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Advancing a theory of change in a collaborative teacher education program innovation through universal design for learning

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\begin{abstract}
This design-based research (DBR) investigates the redesign of a 13-month interdisciplinary teacher preparation program to co-prepare secondary and special education teacher candidates to plan and implement evidence-based practices to meet content and literacy needs of all learners within secondary classrooms. The Theory of Change explores mechanisms for change under the umbrella of Universal Design for Learning (UDL). The UDL framework can support teacher candidates in meeting the needs of students with exceptionalities in the general education classroom, yet few studies have explored the in-depth application of UDL in authentic settings across preparation program duration. DBR methods organize study design, iterative data collection, and retrospective analysis of artifacts including candidates’ edTPA portfolios and action research papers. Findings revealed strengths and challenges in candidates’ (n = 14) application of components. Results for specific components and various disciplines are discussed. Implications for collaborative preparation of general and special education candidates are identified.
\end{abstract}

\section{Introduction}
Over a decade ago, led by NCATE’s Blue Ribbon Panel on Clinical Preparation (2010), teacher educators were given an opportunity to transform preparation programs by answering the call to be more responsive to PK-12 school reform initiatives. While there is some disagreement in how well that call was answered (Robinson & Cote, 2016), now stands another transformational moment for teacher preparation. In the midst of the COVID-19 pandemic, students with exceptionalities are vulnerable to falling further behind their peers as they are educated in online or hybrid general education settings without supports (AIR, 2020). Effective collaborative teacher preparation programs designed to support both special and general educators in meeting needs of students with exceptionalities are in even higher demand. While there will be a return to physical school buildings, there is no going back to the old paradigm, releasing teacher candidates into the profession unequipped to meet these demands and bridge the learning and access gap for our students who struggle the most.

In this paper, we articulate a Theory of Change (see Fig. 1) illustrating components of a redesign of an existing teacher preparation program using a collaborative model to co-prepare special and secondary educators to meet the needs of all learners in the general education classroom. By clarifying components of this design-based research project and articulating a Theory of Change that begins to explore the mechanisms for change using Universal Design for Learning (UDL) as a unifying vision, we seek to clarify how beginning special and secondary educators can be co-prepared to build “collective expertise” to better meet the needs of students with exceptionalities in the general education classroom (Brownell et al., 2011).

\section{Purpose of the study}
The purpose of our research was to investigate the redesign of an existing teacher preparation program as an innovative effort to co-prepare secondary and special education teacher candidates to plan and implement evidence-based instructional practices to meet content and literacy needs of all learners within secondary classrooms. The goal of the redesign was for candidates to develop knowledge, skills, and dispositions for UDL implementation as the cornerstone of effective inclusive teaching. At the national level, UDL is cited as the means by which all students, including struggling learners and students with disabilities, will successfully access the Common Core State Standards.

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NGA & CCSO, 2010) and meet other general education outcomes. The Every Student Succeeds Act (ESSA, 2015) specifically names UDL seven times regarding assessment, literacy instruction, and technology to support the learning of all students (CAST, 2018). Furthermore, the National Education Technology Plan (NETP; Office of Ed Tech, 2016) endorses UDL principles in the development of accessible digital learning environments. UDL’s strong evidence-base and focus on proactive, flexible curricular design to ensure struggling learners and students with disabilities can gain access to general education made it a well-suited pedagogical design goal for the revision of our 13-month Master of Arts in Teaching (MAT) preparation program at a regional university in the northeast.

2.1. The redesign

Guided by technical assistance from the CEEDAR Center at the University of Florida (CEEDAR, 2020), we redesigned our existing MAT program to provide greater efficacy and efficiency in teacher preparation by ensuring graduates are ready to meet needs of diverse learners. We added co-preparation of special education candidates alongside all secondary content areas with emphasis on preparing teacher candidates to use data, content knowledge, and evidence-based pedagogical knowledge to design and deliver instructional and assessment strategies to facilitate significant learning for all students, including struggling learners and those with exceptionalities. Redesign included competencies in disciplinary literacy and academic language, ensuring candidates are prepared to meet secondary students’ literacy and language demands specific to their discipline. UDL was the framework used to foster collaboration and scaffolding of language and literacy in the disciplines.

Our program is unique in its co-preparation of candidates because special education content and competencies are infused across core program courses. General and special education candidates have myriad opportunities to collaborate on projects connected to their clinical placements including lesson plans, action research projects, and video analyses—moving beyond the typical one course in special education model that many general education teacher candidates receive (McCray & McHatton, 2011). Few preparation programs offer coursework related to general and special education teacher candidates collaborating to differentiate instruction for students with exceptionalities (Allday et al., 2013; Wu, 2012). Fewer studies have been published exploring UDL as a solution to improving teacher preparation for students with exceptionalities in general education. The UDL framework embedded in our MAT redesign deliberately included experiences that many general educators reported they lack in their preparation programs: extensive opportunities for communication with special educators, professional learning about students with disabilities, and increased planning time to meet the needs of students with disabilities (Grskovic & Trzinka, 2011; LeDoux et al., 2012; McCray & McHatton, 2011; Owiny et al., 2019; Shippen et al., 2005). We also reframed a deficit view of disability, focusing rather on diversity of strengths and needs across all learners with exceptionalities.

3. Theoretical perspectives

Fig. 1 depicts the project’s Theory of Change which organizes all research components and illustrates hypothesized mechanisms by which redesigned program components (e.g., course work, field experiences, and performance assessments) align to the UDL framework as a foundation for effective inclusive teaching. By clarifying the relationship among these elements, we begin to explore the essential ingredients in an effective collaborative teacher education program and provide the groundwork for further exploration of the efficacy of such programs (Brownell et al., 2011). The sections below describe core inputs for the Theory of Change and theoretical underpinnings for how inputs would yield effective co-preparation.

3.1. Universal design for learning (UDL)

UDL was the unifying innovation in the Theory of Change to address teacher candidates’ knowledge, skills, and dispositions as the driver of change (Rock et al., 2016) because UDL can help preservice teachers plan proactively for diverse learners (Spooner et al., 2007). As an umbrella framework, UDL addresses each of the factors Rock and colleagues (2016) articulate as critical drivers of change in 21st century teacher preparation: the need to (a) create digitally literate classrooms, (b) foster
cultural sensitivity for increasing student diversity, (c) implement evidence-based practices, (d) uphold higher preparation standards for collective impact, and (e) collaborate to improve practice and reach all students. UDL is a scientifically-valid framework with specific guidelines to foster a paradigm shift toward creating dynamic classrooms where diversity and exceptionality are the norm, fostering both academic as well as social inclusion, equity, and access (Hymel & Katz, 2019). UDL is grounded in the science of learner variability and exceptionality instead of disability as deficit (Ok et al., 2017). With UDL, teachers increase flexibility in the ways (a) information is presented, (b) students respond or demonstrate knowledge and skills, and (c) students are engaged. It also facilitates teachers’ ability to proactively reduce barriers in instruction, provide appropriate accommodations, supports, and challenges, and maintain high achievement expectations for all students, including students with exceptionalities (Higher Education Opportunity Act, 2008).

The Center for Applied Special Technology (CAST, 2018) provides the UDL Guidelines as an implementation tool for actualizing UDL (see Fig. 2), specifying evidence-based teaching practices organized around three broad principles of universal design recommending multiple means of engagement, representation, and action and expression. Nine guidelines, corresponding to areas of learner variability and potential barriers to learning, are further delineated across three UDL principles into 31 checkpoints that organize and embed evidence-based practices throughout the framework (Israel et al., 2014).

Although UDL is grounded in learning science, the examination of its introduction in teacher preparation is critical to ensure thorough and accurate implementation of this complex framework in classroom settings. Teacher candidates can be easily overwhelmed by the breadth of instructional choices inherent in the UDL Guidelines. Effective application of UDL requires teacher candidates to possess strong content knowledge, planning skills, and a broad understanding of learner variability. Takemae and colleagues (2018) identified critical components pertaining to teacher candidate learning of UDL: (a) train both general and special education teachers in UDL principles to develop curriculum, unit, and lesson plans; (b) provide ample practice opportunities for planning and implementation of UDL principles; and (c) assess candidates’ understanding of UDL principles and their application in classroom settings. Additional research on UDL effectiveness at the preservice level is needed, specifically in the areas of lesson design and implementation (Basham & Marino, 2013; Spooner et al., 2007).

3.2. Essential elements of the redesign

3.2.1. Collaboration: intersection of general and special education

Collaboration is depicted on the Theory of Change as a core driver of change. Given that 95% of students with disabilities are enrolled in the general education classroom for at least half their day, and most students with disabilities (81%) are educated in general education classrooms for most of the school day (NCES, 2016), collaboration among special and secondary educators is essential. As it is difficult to find general education classrooms with UDL implemented systematically (Basham et al., 2010; Lowrey et al., 2017; Owiny et al., 2019; Ralabate, 2011), we chose to implement the following elements of collaboration to co-prepare special and secondary candidates to enact UDL. First, we provided collaborative opportunities along the continuum of program courses to provide candidates ample and varied practice that will translate to the classroom (Courey et al., 2013). For example, special and secondary candidates worked together to plan, implement, and reflect on UDL lessons in secondary classrooms extending the recommendations from Spooner and colleagues (2007). Candidates also collaboratively reflected on implemented UDL lessons in their field placement through a video analysis assignment, as recommended in Courey et al. (2013).

Our collaborative MAT program is unique in that it brings together
eight departments and three schools across campus to co-prepare secondary and special education candidates. Faculty needed to learn about UDL as a proactive approach to addressing learner exceptionality in the secondary classroom. With the support of the CEEAR grant and administrators at our university, MAT faculty collectively engaged in professional learning experiences about UDL (e.g., outside experts coming in to consult, book groups, UDL workshops) while redesigning the program. These collaborative efforts helped us to proactively integrate UDL into course work and field experiences across each of the program disciplines.

3.2.2. Practice-based preparation: gradual release of responsibility across the program

Another driver of change in our program redesign was the deliberate model of practice-based preparation and gradual release of responsibility across the program. This approach provided the mechanism for deep learning and transfer to classroom practice (Juarez & Purper, 2018). Practice-based learning opportunities are carefully crafted to integrate course content and pedagogy, providing candidates with increasingly complex opportunities to integrate skills and knowledge from their preparation into their teaching (Ericsson, 2014). Our redesign adhered to the three overarching ideas put forth to teacher educators designing practice-based opportunities by Benedict and colleagues (2016): focus, duration and coherence.

3.2.3. Transdisciplinary: infusion of disciplinary literacy and academic language

Learning is driven by the ability to access the academic language of a discipline, and UDL provides specific supports to enable teachers to guide students in language acquisition and expression (Lopes-Murphy, 2012). Students need to be able to use academic language to access, remember, and communicate understanding and to develop disciplinary literacy (First Author, 2019). To that end, many secondary students require explicit instruction to recognize language patterns that are discipline-specific and how those patterns differ from other informal language they use in their everyday lives (Fisher & Frey, 2011). In the MAT redesign, we added a program outcome in which teacher candidates design, deliver, and assess literacy and language strategies to deepen literacy content learning for students within their discipline. We then revised a course to focus candidates’ understanding of disciplinary literacy and how to teach it, while also building awareness of literacy across disciplines. In addition, we added a third discipline-specific methods course addressing language and the ways of knowing and doing within the disciplines. A key driver of change in our program redesign was that candidates understood how literacy helps students unlock content learning in discipline-specific and transdisciplinary ways.

We wanted candidates to deeply understand how to embed literacy supports within their instruction to not only provide access to content learning for struggling learners, but also to enable learners to critically engage with literacy in ways that promote deep learning within the content (e.g., synthesis, analysis, research, knowledge building). This is often a struggle to do well, mainly because the field has yet to develop “clear understandings about how novice teachers are best prepared to provide adolescents with rich, meaningful literacy learning opportunities that advance goals of equity and access” (Kavanagh & Rainey, 2017, p. 905). The practice-based approach we described in the previous section helped us to actualize this goal.

3.2.4. Inclusive and culturally sustaining learning environments

As another driver of change in the program redesign, we emphasized the overlap of UDL and culturally sustaining pedagogy to create inclusive environments (Kieran & Anderson, 2019). The goal of meaningful inclusion is for students with exceptionalities to spend the majority of their learning time supported in general education setting with pull-out services minimized (LeDoux et al., 2012; Owiny et al., 2019). To actualize this, general and special educators must collaborate to scaffold and make learning accessible to diverse learners. If implemented appropriately in terms of both philosophy and teacher action, UDL serves as a culturally sustaining pedagogy focused on emphasizing learners’ cultural, linguistic, and academic diversity as an asset in the classroom (Waitoller & Thorius, 2016). Both UDL and culturally sustaining pedagogies emphasize cultural and linguistic pluralism, issues of social justice, and cultural and social change as fundamental to learning goals in an inclusive classroom setting (Edbyrn, 2010; Moore & Neal, 2007; Kieran & Anderson, 2019; Waitoller & Thorius, 2016). We saw the UDL guidelines as a powerful framework to prepare candidates to proactively plan and implement culturally sustaining pedagogy that minimized threats and distractions (Steele, 2016; Tatum, 1997), optimized relevance, value, and authenticity (Ginsberg, 2005; Howard & Navarro, 2016), and fostered collaboration and community (Dorrin, 2015; Piazza et al., 2015). We ascribed to this overlap of UDL and culturally sustaining pedagogy in the MAT program redesign.

Practically speaking, this “cross pollination” of UDL and culturally sustaining pedagogy as Waitoller & Thorius, 2016 refer to it, was articulated first as one of six program outcomes, and then infused across program courses. UDL philosophy states that disability is merely a function of the interaction between a learners’ strengths and challenges and the learning environment (Lanterman & Applequist, 2018). In response, the ‘classroom management’ course that all candidates take was redesigned to focus on developing accessible learning environments. Inclusive and culturally sustaining UDL approaches were also built in across other program courses, assignments, and assessments and were measured by lesson and unit plan rubrics, field experience and student teaching evaluations, and exit portfolio requirements.

3.2.5. Integration of UDL lesson planning template

Another key driver of change was implementation of UDL using a UDL-centered lesson planning template across all program courses, assignments, and assessments. Reframing the lesson planning template to emphasize UDL (See Appendix A) helped us to teach candidates to plan proactively to meet the needs of struggling learners and those with exceptionalities, versus retrofitting lessons with accommodations and modifications (as in Courey et al., 2013; Theoharis & Causton-Theoharis, 2011). Our goal was for teacher candidates to use the UDL lesson planning template in a way that facilitated UDL habits of mind, organized all components of instruction, fostered communication between co-teachers and collaborators, and deepened meaningful reflection focused on student learning (as in Dymond et al., 2006). Following the recommendations in Dymond and colleagues (2006), we used the UDL lesson planning template as a starting and focal point for full program redesign; it allowed us to maintain a realistic time frame and scope for change, to involve all stakeholders in the redesign process, to use lesson plans to develop and communicate the UDL innovation, and to ensure appropriate supports were available. Of particular importance, most of these plans were implemented in the field with support from a cooperating teacher, addressing a limitation identified across similar studies (Courey et al., 2013; McGhee-Richmond & Sung, 2013).

4. Methodology

Evaluating the effectiveness of teacher preparation reform is arguably one of the “wicked questions” facing teacher preparation (Liguon-garis-Kraft et al., 2014). Design-based research (DBR) methodologies are suitable for addressing complex problems such as effective inclusive collaborative teacher education (Bakker & van Eerde, 2015). The pedagogical goal for this innovation was for teacher candidates to develop knowledge, skills, and dispositions for UDL implementation as the cornerstone of effective inclusive teaching, and we used the redesign of our MAT program as the intervention that would foster this goal. This study was approved by our university Institutional Review Board (IRB).
as part of a larger CEE DAR Center summative evaluation to assess the impact of CEE DAR’s reform efforts on the classroom practice of general and special education teachers. Researchers are increasingly using DBR within alpha stages of research to fine tune interventions before they are utilized in more rigorous experimental studies (Gersten et al., 2000). Design experiments address the need to empirically validate promising instructional practices by investigating the ecological validity of emerging interventions within authentic educational settings to determine efficacy and feasibility (Cobb et al., 2003). The most critical components of the design include (a) a research plan based on theoretical support for learning process and logistics (see Theory of Change, Fig. 1), (b) an iterative nature involving a cyclic, or formative feedback loop of rigorous data collection that is continually analyzed to confirm findings via triangulation and to inform intervention development, and (c) work in close partnership with practitioners (Cobb et al., 2003). We wished to extend the literature base by examining UDL implementation of our candidates, as other studies demonstrated that UDL in general improved candidates’ abilities to meet the needs of students with exceptionalities (Courey et al., 2013; Dymond et al., 2006; Frey et al., 2012; Theoharis & Causton-Theoharis, 2011). Our research question was: How does the redesign of a collaborative teacher preparation program around a UDL framework influence candidates’ ability to plan and implement evidence-based instructional practices to meet the content and literacy needs of all learners?

Because we were looking for descriptions of how candidates met this charge, we iteratively collected and analyzed several sources of qualitative data to inform modification of the intervention, as is consistent with DBR (Reinking & Bradley, 2008). As DBR has the “potential to bridge the gap between educational practice and theory” (Bakker & van Eerde, 2015, p. 2), our goal was to develop and assess a Theory of Change that (a) clarifies the mechanisms by which a UDL framework can be effectively used in collaborative teacher education reform, (b) accomplishes intended goals and improves valuable outcomes, and (c) is applicable in authentic school-based settings (Reinking & Yaden, 2020).

### 4.1. Setting and participants

Our institution is a regional, comprehensive public university dedicated to learning in the liberal arts and sciences, and to education for the professions. The MAT program within which we conducted this study is a selective graduate-level certification program. The 13-month format provides an accelerated route into shortage area classrooms while meeting all state and national accreditation standards. Participants consisted of 14 teacher candidates in the areas of secondary English (n = 4), math (n = 2), science (n = 6), and Spanish (n = 2), placed in eight schools (see Table 1) for the year-long internship and student teaching experience. District enrollments for these schools ranged from 1947 students to 20,983 with students in grades Pre-Kindergarten through grade 12. Our decision to not include special education teacher candidates as participants in this study was deliberate. Although the co-preparation of general and special education teacher candidates was central to this program redesign, our research focused on secondary teacher candidates’ ability to plan and implement evidence-based instructional practices to meet the content and literacy needs of struggling learners within secondary general education content classrooms.

### 4.2. Data sources

Data sources included candidates’ artifacts collected from their edTPA portfolio and an action research project as these tasks reflected an ability to plan evidence-based instructional practices to meet the content and literacy needs of struggling learners. Candidates’ implemented these plans within authentic secondary content classrooms, which is unique in the literature (Courey et al., 2013; Dymond et al., 2006; Frey et al., 2012; Theoharis & Causton-Theoharis, 2011). edTPA (n.d.) is “a performance-based, subject-specific, assessment … to emphasize, measure and support the skills and knowledge that all teachers need from Day One in the classroom.” The edTPA portfolio is comprised of a planned unit of instruction, a video of the candidate teaching, and three reflective commentaries: Planning, Instruction, and Assessment. Our candidates planned, implemented, and submitted their edTPA in the spring semester of their program during their student teaching placement. The action research project requires candidates reflect on their fall semester internship experience and design a research proposal supported by professional literature, then implement the study in their student teaching placement. We analyzed candidates’ edTPA Task 1 Learning Segment, edTPA Task 1 Planning Commentary, Task 2 Instruction Commentary, and the Results and Discussion chapters of candidates’ action research project to determine the nature of UDL implementation and extent to which candidates planned and implemented supports for struggling learners within inclusive classroom settings.

### 4.3. Retrospective data analysis

In addition to iterative refinements to the redesign implementation, a retrospective analysis was conducted after the full year of implementation. In DBR, a retrospective analysis is conducted after all data has been collected as a holistic review (Gravemeijer & Cobb, 2006). Candidates’ artifacts were uploaded to Dedoose qualitative analysis software (Dedoose, 2014) and UDL planning and implementation was determined by the inclusion of 31 UDL checkpoints, which were added manually as codes within Dedoose. We chose to focus on the 31 UDL checkpoints because previous studies examined UDL integration in teacher prep programs in a binary sense, and we wished to further develop the Theory of Change to determine how candidates learned to plan and implement instruction for all learners within secondary classrooms. Initially, we concurrently coded sample artifacts and discussed examples of each of the 31 UDL checkpoints. We engaged in extensive discussion and various analyses before deciding to code each artifact by paragraph, with the understanding that any given paragraph could have multiple codes associated with it. If a paragraph went onto the next page, we agreed to code each as a separate paragraph. To guide our coding, we developed an extensive codebook utilizing the UDL Guidelines and Checkpoints (CAST, 2018).

We then individually coded each candidate’s artifacts. We trained until we reached 100% agreement prior to completing the coding. We disaggregated the data by discipline and rank-ordered and identified the five checkpoints with the highest frequency counts. The low frequency count checkpoints were identified by taking 10% of the highest frequency count for each discipline. For example, the highest frequency count for English was 105. Every component that had a frequency of 10.5 or fewer (10% of 105) was identified as low. There was no limitation placed on the number of checkpoints that were labeled as low. We then combined all the data into Fig. 3 to compare high and low

<table>
<thead>
<tr>
<th>School</th>
<th>Grade</th>
<th>Enrollment</th>
<th>% English Learners (ELL)</th>
<th>% Eligible for Free &amp; Reduced Price Lunch</th>
<th>% Individualized Education Program (IEP)</th>
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</thead>
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<tr>
<td>1</td>
<td>6-8</td>
<td>732</td>
<td>5.6</td>
<td>63.1</td>
<td>9.6</td>
</tr>
<tr>
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<td>9-12</td>
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<td>17.1</td>
<td>11.9</td>
</tr>
<tr>
<td>3</td>
<td>PK-12</td>
<td>574</td>
<td>4.5</td>
<td>53.1</td>
<td>11.3</td>
</tr>
<tr>
<td>4</td>
<td>6-12</td>
<td>733</td>
<td>3.1</td>
<td>45.3</td>
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<td>9-12</td>
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</tr>
<tr>
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<td>9-12</td>
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</tr>
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<td>7</td>
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<td>64.4</td>
<td>12.1</td>
</tr>
<tr>
<td>8</td>
<td>9-12</td>
<td>1191</td>
<td>14.7</td>
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</tr>
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</table>
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We analyzed high and low frequency counts to determine three organizing trends that emerged from the findings described below.

5. Results

We coded and analyzed candidate artifacts to answer our research question: How does the redesign of a collaborative teacher preparation program around a UDL framework influence candidates’ ability to plan and implement evidence-based instructional practices to meet the content and literacy needs of all learners?

5.1. Strengths of implementation of the UDL redesign

The following section is organized by trends that emerged from data analysis that supported and informed the Theory of Change (see Fig. 1). Areas of strength across candidate implementation of UDL are evidenced in their program artifacts. Fig. 3 illustrates all the UDL checkpoints that candidates utilized in their planning, instruction, and action research projects.

5.1.1. Candidates use UDL framework to foster inclusive learning environments and apply principles of culturally sustaining pedagogy

In examining the highest frequency checkpoints, three of the top nine highest related to using UDL to foster inclusive and culturally responsive learning environments. For example, Checkpoint 7.3 minimize threats and distractions was frequently cited by candidates in their artifacts when discussing how to provide options for recruiting diverse learners’ interest and engagement. With a total of 121 instances across all disciplines, it was most frequently cited by science (44 instances) and English candidates (39 instances). A Science candidate underscored the importance of this checkpoint to his content area:

I believe that the creation of a learning environment for the science classroom is key to the inquiry process. I noticed that early on students were very wary of saying a “wrong” answer or asking a question because they are afraid to look “dumb”. These are two components that need to happen in the science classroom. We need to question the phenomena of the world, wonder why these things are happening and not be afraid to be wrong. Every time a response is given, right or wrong, it brings the group one step closer to an explanation.

In addition, Checkpoint 7.2 optimize relevance, value, and authenticity was cited (total of 179 instances) when candidates discussed that they provided options to recruit learner interest within the learning environment. An English candidate reflected on her rationale for tapping into students’ interests in the planning of her lesson:

Student engagement was a priority while planning the segment. Learners are more apt to focus their attention on a task, think more deeply about a task, and persist in a task if they are personally interested (Miller & Brickman, 2004). The “whodunit” mysteries were chosen because they simultaneously harness students’ enthusiasm for controversial or complex ideas and address students’ visual literacy strengths.

Across all disciplines, Checkpoint 8.3 foster collaboration and community was coded most frequently, with a count of 244 instances. This checkpoint was one of the top five most frequently used by English, math, and Spanish candidates, illustrating how candidates plan and reflect to engage learners in collaborative inclusive environments. The selected excerpt demonstrates how an English candidate reflected on particular strategies she used to this end:

Throughout my placement in this classroom I have worked towards creating a safer and comfortable learning environment where students are respectful of one another, which helps this student feel comfortable within the class. The guided notes will serve as a scaffold for them to be able to feel prepared and have what they want to share written down before they get to class.

Fig. 3. UDL checkpoint frequencies.

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5.1.2. Candidates use UDL framework to plan and reflect on evidence-based disciplinary literacy instruction

Transdisciplinary Trends. Six of the nine highest overall frequency counts aligned to our redesign emphasis on disciplinary literacy and academic language, particularly for the UDL checkpoints that were applicable across content areas in transdisciplinary ways. For example, Checkpoint 2.1 clarify vocabulary and symbols was one of the highest utilized checkpoints across all four disciplines, with a count of 181. Use of this checkpoint demonstrated candidates’ ability to provide options for learners to better understand language and symbols. Selected excerpts illustrate how candidates supported student learning by developing vocabulary knowledge through a variety of strategies. A math candidate described vocabulary routines that supported students toward independent mastery of content learning:

Before the beginning of the learning task the class completed a word wall for the unit. Each necessary term was defined by students and examples of each are posted onto a bulletin board in the classroom. Students also have their interactive notebooks. The sections of their notebooks correlate with each unit. However, students have access to their notebooks at all times, and many of the units in Algebra Build upon each other. If students find themselves struggling, my first prompt is to guide students to the correct section of their notebook. This teaches students to use their resources instead of relying completely on teacher support.

Other candidates integrated vocabulary strategies such as Frayer models, graphic organizers for vocabulary learning, guided note sheets, vocabulary-rich discussions, anticipation guides and other pre-teaching vocabulary routines, concept drawing labels, and morphology lessons.

As another example of a transdisciplinary literacy scaffold, Checkpoint 3.3 guide information processing, visualization, and manipulation was coded most frequently across all disciplines with the highest frequency count of any checkpoint at 315 total instances, illustrating how candidates provide options to support comprehension. A math candidate explained how she supported students by providing graduated scaffolds to support student information processing through guided notes and varied representations:

The students were provided with guided notes that contain the properties of exponents that they needed to use in order to complete the problems. The students were previously taught these properties … but as anticipated not everyone could recall all of the rules right away … I continued to write on the board the properties of exponents from the guided notes using words rather than mathematical symbols. I did this to emphasize the fact that the students need to see if we are working with the same base or the same exponent, and depending on the answer to that question we can identify how we are going to approach the problem and arrive at a solution.

Checkpoint 3.2 highlight patterns, critical features, big ideas, and relationships was one of the most frequently coded checkpoints for English, math, and science, and had a total of 224 overall. Checkpoints 3.2 and 3.3 guide information processing and visualization co-occurred 118 times, more than any other checkpoints across the data. Checkpoint 3.3 focuses on the need to make information accessible through explicit cues to help learners attend to the most important elements of the content presented, a goal of academic language and disciplinary literacy instruction. Here an English candidate explained how she purposefully used graphic organizers:

Students were asked to pull information in from the previous day’s slide presentation on post World War I America, a historical documentary video and an in-class reading assignment. After digesting this information, students were to fill out an Event Map graphic organizer in pairs that explained the significance and causes/effects of the ‘Roaring Twenties.’ Students were also asked to share their completed ‘Event Maps’ with the class on the Elmo projector and explain their responses.

Discipline-specific Trends. There were other identified patterns in how candidates planned and implemented disciplinary literacy supports that were specific to a discipline, yet still resulted in overall high frequency counts. For example, Checkpoint 2.5 illustrate through multiple media had a high frequency count for science candidates with a count of 97; whereas no other discipline had this checkpoint in their top five. Artifacts were coded for checkpoint 2.5 when candidates presented key concepts in symbolic or alternative forms (e.g., illustrations, videos, physical or virtual manipulatives, model, diagram, etc.) or made connections between information provided in various forms (e.g. text and an accompanying diagram) to build learner understanding. This checkpoint was also coded if candidates asked students to do the same. For example, one science candidate described the purpose of her lesson:

Students construct evidence-based explanations of the scientific phenomenon by watching a video of the human fetal development, without a lot of frontloading of the information as this is the ‘engage and explore’ stage of the 5 E model. They looked for patterns of growth and development in the video … and developed the concepts … based on their prior knowledge. They have already learned about cells; therefore, they connect the growth in babies to the growth in cells. They also connect the growth and development to the concepts of post-natal growth and development.

In addition, three of the top five most frequently coded checkpoints for science fell within the “provide options for comprehension” guideline with Checkpoint 3.1 activate or supply background knowledge being the fifth most often coded checkpoint, yet this was not one of the five highest in any other discipline.

Checkpoint 5.2 use multiple tools for construction and composition was the highest frequency for math candidates, with a count of 36. Artifacts were coded for this checkpoint if they allowed or required students to use multiple tools (e.g., graphic calculators, graph paper, base-10 block manipulatives) to build toward understanding in construction and composition. One math candidate described how she integrated the use of manipulatives to deepen learner understanding, “… the interventions implemented focus on requiring students to move throughout the classroom (Circuits and Math Workshop), as well as engage in tactile activities that required students to use manipulatives and other body movements to learn content.”

Spanish candidates most frequently integrated Checkpoint 5.3 build fluencies with graduated levels of support for practice and performance with a count of 22. This checkpoint was not in any other discipline’s five highest frequency checkpoints. This checkpoint entailed candidates supporting students’ fluency with discipline-specific language through differentiation and scaffolds such as gradually releasing toward independence, instructing in small groups or with tutors, providing a variety of examples, and illustrating problem solving through multiple strategies. One Spanish candidate explained:

My plans build on each other and make connections between language forms and language functions because all lesson plans involve presentation of key vocabulary as one of the first tasks covered. In order to provide students with the vocabulary needed to engage in communicative tasks throughout the learning segment, I decided to begin the lessons with learning or reviewing important terms followed by tasks that allow students to practice and put the terms into use, skills being put into use. One important thing I took into consideration in regards to vocabulary is the quantity of terms I would be focusing on. I decided to cover reflexive verbs of morning daily routines in the first lesson and reflexive verbs of our evening and nightly routines in the second lesson … By taking this approach into consideration, I try to help students make more efficient use of short-term memory by grouping information. Chunking the vocabulary in this learning segment breaks up long strings of information
in a more useful manner. The resulting chunks are easier to commit to memory than a longer uninterrupted string of information and ultimately, students will be more likely to apply the vocabulary in future written or spoken tasks.

5.2. Challenges of implementation of the UDL redesign

The following section is organized by trends that emerged from data analysis that support and inform the Theory of Change (see Fig. 1) as areas of challenge across candidate implementation of UDL as evidenced in their program artifacts. Fig. 3 illustrates UDL checkpoints cited most and least frequently by candidates.

5.2.1. Candidates need additional practice-based opportunities to develop knowledge, skills, and dispositions around utilizing technology to provide more accessible learning experiences

Of the five overall lowest frequencies (under ten instances) across disciplines, four were related to using technology to provide options for accessing, using, and navigating content. All three checkpoints within the guideline of providing options for perception (1.1., 1.2, 1.3) were infrequently coded across and within all disciplines; Checkpoint 1.1 offer ways of customising the display of information was the overall lowest coded checkpoint integrated by candidates, receiving a total of five overall instances; Checkpoint 1.3 offer alternatives for visual information received eight mentions across candidate artifacts.

The guideline of providing options for physical action, had one of its two checkpoints pertaining specifically to assistive technology (4.2 optimize access to tools and assistive technologies) also ranked as underutilized, cited only nine times in total across all four disciplines. One science candidate illustrated how this checkpoint could be used as he described how iPads helped him optimize access to learning for students with disabilities in his classroom: “Particular students with IEPs in the class also work very well with assistive technology, specifically their iPads. Some of these students struggle with writing, therefore I could also have a supplemental activity that would allow for them to create virtual Punnett square crosses, such as a drag and drop of the alleles where they should go.” Furthermore, Checkpoint 5.1 use multiple media for communication which could also be considered as assistive technology was ranked as underutilized with only eight instances.

5.2.2. Candidates need additional practice-based opportunities to develop knowledge, skills, and dispositions around using UDL to foster executive function and self-regulated learners

Transdisciplinary Trends. Instances of the guideline of providing options for self-regulation were low across and within disciplines for all three checkpoints despite its significance to the overall goal of UDL to develop expert learners (CAST, 2017). Checkpoint 9.2 facilitate personal coping skills and strategies was one of the most infrequent for all disciplines, coded six times and only by science candidates. A science candidate explains how she navigated managing the needs of students with specific needs, while ensuring grade level instruction:

(a student has a) free hall pass to walk around if he becomes anxious, therefore when he entered back into the room, I got him caught back up to what the class was doing in their notebooks … making sure all learners in the classroom were involved, supported and understood their expectations …, demonstrating responsiveness to students with varied needs and backgrounds.

Discipline-specific Trends. Math candidates in particular integrated each of the checkpoints that fall into the “provide options for self-regulation” guideline infrequently. Checkpoint 9.1 promote expectations and beliefs that optimise motivation and Checkpoint 9.3 develop self-assessment and reflection were the least frequently integrated by math candidates. Math candidates were similarly low across each of the checkpoints for the “provide options for executive functions” guideline.

Checkpoint 6.3 facilitate managing information and resources was coded 76 times overall and only four times in Math.

Spanish candidates’ artifacts had low frequency coding for the “provide options for executive functions” guideline. Of the checkpoints within that guideline, only Checkpoint 6.3 facilitate managing information and resources did not fall into the low category. There were zero codes for Checkpoint 3.4 maximize transfer and generalization for Spanish candidates, though it was coded 102 times across the other three disciplines.

6. Discussion: enhancing and inhibiting factors and lessons learned

Here, we describe our analysis of the strengths and challenges of implementation based on the efficiency, effectiveness, and appeal of the program redesign and subsequent modifications per DBR guidance (Howell et al., 2020). We organized this section in via three assertions that emerged from our retrospective analysis (Gravemeijer & Cobb, 2006).

6.1. Assertion 1

Teacher candidates require practice-based experiences across program courses and duration to learn how to collaboratively plan using the UDL lesson planning template in meaningful ways that supports the content and literacy needs of all learners in secondary classrooms. The UDL lesson planning template was the focal point of the program redesign and a foundational component of the Theory of Change. We chose to start with the UDL lesson planning template based on recommendations of researchers who came before us (Dymond et al., 2006). In previous program redesigns, lesson plans were retrofitted with accommodations and modifications, which was not nearly as successful as proactively addressing all needs in the planning process (Courey et al., 2013; Theoharis & Causton-Theoharis, 2011). Collaboration among general and special education teachers and university faculty to create the template along with collaboration between general and special education teacher candidates in lesson development were key drivers in the Theory of Change. We addressed a limitation identified in previous research (Courey et al., 2013; McGhie-Richmond & Sung, 2013) by implementing the UDL lesson plan template in school classrooms with the support of a cooperating teacher.

Evidence gathered from edTPA commentaries, UDL Lesson Plans, and action research projects demonstrate candidate application of the mechanisms within our Theory of Change. Candidates possess knowledge of UDL, learner variability, content, and discipline literacy; skills in planning and enacting UDL checkpoints, incorporating high-leverage and evidence-based practices, and assessing student learning to inform further instruction; and dispositions toward inclusion, learner variability, and reflection. Each has shown themself to be an effective teacher candidate, which will likely lead to them being expert beginning teachers. Our study adds to the dearth of research on UDL as evidence showed that candidates in our MAT program demonstrated its effective application.

6.2. Assertion 2

Shared language across program faculty, clinical educators, and teacher candidates is important when infusing a focus on disciplinary literacy and academic language with the UDL framework. Effective teacher preparation requires a shared language within and across teacher preparation programs. This is especially true in secondary teacher preparation where a growing body of research suggests that middle and high school teachers are competent within their respective disciplines, but may be unprepared to effectively address the literacy needs of their students and meaningfully incorporate literacy within their discipline (O’Byrne et al., 2020). Creating a shared language across program faculty, especially focused on disciplinary literacy and academic language, was a crucial
component of our redesign and a driver of change.

UDL guidelines and use of the UDL lesson plan template were foundational to the development of this shared language amongst our faculty. The guidelines served several purposes. For faculty, the guidelines provided a cohesive framework that resulted in a shared language of pedagogy across courses and departments. For our candidates, the guidelines facilitated design thinking, aiding their ability to proactively identify and address potential barriers to learning for their students. The UDL guidelines served as a tool for effectively identifying and embedding evidence-based practices for teaching disciplinary literacy and academic language within the disciplines. Finally, although it was not an intentional component of our program redesign, the edTPA and its focus on academic language, also aided in the development of a shared language of teaching amongst faculty members.

With the support of CEEDAR, program faculty collaborated on the development of a scope and sequence for teaching disciplinary literacy and academic language across and within courses. We were also able to engage in ongoing professional development on culturally responsive practices and disciplinary literacy provided by CEEDAR and leveraged internal grant funding to support deeper professional development in UDL applications for our faculty and K-12 partner school districts. Web-based resources provided by the IRIS Center and CEEDAR continue to be used by faculty for professional development and course enhancement.

A survey conducted by the CEEDAR Center Evaluation Team (CEEDAR, 2017) found that faculty teaching in the MAT program valued the professional development provided by CEEDAR and were involved in highly collaborative program redesign efforts. Notably, evidence gathered from artifacts involved in this study strongly support this assertion. For example, six of the nine highest overall frequency counts of UDL checkpoints applied by our candidates aligned to our redesign emphasis on disciplinary literacy and academic language. In addition to checkpoints focused on providing multiple means of representation, our analysis also provides evidence that candidates provided multiple means of engagement for their students by minimizing threats and distractions (Steele, 2010; Tatum, 1997), optimizing relevance, value, and authenticity (Ginsberg, 2005; Howard & Navarro, 2016), and fostering collaboration and community (Doran, 2015; Piazza et al., 2015). Taken collectively, these findings serve to strengthen and support our proposed Theory of Change.

6.3. Assertion 3

A unifying vision and leadership at all levels is critical to sustain meaningful redesign of collaborative teacher preparation programs. Collaboration, specifically between secondary and special education, justifiably was foundational to our program redesign, requiring a strong commitment from faculty and administration. Central to our Theory of Change was a shared vision and strong administrative support amongst faculty from eight departments and three schools across our university. External support and resources provided by CEEDAR (e.g., PD and targeted technical assistance) were instrumental in bringing faculty together to focus on envisioning our course work and field experiences (Frey et al., 2012). These efforts resulted in newly developed program outcomes and the creation of a core set of courses designed to co-prepare secondary and special educators with revised syllabi and assignments intentionally focused on the collaboration of secondary and special education teacher candidates.

One challenge that we were quickly faced with during implementation was the lack of placement options that would provide strong collaborative and teaching models for our candidates. The complexity of placing our candidates in yearlong internships coupled with state requirements for student teaching made it challenging for districts to host pairs of general and special education candidates as originally envisioned by faculty. Additionally, available field placements ranged in their ability to provide strong models for collaboration between secondary and special educators. Faculty navigated this challenge by modifying course work to provide opportunities for co-planning and collaboration in class and providing candidates with examples and resources for this work at the national level, such as those provided by the National Center on Intensive Interventions.

Most illustrative of results yielded to come to this assertion comes from a Summative Survey conducted in 2017 by the CEEDAR Center Evaluation Team, “In sum, the MAT reform benefited from solid administrative support, existing infrastructure, a collaborative culture, and effective communication.” This external evaluation coupled with evidence of our secondary candidates’ application of UDL serve to strengthen and support this assertion as an integral part of our proposed Theory of Change.

7. Conclusion

Through the iterative design of the program, in that a new cohort begins each May, we analyze program data and revise the program for each incoming group. Based on study results, we have made the following adjustments to achieve the pedagogical goal more effectively.

We will explicitly model and teach how to use UDL to support students with high incidence disabilities, emphasizing the connection between UDL and supports for struggling learners. Candidates may not have made the connections among accommodations, modifications, and the proactive supports that UDL can provide to struggling learners. By explicitly mapping certain UDL checkpoints to evidence-based practices for supporting students with high incidence disabilities (i.e., UDL Checkpoint 6.2 support planning and strategy development and the evidence-based practice of Self-Regulated Strategy Development), candidates may be better able to articulate the need for UDL to reluctant cooperating teachers as well as find a place for UDL in every lesson.

We also identified an opportunity to better model integration of technology to help learners access new learning, using “smart” classrooms on campus to model for candidates how to use technological tools and assistive technology (i.e., smartboards, google classroom, one-to-one integration) to provide options for recruiting, to plan alternative pathways to deliver content, and to optimize access to content. The current shift to online teaching has enabled us to learn and demonstrate these technologies more seamlessly and explicitly in our teaching.

Another area we identified as a need for improvement are UDL checkpoints that lead learners toward self-regulation. We will explicitly identify self-regulation as a goal for all instruction by adding specific components on the lesson and unit plan templates and rubrics. We also will continue PD on UDL and continue to extend our professional learning community to include our school-based partners. Finally, we identified a need to revise particular program assessments to better elicit candidates’ reaction to meeting the needs of struggling learners to determine the factors that inhibit full implementation of the UDL pedagogical goal as well as to measure the impact of candidates’ UDL implementation on their students’ learning.

7.1. Limitations and implications

DBR is focused on exploring the implications of the pedagogical goal in authentic settings. Therefore, we discuss limitations and implications within our setting. Further research is recommended exploring the elements of this Theory of Change in other collaborative preparation programs.

Program faculty were at varying levels of comfort and confidence with infusing UDL, as evidenced by self-disclosure, researcher observation and field notes, and the CEEDAR summative evaluation. Therefore, some courses were better aligned to UDL, and some faculty were better able to give actionable feedback to move candidates deeper in integration of UDL. There was a perception by program faculty and candidates that some disciplines lent themselves more easily to UDL. Having UDL focused within and across all disciplines helped candidates make better connections among coursework and enhanced effectiveness of the
intervention, but having better alignment of UDL within some courses and not others inhibited overall success.

Candidates’ field placements also impacted their integration of UDL. If candidates perceived their cooperating teachers as inquisitive about UDL and its applications, or as familiar with UDL (this happened more rarely), candidates were more readily able to implement what they were learning on campus in their field classroom, enhancing the effectiveness of UDL by providing candidates more authentic opportunities to integrate UDL and assess the effectiveness. If candidates perceived cooperating teachers as resistant to UDL, they were less likely to fully implement UDL, inhibiting the success of the intervention. Further, cooperating teacher modeling of UDL principles in their own teaching also served to enhance candidate integration.

The rigor and timeline of the program most likely inhibited full integration of UDL components. Candidates complete the MAT program via full-time study in 13 months. Candidates balance 49 credit hours with over 900 h of clinical experience. They only have so much capacity for innovation and new learning in terms of cognitive load (Paas et al., 2003). Other demands such as edTPA, action research, discipline-specific unit planning, financial burdens of full-time study, job search, and pressures of cohort study, many candidates reached a ceiling for new learning, which most likely affected the success of the intervention. The ideal structure for this and other teacher preparation programs includes: (a) all course content aligned to UDL; (b) faculty who develop confidence and skills in explicitly teaching and modeling UDL and providing actionable feedback; and (c) matching teacher candidates with host teachers who embrace and model UDL practices.

CRediT authorship contribution statement

M. Mackey: Conceptualization, Data curation, Formal analysis, Methodology, Writing – review & editing. S.V. Drew: Conceptualization, Data curation, Formal analysis, Methodology, Writing – review & editing. J. Nicoll-Senft: Conceptualization, Data curation, Formal analysis, Methodology, Writing – review & editing. L. Jacobson: Conceptualization, Data curation, Formal analysis, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssaho.2023.100468.

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