. Incl. Educ.* 24, 706–720. doi: 10.1080/13603116.2018.1482014
- Carlgrén, I. (1999). Professionalism and teachers as designers. *J. Curric. Stud.* 31, 43–56. doi: 10.1080/002202799183287
- CAST (2018). Universal Design for Learning Guidelines version 2.2. Available at: <http://udlguidelines.cast.org> (Accessed January 10, 2023).
- City, E. A., Elmore, R. F., Fiarman, S. E., and Teitel, L. (2009). Instructional rounds in education: A network approach to improving teaching and learning. Harvard Education Press.

## Ethics statement

This study involved human participants and was reviewed and approved by University of California, Santa Barbara Institutional Review Board. All participants provided their written informed consent to participate in this study.

## Author contributions

RL and KI contributed to conception and design of the study. RL and KI facilitated the course being studied. RL led data collection and analysis. RL, KI, RS and AM contributed to data analysis. RL wrote the first draft of the manuscript. AM, RS, and KI wrote sections of the manuscript. SZ contributed to data analysis at the final stages. All authors contributed to the article and approved the submitted version.

## Funding

This study was funded by the California Partnership for Math and Science Education.

## Acknowledgments

We acknowledge all the educators who participated in our professional development courses.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.



- Cobb, P., Confrey, J., DiSessa, A., Lehrer, R., and Schauble, L. (2003). Design experiments in educational research. *Educ. Res.* 32, 9–13. doi: 10.3102/0013189X032001009
- Corbin, J. M., and Strauss, A. (1990). Grounded theory research: procedures, canons, and evaluative criteria. *Qual. Sociol.* 13, 3–21. doi: 10.1007/BF00988593
- Cornelius-White, J. (2007). Learner-centered teacher-student relationships are effective: a meta-analysis. *Rev. Educ. Res.* 77, 113–143. doi: 10.3102/003465430298563
- Courey, S. J., Tappe, P., Siker, J., and LePage, P. (2013). Improved lesson planning with universal Design for Learning (UDL). *Teach. Educ. Spec. Educ.* 36, 7–27. doi: 10.1177/0888406412446178
- Craig, S. L., Smith, S. J., and Frey, B. B. (2022). Professional development with universal design for learning: supporting teachers as learners to increase the implementation of UDL. *Prof. Dev. Educ.* 48, 22–37. doi: 10.1080/19415257.2019.1685563
- DeCuir-Gunby, J. T., Marshall, P. L., and McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: an example from a professional development research project. *Field Methods* 23, 136–155. doi: 10.1177/1525822X10388468
- Dolmage, J. T. (2017). *Academic ableism: Disability and higher education*. University of Michigan Press. Michigan
- Edyburn, D. L. (2010). Would you recognize universal design for learning if you saw it? Ten propositions for new directions for the second decade of UDL. *Learn. Disabil. Q.* 33, 33–41. doi: 10.1177/073194871003300103
- Friesen, S. (2016). “Assessment for learning in a math classroom” in *Leadership of assessment, inclusion, and learning*. eds. S. Scott, D. E. Scott and C. F. Webber (United States: Springer International Publishing), 141–170.
- Gutiérrez, R. (2013). Why (urban) mathematics teachers need political knowledge. *J. Urban Math. Educ.* 6, 7–19. doi: 10.21423/jume-v6i2a223
- Griful-Freixenet, J., Struyven, K., and Vantieghem, W. (2021). Toward more inclusive education: an empirical test of the universal design for learning conceptual model among preservice teachers. *J. Teach. Educ.* 72, 381–395. doi: 10.1177/0022487120965525
- Hamraie, A. (2017). *Building access*. University of Minnesota Press. Minnesota
- Hendren, S. (2020). *What can a body do?: How we meet the built world*. Penguin. Australia
- Henriksen, D., Gretter, S., and Richardson, C. (2020). Design thinking and the practicing teacher: addressing problems of practice in teacher education. *Teach. Educ.* 31, 209–229. doi: 10.1080/10476210.2018.1531841
- Hill, H. C., Rowan, B., and Ball, D. L. (2005). Effects of teachers’ mathematical knowledge for teaching on student achievement. *Am. Educ. Res. J.* 42, 371–406. doi: 10.3102/00028312042002371
- Hill, H. C., Ball, D. L., and Schilling, S. G. (2008). Unpacking pedagogical content knowledge: conceptualizing and measuring teachers’ topic-specific knowledge of students. *J. Res. Math. Educ.* 39, 372–400. doi: 10.5951/jresmetheduc.39.4.0372
- Holland, D., Lachiotte, W., Skinner, D., and Cain, C. (1998). *Identity and agency in cultural worlds*. Harvard University Press. United States
- Horn, I., and Garner, B. (2022). *Teacher learning of ambitious and equitable mathematics instruction: A sociocultural approach*. Routledge, Singapore.
- Indar, G. K. (2018). *An equity-based evolution of universal design for learning: Participatory design for intentional inclusivity*. Proceedings of UDL-IRM International Summit 2018. Available at: [https://udl-irn.org/wp-content/uploads/2018/04/Done\\_INDAR.EDIT\\_DH\\_JEG-copy.pdf](https://udl-irn.org/wp-content/uploads/2018/04/Done_INDAR.EDIT_DH_JEG-copy.pdf)
- Kirschner, P. A. (2015). Do we need teachers as designers of technology enhanced learning? *Instr. Sci.* 43, 309–322. doi: 10.1007/s11251-015-9346-9
- Kurtts, S. A., Matthews, C. E., and Smallwood, T. (2009). (dis) solving the differences: a physical science lesson using universal design. *Interv. Sch. Clin.* 44, 151–159. doi: 10.1177/1053451208326051
- Lambert, R. (2021). The magic is in the margins; Universal Design for Learning Math (UDL Math). *Mathematics Teacher: Learning and Teaching Pre-K–12*. 114. doi: 10.5951/MTLT.2020.0282
- Lambert, R., Imm, K., Schuck, R., Choi, S., and McNiff, A. (2021). “UDL Is the What, Design Thinking Is the How:” Designing for Differentiation in Mathematics”. *Mathematics Teacher Education and Development*, 23, 54–77. Available at: <https://eric.ed.gov/?id=EJ1321118>
- Lambert, R., Greene, Q.\*, and Lai, V.\* (2022a). “#DeleteDeficitThinking: Strategies to name and challenge deficit thinking in Universal Design for Learning.” in *Handbook of Research on Challenging Deficit Thinking for Exceptional Education Improvement*. (ed.). R. D. Williams IGI Global. Available at: <https://www.igi-global.com/book/handbook-research-challenging-deficit-thinking/www.igi-global.com/book/handbook-research-challenging-deficit-thinking/273907>.
- Lambert, R., Imm, K., Choi, S., Schuck, R., and McNiff, A. (2022b). “Empathy Is the Anchor”; Universal Design for Learning as Design Thinking. *Roundtable presentation at American Educational Research Association*, San Diego, CA.
- Lanterman, C. S., and Applequist, K. (2018). Pre-service teachers’ beliefs: impact of training in universal design for learning. *Exceptionality Educ. Int.* 28:7774. doi: 10.5206/eei.v28i3.7774
- LaRon, A. S. (2018). Barriers with implementing a universal Design for Learning framework. *Inc* 6, 274–286. doi: 10.1352/2326-6988-6.4.274
- Lee, A., and Griffin, C. C. (2021). Exploring online learning modules for teaching universal design for learning (UDL): preservice teachers’ lesson plan development and implementation. *J. Educ. Teach.* 47, 411–425. doi: 10.1080/02607476.2021.1884494
- Lowrey, K. A., Hollingshead, A., Howery, K., and Bishop, J. B. (2017). More than one way: stories of UDL and inclusive classrooms. *Res. Practice Persons Severe Disabilities* 42, 225–242. doi: 10.1177/1540796917711668
- Meyer, A., Rose, D. H., and Gordon, D. T. (2014). *Universal design for learning: Theory and practice*. CAST Professional Publishing. United States
- Miles, M. B., Huberman, A. M., and Saldaña, J. (2013). *Qualitative data analysis: A methods sourcebook (3rd)*. SAGE Publications, Inc. California
- Moore, E. J. (2017). *UDL in 3D! Proceedings of UDL-IRM summit, 2018*. <https://udl-irn.org/2018-summit-proceedings/>
- Naraian, S. (2019). Precarious, debilitated and ordinary: rethinking (in)capacity for inclusion. *Curric. Inq.* 49, 464–484. doi: 10.1080/03626784.2019.1659100
- Nelson, L. L. (2015). UDL: more than a framework. In Proceedings from the 2nd annual UDL-IRM Summit. Available at: <https://jas3703.files.wordpress.com/2015/12/fc411-proceedings15.pdf>.
- Oliver, M. (2009). “The social model in context” in *Rethinking normalcy: A disability studies reader*. eds. T. Titchkosky and R. Michalko (Canada: Canadian Scholars Press), 19–30.
- Ostrowdun, C. P. (2020). Representations of inclusion: how pre-service teachers understand and apply inclusion across situations. *Exceptionality Educ. Int.* 30, 102–123. doi: 10.5206/eei.v30i3.13509
- Owen, Ch. L. (2005) Design thinking. What it is. Why it is different. Where it has new value. [conference keynote speech]. International Conference on Design Research and Education for Future, Gwangju, Republic of Korea.
- Owiny, R. L., Hollingshead, A., Barrio, B., and Stoneman, K. (2019). Engaging preservice teachers in universal Design for Learning lesson planning. *Inc* 7, 12–23. doi: 10.1352/2326-6988-7.1.12
- Polly, D., McGee, J. R., Wang, C., Lambert, R. G., Pugalee, D. K., and Johnson, S. (2013). The association between teachers’ beliefs, enacted practices, and student learning in mathematics. *Math. Educ.* 22, 11–30.
- Ralabate, P. K. (2016). *Your UDL lesson planner: The step-by-step guide for teaching all learners*. Brookes Publishing. Maryland
- Rao, K., and Meo, G. (2016). Using universal Design for Learning to design standards-based lessons. *SAGE Open* 6:215824401668068. doi: 10.1177/2158244016680688
- Retna, K. S. (2016). Thinking about “design thinking”: a study of teacher experiences. *Asia Pacific Journal of Education* 36, 5–19. doi: 10.1080/02188791.2015.1005049
- Rogoff, B. (2003). *The cultural nature of human development*. Oxford University Press, United States.
- Rowe, P. G. (1987). *Design thinking*. MIT Press. Massachusetts
- Skott, J. (2015). “Towards a participatory approach to ‘beliefs’ in mathematics education” in *From beliefs to dynamic affect systems in mathematics education: Exploring a mosaic of relationships and interactions*. eds. B. Pepin and B. Roesken-Winter (United States: Springer International Publishing), 3–23.
- Smith, S. J., Rao, K., Lowrey, K. A., Gardner, J. E., Moore, E., Coy, K., et al. (2019). Recommendations for a national research agenda in UDL: outcomes from the UDL-IRM pre conference on research. *J. Disability Policy Stud.* 30, 174–185. doi: 10.1177/1044207319826219
- Spooner, F., Baker, J. N., Harris, A. A., Ahlgrim-Delzell, L., and Browder, D. M. (2007). Effects of training in universal design for learning on lesson plan development. *Remedial Spec. Educ.* 28, 108–116. doi: 10.1177/07419325070280020101
- Titchkosky, T. (2011). *The question of access: Disability, space, meaning*. University of Toronto Press. Canada
- Waitoller, F. R., and King Thorius, K. A. (2016). Cross-pollinating culturally sustaining pedagogy and universal design for learning: toward an inclusive pedagogy that accounts for disability. *Harv. Educ. Rev.* 86, 366–389. doi: 10.17763/1943-5045-86.3.366
- Waloszek, G. (2012). Introduction to design thinking. Available at: [http://www.sapdesignguild.org/community/design/design\\_thinking.asp](http://www.sapdesignguild.org/community/design/design_thinking.asp)
- Wenger, E. (1999). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press. England
- Wink, M. N., LaRusso, M. D., and Smith, R. L. (2021). Teacher empathy and students with problem behaviors: examining teachers’ perceptions, responses, relationships, and burnout. *Psychol. Sch.* 58, 1575–1596. doi: 10.1002/pits.22516

## Appendix A

### Focus group questions

#### PD design team questions

- What is the story of your team? Tell us about your process, the highs, the lows.
- Do you see ways in which your final project connects to empathy for teachers?
- What was the role of empathy in your work throughout?
- Were there any tensions in your design work?
- In multiple groups, we noticed a difference between designing and curating resources/implementing. Do you agree? What is the difference?
- Your team met consistently past the actual course. Why did you keep meeting (after the course was over)? What did you each see at the purpose of those meetings?
- What have you taken away from the course, if anything? How has that mattered in your work this fall and winter? (probe for specific instances)
- Do you feel you have been using UDL and/or Design Thinking in your work this year?
- Did you face resistance enacting your learning from this class? What barriers got in your way?
- [Show word clouds] What do you notice and wonder about these images? Why this shift?
- Which ideas about disability shifted for you?

#### Classroom teacher questions

- How is it going this year?
- What was the format of your teaching this year? (e.g., remote vs. in person, students with disabilities, etc.)
- What have you taken away from the course, if anything? How has that mattered in your work this fall and winter?
- Do you feel you have been using UDL in your work this year?
- How did you make those changes in your class? What process did you follow?
- Can you tell us about a particular student that you think was affected by your work in UDL and Design Thinking?
- What is the role of empathy in this work?
- Did you face resistance enacting your learning from this class? What barriers got in your way?
- Can you identify shifts in your understanding UDL? If so what?
- [Show course outcome data & word clouds] What are your thoughts about that?
- Has there been any shifts in how you design in your work? If so, how?
- What do you see as the relationship between UDL and Design Thinking? How has this shifted, if at all?