UNIVERSITY OF CALIFORNIA

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Understanding Curriculum, Instruction and Assessment within Eighth Grade Science Classrooms for Special Needs Students

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Special Education

by

Kate Elizabeth Riedell

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ABSTRACT OF THE DISSERTATION

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Assessment within Eighth Grade Science Classrooms

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Doctor of Philosophy in Special Education

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Professor Alison Bailey, Co-Chair

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The Individuals with Disabilities Education Act (IDEA, 2004) cemented the fact that students with disabilities must be placed in the least restrictive environment and be given the necessary supports to help them succeed (Lawrence-Brown, 2004). This provides significant challenges for general education teachers, especially in an era of standards based reform with the adoption of the Common Core State Standards (CCSSI, 2014) by most states, along with the Next Generation Science Standards (NGSS, 2013). While a variety of methods, strategies, and techniques are available to teachers, there is a dearth of literature that clearly investigates how teachers take into account the ability and motivation of students with special needs when

planning and implementing curriculum, instruction, and assessment. Thus, this study sought to investigate this facet through the lens of differentiation, personalization, individualization and universal design for learning (UDL) (CAST, 2015), all of which are designed to meet the needs of diverse learners, including students with special needs. An embedded single-case study design (Yin, 2011) was used in this study with the case being differentiated and/or personalized curriculum, instruction and/or assessment, along with UDL for students with special needs, with each embedded unit of analysis being one eighth grade general education science teacher. Analyzing each sub-unit or case, along with a cross-case analysis, three eighth grade general education science teachers were observed over the course of two 10-day units of study in the fall and spring, as they collected artifacts and completed annotations within their electronic portfolios (ePortfolios). All three eighth grade general education science teachers collected ePortfolios as part of their participation in a larger study within California, "Measuring Next Generation Science Instruction Using Tablet-Based Teacher Portfolios," funded by the National Science Foundation. Each teacher also provided an in-depth interview as part of the data collection. This comprehensive set of over 200 pieces of data, which includes observations and interviews, as well as artifacts and annotations from the ePortfolios, was analyzed using a grounded theory approach (Strauss & Corbin, 1990). Six central themes emerged from the data.

The findings indicated that teachers incorporated some elements of differentiation, personalization and a limited number of components under UDL to support all learners, including students with special needs. There was no indication that the teachers implemented individualization. In other words, there was limited evidence that teachers planned specifically for meeting the needs of students with a specific disability; rather, they focused on collectively meeting the needs of all learners. They recognized the importance of accounting for student

motivation and sought to provide hands-on, authentic learning opportunities to motivate and engage students. Yet, they did not survey and/or ask students for their perception of their classroom experiences. While teachers did utilize the electronic portfolio and found it valuable to varying degrees, they indicated that collaboration and visiting other classrooms were essential to their professional development. Implications from this study include (1) ensuring that teachers understand the differences among differentiation, personalization, individualization and universal design for learning; (2) training for teachers on how to properly differentiate, personalize and individualize instruction, as well as how to implement universal design for learning; (3) providing teachers with follow-up support within the classroom to properly implement the approaches mentioned above; (4) training for teachers on the importance of eliciting students' perceptions and how to gauge those perceptions; (5) properly disseminating information to policymakers on the realities of the classrooms and the challenges in accounting for the needs of diverse learners. Overall, teaching is complex, especially when supporting students with special needs in urban schools, and teachers need to be not only trusted, but supported in a professional manner.

The dissertation of Kate Elizabeth Riedell is approved.

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Dedication

For Kevin, whose unconditional and unfailing love and support have made this work possible.

For Mom and Dad, whose phenomenal teaching careers have fueled my passion for education from a very young age.

And, for Dr. Joseph Yukish, who has been my mentor from the very beginning and always believed in me as a researcher and teacher.

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CHAPTER 1

Introduction

With the addition of the Common Core State Standards (CCSSI, 2014) and the Next Generation Science Standards (NGSS, 2013), teachers face additional challenges related to how to meet the needs of students with disabilities. Within both sets of standards, teachers are provided with limited guidance as to how to differentiate the standards effectively for students with disabilities, and this constraint hinders general and special education teachers' abilities to meet student needs. This difficulty, coupled with teachers' potential lack of training (e.g., Weiss, Banilower, McMahon & Smith, 2001) within one or more domains of knowledge (Shulman, 1987), can create significant barriers that inhibit students with disabilities from being able to effectively master these standards. However, with a large foray of best practices in science instruction (e.g., Oliveira et al., 2003), guidelines to evaluate science curriculum (e.g., Kesidou & Roseman, 2002), along with best practices for middle school instruction, specifically in regards to motivation (e.g., MacIver & Plank, 1996), teachers have a wide array of tools at their disposal to effectively differentiate science curriculum and instruction to meet the needs of all students.

Kesidou and Roseman (2002) point out that science curriculum should incorporate these five components: (1) unit and lessons must have a purpose, (2) all student ideas must be acknowledged and accounted for during instruction, (3) students must be engaged in a multitude of experiences, (4) students need time to understand and apply scientific ideas, and (5) teachers need to support students in delineating their thinking. While not formally addressing science and instruction, MacIver and Plank (1996) note that the most critical component of fostering student success in middle school is the positive relationship between the teacher and the student.

Essentially, it is critical that a student knows that the teacher has the student's best interest in mind and that the teacher will do anything possible to support the student's academic growth. MacIver and Plank (1996) also note the importance of tailoring the curriculum and instruction to students' interests, which, coupled with the nurturing relationship between student and teacher, elevates student motivation within the classroom.

More broadly, teachers have access to the components of differentiation, individualization, personalization, and UDL (CAST, 2015), which can transfer easily across content areas to support all students, including those with special needs. Differentiation is broadly defined as a teaching philosophy that takes into account the diverse needs of students, while providing instructional supports and adaptations to enable all students to meet grade-level curriculum standards (Tomlinson, 2000; Lawrence-Brown, 2004). Individualization is instruction that only accounts for individual differences among students, not motivational factors that can influence their willingness to learn (Adelman & Taylor, 2006), whereas personalization is instruction that accounts for both the motivation and individual differences among students (Adelman & Taylor, 2006). UDL has three principles: representation, engagement and expression, with associated guidelines and checkpoints that teachers can plan to include within their classroom practice in order to mediate any difficulties for their students (CAST, 2015). Yet, these approaches require time, training and a teacher's ability to successfully embed them within standards-based instruction and assessment for each student with a special education diagnosis that has an individualized education plan (IEP) or a 504 plan, along with his/her peers.

The Individuals with Disabilities Education Act (IDEA, 2004) states that students with special needs must be guaranteed the right to be placed in the least restrictive classroom, which is often the general education classroom. Students with special needs should not be arbitrarily placed in self-contained special education classrooms because of a label given to them from their IEP; rather, their progress should be appropriately measured within the general education classroom with proper supports (Lawrence-Brown, 2004). For the purposes of this study, students with special needs refers to specific learning disabilities (including dyslexia and visual, verbal and/or auditory processing disorders), other health impairments (including attention deficit hyperactivity disorder [ADHD]), and autism (i.e., continual difficulties in social communication and interactions) (American Psychiatric Association, 2013).

When a child is suspected of having a disability by either a parent, teacher, and/or other member of the school personnel, the student must be evaluated under IDEA (2004) guidelines (deBettencourt, 2002), with most children beginning to be identified in second grade. While IDEA (2004) is a federal law, Section 504 is a civil rights statute. Under Section 504, schools must ensure that students with disabilities are not discriminated against and must give these students accommodations to meet their needs. While no federal funding is associated with Section 504, schools must comply with this mandate. There are thirteen categories of disabilities under IDEA and a student must meet the criteria for one or more of these disabilities in order to receive an IEP. An IEP has several components, including a description of the student's current academic performance, what special education services will be given to the student, and the student's level of exclusion from the general education classroom for applicable services, if needed. In addition, modifications for any assessments, along with detail about the services that will be received and the applicable start date, in conjunction with how progress will be documented, as well as how parents will be informed of the student's progress, are all put within the IEP (deBettencourt, 2002).

To be eligible to receive services under a 504 Plan, a student must have a specific physical or mental impairment that specifically hinders his/her ability to participate in a major life activity, such as learning, speaking, walking and/or hearing (deBettencourt, 2002). The criteria for 504 Plan eligibility is much broader than for an IEP, thus, a child can often receive services under a 504 Plan if they are not eligible for an IEP. Under a 504 Plan, students can have related services, such as physical therapy, as well as accommodations within the classroom and instruction tailored to meet their needs (deBettencourt, 2002). While similar, IEPs and 504 plans differ in several ways, most particularly in regards to the level of rigidity in determining whether a student qualifies for an IEP or 504 plan.

Many students who are at risk for placement in special education programs or who already have IEPs and 504 plans often end up in general education classrooms along with their peers. Students with disabilities do not receive greater benefits from being placed in self-contained special education classrooms; rather, the results are equal or better when students with disabilities are placed in a general education classroom with appropriate supports in place (e.g., Affleck, Madge, Adams & Lowenbraun, 1988; Banjeri & Dailey, 1995). Cawley, Hayden, Cade and Baker-Kroczynski (2002) extend this to middle school science classrooms, where they detail how a team of three teachers (out of a 45-teacher sample) applied the concepts of *hands-on* and *project-based learning* to their inclusive classrooms which resulted in equitable student achievement among typical students and their peers with disabilities.

When the No Child Left Behind Act (No Child Left Behind [NCLB], 2001) became law, educators became responsible for ensuring that all students, including those with special needs, met educational standards and succeeded. Marx and Harris (2006) point out that administrators have heeded to the demands of academic testing in language arts and math in grades 3-8, thus putting their time and resources into these areas, with science falling by the wayside. Yet, in 2007, schools were forced to put science back in the forefront with NCLB requiring that students in grades three to five be assessed in science at least once a year, with the caveat that those scores do not count towards a school's Annual Yearly Progress (AYP). However, despite these pieces of legislation, "… many students with disabilities fail to perform successfully in the general education curriculum" (Rock, Gregg, Ellis & Gable, 2008, p. 32), whether in language arts, math and/or science.

Rock et al. (2008) point out that one reason that students with special needs have difficulty within the general education curriculum is that while they are physically in the general education classroom, their needs are not being met by just sitting in the classroom. Similarly, Pisha and Stahl (2005) state that "…students with learning and attentional disabilities and those with limited motivation cannot keep pace in the same class—not because they find the (history) content too challenging, but because they cannot read and attend sufficiently to keep pace with their nondisabled peers" (p. 69). According to the 37th Annual Report to Congress on IDEA (OSEP, 2015), approximately 95% of students served under IDEA were receiving their education in the general education classroom for at least some portion of the day. As such, teachers need to be mindful that there is no "'one-size-fits-all-approach' to instruction" (Rock et al., 2008, p. 32-33).

Teachers can draw upon differentiated instruction or individualization, which "…typically emphasizes detecting a student's deficiencies by monitoring daily performance on learning tasks and then modifying instruction to address those deficiencies" (Adelman & Taylor, 2006, p. 128). Differentiated instruction and individualization, along with personalized instruction that accounts for a student's ability and motivation, can be effectively implemented within general education classrooms to meet the needs of students with disabilities and their peers (Adelman & Taylor, 2006). Unlike personalization, individualization relies primarily on each student's weaknesses and does not address motivational factors. In addition, personalization distinguishes itself by taking into account students' perceptions of the classroom environment, which includes the learning activities and how they fit with the students' goals. Teachers can also utilize UDL (CAST, 2015), which unites instruction and assessment when teachers embed self-assessment and monitoring throughout their instructional practices to ensure students' needs are being met. Overall, teachers have a several approaches that are designed to assist them in ensuring that their instructional and assessment practices meet the needs of all learners, including students with special needs, with personalization specifically addressing students' abilities and motivation.

Problem Statement

Teachers need to be well versed on not only how to identify students with disabilities and the procedures of obtaining an IEP or 504 plan (deBettencourt, 2002), but also how to meet the varied needs of students with disabilities within their classrooms. The National Center for Education Statistics (National Center for Education Statistics [NCES], 2016) keeps a record of how many students ages three to twenty-one receive services under IDEA (2004) for each of the 13 disabilities. During the 2012-2013 school year, NCES (2016) indicated that 6,429,000 students were identified as having a disability and receiving special education services. Of those 6,429,000, over two-million were diagnosed with specific learning disabilities, 779,000 were diagnosed with other health impairment and almost a half million were diagnosed with autism. NCES (2016) also reported on the percentage of students that are in general education classrooms, with notably 61.2% of all students with disabilities spending 80% or more of their time in the general education classroom. However, only 39.5% of students with autism spend 80% or more of their time in the general education classroom, whereas this percentage is much higher for students with other health impairment (63.7%) and for students with specific learning disabilities (66.7%).[1] Since students with disabilities are included within general education classrooms, they need to be provided with curriculum, instruction, and assessment that meets their needs (IDEA, 2004).

However, the inclusion of students with disabilities in the general education classroom can be a daunting task for middle school science teachers, who are facing an achievement gap between students with learning disabilities and their peers, along with decreased motivation from middle school students as a whole (Anderman, 1998). Compounding this, the population of *emergent bilinguals*, ("…students who speak languages other than English" (García, 2009, p.322)), in K-12 in the state of California is roughly 24.5% (Ruiz Soto, Hooker & Batalova, 2015), and McCardle, Mele-McCarthy and Leos (2005) point out that it is critical that "cultural and contextual factors be taken into account" when planning and implementing instruction and assessment (p. 71). While García (2009) specifically point out that, "The term emergent bilinguals refers to the children's potential in developing their bilingualism; it does not suggest a limitation or a problem in comparison to those who speak English" (p. 322), many emergent bilinguals are often dually diagnosed with specific learning disabilities. This is an additional challenge faced by all teachers, especially those in the state of California where the current study takes place (e.g., Artiles, Rueda, Salazar & Higareda, 2005; Sullivan, 2011). Artiles et al. (2005)

[1] All three teachers who participated in this study taught some students who had IEPs due to learning disabilities in reading and math, autism, dyslexia and/or processing disabilities. One teacher also had some students on 504 Plans due to a diagnosis of Attention Deficit Hyperactivity Disorder.

found that emergent bilinguals were consistently overrepresented in both the learning disability and language and speech impairment categories through an analysis of data from 11 urban school districts in southern California.

It is critical that teachers be provided with applicable training that can be effectively implemented for all students to have equitable opportunities to learn. There are a range of professional development activities for teachers, whether through a formal workshop or seminar after-school, or through a short conversation with a colleague in the hallway, all of which have inherent value and need to be studied in greater depth to maximize professional development opportunities for teachers (Borko, 2004). Borko (2004) also notes that the examination of student work, as well as videotapes of teachers' lessons have been effectively embedded into professional development programs for teachers to accelerate their professional growth.

It is largely understood that professional development can elevate teachers' instruction and, consequently, student academic achievement; yet, "Despite recognition of its importance, the professional development currently available to teachers is woefully inadequate" (Borko, 2004, p. 3). While this comment was largely in reference to the need to understand more about how teachers learn and how that learning can inform professional development opportunities that impact student achievement (Borko, 2004), it could also be applied to the limited scope of topics that are addressed, particularly in regards to how to provide equitable instruction for students with special needs and emergent bilinguals. Borko (2004) points out that there are more professional development opportunities for teachers in elementary and middle school, especially in regards to the following content areas: math, science and literacy. Within her work, Borko (2004) does not specifically delineate professional development that targets effective instruction for both special needs students and emergent bilinguals, which might be a by-product of general and special education being treated as separate systems (Buell, Hallam, Gamel-McCormick and Scheer, 1999).

Based on a survey completed by 202 general education teachers and 87 special educators, Buell et al. (1999) found that general educators needed professional development in more areas than special educators to successfully navigate their inclusive classrooms. Specifically, general educators stated that they needed professional development in the following areas: constructing an IEP, embedding modifications within their instruction, monitoring academic progress of students, making adaptations to curriculum, and the application of assistive technology in the classroom. Despite the need for equitable instruction for all diverse learners, there is a lack of training on key topics and skills to ensure instruction meets the needs of all learners. Regardless of these hurdles, general education teachers are still expected to ensure that their curriculum, instruction, and assessment is an effective match for all learners. Electronic portfolios (ePortfolios), which allow teachers to capture images, video, and documents seamlessly within one device, can be a successful tool for teacher reflection and long-term professional development (Barrett, 2000). Within the six current *Teacher Performance Expectations* (TPEs), UDL and Multi-Tiered Systems of Support (MTSS) are now discussed (California Commission on Teacher Credentialing, 2016), which implicitly indicates the state's recognition of the importance of meeting the needs of all diverse learners in the classroom.

This study seeks to illuminate how three Californian eighth grade general education science teachers take into account their students' abilities and motivation (or lack thereof) across two science units, with a focus on students with special needs. More specifically, this study seeks to understand how these three eighth grade general education science teachers plan for and implement curriculum, instruction, and assessment that takes into account their students' abilities and motivation (or lack thereof) through an analysis of artifacts (images, videos, and/or documents) captured by three teachers within their ePortfolios across two units of study, multiple observations of each teacher, and one interview with each teacher.

Significance of the Problem

To meet the needs of these diverse populations, teachers are expected to adopt the philosophy of differentiation, which can encompass a variety of approaches, including individualization, personalization (Adelman & Taylor, 2006), and UDL (CAST, 2015). *Individualization* is when teachers take into account students' developmental capabilities when planning and implementing instruction and assessment, whereas *personalization* also integrates student motivation into the equation. While both seek to create the best "match" for the learner, individualization is usually only successful for the learner who is intrinsically motivated and wants to do well. Whereas, personalization meets the needs of both groups of students—those who are highly motivated and those who are not. UDL (CAST, 2015) seeks to pre-emptively support all learners from the beginning, rather than be situated from a reactionary approach. It is grounded in three overarching principles: (1) provide multiple means of engagement; (2) provide multiple means of representation; (3) provide multiple means of action and expression (CAST, 2015). Personalization (Adelman & Taylor, 2006) and UDL (CAST, 2015) share some similarities, the unifying concept being that when put into place with fidelity, all students can succeed; however, these two approaches also have some finite differences. As Adelman and Taylor (2006) point out, approaches to differentiation eventually rests solely on the learner, and whether the learner's perception deems that the fit of classroom and, in particular, the instruction/assessment, meets the learner's needs. Despite these overarching approaches, teachers are also bombarded with several instructional strategies that have "promise" to meet the needs of all learners. Mastery of all of these complex approaches and their associated components takes time, yet, they are necessary for teachers in order to effectively meet the needs of their diverse student populations.

Finally, middle school science teachers need to grasp the Common Core State Standards (CCSSI, 2004) and Next Generation Science Standards (NGSS, 2013), and employ adaptations and/or modifications within their instructional and assessment practices that will aide students with disabilities in mastering the content. McGinnis (2013) conducted a literature review on the best practices for students with special needs in regards to science curriculum, instruction, and assessment. Recommendations that emerged from this review ranged from modifying the curriculum by aligning reading work to students' comprehension levels to embedding authentic practices focused on developing inquiry. Yet, there were no specific guidelines on how to implement these pieces.

While there is a firm understanding of the importance of differentiation within the curriculum to meet student needs (e.g., Oliveira et al., 2013), there remains to be a firm understanding of how teachers plan for and implement curriculum, instruction, and assessment to meet the needs of all students in the age of standards-based reform, with limited professional development in regards to students with special needs. Furthermore, we also do not have a clear picture of how teachers monitor and reflect upon these processes in order to meet the needs of all students, especially those students with special needs. There is a dearth of literature in this area, and we need to begin to understand how teachers navigate this process so we can properly provide them with the supports they need to ensure that they are using at least some components of differentiation, personalization, and/or UDL in order to meet the needs of their diverse student populations, especially those that have special needs.

Purpose of the Study

This study seeks to shed light on how three eighth grade science teachers plan and implement science curriculum, instruction, and assessment that takes into account their students' abilities and motivation (or lack thereof) across two science units, while implementing the components of differentiation, personalization and/or UDL. Differentiation, personalization, and UDL are three approaches that teachers within any content area can pull elements from in order to ensure that the content aligns with their students' abilities, and with personalization, address the key component of motivation that will allow each student the opportunity to experience unparalleled success in science. Individualization was also briefly examined; however, it was not the primary focus due to its characteristically narrow approach in determining students' weaknesses through daily work, in order to identify modifications to combat students' weaknesses (Adelman & Taylor, 2006). A secondary goal of this study is to understand how teachers monitor and reflect upon these practices for students with special needs. The overall goal of this study is to understand what is happening prior to and during instruction, with the goal of informing future curriculum design and policy initiatives aimed to assist teachers in mediating the success of this sub-group of students. This study seeks to illuminate the necessary pieces of professional development, planning time, and requisite materials that teachers need to have access to in order to master how to provide the best possible differentiated curriculum and instruction for this population of students. Table 1 shows how the research questions align with the data collection procedures.

Table 1

Research Questions and Data

Research Questions	Observations	ePortfolio Artifacts and Annotations	Interviews
1. How do three general education eighth grade science teachers take into account the ability and motivation of students with special needs in inclusive general education classrooms?	X	X	X
1a. How do they plan for and implement the curriculum for this population of students?	X	X	X
1b. How do they plan for and implement their instruction for this population of students?	X	X	X
1c. How do they plan for and implement their assessment for this population of students?	X	X	X
2. How do three general education eighth grade science teachers self-monitor and reflect upon their instructional and assessment practices for students?		X	X
2a. How does this monitoring support what concepts they need to re-teach or extend for students?		X	X

Positionality Statement

I am a former fourth and fifth grade teacher who taught for six years prior to entering a PhD program in special education. Upon entering the PhD program, I worked as an educational consultant across Los Angeles and Orange counties assisting teachers in grades K-8 with modifications and adaptations for their reading and writing curriculum to align with the Common Core (CCSSI, 2014) for students with special needs. When I was a teacher, I had numerous students with special needs in my classroom every year, often making up approximately one-third of my classroom composition. While several of my students were pulled out for some special education services, they spent the majority of their classroom day with their peers in my classroom, thus cultivating my interest on how to meet the needs of this population in an inclusive classroom. I left the classroom at the onset of Common Core (CCSSI, 2014) in Spring 2012. Upon examining the Common Core (CCSSI, 2014), I was daunted by the fact that there were limited resources within the standards themselves and associated curriculum from well-known publishers about how to ensure that my curriculum, instruction, and assessment practices considered my diverse students' abilities and motivation.

While differentiating the Common Core (CCSSI, 2014) was expected of teachers, there was no direct guidance that was research-based as to how to do it. This conclusion was cemented by a white paper that I co-wrote with Dr. Sharon Ulanoff on the implementation of the Common Core (CCSSI, 2014) for Senator Carol Liu. Overall, teachers and administrators were struggling to learn, plan for, and implement the Common Core (CCSSI, 2014) within their classrooms for all students. Teachers planned in conjunction with their colleagues and often created their own curriculum that was aligned with the Common Core (CCSSI, 2014). Thus, the Common Core (CCSSI, 2014) provided an extra level of complexity for teachers when planning for and implementing instructional and assessment practices. Based on this white paper, I also ascertained the pending NGSS (2013) practices would be difficult as well. Thus, the stage was set for investigating how teachers not only differentiated curriculum, instruction, and assessment that was aligned to the standards, but also drew upon personalization and UDL as well.

Summary

The introduction sets the stage for taking into account the importance of students' abilities and motivation, particularly in regards to students with special needs, by utilizing the following three approaches: differentiation, personalization, and UDL. The introduction provides an overview of IDEA (2004), the core piece of policy that governs how students with disabilities receive their education, along with a brief explanation of IEPs and 504 plans. It also delineates how students with special needs are largely included within the general education classroom, and with appropriate supports in place, they can be quite successful in the classroom. However, it also begins to describe the challenges that general education teachers face when trying to craft instruction and assessment that meets the needs of their diverse learners, including students with disabilities, as well as many who are dually diagnosed as emergent bilinguals with learning disabilities. It is also points out the lack of professional development for general education teachers on how to properly address the needs of students with disabilities. Collectively, these challenges result in a lack of equitable instruction for students with special needs and emergent bilinguals.

There is an expectation that teachers draw upon the components of differentiation, personalization, and UDL to meet students' needs, all of which require teachers to not only understand the components of these teaching methods, but also how to effectively implement them in the classroom with diverse learners. This is also compounded by the addition of the Common Core (CCSSI, 2004) and the NGSS (2013), both of which offer limited guidance for how to assist students with special needs meet the requisite standards. Finally, this chapter provides the purpose for the study, subsequent research questions, and the positionality statement. In the following section, the literature on knowledge base for teaching; students with disabilities; curriculum purpose, development, and choice; instruction, assessment, use of teacher portfolios to monitor and reflect on instructional practices; meeting the needs of all students; and differentiation, personalization, and UDL is provided. The theoretical perspectives of the deficit theory, multiple intelligences, the thinking curriculum, and learning progressions are used to frame the current study.

CHAPTER 2

Review of the Literature

Teaching is a complex endeavor that requires much more than mastery of subject matter, but an ability to transmit that subject matter effectively to a diverse group of students all while aligning one's curriculum, instruction, and assessment with standards-based reforms. In addition, it is imperative that teachers understand the developmental needs and overall backgrounds (e.g., parent education level) of the students they are working with, along with their motivational triggers and inherent capabilities. While there remains to be explicit guidance on how to assist students in meeting the standards and performance expectations set forth by the Common Core (CCSSI, 2014) and NGSS (2013) explicitly, teachers can pull from established best practices in science instruction (e.g., Oliveira et al., 2013), while taking into consideration criteria for science curriculum materials (e.g., Kesidou & Roseman, 2002). Yet, the teacher must also rely on his inherent skills, whether learned in his preparation program, on the job, from mentors or other sources, to be able to effectively utilize approaches and associated strategies that will tailor the curriculum, instruction, and assessment within the general education science classroom to meet the needs of all learners.

This literature review provides a foundation for the study by delving into the necessary facets of knowledge required to teach effectively for all students, especially those with special needs, coupled with the overall knowledge base for teaching. This is followed by the literature that focuses on students with disabilities; curriculum purpose, development, and choice; and instruction, assessment, and the use of teacher portfolios to monitor and reflect upon instructional practices. The literature review then moves to a thorough discussion on differentiation by addressing the various definitions and components that have been posited by the field, including differentiation methods specific to learning disabilities. It concludes with an in-depth analysis of personalized instruction and UDL, two approaches with a strong research base that are designed for classroom implementation to meet the needs of all learners.

The Knowledge Base Required for Teaching

Many people arbitrarily enter the field of teaching thinking that their initial training will suffice and provide them with the necessary tools to meet the needs of all students. However, "most learn quickly that teaching is much more difficult than they thought, and they either desperately seek out additional training, construct a teaching style that focuses on control— often by 'dumbing down' the curriculum to what can be easily managed—or leave in despair" (Darling-Hammond, 2008-2009, p. 10). Recent curriculum reforms such as the Common Core (CCSSI, 2014) and the NGSS (2013) are significantly raising the level of expectations for both students and teachers in the classroom. Both reforms rely prominently on "what teachers know and how they teach" (Jenkins & Agamba, 2013, p. 73), otherwise known as content and pedagogical content knowledge, in order for students to be successful. Shulman (1987) points out that pedagogical content knowledge is of particular importance for teachers as, "It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners and presented for instruction" (p. 8). Although, content and pedagogical content knowledge are just two sources of knowledge that a teacher must possess, according to Shulman (1987). Shulman (1987) states that teachers must also possess curriculum knowledge, as well as general pedagogical knowledge (i.e., how to manage and organize a classroom). Shulman (1987) also emphasizes the importance of teachers knowing their individual students and the overall schematic framework behind education. Teachers also need to have a deep understanding of what they are teaching and have the ability to integrate that knowledge across domains (Shulman, 1987). The California Commission on Teacher Credentialing (2016) Teacher Performance Expectations stress the importance of teachers integrating Multi-Tiered Systems of Support and UDL to ensure that needs of all diverse learners are met.

Knowledge about Students with Disabilities.

General education teachers are charged with delivering instruction and assessment to a myriad of students, both with and without disabilities, on a daily basis. It is imperative that they have a background on the disabilities of their students, so that they are in a position to meet their students' needs. In the 37th Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (Office of Special Education [OSEP], 2015), it was reported that, "In 2013, the most prevalent disability category of students ages six—twenty-one served under *IDEA*, Part B, was *specific learning disabilities* (39.5 percent). The next most common disability category was *speech or language impairments* (17.9 percent), followed by *other health impairments* (13.8 percent), *autism* (eight and two-tenths percent), *intellectual disabilities* (seven and one-tenth percent), and *emotional disturbance* (six percent). Students ages six through twenty-one in "Other disabilities combined" accounted for the remaining seven and four-tenths percent of students served under IDEA, Part B" (OSEP, 2015). In addition, it was noted that there was an increase in the reporting of students ages 6-21 with autism, while there was a small decrease in the reporting of students ages 6-21 with specific learning disabilities. Specifically, in California, 7.5 percent of students ages 6-21 is served under IDEA, which is an increase from 7.1 percent in 2008 (OSEP, 2015).

Overall, it was reported in Fall 2013 that 62.1% of students spent the majority of their school day in the general education classroom (OSEP, 2015), again, compounding the importance of general education teachers being extremely knowledgeable about students with disabilities. With such a large amount of time spent in the general education classroom, it is imperative that general education teachers understand each disability and be prepared to meet the variety of needs that are present within the classroom. The basic requisite knowledge that teachers should have on attention deficit hyperactivity disorder (ADHD), autism, learning disabilities, dyslexia, and central auditory processing disorder is delineated below.

Understanding Attention Deficit Hyperactivity Disorder

Miranda, Jarque and Tarraga (2006) point out that there was a substantial increase in the number of students who have ADHD beginning in early 2000 and persisting for a few years afterwards. ADHD falls under Other Health Impairment within IDEA (2004), and is characterized by several symptoms of inattention, hyperactivity and/or impulsivity in at least two environments (i.e. school and home) prior to age 12 that negatively impact one's ability to succeed in those environments (American Psychiatric Association, 2013). Evans, Langberg, Raggi, Allen and Buvinger (2005) note that middle school students with ADHD often have a host of issues, including behavior and academic difficulties, along with problems with their fellow classmates. Beginning in middle school, those with persistent difficulties in these areas as a result of ADHD can experience substance abuse and legal difficulties, as well as potential school dropout (Evans et al., 2005). Despite these inherent negative pieces, a combination of strategic academic techniques, along with family treatment and behavioral interventions have proven to be very successful.

Miranda et al. (2006) note that there are a wide variety of ways to treat ADHD; however, only two treatments are backed up by research: central nervous system stimulants and behavior modifications. Often, these two treatments are used in combination. While psychostimulants have shown "obvious benefits on daily class performance, it has not been demonstrated that stimulants produce long-term changes in the general academic performance of children with ADHD or in specific areas" (Miranda et al., 2006, p. 36). Thus, medication to treat the symptoms of ADHD only fills a void in the interim and does not enable those who have ADHD to make productive changes long term. Similarly, these medications have not been found to assist students in managing their relationships with their peers, which are often affected by the symptoms of ADHD in adolescents. Furthermore, medicating students with ADHD only alleviates the symptoms of some behaviors and not others. So, it is necessary to put additional supports in place in order to mediate the complex symptoms that are present for students with ADHD (Miranda et al., 2006).

While Miranda et al. (2006) acknowledge that family therapy is beneficial (Evans et al., 2005) along with individual therapy and parent training for aiding at home, its success does not translate to mediating the behavioral and academic issues that stem from ADHD in the school environment. As a result, being successful at school can be very difficult for students with ADHD who do not have self-control (Miranda et al., 2006). Miranda et al. (2006) conducted an expansive literature review of studies that documented school-based interventions for students with ADHD between 1996-2005. They found that, "Together, with the behavior modification procedures, Curriculum Based Modification (CBM) techniques—self-instruction, reinforced self-evaluation, and anger control—were frequent components of the school-based programs for treating ADHD" (p. 46). However, with the large majority of the studies within the review focused on how to mediate behavior, not on academic methods that would strengthen students' academic skills such as their proper organization of school supplies and their ability to take coherent notes from the board. While all the interventions were found to positively benefit students with ADHD in the classroom, most of the interventions were focused on students in primary school. Thus, it cannot be confirmed as to whether the findings would generalize to adolescents.

Nowacek and Mamlin (2007) note that there is a dearth of literature on what modifications/strategies that teachers can put in place to meet students' needs. They conducted two multiple-case studies, one with primary teachers and the other with middle grade teachers (grades 4-6), to get a fuller understanding of how teachers identify students with ADHD, along with what modifications that they provide in the classroom. Both groups of teachers defined ADHD in reference to the criteria stated within the DSM IV for ADHD, including attention, distractibility, and hyperactivity.

More specifically, Nowacek and Mamlin (2007) stated that teachers "…identified difficulty coming to attention and difficulty sustaining attention as characteristics and commented on the unproductive movement often associated with students with ADHD" (p. 31). While the teachers were able to aptly characterize a student with ADHD, they did not employ many modifications, with one teacher stating the rationale behind this decision as, "…they are trying to get the students ready for high school, where they believed few modifications would be made" (p. 31). Despite this assertion, middle grade teachers stated that they did modify the environment for students with ADHD in their classrooms and their assignments, and they also used another person to support students with ADHD academically. These academic modifications were provided in conjunction with behavior modifications that were focused on elevating student movement and increasing attention (Nowacek and Mamlin, 2007).

Understanding Autism

The relatively new criteria posited by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (American Psychiatric Association, 2013) do not detail the inclusion of High Functioning Autism or Asperger's as a separate diagnosis; rather, it is embedded into the overall diagnostic criteria for Autism Spectrum Disorder (ASD) and is replaced with a severity scale for the diagnostic criteria. Inclusion within the general education classroom has been cited as being critical to the overall growth of students with autism and, in particular, Leach and Duffy (2009) note, "It is difficult to positively impact the social development of children with ASD if they do not have opportunities to learn alongside their typically developing peers who display well developed social skills" (p. 32). Leach and Duffy (2009) point out that a key component to success within the general education classroom for students with autism is the level and type of support from the special education teacher(s). They state the importance of teachers embedding preventive and supportive strategies within instructional practices for this population of students. More specifically, preventive "strategies may include planning practices, outcome options, environmental considerations, and grouping accommodations;" whereas, "supportive strategies include such techniques as attending to visual cues, verbal rehearsal of rules or directions, and peer-supported cues" (Leach & Duffy, 2009, p. 32). They also indicate that corrective strategies can be used when anything negative occurs; however, if both preventive and supportive strategies are solidified, corrective strategies might not be necessary. Essentially, it is of utmost importance that general education teachers be provided with not only concrete information about how to meet the needs of this population, but also the requisite support to implement what they have learned in their classrooms (Leach & Duffy, 2009).

Odom, Collet-Klingenberg, Rogers, and Hatton (2010) delve into this a bit deeper by detailing "twenty-four focused intervention practices" that teachers can implement within their classrooms for students with autism (p. 275). Odom et al. (2010) detail that, "Focused interventions…are individual instructional practices and strategies that teachers and other practitioners use to teach specific educational targets—skills and concepts—to children with ASD. Intervention practices that have been tested in high quality research designs and found efficacious are considered Evidence Based Practices (EBPs)" (p. 276). Using a distinct set of criteria, Odom et al. (2010) identified the following EBPs that would be successful for facilitating the academic success of students with autism: (1) prompting, (2) reinforcement, (3) task analysis and chaining, (4) time-delay, (5) computer-aided instruction, (6) stimulus control/environmental modification, (7) response interruption/redirection, (8) self-management, (9) structured work systems, and (10) visual supports. Prior to full implementation of an EBP, Odom et al. (2010) state the following, "The first necessary step in building a program for learners with ASD is through assessment of learners' skills, assessment of the requirements of their school, home, or community environment, and use of the information to establish learning objectives (i.e., as in a learner's IEP goals)" (p. 279). In conjunction, Odom et al. (2010) state that it is necessary to involve multiple people within this process, ideally, including the student with ASD, if at all possible.

Despite the emergence of these 24 EBPs to assist teachers, Odom et al. (2010) acknowledge that teachers may be aware of other potential EBPs that will assist their students with autism; however, the efficacy of these practices has not been documented by research. Thus, Odom et al. (2010) recommend that, "…the practitioner (may) draw on his or her teaching or clinical experience to select a practice having some evidence of efficacy for other outcomes and in practitioners' judgment has a high likelihood of teaching the learner the identified objective" (p. 279). Essentially, Odom et al. (2010) trust teachers and clinicians to embed practices that they strongly feel will meet student needs, while ideally collecting data on these potential EBPs to show the benefit of that practice on targeted outcomes. Thus, teachers of students with ASD have the confidence of utilizing the established EBPs that were verified by Odom et al. (2010) and/or putting in place additional practices that they are confident will meet student needs.

Understanding Learning Disabilities

Middle school science teachers need to have the requisite knowledge of what constitutes a specific learning disability, so that they may differentiate curriculum and instruction for this particular student population. In 1968, the definition of *specific learning disability* (SLD) was constructed and since that time, it has not changed (Kavale, Spaulding & Beam, 2009). IDEA (2004) defines *specific learning disability* as:

> A disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which disorder may manifest itself in an imperfect ability to listen, think, speak, write, spell or do mathematical calculations (Title I, Part A, Sec. 602.30).

Specific learning disabilities do not include learning problems that result from any visual, hearing or motor dysfunction, emotional disturbance, mental retardation, and/or any perceived cultural, economic, or environmental disadvantage. Dyslexia, developmental aphasia, brain injury, or minimal brain dysfunction, and perceptual disabilities all fall under the umbrella of specific learning disability (SLD) (P.L. 108-466. Sec 602[30]). However, Kavale et al. (2009) state the use of the word "specific" is not clear, which could lead educators and practitioners to use SLD improperly. Between 1977 and 2004, educators identified students with SLD by identifying a discrepancy between their intellectual ability and achievement in class. However, the use of the discrepancy model of identification was fraught with variability, both in regards to the methods used (grade-level deviation, expectancy and regression formulas, standard-score difference) (Kavale, 2002) and the measures used to test achievement and IQ (Kavale et al., 2009). Due to the lack of clarity in the definition along with the variability of the methods and testing measures, one could argue that "SLD soon transcended its boundaries and became a catch-all classification for a general class of learning problems" (Kavale et al., 2009, p. 42). To clarify this, Kavale et al. (2009) propose a more thoughtful definition that is both more specific in word choice, albeit longer. With the ambiguity surrounding SLD and its diagnosis, the use of Response to Intervention (RTI) was provided in the latest reauthorization of IDEA (2004) as an alternative approach to possible SLD diagnosis.

Response to intervention. IDEA (2004) suggests that schools enact a three-tiered Response to Intervention (RTI) model. Additionally, IDEA (2004) advocates that this model is a method of providing students at risk with the necessary interventions to see if they make adequate progress in order to not move forward with the special education identification process. The first tier of RTI entails ensuring that students receive the best possible instruction within general education, which includes differentiation. The second tier is reserved for students who have not met benchmarks and need more intensive support, and the final tier is reserved for evaluation for special education (Harry & Klinger, 2007). Thus, it is hypothetically possible to provide students with disabilities with personalized instruction within the general education setting to mediate any gap(s). In other words, rather than closely monitoring students' progress through pertinent artifact collection and anecdotal records, students are provided with targeted, differentiated instruction at one level, ranging to individualized intervention at the final level (Fletcher, Coulter, Reschly & Vaughn, 2004).

While RTI provides a better alternative for properly identifying students with learning disabilities and has been recently included as one method of identification for students with SLD in the California Code of Regulations (CCR, 5 CA ADC § 3030), it is another component that middle school science teachers might need to understand and employ within their classrooms, along with the understanding of the definition of SLD. RTI has a rather large research base supporting its use at the elementary level, particularly in the area of reading; however, these results do not effectively translate to the secondary level (Brozo, 2009; Vaughn & Fletcher, 2012). This is partly due to scheduling and structural concerns in middle and high schools, along with lack of content teacher knowledge—all of which are seen collectively as barriers to effective implementation.

With most students at risk or identified with a SLD having difficulty in language and literacy, listening and/or oral comprehension, followed by math, RTI is focused in these areas. However, as these areas are critical to understanding science concepts, it is imperative that general education science teachers know how to intervene and support students who lack mastery in these areas. Vaughn and Fletcher (2012) cite additional challenges for secondary teachers who are implementing RTI within their classrooms. While there has been evidence that reading interventions that target comprehension and word study difficulties have assisted secondary students with learning disabilities, they have not been tested in multi-tiered programs, such as an RTI model. In addition, there remains to be a dearth of reliable and valid tools to monitor middle school student progress within the RTI model. As Vaughn and Fletcher (2012) indicate, content area teachers face significant challenges when trying to effectively embed research based reading practices within Tier 1 instruction, which could inherently inhibit quality science instruction.

Developing an Understanding of Dyslexia

Dyslexia falls under the umbrella of specific learning disability (SLD). Lyon, Shaywitz and Shaywitz (2003) provide the most current definition of dyslexia with the following:

> Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge. (p. 2)

Long, MacBlain and MacBlain (2007) describe a detailed case study of how a school based team facilitated the success of a tenth-grade student with dyslexia. The central goal of this intervention was to put strategies in place to aid in his success with the burden placed on school personnel, while also teaching specific strategies to the student that he could implement on his own. Initially, a training day on dyslexia, including strategies on how to best ameliorate it, was provided to all staff. "This was followed up by individual school departments' examining their policies on the marking of spelling and grammar and some attempt being made to ensure consistency of approach" (Long et al., 2007, p. 128). Thus, the case of this student was not isolated, but looked at as an opportunity to better meet the needs of all students.

The components of this intervention plan included the student not being asked to read aloud in class, the student and his peers who had similar needs being told not to copy notes from the board, and the student being coached on how to be proactive in his own learning with the use of graphic organizers and other similar tools. In addition, a mentor was provided to the student who acted as a liaison between him and other staff members, as needed. Finally, all teachers embraced an interdisciplinary curriculum approach, with study skills taught similarly across all subjects and teachers investing time in creating displays of "model answers" (Long et al., 2007,

p. 128). All students were directly taught how to look over their work carefully and make sure that their answers were complete, especially when given extra time (Long et al., 2007). Working in concert with this student, learning goals were set and, when reached, appropriate rewards were provided. After six months, there was no longer a discrepancy between this student's reading score and his cognitive ability. In addition, he felt that he had better relationships with his teachers and that the whole intervention was very motivating to him. This increased feeling of motivation on behalf of the student was echoed by seven out of his ten teachers (Long et al., 2007).

As a result of this case study, Long et al. (2007) noted that there was a "… need for closer examination of teacher-student empathy when exploring the quality of the learning environment" (p. 130). Thus, Long et al. (2007) administered a pilot survey designed to understand the learning needs of students with dyslexia, as well as their thoughts regarding the school support they received. Twenty-five students completed this survey, and amid the findings, almost all of the students indicated that their teachers did not truly understand what they needed, nor would the students approach their teachers if they were experiencing a problem. Long et al. (2007) states that the survey results indicate "…that students with dyslexia internalize feelings of failure as a result of their dyslexia and not as a result of their lack of effort or commitment" (p. 131), which could also be applied to other students with special needs. Essentially, when a student is diagnosed with a disability, more than just the core symptoms of that disability need to be addressed. A holistic approach needs to be taken into account, with relationships central to the intervention.

While Long et al. (2007) promote the use of a holistic approach to assist students with dyslexia, Reid, Strnadova, and Cumming (2013) suggest a more targeted approach using available mobile technology, which is grounded in the preventative approach of UDL. UDL is centered on three principles: representation, engagement, and expression (CAST, 2015). Reid et al. (2013) state that, "Used and customized correctly, this technology [mobile technology such as iPads], aligns well with UDL as it can provide multiple means of representation, engagement and expression, and benefits all students, allowing them to experience learning in the modalities they are strongest in" (p. 176). Reid et al. (2013) point out that students with dyslexia usually need support in all literacy areas (reading, writing and spelling) as well as organization. Tablets that have a read-aloud function can be incredibly beneficial for students with disabilities, with apps such as *Goodreader, Speak It!* and *Web Reader* being particularly helpful (Reid et al., 2013).

Reid et al. (2013) also indicate that "Dynamic word processing applications can be very useful for students with dyslexia who have difficulties composing text" (p. 177). With many different word processing applications, Reid et al. (2013) note that teachers and parents need to critically think about which one will meet students' needs. Similar to those for reading and composition needs, there are a variety of apps, such as *iTalk, AudioNote* and *Dragon Dictate,* which can all assist students with dyslexia. A variety of applications are also available to assist students with their organization and study skills, all of which, in conjunction with the other applications provide students with dyslexia tools to be able to access the curriculum much easier than before. Thus, it is critical that teachers be properly trained on how to integrate these tools within classroom instruction and assessment, so that there is a seamless transition for all involved.

Developing an Understanding of Central Auditory Processing Disorder

Chermak and Musiek (1992) detail a series of strategies on how to assist students with Central Auditory Processing Disorder (CAPD) within the classroom. Students with CAPD typically are classified as having a specific learning disability (IDEA, 2004). Students with CAPD can show a variety of deficits, such as finding it hard to understand speech when there is significant background noise, having very little attention span, having a difficult time remembering complex information received through auditory means, finding it challenging to remember verbal directions, in addition to not performing to their potential in reading because of difficulty hearing the phonetic sounds correctly (Breedin, Martin, & Jerger, 1989; Ferre & Wilber, 1986; Jerger, Martin & Jerger, 1987; Jerger et al., 1991; Musiek & Geurkink, 1980; Willeford, 1985). Usually, a child diagnosed with CAPD is found to be very inattentive and a poor listener. Chermak and Museik (1992) point out that, "Children and youth with CAPD can become skilled listeners who are actively engaged in discovering what speakers are communicating. To achieve this goal, however, these children and youth must use various strategies to guide their listening and extraction of information from the spoken message" (p. 62).

These strategies include teaching students skills such as: effective paraphrasing and summarizing of material, practicing logical inferences, along with self-regulation and self-evaluation. In particular, students with CAPD need to be taught how to use formal schemata to assist them with processing what they hear. Formal schemata include additive, adversative, temporal, and causal connectives (e.g., *and, but, before*, and *because*, respectively), and patterns of parallelism and correlative pairs (e.g., *not only/but also*; *neither/nor*). The organizing function of schemata is most salient in global patterns, such as *in conclusion*, *and finally*, and *in the beginning*. The integrating and predicting functions of schemata demand greater linguistic sophistication: listeners must focus attention on patterns that fuse and foreshadow ideas, facilitating the construction of relationships and message comprehension. Recognizing the causal connective *because*, for instance, aids message comprehension as *because* predicts the nature of the relationship between two clauses in a sentence (Chermak & Musiek, 1992, p. 64).

Thus, students need to be explicitly taught to listen for these formal schemata to aid in their understanding of what is being stated to them both inside and outside the classroom. However, the acquisition of formal schemata, as well as the application of specific strategies is not enough. Students with CAPD also need be provided with mnemonics, in addition to being taught how to chunk (i.e., group and categorize what they have to hear), and also how to chain together individual items into a story (Wilson & Moffat, 1984). These pieces mentioned above, in concert with being able to effectively apply contextual clues to understand and retain the meaning of the vocabulary they are being told (Miller & Gildea, 1987), all contribute to assisting students with CAPD understand and retain the knowledge that they have been told.

Knowledge of Dual Diagnosis: Emergent Bilingual and Learning Disability

There is an overabundance of emergent bilinguals being diagnosed as learning disabled (e.g., Artiles et al., 2005; Sullivan, 2011), which again, is especially prevalent in California (Artiles & Ortiz, 2002). Yet, McCardle et al. (2005) detail that it is not merely a problem of over-referral for a learning disability for emergent bilinguals, but also proper under-referrals as well. More succinctly, emergent bilinguals are not being properly identified as either having or not having a learning disability. Zetlin, Beltran, Salcido, Gonzalez, and Reyes (2011) point out that it is imperative that trained professionals be involved in cases to determine whether the student’s learning difficulties might require special education services, or just support for English learning in the classroom. Similarly, if a student who is an emergent bilingual is identified as having a disability, it is also critical that those who provide special education services have experience working with emergent bilinguals (Zetlin et al., 2011).

After the referral and identification processes are complete, teachers are charged with creating and/or finding curriculum and instructional materials that support each student's learning needs, but are also culturally and linguistically appropriate (Zetlin et al., 2011). Yet, one would also argue that this tenet would apply to teachers working with this sub-group of students who do not have a formal diagnosis of a learning disability. Nevertheless, to mediate such difficulties for this diverse group of students, Rueda and Windmueller (2006) suggest that educational stakeholders used a tiered approach modeled by Rogoff (2003), in which educational problems are examined through three lenses: individual, interpersonal, and cultural-institutional. At the individual level, factors such as motivation, cognition, and executive functioning are considered, which is coupled with interpersonal relationships and how they affect group work and achievement, for example. Finally, cultural-institutional factors include family, school, and community level characteristics. While Rueda and Windmueller (2006) state that in order for the overrepresentation of emergent bilinguals diagnosed with learning disabilities to be addressed, it is imperative that all three components be given adequate and equitable consideration within the process. One could argue that this systemic approach, which often includes setting short and long term goals within and across each lens is necessary to adequately address the academic needs of this sub-group.

Curriculum Purpose, Development and Choice

Young (2013) points out that even though curriculum lists a set of standards or objectives for students to obtain, the knowledge that is gained is shaped inherently by the students' abilities themselves. Curriculum is a set of "rules and standards by which reason and individuality are constructed" (Popkewitz, 1997, p. 145). The construction of curriculum is largely hampered by political agendas and the rapid expansion of schools across the country. Rather than focusing on the growth of knowledge as a powerful intrinsic aspect to one's own learning, the acquisition of knowledge via curriculum has been fraught with how the acquisition of that curriculum will lead to employment. Additionally, curriculum must take into account students' individual experiences, as the knowledge that is mastered is largely grounded in concepts and standards that can be applied to one's own life (Young, 2013). Curriculum must also challenge students and promote high expectations in order for students to reach their maximum potential (e.g., Oakes, 2005). Thus, while curriculum is a tool to organize standards and expectations and provide students with new knowledge, there are inherent barriers in this complex mission.

When developing curriculum, it is critical that the needs of all students be taken into account. Avcı and Akınoğlu (2014) state that, "One of the most important reasons for school failure is the fact that the curriculum does not address the students" (p. 198). Avcı and Akınoğlu (2014) surveyed 592 teachers on their use of differentiated instruction practices. Within this survey, they asked teachers what influences them in selecting their instructional materials for their classrooms. Among these 12 factors, only three had any relation to differentiated instruction. The top factor in choosing the curriculum was its potential to entertain students, as the teachers cited the fact that they have to compete with electronics now for students' attention. Next, teachers looked critically at the materials for the potential of student retention of materials, with their analysis of curriculum objectives ranking eighth in the selection process (Avcı and Akınoğlu, 2014). One could conclude that choosing curriculum is much more complex than originally thought, as there are several other moderators that influence such decisions, including teacher content knowledge and the diversity of the student population. While many teachers have to use mandated curriculum provided to them by their school or district, teachers need to make choices on which pieces of that curriculum they will use daily and how they will modify or adapt that curriculum to meet the needs of their students.

Implementing Science Curriculum within the Age of Standards-based Reform

Lynch, Pike, and Grafton (2012) implemented three curriculum units (*Chemistry That Applies, Motion and Forces,* and *The Real Reasons for the Seasons)* that met the criteria used by Kesidou and Roseman (2002). Scaling-up Curriculum for Achievement Learning and Equity Project (SCALE-uP) was a research project that was conducted from 2001-2007 across three middle schools to determine the efficacy and sustainability of these units within the context of current educational policy. The units were implemented in five treatment and comparison schools each year, with about 80 classrooms participating. Units were then "scaled-up" or expanded to other schools if they were deemed to be mildly successful (Lynch et al., 2012).

The chemistry unit was found to be highly effective with all subgroups within all five initial middle schools, including those with special needs, and thus, was expanded to all the districts' 30+ middle schools. Despite this, it was deemed cost prohibitive and time consuming. The Seasons unit yielded abysmal results, with all students being outperformed by the comparison group. It distinguished itself from the other units by being mostly teacher directed, yet, along with the chemistry unit was still an approved set of curriculum materials. The results of the Motion and Force unit were inconsistent and not statistically significant, with very little difference between the comparison group and the Motion and Force group at full implementation (Lynch et al., 2012).

Due to these lackluster results, this study offers some very valuable conclusions. First, while the criteria used by both Lynch et al. (2012) and Kesidou and Roseman (2002) were grounded in the curriculum analysis entitled Project 2061, there is limited support that they are a valid measure of the curriculum effectiveness. Lynch et al. (2012) elaborate on this with the following, "…the relationship between the Curriculum Analysis as a procedure performed by a group of experts examining a curriculum unit by reading and analyzing its components and how the unit is actually enacted in classrooms now seems, at best, dubious" (p. 325). Lynch et al. (2012) point out that their implementation of the units did not keep pace with the new state requirements for instructional frameworks and assessments. Essentially, even the best laid out units that meet every criterion for research-based best practices might not yield the most effective results in the classroom with all student populations. As Lynch et al. (2012) put it, "Implementation of even well designed science curriculum materials clearly does not take place in a practice and policy vacuum" (p. 328).

Standards Based Reform Movement and Students with Special Needs

Porter, Polikoff and Smithson (2009) succinctly state that, "Standards-based reform is meant to influence what is taught and in that sense, what students learn" (p. 241). In theory, standards-based reforms can be largely beneficial for improving teachers' instructional practices and student achievement if they clearly specify what teachers need to teach, are not altered to create confusion among teachers, are promoted by passionate experts within the field, and stay in place for a significant period of time (Porter et al., 2009). Hamilton, Stecher and Yuan (2008) point out that while the development of academic standards is the major component of standards-based reform, there are no agreed upon guidelines for how to develop those standards.

The number of students between the ages of three to twenty-one receiving some form of special education service was approximately 6.4 million in 2012-2013. This equates to about 13 percent of all students in public schools, with 35% of the students receiving a diagnosis of a specific learning disability (NCES, 2015). While some of these students are included in the general education classroom, others are not, with the exact numbers in each division unknown. Content and performance standards are meant to be challenging and, thus, can be at odds with the individual needs of students with disabilities (McDonnell, McLaughlin & Morison, 1997). However, “For a number of students with disabilities, the general education goals and instructional objectives associated with standards-based reforms are likely to be compatible with their individualized education programs” (McDonnell, et al., 1997, p. 118). McDonnell et al. (1997) point out that only students with very severe disabilities will not be able to partake in the general education classroom. Since the inception of state standards, it was thought they should be applied to all students. However, as with both the state and national standards, there is a scant amount of information on how to assist students with special needs in meeting these standards (McDonnell et al., 1997).

Instruction

With the adoption of the NCLB Act (2002), teachers have had to match, and in some cases, modify and reinvent, their instruction to align with content and performance based standards (e.g., Stevenson & Waltman, 2005). Thus, Greene et al. (2008) examined the teaching practices and insights of middle school teachers resulting from this reform. Middle school teachers across 13 schools were given a 45-item survey, and results indicated a mixture of positive and negative responses in regards to instructional practices since the implementation of NCLB. Teachers indicated that they adopted different methods for teaching writing and placed emphasis on problem-solving strategies within the classroom. Peer tutoring and self-reflection were embedded within classroom instruction, and reading and writing were integrated with content area instruction. However, teachers also commented on how difficult these standards were for students with special needs and how they did not take into account the developmental stages of adolescence. Based on these findings, Greene et al. (2008) state that middle schools need to find a balance between meeting accountability demands and the needs of their students.

Best Practices in Middle School Instruction Motivating Students to Succeed

Adolescents are unique in that they are gradually seeking independence and begin to look to their peers and teachers for advice first and foremost, instead of their parents (Teague, Anfara, Wilson, Gaines & Beavers, 2012). As such, middle school students need to know that their teachers and peers deeply care about their success. When middle school students acknowledge and feel a part of this team-based atmosphere, they are motivated to do well (Mac Iver & Plank, 1996). Mac Iver and Plank (1996) expand by stating:

> Another potent source of motivation for middle school students is curriculum and instruction that relates to their current interests, connects well to future educational and occupational goals, features intrinsically interesting higher-order learning tasks, and offers leeway for social interaction, student initiative, creative expression, and active participation in the learning activity. (p. 2)

When middle school students feel support from their teachers and peers, in addition to seeing the curriculum and instruction being relevant, student led (as much as possible), and engaging, they then need to experience frequent academic success to build confidence in themselves. When students have continued confidence in themselves, they try harder (Mac Iver & Plank, 1996), and this can lead to a more positive learning environment for all those involved. More broadly speaking, teachers need to know their students and deeply understand their cultural, linguistic, and familial backgrounds to effectively gauge what will motivate them to do well academically (McCardle et al., 2005).

Challenges to Providing Effective Middle School Science Instruction

One barrier to effective instruction in middle school science classrooms is the lack of teacher training with relatively few teachers specializing in science (Berube, 2000; Allen, 2007).

This is compounded by the fact that Weiss, Banilower, McMahon and Smith (2001) found that nearly two-thirds of their counterparts, elementary school teachers, did not have a working knowledge of the *National Science Education Standards* set for by the *National Research Council*. Thus, it can be inferred that middle school science teachers might face formidable content area gaps when trying to assist their students in reaching grade level standards. However, Weiss et al. (2001) found that two-thirds of the middle science teachers surveyed were at least knowledgeable about the document and 69% agreed with it. Tindal and Nolet (1996) state that a limited number of special education teachers have content area backgrounds comparable to teachers that specialize in certain science concepts, such as Earth Science. While general education students often receive science instruction that promotes higher order thinking skills, special education students are often provided with a limited curriculum that does not exude the research based principles of a regular content area science class (Tindal & Nolet, 1996). However, meeting the needs of special education students in the general education science classroom can be inherently difficult (Tindal & Nolet, 1996).

It is imperative that teachers, both in the general and special education classrooms, have an understanding of the science concepts taught not only in their grade, but also in the grades above and below them (Berube, 2000). This will allow teachers to build on the knowledge that should have been mastered from the previous grades and extend it, if the time prevails. Yet, Marx and Harris (2006) point out that the various levels and subsequent amounts of professional development needed to attain this goal nationwide does not exist. Thus, it is recommended that states partner with universities to build a sustainable infrastructure to support this much needed professional development (Marx and Harris, 2006). Teachers need to be prepared with student-directed activities that are engaging and hands-on, and teachers need to ensure that they have built a community within the classroom to foster such activities (Allen, 2007).

Best Practices in Science Instruction

There has been a significant interest among educational stakeholders, particularly science educators, to share best practices in instruction. Despite this interest, there remains to be little empirical evidence such as high student achievement to support these practices (Oliveira et al., 2013). Rivet and Krajcik (2008) state that while there is literature to support instruction that draws upon students' prior knowledge and experiences, there is little empirical evidence that supports this claim. Project-based learning has been found to integrate students' prior experiences successfully, or rather to effectively contextualize the instruction (e.g., Krajcik, Czerniak, & Berger, 2002). Rivet and Krajcik (2008) define contextualizing instruction as, "the utilization of particular situations or events that occur outside of science class or are of particular interest to students to motivate and guide the presentation of science ideas and concepts" (p. 80). With contextualized instruction, the students are more readily able to make connections between concepts rather than focusing on the immediate recall of facts and figures that they will lose after they are tested on it (Rivet & Krajcik, 2008).

Rivet and Krajcik (2008) examined two eighth-grade classrooms that were "part of a district-wide reform effort in science in conjunction with the Center for Learning Technologies in Urban Schools (LeTUS)" (p. 83). The goal of this program was to infuse technology, which was accomplished through project-based learning. Rivet and Krajcik (2008) studied six students of average ability in one classroom and five students in another classroom across 23 lessons total during the 10-week unit on force and motion. Each student was given a score of 0-5 for each lesson based on how well they were able to relate concepts to other known concepts, as well as their prior experiences. Pre- and post-test score gains indicate that the seven students who had higher contextualizing scores than their peers made the most significant gains. However, Rivet and Krajcik (2008) cautioned the readers to not assume a causal inference between the assessments and the contextualized scores from the observations, as some students scored significantly higher on the student artifacts (concept maps and responses to four open-ended questions) that standard multiple choice assessment given.

Oliveira et al. (2013) sought to understand the middle school science instructional practices of seven high and three average performing middle schools as determined by the grade 8 and Earth Science Regents Exam in New York State. A qualitative multiple case study was conducted with 33 total classroom observations and 83 interviews of 2-4 administrators and 4-6 teachers at each site. Oliveira et al. (2013) identified five instructional components that were imperative to student achievement, including use of relevant and engaging curriculum, hands on activities, differentiated lessons, collaborative work and the use of homework to facilitate learning. Specifically, the inclusion of inquiry-based lessons and assignments were closely associated with an engaging and relevant curriculum. Although not mentioned in depth, Oliveira et al. (2013) noted that the integration of reading and writing, along with other subjects were closely associated with the student achievement of higher performing schools. The integration of special education students within the general education classroom was deemed effective, because the special education teacher took part in the instruction, relying on the content expertise of the science teacher (Oliveira et al., 2013).

Assessment

Brookhart, Walsh and Zientarski (2006) state, “Typically, classroom instruction is driven by goals or objectives and then student success on these goals and objectives is assessed” (p.

155). Assessment may be formal and tied to larger objectives, such as evaluating students' performance at the end of a unit, or informal and associated with smaller objectives, when a teacher wants to understand if the student can explain the meaning of a vocabulary word within the duration of a lesson (Brookhart et al., 2006). Bailey, Heritage, and Butler (2014) note the importance of assessing interactions among students and adults with the following: "Children learn through their oral interactions with peers and adults, and the ability to take into account another's knowledge and perspective is important in the process of learning" (p. 12). Interactions among peers and their teacher(s) during content area learning are often deemed to be informal assessment, and the inherent value of these interactions cannot be negated as part of the assessment process.

Stiggins (2002) argues that teachers and other educational stakeholders also need to use assessment as a tool *for learning*, not just *of learning*. More specifically, "When they assess *for learning*, teachers use the classroom assessment process and the continuous flow of information about student achievement that it provides in order to advance, not merely check on student learning" (Stiggins, 2002, p. 5). Stiggins (2002) details several action steps that teachers must undertake in order to assess *for learning*:(1) ensure that students understand the requisite learning goals that they need to accomplish for each unit, (2) use classroom assessments as a tool to increase students' confidence in themselves and take charge of their own learning, (3) modify/adapt instruction as much as necessary based on classroom assessments, (4) engage students and families in continuous dialogue about their assessment results throughout the year and finally, and (5) have the requisite assessment knowledge to be able to construct assessments that will accurately assess student knowledge. Shepard (2000) adds onto this paradigm by stating that students should take an active role in evaluating their own classroom assessments. In addition, the tasks they are tested on should be challenging and ensure that they effectively gauge both learning process and outcome (Shepard, 2000).

Essentially, assessment should be a tool that is used to aid teachers with modifying, adapting, and enhancing their instructional practices as needed to motivate students and accelerate their learning. Assessment should be used for a variety of key decisions that affect student learning and growth (Bailey, et al., 2014). Bailey et al. (2014) details how assessment can be used to identify strengths and weaknesses of students, with appropriate changes made to the program/curriculum as a result, as well as illuminate what needs to be taught to students in the interim. What is clear, however, is that assessment should not be a punitive measure that places blame on teachers and students which is often the result of summative, standardized assessments. Bell and Cowie (2000) detail the importance of formative assessment, as it serves its purpose when it allows teachers to make needed adjustments to their instruction based on the data they receive, whether in the form of written responses or peer dialogue (Duschl & Gitomar, 1997). Bell and Cowie (2000) also detail the importance of teacher knowledge in regards to formative assessment, with teachers' analysis of data critical to their action steps in providing appropriate supports for students. Standardized test data, often received well after the previous class has moved onto the next grade, do not serve the same powerful purpose as formative assessment. While standardized tests will be a mainstay within schools, we need to adequately balance that with assessments *for learning* (Stiggins, 2002), as improved formative assessments have the inherent power to elevate learning, including standardized test scores (Black & Wiliam, 1998), thus culminating in a reduction of the achievement gap (Stiggins, 2002) and, most likely, an increase in motivation.

Classroom Assessment and Motivation

When a classroom assessment is administered in a certain classroom environment (e.g., Brookhart, 1997), the dynamics and composition of that environment can greatly influence a students' effort on that assessment. More specifically, "…students' perceptions of the assessment task (interest, value, importance), perceptions of their ability to accomplish it (self-efficacy), and perceptions of the reasons they want to accomplish it (goal orientations) are interrelated" (Brookhart et al., 2006, p. 153). As such, each of these components greatly influences not only how much effort students will exhibit toward the task, but how well they do on the task as well (Brookhart et al., 2006). However, these motivational factors only come into play when the students know that they are going to be assessed. Informal notes by the teacher(s) about student performance on a day-to-day basis that students are unaware of will most likely not influence a student's effort towards accomplishing the task and requisite achievement. Similarly, the type of task, whether a short quiz that allows the student to use the textbook as a reference, a final test that is a culmination of months of learning certain concepts, or a final project based on students' interests in the topic area will all draw varying levels of effort and achievement among diverse groups of students (Brookhart & DeVoge, 1999).

Brookhart et al. (2006) investigated the varied levels of motivation and effort among 223 eighth grade students on a paper and pencil test, as well as a performance assessment chosen by their regular science and social studies teachers and taken in their usual classroom environments. The teachers worked in teams of two, with both science teachers planning together and using the same paper and pencil test and performance assessment on the same topic. When each assessment was administered, students were given a survey with seven scales to gauge their motivation and effort. The students' test scores for one science teacher were lower than the other science teacher's students test scores (95% to 79%). The students in both classrooms had similar perceptions in regards to their motivation and effort for both assessments, with the exception that one teacher's students viewed the paper and pencil test as having lower value than the performance task. Motivation, self-efficacy, or the belief in themselves that they could do well on an assessment task, was the strongest predictor of student achievement. Thus, motivation, whether in the context of curriculum and instruction, or assessment is a critical component to ensuring student success.

Classroom Assessment for Students with Learning Disabilities

Many students with IEPs and 504 plans have modifications and adaptations specified in regards to both instruction and assessment that range from extended time on tests, to the ability to use assistive technology during the test. However, at the outset, Weisgerber (1994) advocates for including students with disabilities in instructional and assessment conversations, as this will provide the teacher with critical insight for the teacher as to what the student needs. More broadly, students with disabilities are included in large-scale assessments such as standardized tests, where usually universal design principles or item test adaptations are applied (Cawthon, Leppo, Carr & Kopriva, 2013). With universal design, test items are designed considering multiple groups, such as those with hearing and/or visual impairments, and how these groups can access these items. Whereas with item adaptations, the individual test items that were previously constructed were modified to meet the needs of a particular group of students. When item adaptations are made, it is usually for one specific group, such as for emergent bilinguals or students with disabilities. Thus, adapting large-scale assessments for students with disabilities can be inherently complex with so many pieces to keep in mind for each sub-group.

Classroom Assessment and Literacy

The ability to read and write competently will, not surprisingly, aid in the acquisition of science concepts, vocabulary, and practices. However, it is critical that middle school science teachers be able to accurately assess their students' science knowledge without inherently relying on their ability to read and write well. In an effort to assess the efficacy of the Seeds of Science/Roots of Reading (S&R) curriculum developed at the UC Berkeley's Lawrence Hall of Science, a *read along* (a read aloud) was developed where a teacher reads through certain scenarios tied to the science content within the unit. As the teacher reads through the script, he/she pauses at certain time points asking students to attend to certain activities related to the scenarios to show mastery of the science content (Pearson, Knight, Cannady, Henderson, & McNeill, 2015). Pearson et al. (2015) also detail several effective methods of assessing science vocabulary. Asking students for a definition of the word and/or examples, along with a title for a combination of words, in addition to questioning and cloze passages, have been found to be effective methods of assessment (Cervetti, Hiebert, Pearson, & McClung, 2010). Despite finding a way of integrating literacy to gauge content knowledge and being able to assess vocabulary for multiple mediums, it was particularly challenging to assess students' knowledge of developing an argument within the context of science (Pearson et al., 2015).

To address this challenge, Pearson et al. (2005) drew from the perspective of learning progression, in which students gradually acquire more substantive argumentation skills over time through varied methods of support in the classroom (Berland & McNeill, 2010). Across the reading, writing, and speaking domains, Pearson et al. (2015) describe varied levels of progression in which students sequentially build upon the last step to show mastery of the content with appropriate supports. For example, in writing, students are asked to respond to a question and are given a rubric that clearly states that the goal is to not only back up the claim with evidence, but to also consider alternative ideas. Pearson et al. (2015) also posit that we need to assess students' intrapersonal and interpersonal science argumentation, with the former focusing on a students' ability to assert scientific claims and provide supportive evidence and the latter focusing first on a student's ability to listen to his/her peers, critique what he/she hears, and meld his/her own claim with what is heard.

More specifically, Berland and McNeill (2010) detail three components of a learning progression: (1) instructional context, (2) argumentative product, and (3) argumentative process. Within these three components, Berland and McNeill (2010) detail how students' mastery of these components can be assessed along a continuum. For example, when assessing claims within the argumentative product produced by the student, a simple level of mastery would be when the student just defends his/her claims; whereas, a level of complex mastery would be indicative when a student not only defends his/her claims with evidence, but reasoning as well. Overall, Pearson et al. (2015) make the critical point that it is pivotal that we assess along a continuum, and their illustration of how to do this with argumentation is a vital component of any teacher's skillset.

Moving Towards Assessments that Align with NGSS

In addition to integrating and assessing science content through reading, writing, and listening/speaking, teachers are charged with the task of being able to assess students' ability to question and reason deeply about complex scientific scenarios. Ryoo and Linn (2015) sought to meet this challenge by designing two inquiry-based assessments titled *Energy Stories* and *MySystem*, which were part of the research program Cumulative Learning using Embedded Assessment Results (CLEAR). Ryoo and Linn (2015) point out that the Trends in International

Mathematics and Science Study (TIMSS) assessment does not adequately assess students' science content knowledge because they do not probe at students being able to make connections among scientific ideas. Similarly, students are often tested on the most recent content, not their ability to be able to integrate concepts and vocabulary that has been learned across units, which is a weakness of many current science assessments (Ryoo & Linn, 2015). Energy Stories and MySystem address these weaknesses, with Energy Stories asking middle school students to draw upon their energy concepts from photosynthesis and cellular respiration to create a narrative story, while MySystem appeals to visually oriented middle school students as they are asked to create a graphic model on the computer of an energy system. Rubrics accompany both assessments focusing on "…scientifically valid links among ideas rather than detecting correct or incorrect ideas" (Ryoo & Linn, 2015, p. 244). A major strength of both assessments is that they do not focus on recall of ideas; rather, they force students to integrate their ideas into a cohesive piece of writing and graphical representation of energy systems, thus being more effective at evaluating the complex reasoning of a student around a certain topic, such as energy systems. It is clear that with the emergence of NGSS (2013), teachers need to refine their assessment practices to measure students' abilities to engage in complex reasoning; however, such a shift will most likely necessitate needed reflection and/or professional development among teachers.

Use of Teacher Portfolios to Monitor and Reflect on Instructional Practices

Portfolios are commonly used to assist teachers in examining their content and pedagogical content knowledge (Shulman, 1987). In addition, portfolios have the potential to have teachers reflect on their teaching environment, their belief systems and their classroom management, all of which are often intertwined with their instruction (Tigelaar, Dolmans, De Grave, Wolfhagen, & Van Der Vleuten, 2006). More specifically, Pitts and Ruggirello (2012) state that portfolios can be a catalyst for "reflection (which) is comprised of identifying and describing an experience through selection of evidence, analyzing it using a conceptual framework, and uncovering assumptions and conveying future action by articulating growth" (p. 51). As such, portfolios cannot just be a collection of artifacts, rather their construction necessitates built in components for annotation that guide teachers toward reflective practice. Portfolios are a tool that allow teachers to reflect on their teaching and identify areas that can be strengthened or enhanced in the short and/or long term.

Used in both teacher preparation programs and in school districts, portfolios have been examined to specifically understand the growth in teacher candidates and practicing teachers' reflective practices. Fox et al. (2011) sought to understand the growth of reflective thinking among 51 teachers ranging from elementary to high school in an advanced master's degree program. Data analysis was based on the four reflective levels (*awareness of inquiry, beginning to act on one's own inquiry, middle stages of inquiry* and *full engagement in inquiry*) from Rodgers (2002). A fifth level of inquiry *implications of inquiry beyond one's own classroom*, came from the data analysis. Eighty-two percent of the teachers' first reflections were deemed at level one, whereas 30% and 45% of the final reflections were deemed at a level four and five, respectively, indicating growth in reflective inquiry (Fox et al., 2011). Teachers' level of reflection was analyzed from the beginning of the program to the end, noting how several teachers progressed through the levels of reflection (Rodgers, 2002). Through these reflections, Fox et al. (2011) analyzed how these levels of reflection were applied to the professional practice within the classroom. This match or mismatch between personal reflection and actual implementation of their improved instructional/assessment practices provided the basis for whether their reflection increased levels. Teachers also wrote a synthesis reflection after the completion of all coursework requirements, which confirmed the higher number of reflections deemed at a level four or five at the end of the program. Cementing these findings, Borko et al. (2005) reported that teachers found that their reflections from student work samples and lesson plans were "personally engaging and professionally valuable" (p. 95).

Portfolio Use to Foster Reflection on Diverse Student Populations

The National Commission on Teaching and America's Future (1996) stated that the National Board for Professional Teaching Standards (NBPTS) are framed with the intention of getting teachers to reflect on their practice with the result of them improving their craft. However, there is a dearth of literature that explores how such standards assist teachers in reflecting upon their practice in regards to differentiation strategies that are specifically provided to students with special needs. Fox et al. (2011) mentioned how teachers' reflections on their required case study "…increased their awareness of their students' learning styles and the importance of designing instruction that considered the various ways students learn" (p. 156). Kloser et al. (in press) noted that teacher notebooks that ranked in the higher quartile showed evidence of adaptation from assessments. For example, Kloser et al. (in press) note that, "Lisa used information gleaned from students' pre-writes and lab reports to identify students who might need additional attention or concepts to review" (p. 35). While a casual inference cannot be made from this deduction, it does indicate that portfolios have the keen ability to capture nuances in differentiated practice.

Kitchenham and Chasteauneuf (2009) analyzed 1,427 reflective statements from teacher candidates at the University of Northern British Columbia. Using the critical reflection model from Mezirow (1998), it was found that approximately 27% (390) of statements fell under the realm of epistemic critical reflection. Within their examples of epistemic critical self-reflection, Kitchenham and Chasteauneuf (2009) point out a teacher candidate who acknowledged the differences among the students in two biology sections and how he had to modify his teaching and lesson plans to meet student needs. Other epistemic student reflections indicated that teacher candidates recognized that their style of learning often did not match that of their students. Hence, teacher candidates needed to design and modify instruction to meet their students' needs. While both Kitchenham and Chasteauneuf (2009) and Fox et al. (2011) both touch on how reflections among teachers assisted with their acknowledgment of student' differences, Park and Oliver (2008) documented how teachers reflected upon student learning needs and implemented changes in their curriculum/instruction based on those needs.

Park and Oliver (2008) explored how the National Board Certification (NBC) process would influence the pedagogical content knowledge (PCK) (Shulman, 1986) of three high school science teachers. Multiple methods (observations, interviews, teacher reflections and field notes) illuminated how going through the NBC process led to a detailed analysis of student learning needs and an "increased variety in their instructional modes, more careful student grouping, and increased tailoring of their instruction to individual students" (Park & Oliver, 2008, p. 826). Park and Oliver (2008) detailed how this process was specifically helpful for tailoring instruction for students with special needs. More specifically, the use of portfolios led to "…increased variety in their instructional modes, more careful student grouping and increased tailoring of their instruction to individual students" (Park & Oliver, 2008, p. 826). While Park and Oliver (2008) did not delineate which special needs were particularly addressed within the portfolio, it is clear that the portfolios aided teachers in differentiating instruction for all students' levels.

Meeting the Needs of All Students

Regardless of their level and type of certification, teachers need to have a wide foray of knowledge, skills and strategies to meet the needs of all learners. For middle school science teachers, they not only need to know science content, which is often the focus of their teacher preparation programs, but they also must know how to effectively meet the needs of special education students in their classrooms. With the influx of standards based reforms such as the Common Core (CCSSI, 2014) and NGSS (2013), this adds a new level of difficulty to teaching content area instruction and students with special needs. While there are a variety of curriculum resources and instructional strategies that are research based, none are fully inclusive of both the standards and differentiation strategies for students with special needs that would aide teachers in the classroom. Thus, it is imperative that we deeply understand the context of middle school science classrooms, their diverse populations and how teachers are working towards meeting the needs of special education students under the auspices of the increased rigors of curriculum and instruction that are put forth by the NGSS (2013) and Common Core (CCSSI, 2014). Understanding how teachers reflect upon and monitor their instructional practices for students with special needs through the use of an electronic portfolio and other potential tools will assist in laying the groundwork for potential support systems for teachers in this area.

Differentiation, Personalization and UDL

McTighe and Brown (2005) state, "One of the most vexing issues facing contemporary educators involves seemingly competing imperatives of meeting high stakes accountability standards while addressing the individual needs and strengths of diverse learners" (p. 234). Fortunately, all teachers, regardless of grade level or curriculum, have access to three approaches—differentiation, personalization and UDL—all of which provide associated strategies to assist teachers in meeting the needs of all learners in an age of standards based reform. Yet, personalization separates itself from differentiation by emphasizing student motivation and a good "match" between the learner and his/her learning environment. Anderson (2011) states that, "Mass education is adequate, as long as students are highly motivated to learn and get ahead of their peers" (p. 13). Thus, accounting for motivation is a key component in meeting students' needs. Differentiation, personalization and UDL each have components that span the following domains: content (planning), process (instructional implementation) and product (assessment). While the majority of the components among these approaches differ to varying degrees, a few are similar.

Differentiation

Differentiation is a critical skillset needed by teachers, as classrooms are not homogenous and have a multitude of students with diverse learning needs (Lawrence-Brown, 2004). Tomlinson (2000) states that differentiation is a teaching philosophy and is based on the following set of seven beliefs: (1) every student is different in regards to their background experiences, motivation and willingness to learn; (2) the diversity among students is so great that teachers need to take in account what each student needs to learn, the pace at which they learn it, and the support they receive from educators; (3) all students need an adult to push them slightly beyond their capabilities; (4) students need to be provided with connections between the curriculum and their own personalized life experiences; (5) students will learn more effectively when provided with authentic instruction; (6) a supportive learning community is critical to students' academic growth; and (7) the steadfast goal of each school is to draw upon students' strengths to maximize their learning. These seven beliefs are grounded in a theoretical framework that is largely based on principles of cognitive psychology and research on student achievement (McTighe & Brown, 2005).

However, despite the research that supports differentiation in meeting student needs there are several misconceptions about differentiation that permeate the educational landscape. Differentiation is a complex process that begins with detailed planning on behalf of the teacher. Lawrence-Brown (2004) states that the two overarching goals for differentiation are to assist students with meeting grade-level curriculum standards through a series of instructional supports and to adapt the curriculum for certain students with disabilities in order for them to meet their grade level standards. Within a general education classroom, Lawrence-Brown (2004) indicates that general education lessons cannot be “passive;” rather, they must incorporate the following components to meet all students’ needs:

1. Hands-on learning, which incorporates small group instruction that encourages discussion, connections to real-life scenarios, and multi-sensory components.
2. Be able to draw upon students’ interests and experiences (Lawrence-Brown 2004 as cited in Warner & Cheney, 1996; Hollins & Oliver, 1999) and connect to their home communities (Lawrence-Brown, 2004 as cited in Gladdens, 2002).
3. Interweave multiple intelligences (visual, auditory and kinesthetic) (Gardner, 2006) within the lesson.

The three pieces above indicate the components for a “high quality lesson” (Lawrence-Brown, 2004) and further additions must be included within the lesson in order to support students’ needs, beginning with additional supports provided beyond the foundational high-quality lesson. Lawrence-Brown (2004) notes that assistive technology can provide additional supports to students struggling with grade-level content standards. Online graphic organizers, software that illustrates three-dimensional science concepts, as well as technology that delivers speech to text can be helpful to students who are struggling with learning the material. A variety of materials can also be beneficial to students who are struggling. Manipulatives, visuals, charts, outlines and picture cues, as well as books on CD, can provide more scaffolding for students' success. Lawrence-Brown (2004) also indicates the benefits of peer tutoring and one-on-one adult assistance. However, these types of assistance should not be used without caution as dependence can result.

Lawrence-Brown (2004) also denotes the value of adding structure to the curriculum, which can include: emphasizing the most important concepts and skills to providing clear expectations. An inherent goal for struggling students is to become more independent, and Lawrence-Brown (2004) emphasizes the need to break down specific strategies or concepts, modeling for students how to systematically approach and learn the information in a meaningful way. Lawrence-Brown (2004) also advocates for the use of authentic instruction. At the heart of authentic instruction is creating opportunities for students to be able to apply what they are learning to the real world, and, inherently, the presentation of the subject matter will be more motivating for students than in traditional instructional methods. Finally, Lawrence-Brown (2004) advocates for community-based instruction where students are provided with even more opportunities for real-life connections with direct application in the field. Lawrence-Brown (2004) cautions educators to remember that the level and type of support students with disabilities will need often varies from lesson to lesson. Similarly, educators need to broaden their definition of differentiation to not only include students' strengths and weaknesses in regards to the content, but also to include their cultural and linguistic backgrounds when planning and implementing instruction, along with their personal preferences and learning styles.

Differentiation for students with learning disabilities. To meet the needs of all students within inclusive science classrooms, especially those with disabilities, teachers need to differentiate their curriculum and instruction (George, 2005). Tomlinson and Jarvis (2009) state, "Differentiation is an approach to curriculum and instruction that systematically takes student differences into account in designing opportunities for each student to engage with information and ideas to develop essential skills" (p. 599). "Good" teachers are able to differentiate effectively as they realize that there is more than one effective method of instruction (George, 2005), and they can adapt curriculum to meet the needs of every student. However, there is a dearth of research in this area that takes into account motivation in conjunction with differentiated instruction.

Differentiation is a critical component of best practices in middle school science classrooms, as well as other content area classrooms with the goal of increasing student achievement (Oliveira et al., 2013). More specifically, differentiation has been found to increase the success of students with learning disabilities through peer tutoring and tiered levels of instructional support (e.g., Whitworth, Maeng & Bell, 2013; Mastropieri, et al., 2006). Specific instructional techniques, under the broader term of differentiation have been found to assist students with learning disabilities, who commonly have, "Language-based learning problems and poor reading achievement often combine to make acquiring verbal labels for unfamiliar concepts extraordinarily difficult (Brigham, Scruggs, & Mastropieri, 2011, p. 225).

A variety of instructional techniques have been used to assist students with learning disabilities to succeed in middle school science classrooms, which are all methods of differentiation. The use of mnemonics (Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1987) and graphic organizers (Dexter, Park, & Hughes, 2011), have been found to assist with the recall of scientific terms, and vocabulary/comprehension knowledge, respectively. Brigham, Scruggs and Mastropieri (2011) point out textbook based and/or hands-on teaching are the most common types of instructional methods in middle school classrooms, with hands-on based experiences being more successful for students with disabilities. Despite these assertions of differentiated instructional methods, there is very little literature that explains how to capture these methods effectively. While we know that these methods of teaching are effective for students with disabilities, there is a lack of studies that describe how teachers document these practices, reflect upon them and made adequate changes within their instruction and assessment. An efficient tool to capture these pieces of instruction would allow for critical reflection and possible adjustments in practice to lead to more student achievement. The use of portfolios to capture differentiation offers promise for understanding how these practices and additional methods has the potential to foster reflection among practitioners about their differentiation.

Teacher beliefs about differentiating instruction. With approximately 61.1% of all students with disabilities spending 80% or more of their school days in general education classrooms, it is imperative that general education science teachers be provided with the support and tools needed to ensure that this population of students finds success in science (U.S. Department of Education, 2013). Inclusive education, in which students with disabilities are integrated within the general education or mainstreamed into regular education classrooms are becoming the norm (Ware, 2001). Despite the best intentions of any middle school science teacher to meet the needs of students with disabilities, very few teachers have had specific training on how to teach students with disabilities (Norman, Caseau, & Stefanich, 1998). Norman et al. (1998) conducted a survey of science teachers ranging from the elementary to university level in regards to their training, beliefs, and practices regarding students with disabilities. Fifty-four percent of 100 middle school science teachers and 46% of 100 high school teachers returned the surveys (Norman et al., 1998).

Both middle and high school science teachers did not feel as adequately prepared to teach science to students with disabilities, compared to their elementary counterparts. For example, only 27.8% of middle school teachers and 10.6% of high school teachers felt prepared to teach students with learning disabilities in an inclusive classroom, compared to 44.2% of elementary teachers surveyed (Norman et al., 1998). Perhaps, this is because teacher preparation programs focus more on the "what," (i.e., the content), than on the "how," (i.e., pedagogical content knowledge). One of the top concerns of all science teachers was their "limited knowledge about methods and adaptations for students with disabilities" (Norman et al., 1998, p. 141). However, Broderick, Mehta-Parekh and Reid (2005) argue that despite a lack of preparation to teach students with learning disabilities, teachers must first believe that this population of students can learn. Then, they can create differentiated curriculum and instruction to aide in science achievement.

On the other hand, teachers might have a misunderstanding of what differentiation instruction means or unintentionally inflated the level of differentiation within their classrooms. Martinez, Bailey, Kerr, Huang, and Beauregard (2010) conducted a mixed methods study to ascertain the level of academic language exposure and opportunity to learn for English language learners in fourth grade science classrooms. While 49.1% of teachers identified making adaptations for students of varied abilities, and 37.7% of teachers indicated they made modifications for students with special needs and/or ELLs, the classroom observations of five teachers reported inconsistencies with the self-report. More specifically, teachers stated on the surveys that they used a wide variety of instructional strategies and approaches within the classroom; however, this was not the case when triangulated with the two observations per classroom. Despite the limited observations, these findings indicate that differentiation for special populations may not be as prominent as teacher's report.

Training teachers to effectively differentiate instruction. More and more school districts are moving towards including special education students within the general education classroom or moving towards an inclusion model (Hamre & Oyler, 2004). This move is also in part due to the steadfast commitment of IDEA to ensure that students with disabilities are placed in general education classrooms (P.L. 105-17, Amendments of 1997). As Dee (2011) states, "Fusing the concepts of differentiation and inclusion promises to move educators closer to the ideal of instructional equity in meeting the needs of all learners in the general education classroom" (p. 54). Hawkins (2009) concurs and adds that differentiation is the most "logical" way to ensure that all students' needs are met (p. 11). While this is the ideal, the road to get there can be inherently difficult for teachers. First, general education teachers must have the mindset that all students can succeed in their classroom, and, secondly, that they are capable themselves of differentiating instruction for their students. It is not only daunting for new general education teachers to adapt and modify their instruction for students with special needs, but also difficult for veteran teachers (Dee, 2011).

Professional development training on differentiation. Hawkins (2009) states that professional development of practicing teachers must consist of the following three components: (1) assisting teachers with reflecting upon differentiation and its inherent challenges; (2) providing guidance on how to make the shift from a traditional classroom model, to one with differentiated instruction; and (3) giving students ample time to ask their own questions relative to their classrooms. Teachers could also benefit from analyzing how motivation is a critical component of student success, as evidenced by the work of Adelman and Taylor (2006). Differentiation, coupled with consideration of student motivation, will allow teachers to meet the needs of a greater proportion of students.

Personalization

Personalization is another approach that is targeted to meet the needs of all learners; however, unlike differentiation, teachers also take into account the motivation of their students when planning and implementing instruction and assessment. In an era where RTI is becoming more prominent with its tiered levels of support, with the first level focusing on whole instruction, Adelman and Taylor (2012) detail the importance of personalized instruction in ensuring that RTI is effective. More succinctly, Adelman and Taylor (2012) detail that, "If motivational considerations are not effectively addressed, there is no way to validly assess whether or not a student has a true disability or disorder" (p. 16). Taylor and Adelman (1999) detail this further by stating that personalized programs are key to:

> maximizing motivation and matching developmental capability should be a sufficient condition for learning among those students whose difficulties are not the result of interfering internal factors. Personalized programs also represent the type of program regular classrooms might implement in order to significantly improve the efficacy of inclusion, mainstreaming, and pre-referral interventions. (p. 258)

Most teachers collectively agree that the best instructional programs and interventions align to students' abilities. However, most teachers and school personnel do not stress the importance of embedding student motivation within their instruction (Taylor & Adelman, 1999), despite their probable recognition of its importance. Taylor and Adelman (1999) state how motivation needs to take center stage when planning and implementing instruction and point out that, "…motivation is a key antecedent condition. That is, it is a prerequisite to student performance" (p. 258). It is essential that motivation be taken into account when planning the content that will be taught, the instruction or process of learning, as well as the assessment (product) that results from the learning.

Taylor and Adelman (1999) focus on the importance of not relying on extrinsic rewards to motivate students. Rather, "…programs must be designed to maintain, enhance, and expand intrinsic motivation for pursuing current learning activities and also for involvement in related learning activities beyond the immediate lesson and outside of school" (p. 260). Students with disabilities, especially those diagnosed prior to middle school, might have had prior negative experiences within school and/or negative connotations associated with school. Thus, it is imperative that these students experience variety throughout the instructional day in regards to instruction and assessment and see their teacher(s) as a support, rather than an opponent. Additionally, each learner needs to be actively involved in their education by taking part in decision making. Finally, it is essential that each teacher take into account students' interests (Taylor & Adelman, 1999) to ensure that students see value in what they are learning.

Overall, personalized learning is built upon a strong working relationship between student and teacher, one which gradually builds mutual sense of trust, communication and support between student and teacher (Taylor & Adelman, 1999). Yet, "how positive the relationship is depends on how learners perceive the communication, support, direction, and limit setting" (Taylor & Adelman, 1999, p. 264). Thus, student perception is an essential component to personalization. If students do not succeed through carefully planned and executed personalization, remediation is often needed; however, Taylor and Adelman (1999) point out that it is usually not needed due to non-remedial, whole class approaches, such as personalization.

Within personalization there are five components that reside under content, or in other words, components that teachers take into account when planning their instruction and assessment: (1) ensuring clear understanding of key concepts; (2) meaningful, authentic activities; (3) students abilities, as well as developmental and individual differences among students; (4) overall facilitation; and (5) scaffolding. Within the process domain (i.e., what occurs during instruction), the following components are inextricably linked to personalization: (1) meeting students' motivation and individual capabilities (i.e., finding the optimal match between motivation and capabilities), (2) carrying out a decision making process with students, (3) relating new information to prior knowledge, (4) active involvement and collaboration among peers and/or teachers; (5) taking time to practice, (6) engaging homework and motivated practice, (6) social participation and interaction, (7) embedding key instructional strategies, and (8) ongoing dialogue between students and teachers. The following components compose the product domain: (1) engaging in self-regulation and being reflective, (2) assessments that originate in the classroom, (3) formal and informal conferences with learners, (4) progress setting/mutual evaluations of progress, and (5) provide authentic assessment with various options (Adelman & Taylor, 2006).

Content components. When students learn a new concept, it is critical that they learn it in a manner that allows for in-depth exploration and mastery of concepts and terms. More specifically, "Learning is better when material is organized around general principles and explanations, rather than when it is based on the memorization of isolated facts and procedures" (e.g., Resnick & Klopfer, 1989). Thus, it is critical that teachers strategically plan their units and requisite lessons of instruction to cohesively integrate the concepts and terms, so that students will not only see, but know how they are integrated. Secondly, it is essential that students be provided with activities and tasks which connect to real-life scenarios (i.e., activities and tasks that have a purpose) (Adelman & Taylor, 2006; Patrick, Kennedy & Powell, 2013). Overall, "The intent is to enhance student valuing of the curriculum through working on somewhat complex problems and tasks/projects they naturally experience or that they will experience later in their lives" (Adelman & Taylor, 2006, p. 267). Teachers need to know their students well enough to not only plan for, but also implement instruction and assessment pieces that allow them to connect to their current and projected experiences.

This component is inherently connected to ensuring that the differences in students are taken into account. When teachers account for student capabilities within their lesson planning, it aids in ensuring student success (Adelman & Taylor, 2006; Patrick et al., 2013). After these tasks and experiences are planned for, it is essential that facilitation and scaffolding be taken into account. More specifically, in regards to facilitation, it is critical that the teacher ensure students feel as though they are not in a very large class. To attain this, it is critical that teachers provide a lot of individual options, partnership and small group work to break up the large class (Adelman & Taylor, 2006). Finally, scaffolding is defined as ensuring that proper techniques are used to ensure a good match between learner motivation and developmental capabilities (Hogan & Pressley, 1997 as cited in Adelman & Taylor, 2006). More specifically, the following are examples of scaffolding: clear explanations of concepts, lots of student participation, ensuring student understanding (written and/or verbal), teacher modeling and guiding of the thinking process, asking students to contribute through prompting, and providing extensive positive feedback and supportive self-evaluation (Adelman & Taylor, 2006, p. 133).

Process components. The core process component under personalization is a teachers' ability to meet student motivation and individual capabilities. Essentially, teachers need to implement classroom activities, tasks, etc. that provide a cohesive match with each student's motivation and individual capabilities. They also need to reflect upon whether their activities, tasks, etc., did, indeed, meet their students' motivation and individual capabilities (Adelman & Taylor, 2006; Center for Mental Health in Schools at UCLA, 2012). Adelman and Taylor (2006) detail several techniques to enhance motivation: (1) nurturing learning: positive feedback, reduction in criticism, reassuring students, providing and listening to goals, issues, etc.; (2) creating an atmosphere for exploration and learning: reducing the amount of work, encouraging students to pursue what they like, modeling affect and sharing clear expectations; (3) ensuring a sense of protection for exploration and change: supporting students' risk taking, creating work areas that are quiet, reassure learners when risk taking is and is not successful, etc. (Adelman & Taylor, 2006). Adelman and Taylor (2006) also detail additional techniques to support learning (p. 134): sharing small amounts of information with the students, (i.e., breaking down the information into manageable parts), multi-sensory pieces, step by step directions along with prompts and cues, assisting with study skills, technological assistance (computers, etc.), additional people (co-teacher, volunteer, etc.); active contact and use: frequent review, use of games, references (dictionaries, etc.), and slowing increasing the difficulty of the material.

Decision making is also a process component in which teachers create and carry out a decision-making process that involves the student, so that it will inherently increase his/her motivation. More specifically, "…decision-making processes that affect perceptions of choice, value, and probable outcome are essential to programs focusing on motivation" (Adelman & Taylor, 2006, p. 122; Center for Mental Health in Schools at UCLA, 2012). In addition to ensuring that there are meaningful, authentic activities, it is critical that during the actual instruction, the teacher and, ideally, the students are able to relate to the new information that is being presented/learned to prior knowledge. In sum, making connections between what is previously known and what information is being presented to the students is an essential piece to mastery of concepts (Bransford, Brown & Cocking, 1999 as cited in Patrick et al., 2013).

Within these processes, student involvement is critical. At a foundational level, it is important that students are actively involved within instruction and are collaborating with one another and/or the teacher (Center for Mental Health in Schools at UCLA, 2012; Patrick et al., 2013). Two ways to enhance active involvement are to provide choices in regards to academic tasks and classroom activities (Adelman & Taylor, 2006; Center for Mental Health in Schools at UCLA, 2012), as well as choices in regards to facilitation, including student- and teacher-centered whole and small group instruction, as well as paired and one-to-one assistance. This is also similarly supported by social participation/interaction, as “Learning is primarily a social activity and participation in the social life of the school is central for learning to occur” (Patrick et al., 2013, p. 7; and is supported by Rogoff, 1990; Vygotsky, 1978). It is important to remember that active interactions among students within their environment are mediated by good support and guidance within the classroom. Project-based learning is a clear example of social participation/interaction. The teacher’s role in the classroom cannot be understated in regards to effectively implementing instruction.

In addition, students need time to practice the skills and concepts that are needed to master the material (Patrick et al., 2013). Within these practice times, it is essential that students be provided with well-designed, engaging homework and in-class practice that is specific to students’ interests (Adelman & Taylor, 2006). As an added layer, it is critical that students be provided with various practice options that span multiple modalities (Adelman & Taylor, 2006; Center for Mental Health in Schools at UCLA, 2012) and a range of examples, including interactions, applied activities, listening games and activities, inquiry-based learning, use of manipulatives as well as questioning. It is imperative that these options for practice are not too easy or too hard, but just "right." When teachers are teaching, they need to be strategic and embed key instructional strategies. More specifically, instructional strategies need to be employed that are flexible enough to meet the varied needs of the students in the classroom (White & Frederickson, 1998; Patrick et al., 2013). Hands-on, blended, and inquiry-based learning are key instructional strategies that are inherently flexible enough to meet the needs of all students, including those with special needs. Finally, it is very important that teachers continually reflect on their instructional practices both individually and in conjunction with their students. Adelman and Taylor (2006) note the importance of beginning and sustaining mutual/ongoing dialogue (i.e., conferences among students and teacher). It is imperative that each teacher engage in dialogue individually with his/her students, with the teacher with the student and not at the student (Adelman & Taylor, 2006; p. 125). Then, the teacher and student examine progress together and share students' perceptions of how things are going.

Product components. A central theme pervading the components within the product domain of personalization is reflection and progress. First, the students must engage in self-regulation and be reflective as to what they have learned currently, as well as what they will learn in the future. More succinctly, learners must know how to plan and monitor their learning, how to set their own learning goals and how to correct errors (Patrick et al., 2013). All of this work will have to be strategically facilitated by the teacher. A key characteristic of assessments within a personalized approach are that they originate from the classroom. More specifically, assessment should stem from classroom activities that were engaging, motivating and reflective of student achievement (Adelman & Taylor, 2006). Additionally, the assessment process must be interactive, as the teacher needs to not only review the assessment, but provide feedback to guide student learning (Adelman & Taylor, 2006).

Throughout this assessment process, positive feedback must be provided. "And with a view to enhancing positive attitudes, feedback is conveyed in ways that nurture student's feelings about self, learning, school, and teachers. Handled well, the information should contribute to the student's feelings of competence, self-determination, and relatedness and should clarify directions for future progress" (Adelman & Taylor, 2006, p. 130). Throughout the assessment process, students need to be provided with authentic assessment that has various options. These various assessment tools can include: observations, interviews, projects, reflective journals, demos and collection of student work. Essentially, "assessment must reflect student learning, achievement, motivation, and attitudes on instructionally relevant classroom activities" (Adelman & Taylor, 2006, p. 129). Finally, progress setting by the students/mutual evaluations of progress are critical components in helping students move forward. More specifically, this process involves the teacher and student examining the students' progress to date. Together, the teacher and student can identify next steps in the learning process, ensuring success together and modifying these decisions as needed, while also taking in account students' perceptions of the "match" (Adelman & Taylor, 2006; 2012).

Universal Design for Learning

Basham, Israel, Graden, Poth and Winston (2010) state that UDL is known and accepted as an approach that can assist all learners within the classroom. Jimenez, Graf and Rose (2007) expand upon this by stating that "One approach to making general education curriculum more accessible to diverse learners regardless of ability, learning style, language, or culture is the application of UDL" (p. 42). It can be inferred that what makes UDL so appealing to general education teachers is that it, "…shifts the focus toward appropriate instruction for 'all' learners rather than those with special needs exclusively" (Jimenez et al., 2007, p. 44). Thus, when teachers use UDL, they can be assured that the principles and associated guidelines are meeting the needs of all students. This makes planning and implementing curriculum, instruction, and assessment somewhat easier, as a teacher does not necessarily have to look for different methods and/or strategies for their diverse learners.

The term *universal design* was originally coined by Ronald Mace, an architect and director of the Center for Universal Design at North Carolina State University. The original concept of universal design centered on ensuring that products and aspects of the environment were inclusive for all individuals, with features such as closed captioning and cuts in curbs for those in wheelchairs as examples of universal design (McGuire, Scott & Shaw, 2006). Universal design began to expand to classroom environments under the leadership of David Rose and Ann Meyer who co-founded the Center for Applied Special Technology (CAST) in 1984 (Rose & Meyer, 2000, 2002). UDL was developed after the 1997 reauthorization of IDEA, which was timely, as students with disabilities were increasingly able to be part of the general education classroom, but their ability to access general education curriculum was questionable. UDL gained continual notoriety when it was officially mentioned within the 2004 reauthorization of UDL (Edyburn, 2005).

Unlike other approaches, UDL necessitates that teachers take a proactive approach in meeting their students' needs. Teachers need to strategically plan prior to instruction how their tasks, activities, projects, etc., embed the three principles of UDL: representation, engagement, and expression. One example of an instructional method that supports UDL is the use of differentiation (Rose & Meyer, 2002); however, each principle has its own set of guidelines and complementary checkpoints to assist teachers (CAST, 2015). When the three principles of UDL are implemented properly, they can aid teachers to "…recognize barriers to learning, strategically address such barriers, and monitor student progress" (Coyne et al., 2006, p. 1). Pisha and Coyne (2001) point out that when UDL is properly embedded within the curriculum, students will most likely not realize that the principles are in place. Spencer (2011) details that representation refers to "how to teach to the content to make it accessible," with expression being "how the students will show what they learned," and engagement being "how to motivate all learners to do their best work" (p. 11). Under these principles, there are several supporting guidelines and associated checkpoints to further illustrate the components in detail.

Representation. Representation has three guidelines: "comprehension," "language, math expressions and symbols," along with "provide options for perception" (CAST, 2015). Under comprehension, CAST (2015) lists the following four checkpoints: "activate and supply background knowledge," "highlight patterns, critical features, big ideas and relationships," "guide information processing, visualization and manipulation," and "maximize transfer and generalization." Overall, the comprehension guideline seeks to ensure that students are able to make connections between the content that is taught and their own lives in conjunction with using tools (i.e., graphic organizers and checklists) to support their acquisition and mastery of learning.

The following checkpoints are under the guideline "language, math expressions and symbols:" "clarify vocabulary and symbols," "clarify syntax and structure," "support decoding of text, mathematical notation, and symbols," "promote understanding across languages," and "illustrate through multiple media." Central to the "language, math expression and symbols" guideline is the teacher ensuring that students are provided with the requisite tools and strategies (i.e., navigating complex texts with various diagrams, use of visuals, etc.) to clearly understand the vocabulary that is necessary to master a concept. Additionally, this guideline strives to ensure that students are provided with the information in their dominant language and have access to technology to aid in their understanding of the texts (i.e., digital texts). Under the guideline, "provide options for perception," the following checkpoints apply: "offer ways of customizing the display of information," and "offer alternatives for auditory and visual information." This guideline is meant to ensure that students are presented with critical information that takes into account key ways to maximize the layout of the text and that visual and/or auditory information is presented in different ways, such as the use of Venn diagrams, etc. (CAST, 2015).

Engagement. The following three guidelines fall under the engagement principle, "self-regulation," "sustaining effort and persistence," and "recruiting interest." All three guidelines center on the importance of students being able to relate to the concepts being presented, in conjunction with students developing and maintaining a skillset that not only allows them to reflect upon their progress, but have the coping skills to be able to move forward when things become challenging (CAST, 2015).

Self-regulation. The following checkpoints fall under the guideline of "self-regulation:" "promote expectations and beliefs that optimize motivation," "facilitate personal coping skills and strategies," along with "develop self-assessment and reflection." These checkpoints are meant to aid the teachers to embed strategies and tools to foster students' ability to self-motivate, develop a skillset that will enable them to reflect upon their academic growth and set goals for the future. Specific tools and strategies to foster this guideline include: mentoring students in their use of checklists and rubrics, providing scaffolds and feedback and helping students develop a recording system to track their growth or lack thereof in regards to the subject matter being taught (CAST, 2015).

Sustaining effort and persistence. The following four checkpoints are found under the guideline, “sustaining effort and persistence:” “heighten salience of goals and objectives,” “vary demands and resources to optimize challenge,” “foster collaboration and community,” and “increase mastery-oriented feedback” (CAST, 2015). Collectively, these checkpoints seek to ensure that students are able to forge onward in meeting their academic goals, with the requisite tools and strategies to assist them in breaking down any challenging material along with ensuring that students not only see the value of a collaborative environment, but engage in it along with being receptive to positive feedback.

Recruiting interest. Three checkpoints make-up this guideline, “optimize individual choice and autonomy,” “optimize relevance, value and authenticity,” and “minimize threats and distraction” (CAST, 2015). The core of this guideline resides in the teacher providing students with the opportunity to become actively involved in deciding what activities/projects constitute classroom instruction, along with ensuring that the chosen activities are applicable to student lives to enable mastery of material. Finally, this guideline seeks to ensure that teachers build a classroom community that is supportive of risk taking, along with varying the demands of the work required within it to facilitate student success.

Expression. The following guidelines reside under the principle of “expression:” “executive function,” “physical action,” and “provide options for expression and communication” (CAST, 2015). Overall, this principle seeks to ensure that teachers are providing the necessary supports to enable students to not only set goals, but integrating prompts and scaffolds to ensure that students stop and reflect upon their work, in addition to providing them with varied to tools (i.e., manipulatives, multiple media, sentence stems, etc.) to enable to them to effectively communicate what they have learned.

Executive function. The following checkpoints exist under this guideline: “guide appropriate goal setting,” “support planning and strategy development,” “facilitate managing information and resources,” and “enhance capacity for monitoring progress” (CAST, 2015). With goal setting, it is essential that the teacher be able to model how to set realistic goals and how to monitor those goals with the requisite checklists. Next, it is critical that teachers fully explain how to do certain tasks, such as explaining the work that was completed, as well as reflecting upon the work that has been finalized. The third checkpoint, “facilitate managing information and resources,” stresses the importance of the teacher providing the students with guidance on how to take notes and organize the information they are learning, with the aid of graphic organizers or similar tools. Finally, the last checkpoint, “enhance capacity for monitoring progress,” focuses on supporting students to ask the right questions as they self-monitor and reflect upon their work, in addition to guiding students on asking for the type of feedback that they need to move forward.

Physical action. “Vary methods for response and navigation” and “optimize access to tools and assistive technologies” reside under this guideline (CAST, 2015). This guideline and its associated checkpoints focus on teachers’ providing alternatives to students when activities/tasks are too physically demanding, as well as ensure that these alternatives include accessibility options for the computer.

Provide options for expression and communication. Three checkpoints reside under this guideline: “use multiple media for communication,” “use multiple tools for construction and composition,” as well as “build fluencies with graduated levels of support for practice and performance" (CAST, 2015). Central to these checkpoints is ensuring that teachers are flexible in how they allow students to show their knowledge of a concept/problem/term, such as through art, texts, or manipulatives while providing access and guidance on how to use tools such as text to speech to facilitate these options. Finally, this guideline stresses the importance teachers scaffolding the tasks/activities with the varied feedback to meet student needs in order to build independence among students.

Conceptual Framework

First, this study takes aim at the deficit model and seeks to reject it. Students with learning disabilities have inherent challenges in mastering content area knowledge, but when teachers utilize the approaches of differentiation, personalization and/or UDL, they can assist in overcoming this barrier. Valencia (2010) defines the deficit thinking model thoroughly by stating:

> The deficit thinking model, at its core, is an endogenous theory—positing that the student who fails in school does so because of his/her internal deficits or deficiencies. Such deficits manifest, adherents allege, in limited intellectual abilities, linguistic shortcomings, lack of motivation to learn, and immoral behavior. (p. 7)

Valencia (2010) identifies six components of deficit thinking: victim blaming, oppression, pseudoscience, temporal changes, educability and heterodoxy. While Valencia (2010) posits that deficit thinking is largely in relation to economic and racial status, it can also be applied to students with disabilities. In relation to this study, victim blaming, oppression and educability all apply. Victim blaming deems that the performance of a student is a product of their internal motivation and cognitive disabilities. It does not recognize the influence of a teacher, his or her training, curriculum or instructional components, as well as his/her ability to personalize instruction. With oppression, there is an insistence that students with disabilities need to be kept in their place and will not accelerate in their ability to learn, no matter what modifications are put in place. Finally, the educability piece seeks to focus on maintaining students' limitations, without developing their inherent abilities (Valencia, 2010). Differentiated instruction, personalization and/or UDL could all be considered an intervention for students with disabilities, which could defy their limitations and strengthen their abilities.

There are a multitude of factors that can affect how a student learns curriculum standards and meet performance expectations, and this study looks critically at three components: curriculum, instruction, and assessment within three eighth grade science classrooms. In planning and executing such instruction, it is imperative that teachers take into account personalization in order to ensure that students abilities' and their motivation are taken into account. In keeping with this concept, the study is grounded in Howard Gardner's multiple intelligence theories, which assert that students have one or more of the following intelligences: linguistic, mathematical/logical, naturalistic, spatial, bodily/kinesthetic, musical, interpersonal, and intrapersonal (Gardner, 2006). It is posited that if a teacher can identify each child's unique intelligence(s) and embed that within his/her teaching, that child will be more successful (Adcock, 2014). In summary, this study hopes to lay the groundwork in understanding how students with existing disabilities can have their needs met through differentiated curriculum and instruction, in addition to personalized instruction and UDL within the three eighth grade general education science classrooms in the era of NGSS (2013) and Common Core (CCSSI, 2014) implementation within the state of California.

This study is also grounded in the Thinking Curriculum set forth by Resnick (2010). Resnick (2010) states, "The Thinking Curriculum calls for instruction that is high in cognitive demand (conceptual learning, reasoning, explaining, and problem solving are engaged daily) and that is embedded in specific challenging subject matter" (p. 186). The Thinking Curriculum stands behind the precept that students will only truly learn the content if they are provided with the structure to not only explain it, but interpret it as well (Resnick, 2010). Resnick (1989) believes that content area material and thinking skills can be taught concurrently for all students. Yet, "the habit or disposition to use the skills and strategies, and the knowledge of when they applied, needed to be developed as well" (Resnick & Klopfer, 1989, p. 7).

Resnick (2010) points out that most students have the capacity to learn and think at a very high level; however, the institution of schooling requires considerable restructuring to ensure that all students are held to high standards or 21st century skills. Students also need to be taught to self-monitor their learning and collaborate with their peers as they learn content area knowledge. The Thinking Curriculum requires teachers to have a "clear intellectual goal" with specific academic tasks scaffolded by the teacher to ensure deep learning (Resnick, 2010, p. 187). The Thinking Curriculum rejects rote learning whereby students learn a series of skills through repetition or "drill and kill." The Common Core (CCSSI, 2014) and NGSS (2013) necessitate teachers being able to provided implement curriculum with clear goals and in-depth "subject-specific" teaching.

Finally, this study draws on the research base of learning progressions in science education. Berland and McNeill (2010) succinctly summarize this with the following, "Learning progressions are currently described and used in the science education literature in different ways including as (1) a developmental progression for how understanding develops, (2) increasing levels of complexity of the disciplinary knowledge and practices, and (3) pathways to support student learning" (p. 767). Within learning progressions in science, students are often prescribed a starting or "anchor point" that will progressively lead to a finite goal, or mastery of content with the appropriate supports in place which take in account students diverse backgrounds and needs (e.g., Lehrer & Schauble, 2009). Essentially, learning progressions could be analogous to individualization, in that it takes into account student's ability and background, but also differentiation, as it looks at what appropriate supports a student needs in place in order to succeed in science.

Summary

Regardless of their level and type of certification, teachers need to have a wide foray of knowledge, skills and strategies to meet the needs of all learners. For middle school science teachers, they need to know not only science content, which is often the focus of their teacher preparation programs, but they also must know how to effectively meet the needs of special education students in their classrooms. With the influx of standards based reforms such as the Common Core (CCSSI, 2014) and NGSS (2013), this adds a new level of difficulty to teaching content area instruction and students with special needs. It is imperative that we deeply understand the context of middle school science classrooms, their diverse populations and how teachers are working towards meeting the needs of special education students under the auspices of the increased rigors of curriculum and instruction that are put forth by the NGSS (2013) and Common Core (CCSSI, 2014). These new understandings will aid in ensuring that teachers are provided with the necessary resources and training to meet the needs of all learners. Similarly, understanding how teachers reflect upon and monitor their instructional practices for students with special needs through the use of an electronic portfolio and other potential tools, will assist in laying the groundwork for potential support systems for teachers in this area.

CHAPTER 3

Methods

This study utilized a sub-sample of eighth grade science teachers from a larger National Science Foundation (NSF) study, "Measuring Next Generation Science Instruction Using Tablet Based Teacher Portfolios." Under the direction of Principal Investigator (PI), Dr. José Felipe Martínez, and co-PI Matt Kloser and Rose Rocchio, the NSF research project aimed to build upon the strengths of previous research of portfolio documentation in science classrooms (Martinez, Borko & Stecher, 2012) with the development of a new flexible, e-portfolio tool. This tool allows teachers to capture the interactive aspects of instruction through video and photo, in addition to being able to scan documents such as lesson and unit plans, which is a significant improvement from traditional paper-based portfolios. By capturing artifacts in "real-time," and being able to actively respond to those artifacts via guided questions, the e-portfolio will hopefully assist teachers in reflecting upon their practice, in addition to diagnosing their strengths and weaknesses, which could lead to the e-portfolio potentially supporting professional development efforts directly related to teacher needs.

The larger study had several aims, all of which are substantially different from the current study. First, a subset of participants' ePortfolios will be used for a generalizability study (Shavelson & Webb, 1991). The larger study seeks to understand how the ePortfolio is used within the classrooms and what challenges/advantages the interface of the ePortfolio provides teachers. An additional goal of the study is to see how the ePortfolio affords teachers the opportunity to reflect on their instructional and assessment practices in general; however, the larger study does not focus on special needs students, as this study has set out to do. Finally, the larger study will also investigate how two professional learning communities at two separate schools use the ePortfolios. This study concluded at the end of the 2015-2016 school year, and data analysis for the larger study is currently underway.

The current study specifically focused on understanding how three eighth grade science teachers from the larger study took into account student ability and motivation when planning for and implementing curriculum, instruction, and assessment for students with special needs. More specifically, the teachers' approaches to and their implementation of curriculum, instruction, and assessment were explored in terms of how they aligned with the research based components of differentiation, personalization, and UDL. This study sought to understand how teachers monitor and reflect upon their instructional and assessment practices for students with special needs.

The following research questions guided this study:

1. How do three general education eighth grade science teachers take into account the ability and motivation of students with special needs in inclusive general education classrooms?
    a. How do they plan for and implement the curriculum for this population of students?
    b. How do they plan for and implement their instruction for this population of students?
    c. How do they plan for and implement their assessment for this population of students?
2. How do three general education eighth grade science teachers self-monitor and reflect upon their instructional and assessment practices for students?

a. How does this monitoring support what concepts they need to re-teach or extend for students?

Embedded Single-Case Study Design

The study uses case study methodology (Yin, 2008) to describe in-depth how three eighth grade general education science teachers implemented UDL components in their instruction and how they differentiated and/or personalized curriculum, instruction, and assessment for one period of science instruction for their diverse student population, particularly those with special needs. The study was conducted without manipulating the context of each classroom or the behaviors of the teachers or students. A case study approach allows for a convergence of multiple measures to triangulate data that will support the results (Yin, 2008) and "anchored in real-life situations, the case study results in a rich and holistic account of a phenomenon" (Merriam, 2009, p. 51).

The design for this study was an embedded single-case study with the case being differentiated and/or personalized curriculum, instruction and/or assessment and/or UDL, for students with special needs and with the individual unit of analysis being each teacher within the case. The context for the case was a subset of regular education eighth grade science classrooms (one period of science instruction) within an urban school district (see Figure 1) that completed a teacher credential program and received professional development at their schools.

Baxter and Jack (2008) note the benefits of a single case with embedded units through the following: "The ability to look at sub-units that are situated within a larger case is powerful when you consider that data can be analyzed *within* the subunits separately (within-case analysis), *between* the different subunits (between-case analysis), or *across* all of the subunits (cross-case analysis)" (p. 550). An embedded single-case design allows for an analysis of the case, differentiated and/or personalized curriculum, instruction, and assessment for special needs students, and/or UDL, in much more detail than if only a single case, one teacher, was selected. Yin (2014) expands upon this by saying, "The subunits can often add significant opportunities for extensive analysis, enhancing the insights into the single case" (p. 56). For the purposes of this study, data was analyzed across all sub-units for a cross-case analysis. This case study was classified as descriptive based on the overarching goal to describe the differentiation and/or personalization, along with UDL among a small number of eighth grade general education science teachers specifically targeted for their eighth-grade special education students, their challenges in meeting the needs of this population of students, along with the teachers' monitoring and reflection of their instructional practices for this population of students.

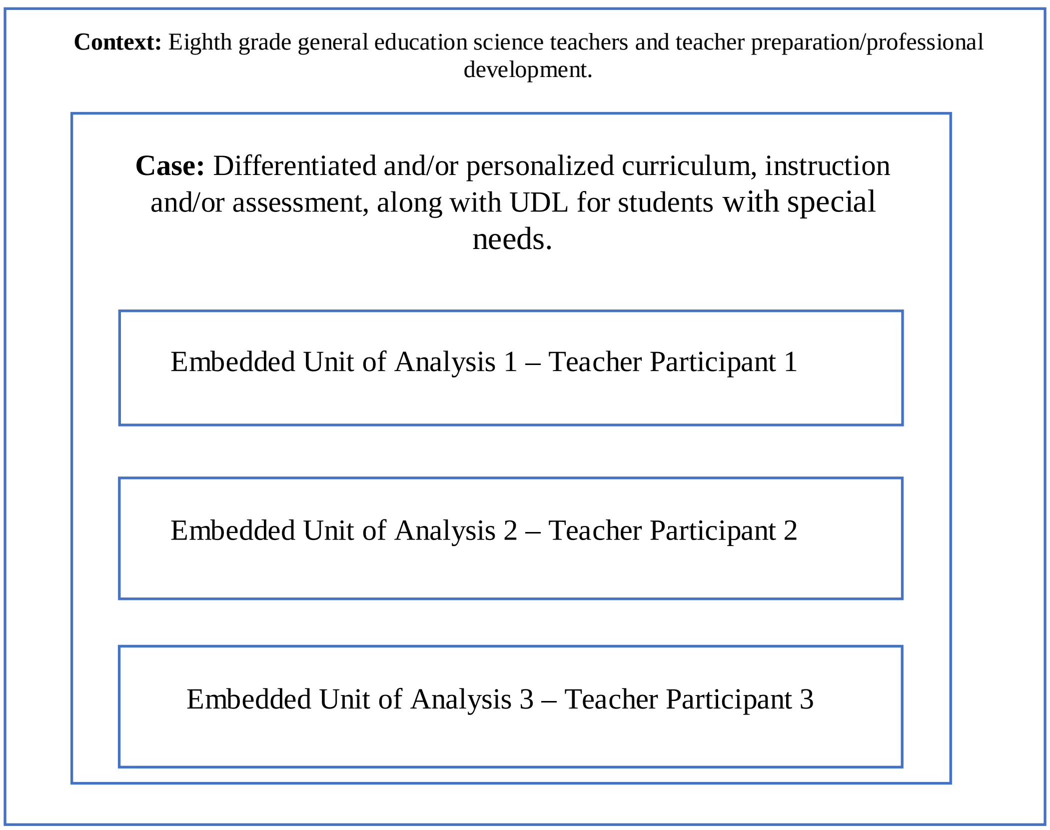


Figure 1. Embedded single-case design (adapted from Yin, 2011)

While case studies can be categorized as explanatory, exploratory, or descriptive (Hancock & Algozzine, 2006; Yin 2014), I did not seek to explain why differentiation and/or personalization, along with UDL, exists for students with special needs in these classrooms; rather, I sought to describe the number and types of elements teachers' exhibited under each of the following approaches: differentiation, personalization, and/or UDL for curriculum, instruction, and/or assessment in order to build potential research questions for a subsequent study (Yin, 2014). Furthermore, I also sought to understand how they monitored and reflected upon their instructional and assessment practices to meet the needs of this sub-group of students. This study was also not trying to understand why teacher's monitor and reflect upon their instructional practices for students with special needs, but how and when they do it.

Setting

This study was conducted in three middle schools within a major urban school district. The school district has over 900 schools and 187 charter schools, enrolling approximately 640,000 students in grades K-12. There are about 110,000 students enrolled in the districts' middle schools (6-8), with the majority of the student population being Latino (74%), followed by African American (8.4%), White (9.8%), Asian (6.0%), Pacific Islander (0.4%), and American Indian/Alaskan Native (0.2%). Approximately 22% of students enrolled in grades K-12 are emergent bilinguals, with 92.8% of these students speaking Spanish. There are over 25,000 K-12 teachers employed by the district during the year of the study. I gained entry into the setting through my involvement as a graduate student researcher in the larger NSF study.

Two middle schools selected for this study are district funded charter schools and the other is a public school. One charter school serves students in grades 6-8 with a central location in the district, while the other school comprises grades K-8 and is located in the southern most section of the district. Both charter schools had open enrollment during the year of the study, and each had a special education teacher on-site who was available to consult with the teachers about their science instruction and assessment. The eighth-grade science teacher from the middle school charter did not have any aid support in the classroom. However, her colleagues who taught English and math did have aid support intermittently throughout the day. She did consult with the special education teacher in regards to students' IEP and 504 plans. All students with special needs at the middle school charter had the option to take formal assessments in the special education classroom.

While the eighth-grade science teacher in the K-8 charter did have some aid support periodically, it was only during English and math. She did not consult with the special education teacher who was on site for science, but was given in-class support for students with special needs as dictated by their IEP or 504 plan in English and/or math. The public school serves students in grades 6-8 in the southeastern part of the district. The teacher at the K-8 charter school taught all subjects in addition to science, while the other teachers solely taught science. The eighth-grade science teacher who taught at the public school had a special education teacher in her classroom for the science period that she collected ePortfolio data and was observed. In all schools, student demographics are comparable to those in the district as a whole, and class sizes range from 25-36 students in all three schools.

Participants

The participants selected for this study were purposefully chosen in order to critically understand how they took into account their special needs students' abilities and motivation through their potential planning and implementation of UDL, as well as through their differentiation and/or personalization of curriculum, instruction and/or assessment. The participants were also selected in regards to their willingness to share how they monitored and reflected upon their curriculum, instruction, and assessment for their special needs students. All three participants were recruited as part of the larger NSF study, with Beth known from the first author's prior work as a professional developer and the remaining two participants, recruited through their response to an email sent by the principal investigator, Dr. José Felipe Martínez, as part of the larger study. The two teachers who worked at charter schools (Beth and Jenny), stated that I could visit their classrooms to observe any time, whereas Megan stated I could come and visit as long as I set up a time with her. It is hypothesized that the charter school culture allowed for flexibility in this area.

These three eighth grade science teachers were very enthusiastic and from the outset of the first meeting, were more than willing to be observed as many times as needed during their fall/winter and spring e-portfolio collections of both a physics and chemistry unit. This was a critical factor in participant selection, as observations constituted the main data source for the study, so it was imperative that teachers welcomed an observer (myself) into their classrooms. It was assumed that the initial rapport developed from the first meeting to the first observation, aided in the ability to take in-depth field notes to effectively capture what occurred within the classroom. Each teacher also had at least two special education students in their science periods that they included within the artifact collection for the larger study, thus providing a class composition that would allow for potential differentiation, personalization, and/or the application of UDL principles to meet the needs of all students, including those with special needs. Finally, all teachers had more than one year of experience in the classroom, which allowed them to draw upon past experiences of differentiating and/or personalizing curriculum, instruction and/or assessment along with implementing elements of UDL for students with special needs.

Participant #1 – Beth

At the completion of the study, Beth had taught eighth grade for three years. She teaches all middle school subjects including science. She previously taught fifth grade at the same school for two years. Beth also taught fifth grade at another school, and at the completion of the study, she had taught for 13 years. Teaching is Beth's second career, as she previously worked in the advertising and the entertainment industry. She is very close to obtaining her Master of Education degree and holds a preliminary credential. She continues to engage in a multitude of professional development opportunities, whether mandated by her charter school, or on her own accord. Beth's teaching philosophy is grounded in creating project-based instruction, which is an approach that she believes will reach all students.

Beth's classroom: Horizon charter middle school. Beth's classroom had a mix of desks and tables. The back wall contained storage closets for hands-on materials, with one full closet devoted to science manipulatives. Vocabulary charts that were made by Beth covered every inch of available wall space and were grouped by subject, with the majority of the posters covering science and math vocabulary. Beth did not have a teacher's desk; instead she situated herself up front with her Elmo projector/document camera and computer. However, she rarely taught from that position; rather, it was just a place to store her materials. She allowed students to sit where they wanted, so there was a lot of movement throughout the classroom; however, students always had their own storage space for materials. Science experiments were often demonstrated from the table in the center of the room, with the students making a giant circle around the table. The school itself consists of one wing that is attached to a district elementary school, with limited access to outdoor space.

Participant #2 – Jenny

Jenny is a former Teach for America (TFA) fellow and completed her second year of teaching at the end of this study. She was the teacher with the least amount of experience in this study. She teaches at the charter school for students in grades 6-8, which was her first year at that school. She completed her Master of Arts in education in May 2016 and has her preliminary teaching credential. She has only taught eighth-grade middle school science. Jennifer's teaching philosophy centers around inquiry-based teaching, coupled with a hands-on approach in order to meet the needs of all learners.

Jenny's classroom: Pacific charter middle school. Jenny's classroom was the only classroom without windows; thus, she brought in six lamps of her own that she strategically placed throughout the room. Like Beth, she had tables, but no desks. She had assigned seating, placing those students who were struggling with science at the two center tables and the remaining students at the two tables to the right and left of the classroom. She had a word wall on the far right-hand side of the classroom, student projects were displayed on two bulletin boards, and student grades (anonymized by ID number) were placed on a bulletin board closest to the door. Her Elmo and computer were in the center of the room, so that she could use it to display on the white board. The objective and agenda for each day were always written on the board.

Participant #3 – Megan

Megan has taught for 27 years, with 18 years teaching middle school science and, as such, was the veteran teacher within this study. She has her Master of Arts in teaching and her clear credential in science. She is the science team leader for the eighth grade at her middle school. She solely teaches the inclusive science classes and was the only teacher in the study to work with a special education teacher (co-teacher) during the period of observation and portfolio data collection. She also participated and led a bi-weekly professional learning community for the eighth-grade science teachers at her school. Megan's teaching philosophy is grounded in the importance of engaging students in real-life practices.

Megan's classroom: Santa Maria middle school. Megan had the largest class with 36 students, and, thus, unless a student was absent, there were no more than two open seats within the classroom. The tables were arranged in rows that all faced her teacher desk which was at the center of the room. Students had assigned seats, with four students per table. Lab materials resided on the left side of the classroom due to two sinks being present, and book cases were to the left. Megan also had a large shared closet with the other science teacher next door, where the majority of materials and manipulatives were stored. Megan used the large chalkboard in the front of the room to detail the objective for the day and the agenda, as well as key words and concepts for the lesson. This information was always reiterated within her daily power points.

Data Collection Procedures

The data collection for this study took place during the 2015-2016 school year and consisted of observations, an examination of a variety of ePortfolio artifacts and annotations (collected twice during the year), and individual interviews (see Table 2). This study spanned two units of science instruction during the late fall/winter of 2015 and late winter/early spring quarters of 2016. The first unit was focused on a physics theme, while the second unit was a chemistry unit (see Table 3). The first set of observations took place in late fall/early winter (November 2015—January 2016) in conjunction with the teachers' first portfolio collections. The second set of observations took place in late winter/early spring (February—April 2016) in conjunction with the teachers' second portfolio collections. The interviews for all teachers took place in May 2016.

Table 2

Data Collection Procedures

Type of Data	Number	Duration	Kind
Fall Observations	Six each for Beth and Jennifer; three for Megan	50 minutes each	Observer as participant
Spring Observations	Five for each teacher	50 minutes each	Observer as participant
ePortfolio Artifacts and Annotations	All responses	Two two-week samples	Artifacts and associated annotations
Individual Interviews	1 per teacher	40 mins. for Megan; 80 mins. each for Beth and Jenny	Semi-structured

Table 3

Science Units

Teacher Participant	Unit 1	Unit 2
Beth	Forces & Motion	Matter and its Interactions
Jenny	Forces & Motion	Structure of Matter
Megan	Density	Acids and Bases

Data sources for this study included field notes from individual classroom observations, transcripts from one interview per teacher, and annotations and artifacts (documents, videos, and/or images) from the ePortfolios (see Table 4). Patton (1990) states that, "Multiple sources of information are sought and used because no single source of information can be trusted to provide a comprehensive perspective. By using a combination of observations, interviewing, and document analysis, the fieldworker is able to use different data sources to validate and cross check findings" (p. 244). For this study, document analysis stemmed from what the teachers collected for their portfolios (specifically the documents and the annotations), in addition to some documents that teachers provided to me by the teacher during my visits. Thus, all sources of data will be infinitely important in the dissemination of the findings.

Table 4

Data Sources

Type of Data	Number
Instructional Artifacts (Portfolio One)	52
Assessment Artifacts (Portfolio One)	12
Initial Reflection (Portfolio One)	8
Concluding Reflection (Portfolio One)	4
Instructional Artifacts (Portfolio Two)	70
Assessment Artifacts (Portfolio Two)	6
Initial Reflection (Portfolio Two)	6
Concluding Reflection (Portfolio Two)	5
Observations Fall/Winter (Portfolio One)	18
Observations Spring (Portfolio Two)	20
Interview (Spring)	3

Merriam (1998) indicates that all three data sources (observations, documents, and interviews) are rarely equally weighted, which is true in this study, as observations conducted for this study served as the main data source. In this case, documents include what was captured through teachers' ePortfolios, as well as what was given to the researcher during her observations of each teacher.

Teachers for this study were instructed to collect instruction and assessment artifacts within their ePortfolios for one two-week period in late fall/winter and one two-week period in the spring during the 2015-2016 school year, with each collection period spanning 10 consecutive days. However, due to a variety of circumstances, these two-week collection periods were not 10 consecutive days, and the uploading of the data often occurred well beyond the completion of the actual unit. For example, Jennifer began her unit on Forces & Motion in early November; however, due to conferences and professional development days, as well as the need for student review, her unit was not completed until after the three-week winter break in mid-January. Thus, her final concluding portfolio was not finished until January. Megan completed her first portfolio in early December prior to the district's winter break, but did not finish uploading the data until the end of January 2016. Finally, Beth also needed additional time due to her students' lack of mastery of the concepts, so she did not finish her first portfolio until after the three-week winter break in mid-January. Despite the lateness in uploading, I ensured that both two-week portfolios (one for physics and the other for chemistry) coincided with the observations.

In addition to the 10 days of portfolio collection, the teachers completed an initial reflection to provide context for each 10-day unit collection prior to their first day of collection, including the curriculum that was being used and the final reflection that details how students did not meet, met or exceeded the goals of the unit (see Appendix B) for each portfolio. Teachers also provided a set of annotations for each instructional and assessment artifact that they uploaded and described any modifications or adaptations that were made for that specific artifact (see Appendix C). Finally, teachers completed a concluding portfolio entry to reflect upon the work that was collected and annotated across each 10-day portfolio.

The rapport that was developed with the teachers in the fall was maintained throughout the spring, which allowed me to have a thorough interview with each of the participants. (Although, due to her commitments both before and after-school, the interview with Megan was limited to about 40 minutes, whereas the interviews with both Beth and Jenny each lasted about 80 minutes.) However, because the majority of the observations and requisite field notes were only collected while the teacher was gathering data from the portfolio, these are snapshots of how the teachers accounted for students' abilities and motivation through curriculum, instruction, and assessment, which is a limitation of the study. However, unlike traditional paper and pencil portfolios, teachers used video, photos, and/or documents to portray their curriculum and its implementation for all students within their classroom. Interviews were conducted after the completion of the second portfolio that included a variety of questions ranging from teachers' philosophies of differentiation and personalization, to their implementation of these concepts (see Appendix E).

Observations

Observations were conducted in each classroom to ascertain the context of the classroom, as well as the instructional approaches and/or assessment practices that were undertaken during the lesson(s). A total of 10 observations were conducted in Beth and Jennifer's classes; eight observations were conducted in Megan's class. Detailed field notes were taken during each visit, which spanned approximately 50 minutes per visit for each teacher in addition to 10-15 minutes of debriefing with each teacher after the lesson. At each visit, I was never a complete observer; rather, I was an observer as a participant (Merriam, 1998), one who was able to "observe and interact closely enough with members to establish an insider's view without participating in those activities constituting the core group of membership" (Adler & Adler, 1994, p. 380). For several of the visits with Beth, I did become a participant as I co-lead some of the lessons at Beth's request. In Jenny and Megan's class, I did participate in a few lessons; however, I tended to assist small groups and individual students, rather than co-lead. Having forged relationships with several of the potential participants in my study as part of the larger NSF study, it was difficult to be a complete observer each time. Additionally, as I bring an insider view to this study as a former teacher, my past and current experiences doing observations have shown that teachers often want to interact with me prior to, during and after observations to discuss what they taught and will intend to teach and/or assess in the future.

Despite this conjecture, as the researcher, I understand that I am “the primary instrument of data collection” (Merriam, 1998); thus, it was imperative that I constantly examined my biases and remained objective during data collection. As such, I wrote my field notes both during and after the observation to be as factual as possible, constantly re-reading them as I wrote to ensure that I did not add adverbial phrases that would make my field notes interpretive and/or subjective in nature. While I did highlight and/or note several points of each set of field notes that might be a component of UDL, differentiation, and/or personalization, I double-checked each example through the analysis process by ensuring that each excerpt was grounded in research.

Observations started at the beginning of each unit, or very close to it, with additional observations throughout the unit and, finally, observations towards the end of the unit to view some assessment practices. During the fall, both Beth and Megan were observed concurrently, with Jenny being observed approximately one month before Beth and Megan. While the intention of the field notes is to align them with the research questions, the field notes concentrated on the following components as detailed by Merriam (2009): physical setting, participants, activities and interactions, conversations, subtle factors (including non-verbal communication), and my analysis of my own role within the classroom. The purpose of gathering this wealth of information is to provide context and to ensure that all proper aspects of the classroom curriculum, instruction and/or assessment were equally accounted for.

Merriam (1998) ascertains that a researcher should, “record field notes as soon as possible after observing; in case of a time lag between observing and recording, summarize or outline the observation; draw a diagram of the setting and trace movements through it, and incorporate pieces of data remembered at later times into the original field notes" (p. 105). Field notes were rewritten after each observation in order to include details that might not have been captured within the time constraints of the original observation and often took into account the additional documents that were given to me from the teacher, many of which were new or additional evidence of UDL, differentiation, personalization and/or the lack thereof. In regards to additional materials, for example, Jenny provided me with all lab handouts, as well as any additional notes and "Do Now" assessments, while Beth gave me access to the online physics and chemistry units in case I wanted to print anything out. "Do Now" assessments contained a few questions about previous concepts and were given by Jenny to her students at the beginning of every science class. After all observations were typed up and any additional notes/documents scanned in with the observations, they were uploaded to Dedoose, a qualitative analysis software program for coding (dedoose.com, Lieber, Weisner, & Taylor, 2016).

Merriam (1998) further indicates that the thoughts and commentary by the observer are critical to the depth of the field notes. I ensured that my field notes included my personal commentary, which included but was not limited to my questions about the observations and initial interpretations of what I just observed (Merriam, 1998). While I typed up the notes, I often expanded upon my analytic memos (comments), and recollected additional moments of UDL, differentiation and/or personalization. In addition, after almost each set of field notes was rewritten, I wrote and/or expanded upon short analytic memos that not only summarized each observation, but also extended it and included my thoughts about the observation. Miles, Huberman, and Saldana (2014) state that, "An analytic memo is a brief or extended narrative that documents the researcher's reflections and thinking processes about the data" (p. 95). These analytic memos allowed me to begin to make sense of the data by noting any emergent patterns as I progressed with field note collection, in addition to capturing how the data supports or challenges the research questions. Analytic memos also serve to detail my personal reflections and biases that might occur during field note collection (Miles et al., 2014). As such, the final set of field notes were much more detailed than those that were initially recorded, and include several more details that were integral when data analysis was undertaken.

During the observations, teachers were instructed to not deviate from their planned lessons and assessments in order to capture the authenticity of their teaching practices. Teachers were told that observations were meant to complement and provide additional depth to their portfolio artifacts and associated annotations and to shed light on their curriculum, instruction, and assessment practices in general. They were also told that the observations were being conducted in order to understand how they met the needs of all learners. The observations were the main form of data collection within this study and served to anchor the study in critically understanding how each teacher met (or in some cases) did not meet their students' abilities and motivation through UDL, differentiation and/or personalization.

ePortfolios

Two ePortfolios for each teacher were collected by each teacher. As part of the ePortfolio requirements for the larger study, teachers were asked to collect at least one instructional and one assessment artifact each day. However, this varied among all three teachers based on their units of instruction, classroom composition, etc. The NSF study has a very broad definition of instructional artifacts and provides teachers with examples of instruction artifacts, along with what artifacts could be included for the initial and final reflection (see Appendix D). Teachers included documents that they would use during their normal instruction planning and pictures with associated videos, along with teacher annotations.

Yin (2014) cites four strengths of documents: they can be examined multiple times; they are part of the teachers' daily curriculum and instruction; they often have particular pieces of information, such as important references to curriculum resources; and they cover a longer period of time than observations. Overall, the purpose of examining the artifacts (pictures and documents) and requisite annotations from teachers was to have a more complete picture of the differentiation, personalization, and/or components of UDL that were implemented by teachers across two units of study.

Interviews

One in-depth interview was conducted with each teacher after the collection of the second ePortfolio. The interviews were audio-recorded, and anecdotal notes were gathered by the researcher during the interview. The primary goal of each interview was to understand how teachers' planned-for and/or differentiated curriculum and instruction for students with special needs, and to understand challenges and/or successes they encountered in implementation. I also inquired if teachers differentiated curriculum and instruction processes differently by unit, accounted for motivational factors for each individual student (i.e., did they personalize instruction?), and/or over time as they got to know their students and their strengths/weaknesses. The final goal of the interview was to understand how teachers utilized the ePortfolio and any other additional tools to monitor and reflect upon their instructional methods for students with special needs. The interview was semi-structured and I asked follow-up questions/probes that were pertinent to understanding these goals, but might not be listed within the interview protocol, which were largely drawn from the observations (Appendix E).

Interviews were a critical component of this study as they provided insight into teachers' understanding of differentiation and/or personalization, their planning process, challenges and successes in incorporating differentiated curriculum and instruction for this population of students. In addition, the interviews allowed for the researcher to ask specific questions directly related to the research questions (Yin, 2014), which might not be answered through other sources of data. Finally, analytic memos were written directly after each interview prior to transcription to ensure that the researcher captured any biases that have emerged, as well as detailed how the data initially supports or detracts from the research questions (Miles et al., 2014).

Data Analysis

Data analysis began concurrently with data collection. Merriam (2009) states, "the process of data collection and analysis is recursive and dynamic" (p. 169). As such, data collection and analysis were simultaneous processes; however, the strength of the analysis increased once data collection was finished. Additionally, when data analysis is done in conjunction with data collection, it is easier to facilitate the researcher's recall of interviews and observations. To facilitate analysis, a clear, chronological record was kept of all data sources that are collected and a data accounting log of all data was used to keep track of the data (Miles, Huberman, & Saldana, 2014) and a contact summary form was used after each visit and interview to facilitate the reflections, questions and emerging themes that I saw and/or heard during each visit. All data sources were uploaded to the online data analysis program Dedoose (dedoose.com, Lieber, Weisner, & Taylor, 2016), which was used to facilitate coding.

With slightly more than 200 pieces of data utilized for this study, the data analysis process was thoughtful and extensive. Three rounds of coding were completed to examine each case individually, with a final codebook resulting from selective coding that took place after the second round of coding. The central themes and sub-themes that emerged made up the final code book were used to recode all the data for a third time to ensure completeness. After this final round of coding, two of the features within the analysis section of Dedoose were utilized to verify the six central themes and 20 associated subthemes that compose the findings section in Chapter 4. Then, a cross-case analysis of the themes in relation to differentiation, personalization, and/or UDL was undertaken.

Observations and ePortfolio Data

Immediately upon the completion of the final set of typed field notes, they were uploaded to Dedoose. An open coding process in conjunction with an a priori – codebook was used to code the initial set of observations. The observations for late fall/early winter for each teacher were coded in conjunction with her portfolio annotations, documentation and pictures. Beth's observations and portfolio annotations from late fall/early winter were coded first, followed by the late fall/early winter observations and requisite portfolio annotations of Jenny and Megan. Pictures and associated videos were too cumbersome to be uploaded to Dedoose, with each file, even at the smallest size possible, taking 5-10 minutes to upload successfully. As such, only Beth's pictures from the first portfolio were uploaded to Dedoose; however, only the first picture was analyzed as a test case, and then it took about 10 minutes to download. Thus, all pictures were downloaded from the secure cloud based storage system that held the data for all portfolios, and then they were inserted into each document with field notes if possible, or if not, they were just viewed on the cloud based storage system that housed all the data from the NSF study.

The memo function in Dedoose was rarely utilized for analysis, as the analytic memos were embedded within the observations themselves. Each memo was revisited throughout the entire coding process and was coded to allow for easy sorting within Dedoose, as advised by Miles et al. (2014). Again, all observations and the requisite portfolio annotations from the fall/winter were coded first. Then, taking into account the open coding and a priori-codebook from the first round of coding, the second round of coding began, using a more condensed codebook that resulted from axial coding (i.e., condensing the initial codebook and codes that resulted from the first round of open coding). However, this second round of coding, which encompassed the later winter/early spring observations and requisite portfolio annotations for Beth, Jenny and Megan, resulted in 688 specific codes, as it also included a multitude of new open codes that emerged.

In order to make the final codebook more manageable, I returned to the literature to ensure that the components of differentiation, personalization and UDL were broadly defined, but were not too specific, so that the final analysis would not be too unmanageable. To ensure that all codes in the final codebook were properly applied to the all of the data, a final round of coding using the final codebook was undertaken of all data pieces. The excerpts that resulted from the final codebook served as the data for final analysis.

Interviews

The interviews were part of the second and third rounds of coding. While all interviews were recorded and transcribed, I also had taken detailed typed notes during each interview which not only noted the dialogue, but also the affect as well as any particular body language that was pertinent to the questions that were asked. After each interview, I mirrored the process that Seidman (2013) dictates by marking what was significant, particularly in regards to my research questions and any interesting facts. While each interview had set research questions that were closely aligned to my research questions, many additional themes emerged as well. The interviews were coded within the second round of coding, as well as the final round of coding, which resulted in new codes. This is in concordance with constant comparative analysis (Strauss & Corbin, 2014). In particular, these interviews led to key teacher insights on each teacher's thought process in regards to differentiation, accounting for student motivation and their reflections of their use of the ePortfolio.

Iterative Coding

Three rounds of coding were conducted as part of the data analysis, with the first round of coding limited to the late fall/winter portfolios of a physical science unit for each teacher, along with the requisite observations completed in each teacher's classroom. After the first round, axial coding allowed me to condense applicable themes and a newly revised code book emerged to apply to the second round of data. The second round of coding consisted of the second portfolio of a chemistry unit in the spring, along with the associated observations. The final themes and associated sub-themes were a result of selective coding. To ensure that all applicable data was coded with these themes and sub-themes, I went back and recoded all of the data. Then, using the code application and code co-occurrence tools from Dedoose, all themes and sub-themes that emerged from the selective coding process were verified.

First Round of Coding (First Portfolio and Associated Observations)

Using a grounded theory approach (Strauss & Corbin, 1990), I began with open coding the field notes gathered during the fall/winter from each classroom to establish initial themes across the data. This was done in conjunction with an a priori-codebook that was generated from the initial literature review that was in the dissertation proposal, along with additional research to ensure that all potential codes (i.e., any additional components within differentiation and personalization were accounted for). After going through the first set of data that stemmed from the first unit (physics) in the late fall/early winter using the initial a priori codebook and open coding (Table 5), I then engaged in axial coding where I grouped similar codes into more centralized themes which composed my second code book.

Second Round of Coding (Second Portfolio and Associated Observations, as well as Interviews).

The code book that emerged from the first round of data collection was then applied to the second set of data (observations and ePortfolio artifacts and annotations from the late Winter/early Spring) in conjunction with additional open coding. The open coding from the second set of data resulted in several new themes, particularly in reference to the interview data. This final round of coding proved to be extensively arduous with hundreds of new codes emerging based on my efforts to make the codes too detailed. Thus, 688 codes emerged. Upon critical reflection of the codes, I realized that many could be condensed and grouped together under the following approaches: differentiation, personalization, and UDL. However, I wanted to ensure that the codes were organized in a cohesive way, so I organized the codes under the following domains for differentiation and personalization: content, process, and product—all of which were grounded in research. Thus, a return to the literature, as well as an extensive review and condensing of previous codes led to selective coding where the central and sub-themes of all pieces of data were to answer my research questions (Merriam, 2009; Strauss & Corbin, 1990; Ulanoff, 2013).

Third Round of Coding – All Data Coded for a Second Time

As a final step, all data was coded an additional time with the final codebook that had the central themes and associated sub-themes that emerged from selective coding to ensure that each central theme and associated sub-themes were properly applied to the data, and no piece of data was left unaccounted for. Again, these six central themes and 20 associated sub-themes painted a vivid picture of how teachers account for the ability and motivation of students with special needs within their classrooms, as well as how they reflect upon their practices. Figure 2 demonstrates the coding process.

Table 5

Examples of Open Coding

Best Practices in Science Instruction	Meeting the Needs of All Learners	Personalization	Universal Design for Learning	Assessment
Project based learning	Scaffolding	Positive feedback	representation	Assess for learning
Engage students	Engaging content	Engaging homework	engagement	Student assessment
Series of artifacts	Home language	Various practice options	expression	Student involvement
Collaboration	Partnerships	Mutual dialogue	Executive functioning	Varied options
Cognitive tools	Hands-on learning	Choice	Physical action	Interactive assessment
Contextualize instruction	Student interests	Decision making	Assistive technology	Check for understanding
Support prior knowledge	Multiple modalities	The Match	Self-regulation	Informal assessment
Use of technology	Multi-sensory	Interaction	Interest	formats
Relevant and engaging curriculum	Graphic organizers	Progress setting	Options	Assessment as motivation
Differentiated lessons	Peer tutoring	Class Origin-Assessments	Executive functioning	Standardized
Hands on activities	Open ended questioning	Exploration	Varied communication	Embed assessment

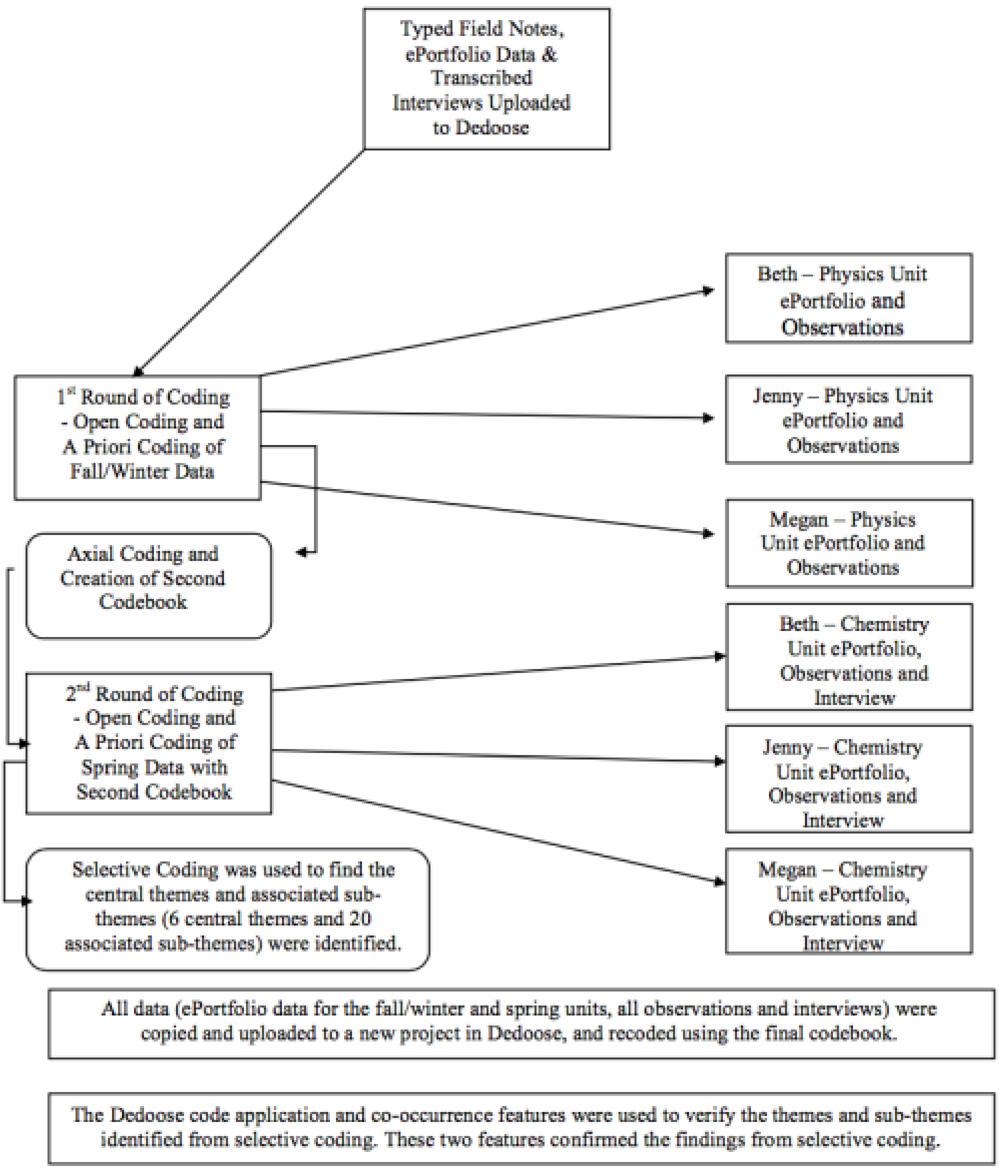


Figure 2. Data coding procedures

Overall Analysis

Again, the initial observations taken in late fall/early winter were coded with an a priori codebook and open coding, in concordance with the teachers' annotations from their ePortfolios, beginning with Beth, followed by Jenny and then Megan. The resulting codes were then condensed through axial coding to detail a more condensed list of themes. This codebook was then applied to the late winter/early spring observations and teachers' annotations from their ePortfolios, along with their interviews, again beginning with Beth, followed by Jenny and then Megan. Interviews were the final source of data coded, using both an a priori codebook as well as open coding. This round of coding became quite cumbersome with over 600 main and sub-codes. Thus, this required a return to the research to properly define the broad components of differentiation, personalization, and UDL, as well as multiple literacy practices, teacher reflection pieces, and state and national standards. This return to literature, along with a thorough examination of all 600 plus codes, led to a condensed final codebook of 105 codes.

This final codebook was then used a basis for a final round of coding that encompassed all data from the study. The data were then copied into a new project within Dedoose to make it easier to code. This codebook was applied in the same way as the two initial rounds of coding, by first coding the late fall/early winter observations and annotations for Beth, Jenny and Megan, followed by their late winter/early spring observations and annotations, along with their interviews. These excerpts, along with their supporting pictures served as the data for the final analysis. These data were then grouped into six central themes that were consistent across all three cases.

Utilization of Dedoose. After the third and final round of coding, I used the code application feature within the analysis section of Dedoose to verify the central themes and associated sub-themes that were identified through the selective coding. This feature generates an extensive Microsoft Excel spreadsheet, which itemizes how many times each code was found in each piece of data and across the data set. This verified the six central themes that emerged from the data through selective coding: differentiation, personalization, hands-on authentic learning strategy, UDL, teacher reflection, and monitoring instruction and assessment, which are further described in chapter 4 along with their accompanying sub-themes.

Credibility and Trustworthiness

As Creswell (2012) recommends, the triangulation of data sources was used to establish credibility and trustworthiness of this study. The use of observations, interviews, the ePortfolio artifacts and their subsequent annotations all lend credibility to this study. With the intention of creating an embedded single case study that is reputable in the field, the triangulation of multiple data sources that inform the findings and conclusions make this study more convincing (Yin, 2014). In other words, all findings within this study were supported by multiple pieces of evidence. Yin (2014) indicates, "the most important advantage presented by using multiple sources of evidence is the development of *converging lines of inquiry*" (p. 120). The triangulation of multiple pieces of data also lends more strength to the construct validity of this case study with multiple measures of differentiation. As this is a descriptive case study with the research questions initially framed by "how," it was easier to determine the external validity of this study. Formal member checks with each participant in regards to the observations, interviews, and data collected from the classroom were conducted to strengthen validity, after the final round of coding was completed and the results (final themes) were identified. More specifically, each teacher participated in a short (approximately 20-25 minute) informational interview to ensure that all themes have been correctly identified and interpreted based on the upon the excerpts. Each teacher was also provided with a summary of the findings and conclusions that were only pertinent to her classroom for her review. No teacher had any objections to what was delineated within this study. A critical friend was also used to ensure that the first round of coding was agreed upon. To ensure proper reliability within this study, all procedures were detailed clearly and firmly operationalized (Yin, 2008).

CHAPTER 4

Findings

The purpose of this study was to explore how three eighth grade science teachers plan and implement curriculum, instruction, and assessment that takes into account their students' abilities and motivation. More specifically, this study sought to explore how the teachers utilized differentiation, personalization and/or the principles of UDL to plan for, as well as carry out instruction and assessment. These three approaches were chosen because within the literature they are delineated as approaches that target the needs of all diverse learners, including special needs students. It is largely recognized that there is a connection between assessment and instruction (e.g., Martone & Sireci, 2009), with assessment largely informing instruction. However, assessment and instruction were separated for the purposes of this study for two reasons: in order to examine them at a more finite level, and because the ePortfolio required teachers to upload instruction and assessment artifacts and annotations separately.

Some components of differentiation and a personalized classroom were evident among each teacher and across all teachers. However, based on the data, there were limited components of UDL found for each individual teacher and across all teachers. Teachers made targeted adaptations for students with special needs and emergent bilinguals when needed, some of which could be attributed to differentiation, personalization and/or UDL. There was no evidence of individualization by any teacher, as no teacher used daily assessments for each student to determine his/her deficiencies in order to modify instruction (Adelman & Taylor, 2006).

An additional purpose of this study was to understand how teachers utilize the ePortfolio to monitor and/or reflect upon their planning, instruction, and assessment practices. The findings indicate that while ePortfolios are beneficial to some extent, other experiences, such as visiting one another's classrooms and collaborating with colleagues is more important. In reporting these findings, this study utilized three sources of data: (a) observations, (b) portfolio annotations and associated artifacts, and (c) interviews.

Central Themes

Six central themes that emerged from the data: (1) accounting for students' motivation and holistic needs; (2) pedagogical practices: fostering engagement and student interest; (3) scaffolding; (4) oral language and literacy; (5) using assessment as a teaching tool; (6) teacher professional growth and development (see Table 6). These themes emerged across all data sets and were verified through the code application analysis features on Dedoose. While the requisite themes that were found across all classrooms during observations and document analysis, the interviews lent specific data towards the challenges that teachers face in planning for and implementing instruction and assessment that will meet their students' needs and address their capabilities. Similarly, the interviews allowed for the teachers to divulge their feelings about the usefulness of the ePortfolio in monitoring and reflecting upon their instruction, as well as their views on what will assist them in their own professional growth.

Table 6

Central Themes

Central Themes	Brief Description	Examples
Accounting for Students' Motivation and Holistic Needs.	Teachers took into account students personal and academic needs. They recognized that students came from impoverished areas and were understanding of the challenges that they faced outside of school. They also sought to provide targeted support through certain adaptations to address their academic needs, while devising activities to motivate students within the classroom.	Lately, it has been hard (in regards to motivation). Some students are extremely motivated. They are super into it. They are coming up with all kinds of wonderful questions. They are curious. They are engaged. They are participating. They are hungry for more. They want to know more, but there is a larger subgroup then usual that

		has been very difficult to motivate (Jenny, Interview).
Pedagogical practices: Fostering engagement and student interest.	Teachers drew upon a variety of instructional practices; however, hands-on activities and projects were most frequently used throughout the classroom. These two practices were thought to engage students by increasing active participation and, ideally, pique their interest.	In her fall portfolio, when asked to what extent were you successful in engaging students in these practices in this unit? Megan stated, "students were engaged through the unit because they were working in groups of four doing most of the activities. They enjoyed this unit and 88% [of them] turned in the density bottle project."
Scaffolding.	All students were provided with scaffolding throughout each lesson. Concepts were modeled to students, and, gradually, students took on increasing levels of independence in their mastery of the concept through varied activities such as experiments, drawing and writing, and calculations. Teachers also made use of certain tools (e.g., prompting and visuals) that were targeted to assist certain students that needed additional scaffolding prior to independence.	After the students had practiced the formula *distance= rate x time* as a class, students practiced the formula in small groups and independently, using their practice times and associated distances from their balloon race activity during the force and motion unit. Beth circulated among her students and then redirected them when she noticed confusion (Beth, Field Notes).
Oral Language and Literacy.	Teachers spent a significant amount of time discussing and teaching scientific vocabulary/terminology to aid in student understanding of the concepts at hand. They also engaged students in questioning, in order to facilitate their understanding of the concepts, along with doing their best to find reading materials that were at their level.	"'I will definitely have to front load all students with scientific terminology and basic atom structure information depending on a pretest of concepts covered prior to their eighth-grade exposure of this content." (Beth)
Using Assessment as a Teaching Tool.	Teachers used both informal, formal and alternative assessments to gauge student understanding at the beginning, middle and end of each unit. Teachers saw assessment as a way to make changes to their instruction "mid-course" as well as how to refine units as needed.	Based on the [assessment] results I noticed that my students have a basic prior knowledge on the topic because only one student performed advanced and four proficient. The majority of my students have basic knowledge (twenty-three), three performed below basic, and three far below basic. This data helped me plan my lessons including more hands-on

		activities, labs, visuals, active notes, vocabulary reviews, questioning, videos and collaborative learning (Megan, Annotation from Portfolio Two).
Teacher Professional Growth and Development.	Teachers identified the challenges in accelerating their professional growth, such as finding adequate resources to meet their needs, as well as their thoughts on current tools, such as the ePortfolio. Teachers also spoke about the importance of collaboration among peers and the need to visit one another's classrooms.	"I also think it [ePortfolio] is useful when you are trying to show someone how you teach and what you do." (Jenny)

Accounting for Students' Motivation and Holistic Needs

All teachers collectively recognized that motivation was important for student success and associated certain instructional activities with motivation. Several personal challenges that the students had to deal with, whether it was lack of sleep or resources at home, were noted, with the teachers largely identifying that the traditional classroom set-up did not meet the needs of their students. They also recognized that students with special needs required certain modifications and adaptations to assist them in fully participating in instruction and assessment in order for them to make progress in science classroom.

Addressing motivation among students. All three teachers clearly recognized that increasing and sustaining a high level of motivation among students was critical to their planning and implementation of instruction. Each teacher associated student motivation with student engagement and interest. All three teachers identified certain activities and practices that they felt were critical in raising students' level of motivation, yet there was no evidence across the data that teachers asked students whether these activities and practices were motivating for them.

Beth held a steadfast belief that every child can be motivated. She stated, "I've never seen a kid, we may differ on this, but I've never met a kid who can't be motivated to do something" (Beth, Interview). Beth noted that she takes student motivation into account whenever she plans by finding engaging literature and, ideally, planning instruction outside in order to pique their curiosity and get them comfortable with the subject matter. For her, engagement was synonymous with motivation, and Beth explained that she tries to "lead students in" with an engaging video, discussion, vocabulary, or field trip. Then, Beth implements a hands-on activity or project that is coupled with some notes or reading to engage them further and, hence, motivate them to learn about the content. She indicated that when a student is unengaged, she believes it is a defense mechanism for them because they do not know how to do the task or understand the concept that they are presented with. Thus, it is the teacher's job to find an area that the student is good at, which will inherently increase his/her engagement and level of motivation.

Jenny indicated that building and sustaining motivation among her students was critical for student success. When asked in her interview the role that motivation plays in the planning process, she stated that, "It plays a big role" (Jenny, Interview). With every unit, she noted that she does her best to tie the concepts to what is happening in the real world. Jenny also tries to connect the concepts that she is teaching to movies that they like, which elaborated upon with the following:

> *Interstellar*, *The Martian*, and I know it is cheesy, but it gets them thinking about it [the science concept] … I had a group of students thinking that they could solve the gravity equation because of what they learned in physics plus they saw the movie about trying to do it. It inspired them to think outside the box (Jenny, Interview).

Memorization of facts and figures were not what was centrally important to Jenny. She was more concerned about engaging and motivating students to explore science long-term. Jenny wanted them to see how science was connected to real world experiences and how they could pursue science professionally. She felt that field trips and speakers within the classroom would motivate students, as she pointed out in her interview,

> I think field trips would have sometimes been more helpful [than instructional activities in the classroom] to motivate them. To see things in the real world. I think next year we will not be able to have many field trips at this school, so over the summer I am going to start looking for guest speakers to come in and do demonstrations so at least they will be getting some exposure to professionals in the [Science, Technology, Engineering and Mathematics] field. My goal is to have at least one speaker per unit come in. That way, someone other than me is helping them get motivated about what they are learning. [They need to see that] someone else finds this interesting too, not just my science teacher. I think that would be helpful for them. (Jenny, Interview)

Beyond trying to embed field trips and speakers within the science fields Jenny mentioned how critical attitude was in motivating students at the time of the interview. She indicated how she was struggling to increase student motivation with the majority of her students,

> Lately, it has been hard (in regards to motivation). Some students are extremely motivated. They are super into it. They are coming up with all kinds of wonderful questions. They are curious. They are engaged. They are participating. They are hungry for more. They want to know more, but there is a larger subgroup then usual that has been very difficult to motivate. That when, with the lab, it is just baking soda and it is just vinegar, this is not very interesting. They come with a very negative attitude. They just want to see things blow up and do crazy things. (Jenny, Interview)

So, Jenny continued to forge ahead in the hopes that they would see the inherent value in the tasks/projects, which, ideally, would reignite their curiosity and lead to increased motivation. She indicated that she felt a large part of this issue was the declining respect for adults at the school during this time period, specifically in regards to the administrators. Jenny felt that she had to work even harder for her students to see value in what she was doing in the science class and provide even more interesting activities for them to create a motivated class.

When Megan was asked in her interview the role that motivation plays in the planning process, "It [motivation] plays a huge role. It does because if you do not have their motivation, if you do not have their attention, you're not going to get anything across" (Megan, Interview). Megan pointed to the importance of allowing students to explore the materials and interact with them (i.e., provide them with hands-on activities). She stated that lecturing de-motivates them and "…that I will lose them. They'll sleep, their inappropriate behavior will increase" (Megan, Interview). Megan tries to bring students outside the classroom whenever possible, as she stated that the simple act of doing an activity outside the classroom motivates them. She pointed to how much they enjoyed launching their rockets outside and racing the cars that they made down the racetrack. Megan also stated how projects can be inherently motivating, such as the density bottles.

Understanding the personal challenges beyond the classroom. For Beth, understanding students' needs that extended beyond the classroom took priority over the curriculum, instruction, and assessment. She took direction from her students as equally as she did the demands of her teaching, as she understood the struggles that her students dealt with on a daily basis, beginning with lack of sleep. In her interview, Beth stated,

> … if a kid comes in here and puts her head down and goes to sleep, I let them sleep. And, I'll wake them up later on, and I'll catch them up. I know they're going to catch up eventually. So, there's got to be something going on and usually if they are not engaged, it's because something's going on. And each kid has something different going on. They're unengaged because they're, you know, sometimes you just have to let it go. I've let kids who are unengaged, sit at the back of the room, until they start begging to become a part of it. Because you can spin your wheels and you can – and if it's not working, then you should—you can't bang your head against the wall, sometimes you just need to step back and let them. Like for one student right now, I'm just—she's going back to her class. She is absolutely not going to engage in anything, so I'm smiling at her, but ignoring her completely and all of sudden she will just engage…

The students rarely got homework in Beth's class to address their lack of academic skills within this content area, as they were not likely to complete it at home due to their responsibilities at home and/or stressful situations that were prominent in their lives. She indicated in her interview that she tried to give the students agendas, but they lost them. Beth stated in more detail, "This is the thing, again organization, if you have at home a space that your parents have set up with a desk, shelves, quite then, you are going to be an organized person."

However, Beth did not assume that her students had any of these items at home and thought squarely of how to meet their needs at school, with the thought that they, "should have more time to wake up in the morning…these kids are really meant to come to school too early in their teenage years, they're too tired" (Beth, Interview). Beth mentioned that the students desperately need their own space, whether that is individual space or space to build comradeship with their peers. She reiterated multiple times how critical it is for students to have a space of their own, or a "home base" where they can practice what they need to, but also provide them a sense of stability, which many of the students do not have at home. Beth discussed the importance of having a fluid classroom, with the students being able to move from their home bases as well, because just as:

> …these children need a place that they don't move from, they also need to be able to go to those round tables, so having fluid classroom opportunities just so they could have some different places to go to, and also, do you know why they wear their hoodies (looking at me), to focus, which is important too. Too often, teachers are trying too hard to control behavior and it would be so easy to not have that problem if we could be more fluid with the furniture and if they had access to resources, it would be much better (Beth, Interview).

As such, it is critical that students, especially those from impoverished areas be provided with an environment that meets their needs and a teacher that understands their circumstances.

Jenny also found that the classroom was quite restricting for students; however, she took a different vantage point on this subject than Beth did.

In general, Jenny thought that "…our traditional classroom set-up is restricting and I think this allows the schools to teach on any budget to really provide students an alternate way of learning without costing more money." Essentially, teachers are constrained by cost and resources, both at school and at home when the traditional classroom is what holding back from more alternative and effective methods that meet student needs, which she delves into more with her interview:

> It (the traditional classroom) makes flip classrooms so difficult. I actually started the year doing a flip classroom, but I would get more than half of the students who have not watched the video, or answered the questions, or read the article online, or whatever because they do not have access to the internet. I think that is part of working with low-income communities. They do not have access to these things.

Jenny tried to explain even further by pointing out that while there are many expectations placed on the students, they are often unable to meet them because of their individual circumstances. She goes into this further with the following quote:

> I know that schools and colleges expect everyone to have a laptop, and they expect everyone to have Wi-Fi, and that is just not the reality for all students at this point. I know that they want to buy everyone an I Pad, but that does not mean that they have Wi-Fi at home. It does limit the flip classroom, which I think would be so helpful. Unbelievably helpful, and that would be the homework I assign every day.

However, due to the difficulties that students have when they get home, often as a result of living in a low-income community, Jenny stated to me on multiple occasions that she does not provide students with homework, unless it is absolutely necessary. Megan gave limited homework because she said that students rarely bring it back to school. She recognized the difficulties that students faced outside of school and how most were below grade level academically, thus affecting their confidence.

Addressing students with special needs. To meet students' academic needs, all three teachers recognized and implemented modifications or adaptations to assist students with special needs and emergent bilinguals. Within her portfolio, Beth identified several instances where she made modifications or adaptations just for special needs students, in addition to putting in place modifications or adaptations for both special needs students and emergent bilinguals. Jenny and Megan did not identify specific circumstances were they only noted modifications or adaptations for special needs students. Rather, they noted several instances throughout each unit where they made modifications or adaptations for special needs students and emergent bilinguals (see Table 7).

Table 7

Examples of Modifications or Adaptations Identified by Teachers within Portfolios

Teacher	Modification or Adaptation	Special Needs Students	English Language Learners
Beth	Additional time to color periodic table.	x	
	Providing extra support and monitoring of students as they used hot water during an experiment.	x	
	Providing strong support with measuring and calculations.	x	
	Reading the directions, clarifying vocabulary, acting out concepts, allowing extra time, modifying assessments and facilitating grouping.	x	x
Jenny	Guided notes were provided to students, what was in blue in the presentation went in the blanks of the graphic organizers.	x	x
	Thought bubbles included throughout the reading of each paragraph to help students monitor their comprehension and metacognition and to reflect on their own thinking.	x	x
	I included visuals for each practice question in individual boxes to direct their attention and prevent them from getting overwhelmed by a textual description or long lists.	x	x
	I provided guided notes that included a graphic organizer, lines to keep their writing neat and a space for drawing examples of each type of force to help students understand the language better with visual examples that they take the time to draw to demonstrate they are thinking about the type of force conceptually, not just copying down the notes.	x	x
Megan	The text was highlighted for the students and they were provided extra time for content mastery. Students were read aloud to and given guidance on how to complete the activity.	x	x
	Provided more time to complete the test, read test directions orally, repeated test directions as needed, asked students to repeat directions in their own words, provided breaks, broke up the test into two sessions, and provided assistance via the special education teacher.	x	x
	A special education teacher was supporting the students' learning by reading the directions aloud, providing them with more time and giving them step by step directions.		
	Extra time was given to complete the assignment, the directions were repeated as needed, extra support was given by a special education teacher, along with visuals, a thinking map (double bubble map) to reinforce concepts learned, and have students work in small groups of four.	x	x

Jenny specifically noted within her interview that she needed to do a better job of providing sentence stems for particular students [including students with special needs] with the goal that she would, “anticipating them having difficulties starting off, explaining their answers, supervising more sentence structures and starting support is definitely necessary” (Jenny, Interview). So, not only are sentence stems critical, but planning for the creation of appropriate sentence stems, along with which students need them is also of utmost importance. Overall, Jenny was the only teacher who mentioned how she needs to specifically examine how to adapt or modify her instruction specifically for students with special needs.

Jenny and Megan both used Power Point slides and guided notes, which they stated took a long time to prepare informally throughout my observations. Both teachers indicated that they spent a tremendous amount of time looking for pictures to facilitate student understanding of the concepts that they could insert into their power points and/or guided notes. Jenny also spent time going through the readings she gave the students, which were always in the form of hand outs, and added thought bubbles to them, with questions to prompt student thinking. These adaptations were specifically targeted for students with special needs and emergent bilinguals, but given to everyone. The adaptations took time and needed to be completed during the planning process. Throughout instruction, each teacher was never stagnant and was always moving around the room to check for student understanding. It was at these moments during my observations that I witnessed Beth supporting special needs students with their calculations of the formula *distance= rate x time*, for example, and Megan rereading directions to a lab to ensure student understanding. The teachers were well aware of the students with special needs in their classrooms; however, the focus of their instruction was examining how they could meet the needs of all their learners collectively, not individually.

Taking into account the needs of all learners. Despite these targeted modifications or adaptations, the data largely pointed towards teachers addressing the combined academic capabilities and needs of all diverse learners through their implementation of hands-on activities and projects on a regular basis. Ideally, each hands-on activity and project was authentic, so that students would see how they would tie to something that they directly experienced, or something that was happening or could happen in the world around them. Bailey et al. (2014) define authentic as "… real-world or stimulated real-world activities that students can engage in" (p. 8). The use of authentic instruction or assessment with students continues to be a contested topic within the education field.

When asked to expand upon her teaching philosophy in regards to the various sub-groups of students present within her classroom, Beth stated, "My philosophy is that if you have enough time to create units, that are project-based, all the students at all of those levels will have meaningful input and come away with meaningful experiences" (Beth, Interview). Jenny was in similar agreement with Beth, as was Megan about the importance of implementing hands-on activities and projects to meet the needs of all learners. When asked about her philosophy of teaching during the interview, Jenny reiterated this approach by saying, "I center around inquiry-based teaching methods, using a very hands-on approach because we're learning science where I allow students to investigate information that is not always in the lab." For Jenny, hands-on activities involved projects, experiments, and online simulations, which took place through an Investigation Before Explanation (IBE), in which students were given minimal direction from the teacher to have an opportunity to explore the concept, as well as during the main part of the lesson with more teacher guidance.

Megan expanded on these assertions in her interview, stating that, "students learn better when they participate actively in activities, specifically more hands-on activities." During her interview, Megan listed the critical activities that led to student engagement in her classroom, such as building cars and rockets during the force and motion unit and constructing density bottles. More specifically, in the concluding reflection of her second portfolio, Megan noted that this particular unit was not atypical of previous units; however, this was a positive aspect. She stated, "There were more hands-on activities in this unit. Students were more engaged because they were able to see and touch the experiments. This meant more to them because it made more concrete sense."

Pedagogical Practices: Fostering Engagement and Student Interest

Teachers used a variety pedagogical practices to meet the needs of their diverse learners, which are listed in Table 8. When enacting these practices, teachers used many different materials to facilitate these practices (see Table 9), along with a variety of grouping strategies (see Table 10). Thus, these eighth-grade science classrooms were never stagnant with the students solely following a traditional lesson structure with a teacher lecturing on concepts followed by independent practice with a paper and pencil activity. The most prominent pedagogical practices that emerged from the data were hands-on activities and projects that were grounded in real-world experiences.

Table 8

Variety of Methods Used by Three Eighth Grade Science Teachers

Method	Beth	Evidence - Beth	Jenny	Evidence - Jenny	Megan	Evidence - Megan
Direct Instruction	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes

Method	Beth	Evidence - Beth	Jenny	Evidence - Jenny	Megan	Evidence - Megan
Authentic Instruction – Hands-On and Project Based Learning	Yes	Portfolio Entries, Field Notes, and Interview	Yes	Portfolio Entries, Field Notes, and Interview	Yes	Portfolio Entries, Field Notes, and Interview
Workshop (Mini-Lesson, Guided Practice)	Yes	Field Notes	Yes	Field Notes	No	N/A
Textbook (Teacher Manual)	Yes	Portfolio Entries, Field Notes	No	N/A	Yes	Portfolio Entries, Field Notes
Online Lesson Plans	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	No	N/A
Self-Directed Learning (i.e., Independent Learning)	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	No	N/A
Games	Yes	Portfolio Entries, Field Notes	Yes	Field Notes	No	N/A
Stations/Blended Learning	No	N/A	Yes	Portfolio Entries, Field Notes	No	N/A

Table 9

Variety of Materials Used by Three Eighth Grade Science Teachers

Material	Beth	Evidence - Beth	Jenny	Evidence - Jenny	Megan	Evidence – Megan
Videos	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes
Online Simulations	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes	No	N/A
Songs	Yes	Portfolio Entries, Field notes	No	N/A	No	N/A
Textbook Readings	Yes	Portfolio	No	N/A	Yes	Portfolio

Material	Beth	Evidence - Beth	Jenny	Evidence - Jenny	Megan	Evidence – Megan
		Entries, Field notes				Entries, Field notes
Other Reading Materials (Articles, Chapters)	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes
Manipulatives/Objects, (e.g., density cubes, cars, graduate cylinders, etc.)	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes
PowerPoints	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes	Yes	Portfolio Entries, Field notes

Note: Only Jenny had consistent access to technology, with a set of Chromebooks that stayed in her room.

Table 10

Variety of Grouping Strategies Used by Three Eighth Grade Science Teachers

Grouping Strategies	Beth	Evidence - Beth	Jenny	Evidence - Jenny	Megan	Evidence - Megan
Whole Group	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes
Small Group	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes
Pair-Share	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes
1:1 Assistance	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	No	N/A
Small Group	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes	Yes	Portfolio Entries, Field Notes
Peer Tutoring	No	N/A	Yes	Field Notes	No	N/A

Hands-on learning was largely characterized by the use of manipulatives, usually during a lab setting in a science class, as well as through online investigations. Essentially, the use of paper and pencil was minimal by students throughout all three classes with the exception of formative assessments, filling out lab and/or activity sheets, in addition to completing guided notes. Projects were open-ended, necessitated collaboration among peers, and centered on the students' ability to integrate the concept that they learned throughout the science unit in order to complete a task and solve a problem. Most projects were culminating activities after a series of lessons and were used as a main assessment. With both hands-on activities and projects, students had many opportunities to work with their peers in both partnerships, small groups, along some whole class and independent work. All the teachers intended to and, for the most part, enacted hands-on and project-based activities that were connected to something the students knew about, could and/or would experience in the real world.

Beth: Hands-on activities and projects. Beth utilized the hands-on activities that were part of their textbook series during the fall unit, but also supplemented those with other activities, such as Live Action Role Play (LARP). She explained to me that LARP activities centered on active, kinesthetic learning that centered on students working together to complete a task. The LARP activity during the fall unit on forces and motion was a team balloon race, coupled with trivia questions that would be asked by Beth throughout the course (students had to navigate six obstacles by getting their balloon by blowing or sucking in through straws across or in some cases through those obstacles). Beth kept the time as each team went through the course, and then paused the time after the students completed each obstacle. With an initial practice run by the students coupled with modeling of the activity by Beth and myself, along with the practice runs and final run through the course, the LARP activity spanned approximately three class periods.

After a practice run and an initial calculation of their times, Beth explained to the students that they needed to change the velocity of the balloon by applying force using the breath from each team member. She modeled how to go through the course and stopped to explain that they would have to take turns to move and stop the balloon with their own breaths. Beth had a student stop her at certain points in the course to ask her a trivia question, as well as time her. Then, she asked me to go through obstacle course. Beth timed me and stopped me at certain points to ask me different trivia questions than she was asked.

After this modeling, all groups were given about 20 minutes to practice the trivia questions about force and motion, as Beth prepped the balloons and distributed them to the students. During the practice runs, the teams were initially unclear about how to modify the balloons because they had to account for the helium in the balloons. Some of them added paperclips (about 3 to the end of the string), others added paper, while some added pen clips. After the students went through the course, Beth asked them to write the following in their notebooks: make a plan for Monday's race, list the equipment for your new balloon, give jobs to each group member, and decide what trivia questions you are going to ask another group.

So, while there was scaffolding provided for each group through modeling and a series of practice opportunities, the students had to decide on a plan to revise their work and move forward more successfully for the next balloon race. This was an activity with very little direction. The students had to figure out how to work together to get the balloon to move. There were a variety of easy trivia questions and multiple ways to change the velocity of the balloon by manipulating it and applying different forces. As such, students were essentially "forced to collaborate" with one another in order to ensure that everyone was a part of the group; yet, the collaboration was not forced, as students came together frequently to discuss how to modify their balloons to make it through the course the fastest.

For the spring unit, Beth chose to use the middle school chemistry lessons from the American Chemical Society (http://www.middleschoolchemistry.com/lessonplans/), which provided background on key foundational concepts, such as an exploration with thermometers, which was a simple but hands-on activity. Similarly, the lessons broke down complex concepts such as molecules and their properties in an easily digestible manner, according to Beth, which was evidenced through a hands-on activity during the second unit in her classroom. Students were able to see a bubble expand as they put the water bottle bottom down in hot water with the top previously dipped in detergent. The students explained that the heat helped the bubbles expand, whereas when they put it in the cold water then the molecules contracted—having less energy, molecules were not moving as fast, therefore, the bubbles did not expand. Beth emphasized that she wanted students to observe and think about what they were looking at. She did not require them to write down their observations or thoughts.

On the last day of data collection for the second portfolio, Beth had the students play a card game based on the periodic table. While I observed that the students were engaged, she confirmed this through the following annotation in Portfolio Two, "Students had an opportunity to further their concepts of the elements [of the periodic table] through play. They were engaged and eager to play this more often. It incorporates opportunities to succeed for all levels of students' understanding of the periodic table" (Beth, Portfolio Two).

When asked to what extent her students were able to reach the learning goals for this spring unit, Beth stated:

> The students were able to reach learning goals. The primary goal in this class was to have students realize the importance of science and to understand and concretely experience their absolute ability to learn, research, apply and contribute scientific concepts daily. In engaging and hands-on activities and fun-shared experiences, they love science. They are not intimidated by it. This will help them in high school. As far as solidly learning the content, the results vary. With additional opportunities to study, they have a good foundation. (Beth, Interview)

These statements made by Beth underscore the importance of using hands-on activities for students to learn critical concepts, but also as a catalyst to motivate them to continue to learn about and enjoy science.

Jenny: Hands-on activities and projects. Jenny embedded hands-on activities after the DO NOW activity, which was a short sheet handed to the students at the beginning of class with one or two review questions on it from a previous lesson. After approximately 10 minutes for the students to complete the DO NOW and correct the questions, the students began their Investigation Before Explanation or IBE. Each IBE consisted of either a short experiment or task, which would precede the main lesson. Each IBE had very little teacher direction, with Jenny only rereading the directions for the IBE or clarifying certain vocabulary within the questions of the IBE. She emphasized to me repeatedly through the observations that she wanted students to be able to struggle with the material in the IBE and think about what they would be discovering within the main lesson.

Several of the IBEs involved PHET simulations (https://phet.colorado.edu/en/simulations/category/new) developed by researchers at the University of Colorado-Boulder. Students worked in pairs to go through the PHET simulation that was accessed online on a Google Chromebook. Each PHET simulation involved a computer animation that had the students to apply their knowledge of a certain scientific concept. For example, one PHET simulation tested their knowledge of net force. Every PHET simulation was accompanied by a handout that Jenny created on her own to guide the students through the simulation and required students to answer a series of questions based on the simulation. As an example, the steps and questions from the IBE Net Force Simulation are provided below.

IBE Net Force Simulation Handout

Investigation Procedure:

Arrange the players on the tug of war game so that there is no motion.

What is the net force?

Arrange the players on the tug of rope game so that the red team wins.

What is the net force of this example?

Arrange the players on the tug of rope game so that the blue team wins.

What is the net force in this example?

Analysis Questions/Reasoning:

Give an example of balanced forces from the simulation.

Give an example of an unbalanced force from the simulation.

Balanced forces cause a change in motion – True or False?

Unbalanced forces cause a change in motion – True or False?

When I observed the students working on the net force PHET simulation, they were very engaged throughout the lesson and were successful in reaching the learning outcomes. The computer simulation involved placing people on the tug of war rope to exert an equal force in the tug of war game. Working with partners, the students never took their eyes off the computer screen. The students worked together to move the people for the tug of war in a certain direction to understand the concept of net force. When Jenny went through the handout at the end of the lesson, all students raised their hands prepared to answer with about three-quarters of them having filled in the information on the sheet.

The PHET simulations that were referenced during the IBEs were always referred to numerous times throughout the unit, for review. In addition, they were referenced in the spring when the students were preparing for the final administration of the California Star Test for science. In the fall, one IBE was entitled, "Increasing the Force" and students were told that they were trying to investigate how force affects acceleration. This was a hands-on activity that did not involve the computer and the students were provided with the following directions:

> You will be working with your partner [students were able to choose their own partner for this IBE]. You will need a ruler and a toy car. The mass of the toy car is 5 g. Align the toy car to 0 cm on the ruler. [After the lesson, Jenny tells me that this was really hard for the students, as many of them do not know the difference between inches and centimeters.] Then, you will be pulling the car back at specific increments and observe how the force you apply affects the car's acceleration. Jenny then provided the following template to help students record their notes:

Trial	Pull car back by ___ cm	Observation about the car's acceleration (how fast did the car accelerate, how far did it go? Any other observations you have)
1	2 cm	
2	6 cm	
3	10 cm	

Figure 3. Recording sheet for car IBE

Jenny also created group stations where each inclusive group would be able to learn the content through hands-on activities that were highly structured which are meant to require little to no guidance from the teacher. As evidenced from the directives on the handout (see below), the group activities were highly structured in addition to being strategically placed around the room:

> From Handout:
>
> Station #1: Gravity and Normal Force (Directions to right and open box to left with – "Draw the book on the table AND the book on your arm in this box."

Hold your arm out straight with your palm up. Place a textbook on your palm. Hold the textbook as still as possible for 1 minute.

*Do you feel a force acting on the textbook? ________________________

Describe this force? ____

What keeps this book from falling to the floor?
____

Now place the book on the table.

*What is now keeping the book from falling to the floor?
____

Station #2: Friction

(In box to the left – "Draw the two books being pulled by the spring scales in this box.")

Feel the bottom of textbook #1 with your hand. Now pull the textbook across the table using the spring scale.

*What does the bottom of the book feel like?

*How much force, in Newtons (N), does it take to move the book?

Feel the bottom of textbook #2 with your hand. Now pull the textbook across the strip of sandpaper.

*What does the bottom of book #2 feel like?
____

*How much force, in Newtons (N), does it take to move the book?
____

Station #3: Elastic Forces – Compression (In the box to the left – "Draw the book balanced on the meter stick in between two tables in this box.")

Observe the textbook that is balanced on the meter stick.

*Is the meter stick straight? ____

Now gently lift the textbook.

*What happens to the meter stick? ___________________________________

Place the textbook back on the meter stick.

Station #4: Air Resistance (In the box to the left – "Draw the book balanced on the meter stick in between the two tables in this box.")

Drop the "parachute" holding the washer and a washer by itself at the same time.

*Which washer hit the ground first?
____

Repeat the process again and observe.

*Which force is resisting the pull of gravity? How do you know?

Place the parachute and the washer back on the desk.

Station #5: Elastic Forces – Compression (In the box to left – "Draw the book on the sponge in this box.")

Observe the sponge resting on the table. Now place the textbook on top of the sponge so that it covers up 1 cm of the sponge's edge.

*What happens to the sponge?
____

Remove the textbook and observe the sponge.

*What happens to the sponge?
____

Station #6: Elastic Forces – Tension (In the box to the left – "Draw the two washers hanging from the stand in this box.")

Examine the washer hanging from the string.

*Describe the forces acting on the washer:
____

Gently pull down on each washer.

*How are the forces acting on each washer the same? How are they different?
____

However, despite these group activities being highly structured, the management of the groups moving among the centers was a bit difficult as noted by the following field notes from the fall. After one lesson, Jenny came up to me after the lesson and said that things did not go very well. I said that I disagreed, because by the 3rd rotation at the centers, the kids were definitely beginning to get it (i.e., what was expected of them, what they needed to learn, etc.) Interestingly enough, the kids had a hard time rotating from center to center—they could not figure out how to switch around to each station without arguing. Also, within stations, they could not figure out how to rotate either…it was almost as if they had to practice the rotations. For each center, Jenny provided students with guided notes so that they did not have to write full sentences. Despite, the difficulty that the students had transitioning from one station to another, they put forth an effort to do their best to work with one another and "problem solve" any questions that they may have had. These opportunities that Jenny created not only offered hands on learning experiences, but fostered collaboration among students. She noted in her initial reflection,

> My lesson plans are in the 5E format: Engage, Explore, Explain, Elaborate and Evaluate. This lesson cycle utilizes an inquiry-based teaching methodology that I believe enhances students' learning by allowing them to investigate like scientists before the teacher explains the concepts. When successful, the students will have learned the concept in the explore phases (IBE) before the teacher explains the concept in the following phase.

For Jenny, her IBEs, whether online or not are critical hands-on activities that she feels not only help the students understand the material, but engage them as well. She noted within her interview that explaining the material and identifying misconceptions associated with the content has been extremely helpful for students with special needs and English language learners, as the activities associated with these two overarching pieces involve activities that generate a lot of movement:

> They're able to receive the information in multiple modalities, so not just notes, like they get hands-on lab experience. They get to see things move, they get to see things change, they get to see cause and effect happen before their eyes. They're able to see patterns and colors, shapes and sizes. So regardless of language or ability having those additional like ways of getting information to them, and having them come to conclusions on their own before I teach them anything myself, I think also proves to be beneficial for them. Sometimes the noise levels

> are difficult for certain students with IEPs, the distractions – you know add to their impairment, but it comes hand in hand with inquiry-based teaching. That's something that I need to work on – my groupings – to get students with distractibility issues in a very quiet and focused group.

Jenny was adamant that hands-on inquiry-based learning, especially activities that were presented without prior direct teaching allowed all students to gain a better understanding of the concepts, as they were forced to critically think about them on their own first and foremost. In her final concluding reflection for portfolio one Jenny noted, "projects are also very common in my instruction, I like to use alternative assessments to monitor student learning, growth and achievement."

For the rocket project, Jenny had a clear objective, which she detailed in an annotation in her first portfolio:

> The purpose of this project was to design a bottle rocket with the least mass and most aerodynamic design to be able to demonstrate Newton's 2nd Law of Motion by applying air pressure force to observe its acceleration. The students were able to achieve the purpose of building their rocket models to prepare for the upcoming rocket launch the following Monday.

When asked what modifications/adaptations were made for the rocket project, Jenny noted:

> This activity allows for students of any capability to excel by constructing a model rocket of their own design. This is kinesthetic and allows for an enriching experience with Newton's 2nd Law of Motion. This also allows for gifted students to go above and beyond expectations and design a very aerodynamic bottle rocket with low mass to demonstrate a deeper understanding of Newton's Laws and synthesize what they already know about air resistance, gravity and pressure.

All of Jenny's lessons and associated activities were grounded in a 5E Inquiry Model, which asks students to: engage, explore, explain, elaborate and evaluate within a science model. This project-based framework was central to Jenny's planning and implementation of instruction for all students. Figure 4 shows an example of the rocket project.

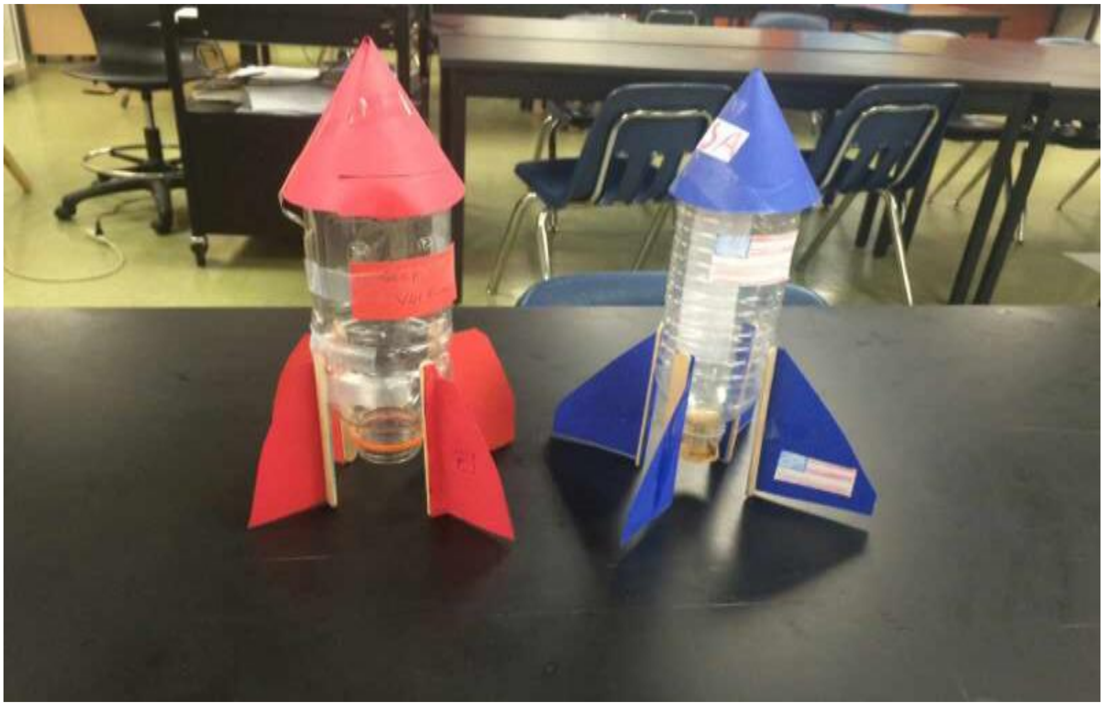


Figure 4. Rocket project – forces and motion.

Megan: Hands-on activities and projects. Megan required writing as an extension of all of her hands-on activities, as evidenced by a series of density mini-labs and lessons about acids and bases. The acids and bases unit that was detailed within the second portfolio included a variety of hands-on activities. First, students studied the effects of acids and bases on the browning of apples, which was presented in a formal lab write up by the students. In an effort to facilitate collaboration among her students, Megan had several students work together to create a display of this hands-on activity for the science fair.

More specifically, Megan stated in reference to sub-groups of students, such as students with special needs, "Students like real-life practices. I mean, they want to know why we are learning that. They want to know what it is useful for, and how it can connect to real-life" (Megan, Interview). Megan also went to state the importance of having specific sub-groups of students take part in hands-on activities, because it forces them to actively participate, which allows them to learn better.

Megan emphasized the importance of engagement, which was exemplified in the concluding reflection for Portfolio One. When asked to what extent were you successful in engaging students in these practices in this unit? Megan stated, “students were engaged through the unit because they were working in groups of four doing most of the activities. They enjoyed this unit and 88% [of the students] turned in the density bottle project.” When asked what the purpose of the instructional activity was (i.e., the density project), she stated the following in the first portfolio:

> [The purpose is to] have students use different liquids to create a density bottle. Students must be able to explain that liquids with a density greater than 1 gram per cubic centimeter will sink and liquids with a density less than 1 gram per cubic centimeter will float when it is placed in water. Students must be able to explain which liquid has the highest density and which liquid has the lowest density.

While Megan modeled this assignment and described each step in class, over a series of days, this assignment was completed at home and then displayed in class. The students took a bit of time during the end of the final class to explain their density bottles (see Figure 5).

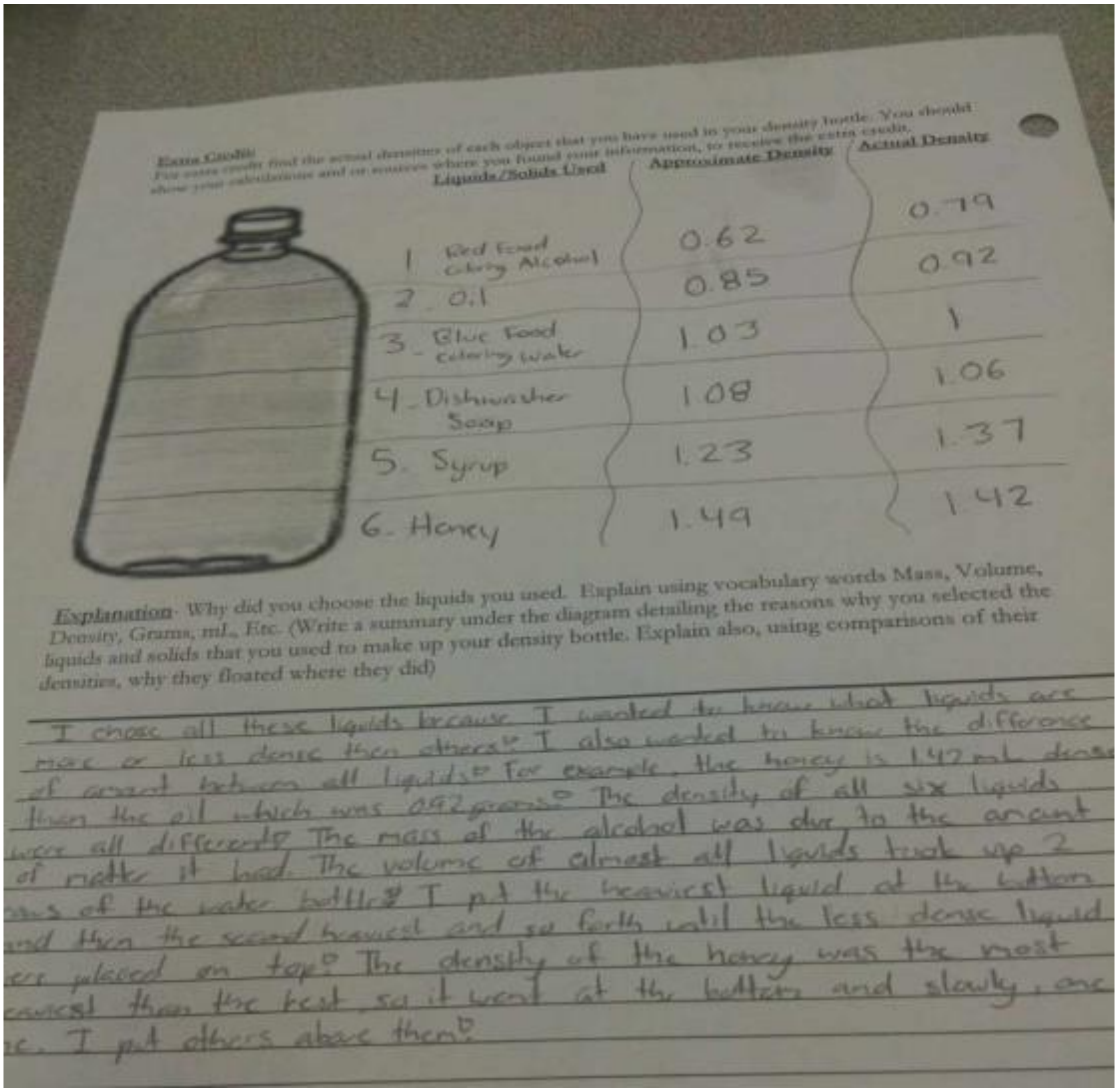


Figure 5. Density bottle handout

Megan reflected on the acids and bases lab after the students were finished. She stated the following in the second portfolio:

> There will be no changes to this lab because the students were able to observe and make their own hypotheses without difficulty. They were engaged and participated in class discussion. Students were working small groups of four, which made it easier for them to understand the concepts.

Thus, it was group work, coupled with hands-on activities, such as experiments, which were the core components to the classroom.

Scaffolding

Scaffolding was a key component that was embedded throughout instruction with each teacher providing varied levels of support to aid students in their acquisition of key concepts. Overall, all teachers did some form of modeling, followed by guided and independent practice. In the process, teachers sought to activate students' background knowledge, while providing certain students with visuals, demonstrations and 1:1 support with explicit prompting, on an as needed basis to further scaffold key concepts for them.

Beth spent a significant amount of time breaking apart key concepts, and then had students work in small groups and/or partnerships in order to build independence in learning concepts. She always circulated around the room as students practiced in groups or independently. For example, after students practiced the formula: distance = rate x time, as a class, students practiced the formula in small groups and then independently, using their practice times and associated distances from their balloon race activity during the force and motion unit. Beth circulated among her students and then redirected them when she noticed confusion. She asked students to explain the formula to one another and give an example prior to moving on from science.

During a subsequent lesson in Beth's classroom, she noticed that the students were having difficulty with this formula, so she called up two students to the front of the room to do push-ups for two minutes. After the two boys completed the push-ups, the students "were told (by Beth) to go back to their desks and find the rate (# of push-ups per second)." So, Beth wrote on the board: Student 1 – distance (# of push-ups)/ time (# of seconds) = 58/120 = .48. So, Student 1 completed .48 push-ups per second. Then she wrote the same thing for Student 2 – Distance (# of push-ups)/ time (# of seconds) = 36/120 = .3. Student completed .3 push-ups per second. Beth initially broke down the concept of the formula again by explaining what each term meant. She then went through her calculations step by step. Beth then provided time for small group and independent practice with additional examples. When she noticed that many students were reaching mastery, she brought students back together to reinforce the terminology and how to properly do the calculations.

During the spring unit, Beth allowed for wait time, recognized that students were struggling, and, consequently, provided the necessary support that would allow them to eventually progress to mastery of the concept. For example, during one lesson in the spring unit, she asked the students to define a molecule. Beth waited for approximately two minutes for the students to answer, but unfortunately, none of the students raised their hands. She then followed up by asking them to define the parts of an atom. Beth waited for several minutes again and then noted that protons, electrons, and neutrons are the parts of the atom. She continued to describe the nucleus in great detail, always referencing the drawings that she gave the students. Beth then asked the students to repeat the parts of the atom aloud and to one another. Next, she asked the students to draw what an atom looks like in their notebooks. Beth said to me at the end of the lesson that she was not concerned as to whether anything was accurate or not; rather, she was much more concerned with the fact that everything was labeled and that they could justify their placement of the protons, neutrons, and electrons within the atom, as well as the fact that they could also add in vocabulary.

Over the course of the next few lessons, Beth then had the students label the drawings, write about them with guidance from her, and finally integrate this knowledge with activities from the periodic table. She spent a significant amount of time providing students with the requisite background knowledge to be successful, and then slowly reducing the amount of support as the unit progresses. For example, with the balloon race, a live action role play (LARP) activity, Beth began by providing background information, such as how to measure the course (mean, median, and mode), which lead to teaching the formula *distance = rate x time,* as well as directly teaching and integrating applicable terminology, such as *velocity, force,* and *pressure*.

While it was important to scaffold the actual hands-on activity or project, Jenny found that it was imperative to scaffold the introduction and set-up of activities as well in order to facilitate student success. For example, when teaching solids, liquids and gases, Jenny strategically planned her phase change lab. Within one lesson during the second unit, she scaffolded the lab in order to support her students by initially asking, "So what do solids look like… who remembers from a past science class?" One student stated, "They are packed together." Another provided an example of how a table was a solid. Jenny then told the class, "Water is H_2O as a solid, and when it turns to a liquid, it is H_2O, and then when heat is added again, it turns into humidity (or a gas). Why is it a physical change? This is what we will investigate." After this brief introduction, Jenny gave the students the procedures to the lab that were typed out on small strips of paper, but they were mixed up in an envelope. The students then had to put the strips in order for the procedure of the lab, and many students raised their hands for help from Jenny or me.

Megan also recognized the importance of scaffolding the set-up of lab activities. As a central component to her spring unit, students took part in an acids and bases lab. Megan had originally planned to have the students do the acids and bases lab earlier in the unit as she led with the following questions as an initial activity called the Catalyst to set the stage for the lab:

1) Can you think of any substances that you believe are acids?

2) What is the pH of water?

3) Is baking soda an acid or a base?

She began to preview what was on the board with a handout entitled “Lab Sheet Acids and Bases.” With all hands-on activities, Megan modeled each step of the process for her students, including how to get the materials out (e.g., various liquids to determine the pH). She also modeled one component from each piece of the handout (see Figure 9). Students were asked to use red and blue litmus paper and cabbage juice to test the items.

Not only did Megan model how to gather the materials, use them properly, and carry them through the lab, she also showed the students how to effectively work as a team. Megan went through the importance of having each student take part, emphasizing that even though everyone might not be able to test the pH of each liquid, each person should have the opportunity to test at least one and then, respectfully getting his/her group’s attention to alert them to the result. After twelve items were tested for their pH with both blue and red litmus paper and cabbage juice, Megan talked about how to properly work together to ensure that the remaining activities were completed by each person. She stressed the importance of not eating or drinking any of the twelve items. After this in-depth series of directions, Megan moved forward with the lesson by having the students get their lab papers and set up their trays containing the items. She told them they needed to practice getting the materials ready as a group for the lab. Megan noted that preparation was essential to all labs. The following day, the students embarked on the activity with few problems.

Jenny also scaffolded her directions prior to the beginning of an activity to provide structure, she also was highly adept at providing the scaffolding for worksheets, and more complex topics through an “I do,” “We do,” and “You do” model. This structure was used frequently by Jenny with the handout serving as a tool that inherently provided students with varied levels of support that was critical to their success. When this tool was used, it was always used after the Investigation Before Explanation, with Jenny modeling how to do the "I do" problem. Students were not asked to raise their hands as she did the problem; rather, they were asked to listen and copy down what she did step by step.

Even if they did not have their notes down from the "I do" on the board (as a model), Jenny left the answers on the board that they could go back to and refer to them while they were doing their problems. Then, she would proceed to the "We do" section, where she would begin modeling the modeling, but would ask students to help her out with solving the problem by providing her with the "givens," then the "equation," and finally the "answer." Jenny would ask the students to explain each part of the process and would then repeat that for the students to aid in their understanding. Finally, the students would have a chance to complete the "You do" problem, in which they were expected to try the problem independently. I noted within my field notes that the scaffolding of the worksheet (see Figure 6) was highly effective with the "I do," "We do," and "You do" model, as evidenced by the fact that 90% of the students, including two special education students who were able to hand in their papers by the time the bell rang (which was rare within this classroom).

I DO: (1) A dog that has a mass of 12 kg is accelerating at $3m/s^2$. What is the force acting on him?

Givens: Equation: Answer:

WE DO: (2) If an object is accelerating at a rate of $7m/s^2$ and has a mass of mass 11kg. What is the force?

Givens: Equation: Answer:

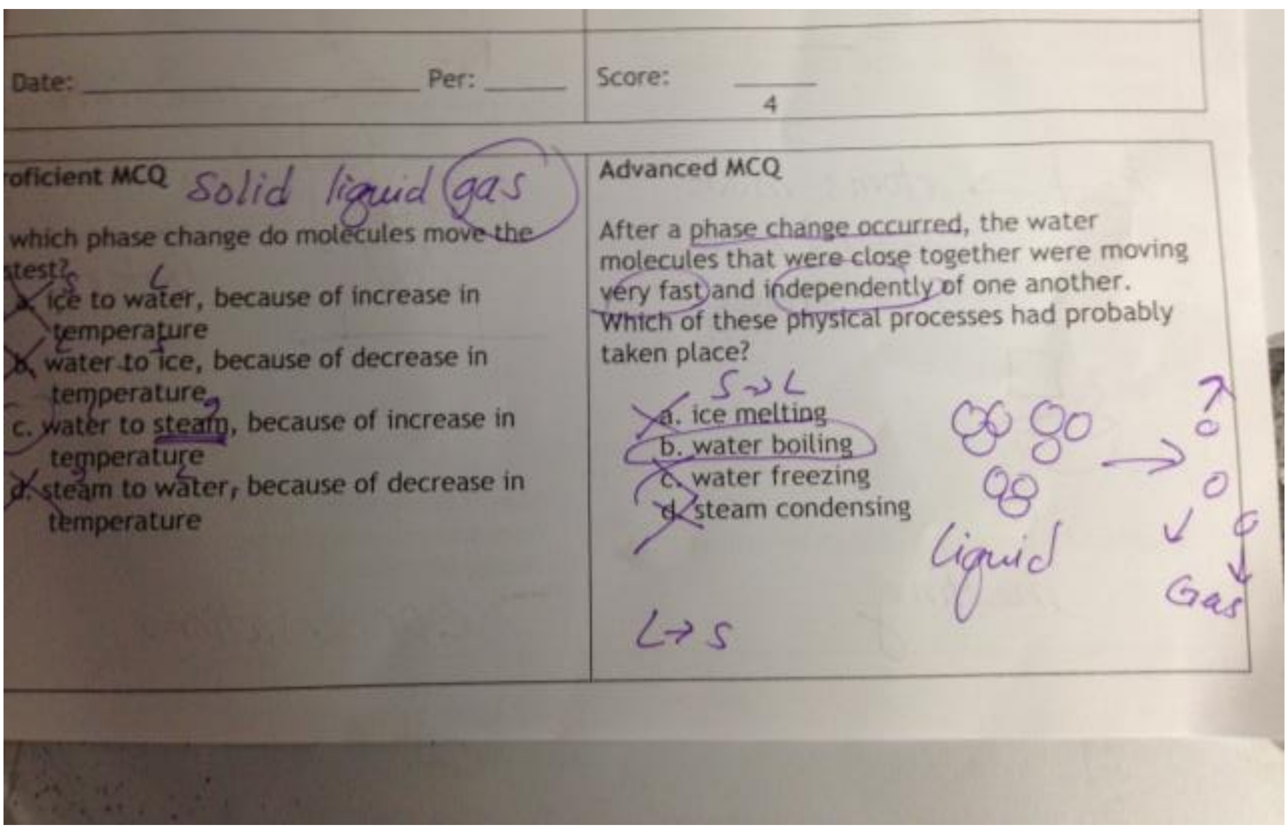
YOU DO: (3) Find the acceleration of an object if it has a mass of 22kg and a force of 66 N is acting on it.

Givens: Equation: Answer:

Figure 6. "I do," "We do," and "You do" worksheet

Jenny also used presentations to clearly illustrate specific concepts, as illustrated in one lesson that was observed during the unit in the spring. During this lesson, she went through the slides in a detailed way, reading them one by one to her students and asking them to follow along. Students were encouraged to ask questions at certain points by Jenny and to talk about the concepts among themselves. At a break during the lesson, she told me that her presentations are minimal, because she wants students to add in pieces about the content that they know. Jenny stated that she has several pictures within her PowerPoint presentations to facilitate discussion among her students. She indicated that she also tries to emphasize how concepts connect to real world activities and gives examples in her presentations. However, in this particular lesson, one slide had a picture of a glass of water on one side and ice cubes on the other side, and the students were asked whether it was an example of a physical or chemical change, which was difficult for the students to answer. Students were confused, so Jenny drew additional examples of physical changes and chemical changes on the board and explained each one in detail to her students. She then encouraged students to talk about the concept again, among themselves and reread their notes to ensure understanding.

After each "Do Now," was explained or in some cases handed out (often on a small piece of paper) within Jenny's class, she would survey the room and delineate who needed explicit prompting to get started. Often, a student with special needs would need an explicit prompt to get started, which was seen during a lesson in the spring. Jenny walked around the classroom as students worked on the "Do Now" and stopped to work with a student with special needs. She said, "Let's do the first one together… Let's think about this logically… would atoms move fast in a solid?" The student quickly responds, "No," and picks letter C. She then proceeds to draw a picture for the second question (see Figure 7) and asks him pertinent questions to scaffold his thinking.


Date: ______ Per: ______ Score: ______ 4

oficient MCQ
Solid liquid gas
which phase change do molecules move the test?
a. ice to water, because of increase in temperature
b. water to ice, because of decrease in temperature
c. water to steam, because of increase in temperature
d. steam to water, because of decrease in temperature

Advanced MCQ
After a phase change occurred, the water molecules that were close together were moving very fast and independently of one another. Which of these physical processes had probably taken place?
S→L
a. ice melting
b. water boiling
c. water freezing
d. steam condensing
liquid
Gas
L→S

Figure 7. Explicit prompting and support for one student with special needs

In addition to 1:1 supports with specific prompts to aid in information processing, small groups were necessary tools noted by all three teachers to effectively scaffold and break down the information presented. Beth noted that her modifications or adaptations for an explanation on forces and interactions required small group support and a break-down of each example, despite the visuals and manipulatives that were embedded within the activity. In addition, Beth utilized a workshop methodology (Calkins, 1994) throughout all her lessons which inherently has scaffolding built in. During one lesson in the first unit, the field notes indicated that Beth gave very explicit directions upfront, followed by modeling and independent practice. All three of those components are central to workshop (Calkins, 1994).

During the independent practice portion throughout each lesson across both units, Beth was consistently making her way throughout the classroom to aid the students, which was evident through the following example detailed within the following lesson. Beth came to the back left table and she rereads the questions to the students and breaks down the information. She states to the students, “So, if you push it, completely frictionless, then what happens… students were unsure, so she says, I am going to replay the video…” The video was about friction and distributed by *Magic School Bus* (Scholastic, 2016). (Beth then went and followed up with the students again to ensure they had a clear understanding.) She was never one to sit back and completely detract from any activity; rather, she would let students struggle a bit with the material, and then she would step in and provide support as needed.

In Megan’s initial reflection in her second portfolio, she detailed the importance of providing guided/scaffolded instruction to her students by stating the following:

> After the agenda and posted question of the day are provided, then guided instruction is implemented which might include: close reading, KWL chart, brain storming, thinking maps, instructions for the lab, active notes, read and discuss the text, interpret graphs for information.

Like Jenny, Megan utilized guided notes, where students were able to fill in the information with guidance. Whether through materials or instructional methods, there were varied levels of support that were provided to the students. Many teachers provide their students with various graphic organizers to capture their thinking, in addition to guided (active) notes for their students (see Table 7 for examples of curricular modifications used by the teachers).

Literacy and Oral Language

With the abundance of academic vocabulary used across the physics and chemistry units, coupled with the students' low reading levels, teachers emphasized vocabulary throughout all units. Whether through word walls, explicit instruction, within discussions and/or through graphic organizers, teachers did their best to assist students in their mastery of the vocabulary. Beth additionally noted in her initial reflection within portfolio one "Basic vocabulary is a front loader with ELL [English language learner/emergent bilingual] students." While explicitly stated by Beth, both Jenny and Megan informally stated to me across each unit the importance of ensuring that students understood and properly applied the scientific vocabulary within the unit.

To assist students with their understanding of the science concepts within each lesson, each teacher did her best to engage students through whole and small group discussions, as well as partnership work with targeted questions to get them to think critically about the concepts that were presented. Essentially, the data pointed to the importance of "tapping into students' current knowledge" and intentionally frontloading them with critical terminology and concepts so that they would succeed in understanding the concepts that were presented.

Vocabulary. Vocabulary was emphasized to some degree within every lesson that was observed for all three teachers, whether in-directly through a word wall, or directly through group work or teacher directed instruction. Beth often wrote charts with her students, capturing key concepts and vocabulary as she discussed them with her students. During one lesson, Beth titled a chart, "Chemistry is the Study of Matter." As she spoke to the students, she summarized her short discussion by capturing the concepts on the chart, such as: "The particles of a liquid are attracted to one another, are in motion and are about to move past one another." Beth then wrote "thermometers" on the chart and then turns to the class and says, "Tell your neighbor what you did with the thermometers" (the students had just measured the temperature of both hot and cold water in small groups). Then, after some discussion, she wrote:

Thermometers – Liquid

Heated – Cooled

Beth then posed the following question to the class, "What else did we find besides temperature?" One of the students responded with the following, "Molecules move faster and increase the heat – when molecules cool down in cold water, they slow down." Beth nodded, and then writes on the chart:

Heated Up – Cooled

As she wrote items on the chart, the discussion was stimulated, with the students consistently focused on the terminology and concepts that were captured on the chart. Beth used a chart to introduce key concepts and scientific terminology, as well as for review whenever needed.

Vocabulary was an ever-present piece throughout each science period in Beth's classroom, as she often prompted the students to speak like a scientist and use scientific vocabulary. During one lesson in the forces and motion unit, she rolled a soccer ball back and forth to one student as part of a demonstration. After rolling the soccer ball a full time, Beth stops for a moment before rolling it back and says, "However, let's use this with scientific vocabulary—you will exert a force to roll a ball…" She then asks the student to repeat it. This emphasis on scientific vocabulary continued throughout the unit, even through to the final assessment, where the students were asked to describe what was happening in a you-tube clip about a storm in Norway. Beth indicated that journalists need to explain what is going on and as they write, they include scientific vocabulary to explain what is going on. She read off the chart during this activity, with the vocabulary that she added throughout the unit. Beth modeled for the students how she used force, motion, etc. within her sentences to show the students how a journalist would report what happened during the first half of the video. She reiterated to the students that they needed to use scientific terms in their writing, as they were journalists.

Thinking like a scientist was critical, but so was talking and writing like a scientist, which necessitated the use of scientific vocabulary. This was central to Beth's lessons. Subtly, Jenny also emphasized using scientific vocabulary throughout her lessons, e.g., when one student answered a question from DO NOW in the first unit, the student stated that a Hot Wheels car will be easier to accelerate because it is lighter. However, Jenny corrected her by stating that the student cannot use *lighter*; rather, she needs to use *less mass*, because that is the appropriate scientific vocabulary.

Jenny usually embedded vocabulary teaching in her discussions with her students, along with pre-teaching the vocabulary prior to the lesson as needed. She encouraged students to use proper scientific vocabulary when completing their hands-on activities or projects as she walked around the classroom monitoring students work. Jenny also clarified vocabulary for her students by pointing out the words on the word wall orally, which was especially prevalent throughout the lessons in the spring unit:

Atom

Nucleus Electron Cloud

Proton (+) Electron (-)

Isotope Groups/Families

Ion (+ or -) Alkali

Ionic   Alkaline Earth

Covalent Halogens

Noble Gases

Periodic Table

Elements

Trends

Atomic # (P)

Atomic Mass (P + N)

While there were no illustrations listed next to any of the words, Jenny would reference them in each lesson that I observed. Megan tended to directly teach vocabulary to the students to ensure that they were clear on the terms that were used during the lesson. In an effort to teach the Archimedes principle, “the buoyant force on an object in a fluid is an upward force equal to the weight of the volume of the fluid it displaces,” Megan spent a substantial amount of time pre-teaching the majority of the vocabulary words with the definition throughout one lesson. She provided the students with a handout that had a mix of illustrations and guided notes. Megan flashed on the screen two pictures to help the students—one of a person pushing a block and then other of tug of war. She told the students that they could copy her pictures or create their own. Most of the students end up copying Megan’s pictures.

Moving beyond force (push and pull), she moved onto fluids, with a picture of a balloon and water on the screen. She then moved on to buoyant force and required students to draw a picture and only add in some of the phrases for the definition, such as *upward force* and *the* *weight of the object*. Megan stopped several times to ensure that the students were clear on the vocabulary prior to moving forward. She also had them discuss the vocabulary within their partnerships as well. An artifact within her second portfolio showed how Megan began a vocabulary sheet in class that was eventually sent home for homework for anyone who did not finish it. She went through each definition and term with the students, often highlighting examples of illustrations that were completed by her students (see Figure 8).

This vocabulary sheet was then stored in their folders and reviewed throughout the lesson, to ensure that the students were clear on all the vocabulary that was being taught throughout the unit. As Megan indicated through her initial reflection for Portfolio One, she had students use thinking maps to not only "record important information," but to also solidify vocabulary through visual information. Within her second portfolio, on the sixth day of instruction, Megan aided the students in completing a thinking map that compared acids and bases (see Figure 9). This thinking map was completed by each student as part of a whole class lesson.

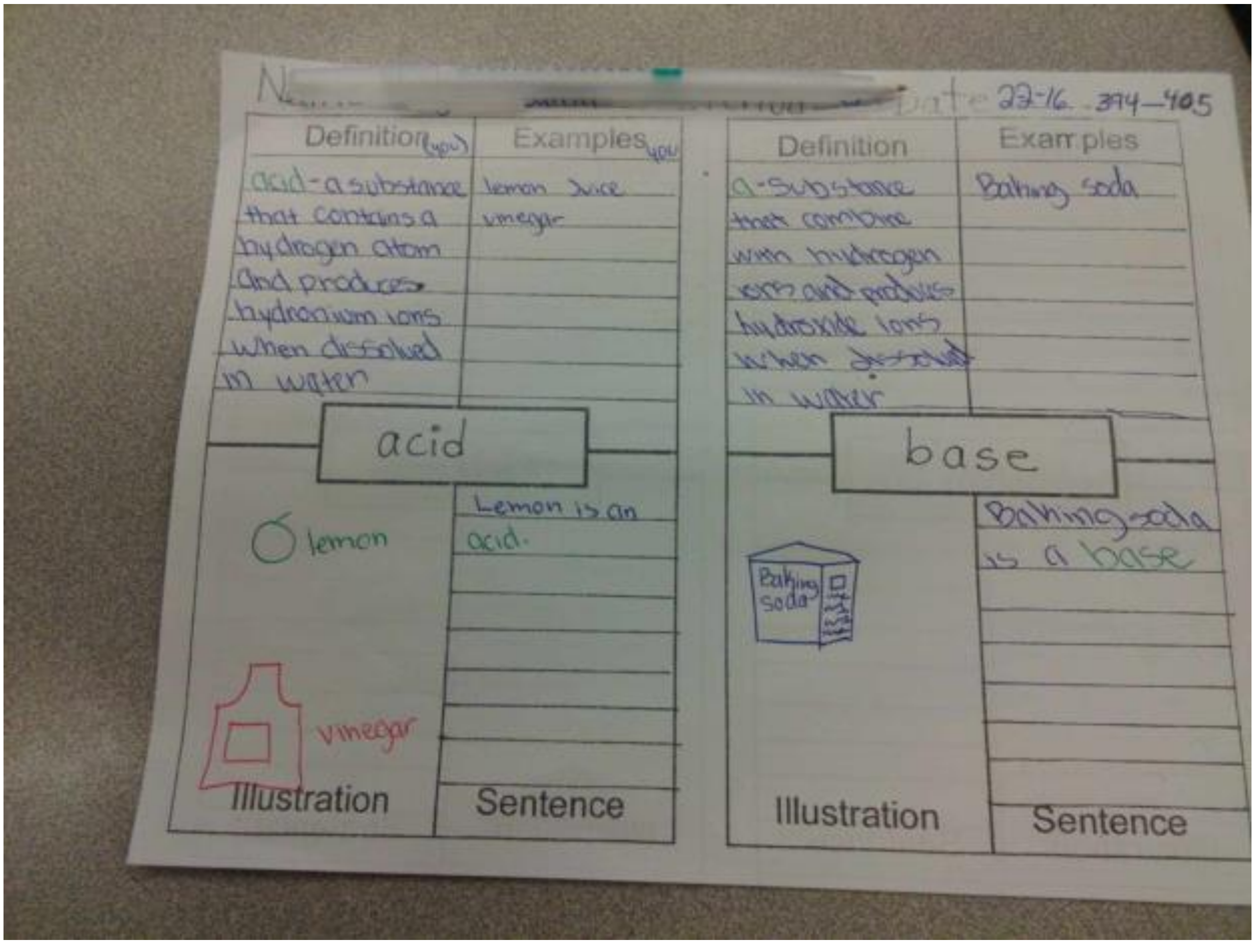


Figure 8. Acids and bases vocabulary notes

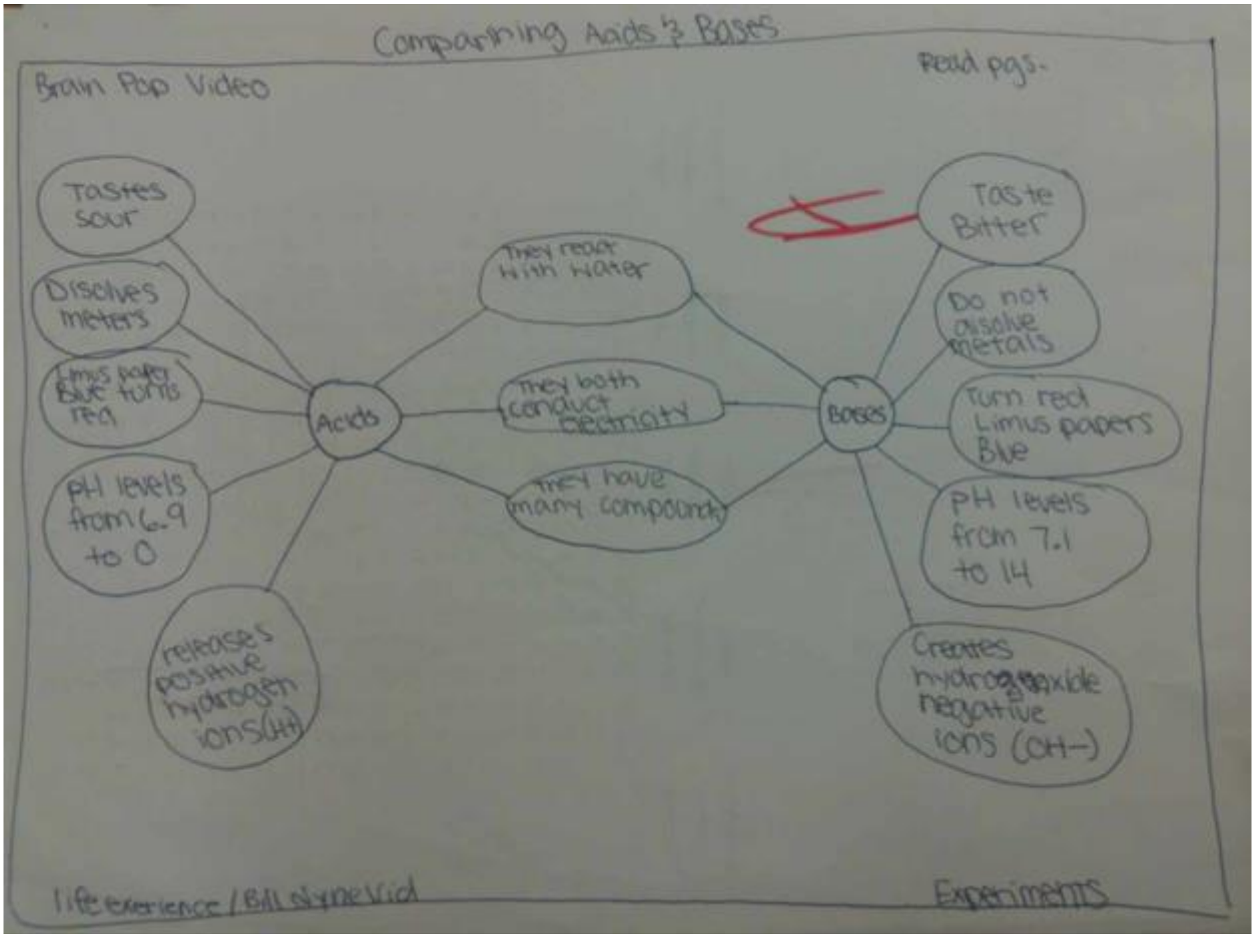


Figure 9. Thinking map (graphic organizer)

Megan stated the following in an annotation of her second portfolio in response to the question, "What was the purpose of the instructional activity related in the artifact?"

> To encourage students to review their notes to distinguish acids and bases and their properties. This map is useful in comparing and contrasting two items or concepts. Students place between the two concepts the qualities that they share with the differences are placed on the outside of the concepts. They can use any word or phrases that are appropriate. Color coding the similarities/differences will help students to identify the relationship between the two concepts.

As such, all teachers embedded vocabulary within their pre-teaching of the unit, throughout the classroom environment, or as needed through the class discussions. Despite these efforts, vocabulary often proved to be a barrier to the students fully understanding the concepts that were taught during class, as it was observed that many students in Jenny's class had difficulty navigating a quiz on forces and motion, when they were asked to make quiz corrections. During this exercise, Jenny discovered that many of her students were confused by not only vocabulary within directions on the quiz, but also vocabulary within the questions of the quiz. Several students could not pronounce the vocabulary words, nor did they know the definitions, even though many of the definitions could be found on the matching section of the quiz. This example from Jenny's classroom was common and also seen within other classrooms as well. While Beth stated it would be advantageous to have students review scientific vocabulary at home, this was not a reality for her students, as they will not be to "truly" study because many had stressful situations at home.

Questioning. Teachers posed questions to their students orally and in writing for various purposes, whether to reinforce concepts, clarify vocabulary and/or extend student thinking about a certain concept. Beth talked about questioning as a valuable component in Portfolio Two, "I use question/answer techniques to assess prior knowledge, review and front load vocabulary" (Beth, Portfolio). Beth often provided the students with a broad question at the beginning of each lesson and then clarified the question, as each student worked to answer the question with a partner. For example, in one lesson she asked the whole class, "How would you explain what matter is?" Students did not answer after some wait time, so Beth asked the question again. She reminded them that they had the answer in front of them on their handouts and that matter takes up space and has mass. Beth reiterated that this was a review from yesterday. She then had the students turn to a partner, ask the same question, as well as what an atom or molecule is to practice question and answer, reminding them that the answers are on the handout in front of them that they received from yesterday's lesson. Beth did not partner students with special needs with a stronger student for this exercise, and she did not point out the vocabulary to them to help with this exercise.

After moving around the classroom and listening in to students' conversations, Beth brought them back together and asked them to define a molecule. This time, a student was quick to answer and stated that a molecule is what happens when two or more atoms join together. She repeats this process for solid, liquid and gas, by first posing the questions to the whole class, then having them ask each other, and then repeating the questions again with the whole class. Finally, Beth had them highlight certain terms on the handout that were associated with the definitions, stating to me after the lesson that these were terms that were difficult for many students to understand or pronounce as part of the overall definition. It was unclear whether all students, including those with special needs, gained a clear understanding of the material through this approach.

Jenny utilized questioning within lab activities. For example, during one lesson she asked, "If I increase the temperature of this water, what will happen?" Most of the students responded in unison by saying, "The molecules will definitely move faster." After some reading of the lab handout, Jenny then asked the students, "How does the heat affect the molecules?" Some of the students began to chat amongst themselves, but as the students began get distracted, Jenny stated, "When you add heat, it does several things, so many answers would work. With heat, you gain energy and move faster, which reduces attraction." Jenny then asked a student to define the phase changes of water, and the student repeated them for the class. The other students were sitting at their tables, with only a portion of the students listening as gauged by their eye-contact and body-language towards Jenny and the student.

Overall, as the students went through the labs for both units, Jenny consistently asked students guiding questions to help them aid their thinking. For example, during a chemistry lab, she was walking around from group to group asking guiding questions and modeling the stations if needed. Jenny would ask several questions to the students such as, "What are you observing here? Is it a chemical reaction?" She kept moving from station to station, almost for one-minute intervals. The questions that were directed towards the experiments were much more broad, while the questions that both preceded the labs and occurred during the overview of the presentations and/or notes handed out were much more specific. This was seen during a lesson when the students were doing a "physical or chemical" reaction "think-pair-share," where the students were taking notes based on the PowerPoint presentation. Jenny asked the students to define physical and chemical changes, pointing to the pictures on the power point.

Questions were also used for the purpose of checking for understanding, while gradually increasing students' levels of analysis and synthesis, as seen through the following activities that delved into Newton's Second Law. Jenny detailed this concept in an annotation in her first portfolio:

> The purpose of this activity was to dive deeper in the understanding of Newton's second law. The students used three different Internet simulations to explore the 2nd law. The students first watched a BrainPOP® video and then took a quiz to check their understanding of Newton's three laws. The second portion using the PHET online simulation on forces and motion basics really puts all the pieces of Newton's second law together. The activity was able to achieve its purpose because students are able to kinesthetically and visually manipulate the second law by altering mass, force and acceleration in a variety of scenarios guided by the activity. The focus questions that guided they're thinking throughout the process help to check for their understanding. The analysis questions at the end required to them to use higher depth of knowledge in more application and synthesis questions.

Scaffolding questions from low to high levels were also an integral component in Megan's teaching, as she sought to use questioning as a technique to increase the level of students' thinking. In one entry in her first portfolio, Megan stated that she was submitting the students' Mass and Density Lab Evaluation with Read-Encode-Annotate-Ponder (REAP) questions as an artifact in her portfolio. In describing the purpose of the activity, she stated,

REAP questions are a method of formative assessment that combines the time-tested ideas of Blooms Taxonomy with new research on student assessment. The level of thinking increases from basic recall to complex analysis and predictions. This tool can be used throughout or at the end of each lesson. Questions on this handout ranged from: What is density? to Which is more dense: solid, liquid or water? to What type of property is density? Thus, students were able to build upon their answers (Megan, Portfolio).

Megan noted that this approach was particularly effective for all students, with special needs and emergent bilinguals being able to answer the more basic questions on the handout with her support or the assistance of the special education teacher in the classroom. Additionally, students at or beyond grade level could challenge themselves with higher-level questions.

In regards to materials/resources, Megan noted that she desperately needs high interest texts that are at the students' levels. She expressed that books/reading materials at their level are boring for them, including the textbook. More specifically, the textbook needs to be more visual. She stated that with the textbook, "It has a lot of information that they do not read" (Megan, Interview). Megan also indicated the importance of having colorful pictures (i.e., visuals) for them. She elaborated on this with the following, "That's why I use the PowerPoint. I need visuals for them to understand" (Megan, Interview).

Using Assessment as a Teaching Tool

A multitude of assessment practices were prevalent across all three teachers with the primary emphasis on students' making progress and developing a love of learning. The secondary emphasis was on academic achievement, largely gauged by their ability to memorize vocabulary and concepts. Central to both the primary and secondary purpose of assessment was the ability of teachers to use what informal and formal data that they had gathered to influence their teaching decisions. Informal assessment data was gathered through teacher observation of students during hands-on activities and projects, as well as their participation during small and whole group discussions, in addition to any writing or drawing done daily throughout the unit. Formal assessments included paper and pencil tests, as well as presentations, with alternative assessments such as projects often serving as the summative assessment of the unit.

While the teachers sometimes made changes "mid-course," such as Jenny noting that students needed to embed another activity to re-teach ionic and covalent bonding within the spring unit, teachers also used assessment to understand what they would change or not change when they teach the unit again next year. All of the teachers utilized assessment to inform their understanding, as seen through Megan's annotation on the first day of her second portfolio:

> Based on the [assessment] results I noticed that my students have a basic prior knowledge on the topic because only one student performed advanced and four proficient. The majority of my students have a basic knowledge (twenty-three), three performed below basic, and three far below basic. This data helped me plan my lessons including more hands on activities, labs, visuals, active notes, vocabulary reviews, questioning, videos and collaborative learning."

Assessments were invaluable in helping the teachers plan a variety of activities to ensure that all students' needs were met throughout each unit. Through the assessment artifacts within the ePortfolio, each teacher had the opportunity to explain their use of assessments as teaching tools through their answers to the following question, "Based on what you learned in the assessment, in which ways did the students generally reach or come up short of the learning goals?" For example, in response to this question, Jenny stated the following within Portfolio One:

> Yes, students generally reached the learning goals. Most students were able to calculate force, mass, and acceleration by manipulating the second law equation. Most students had difficult time with question number 6 because the most common incorrect response was to push with less force. The correct answer was to push with half as much force because the mass has been reduced by half. Students were not always understanding the direct relationship between force and mass.

All three teachers implemented assessments that preceded content delivery in some form; they also used summative assessment to find out what the students learned. For example, Megan emphasized the use of a pre-assessment before each unit, which served as a needs assessment. The pre-assessment was a key tool in the execution of the unit as evidenced through Megan's concluding reflection in her second portfolio. She reflected, "the students took a pre-test to determine their prior knowledge on the topic. The lessons were planned based on the results from the pre-test. The final test was used to compare the students' growth."

Even though Megan did not emphasize testing or the notion of studying with her students, the use of the word test inherently created anxiety for them, which was seen during my observations when the students took the test after the browning apple experiment, which served as the initial investigation for the unit. After Megan announced to the class that they had finished the experiment and that the apple that did not turn brown was the one with the lemon juice, she alerted the students that they were going to take a test. The students began to talk amongst themselves stating that they had no idea that they had to take a test, and many wanted to know if this would count against their grade.

Megan also had the students keep track of their work; every handout, lab exercise and essentially any piece of paper was worth a set of points that the students entered into their science folder. This allowed teacher and students to keep track of their progress and make adjustments as needed. Jenny used the DO NOW, which was a short paper with no more than two review questions at the beginning of class as a combination of a review and pre-assessment prior to each lesson. She used both formal and informal assessments throughout her units, as described through the following annotation from her initial reflection from the second portfolio:

> The students will take a structure of matter pre-assessment to gauge their current knowledge on topics covered in this unit. Weekly assessments will be given, as well as assessing corrected CER's [students' ability to make a claim, give evidence and supportive reasoning for a scientific concept] for inquiry investigations to understand students' thinking at a deeper level of application and synthesis. There will be no formal unit assessment for this unit; rather, they will complete a thermal energy engineering design challenge (solar ovens), and a district benchmark exam.

While Megan used a series of formal assessments for the most part at the beginning of and throughout the two units, and Jenny used a combination of formal and informal assessments, Beth had a slightly different philosophy in regards to assessment. In particular, she sought to use an informal check in with students at the beginning of each lesson, as well as throughout the lesson. The final projects she assigned at the end of each unit, e.g., the balloon race and periodic table game, were more social rather than a more formal assessment, such as a paper and pencil test. She did embed written tasks in her units, e.g., a writing about a storm for unit one and a content essay in unit two that integrated chemistry and black smith principles. Beth detailed her assessment process in more detail in her initial reflection from the second portfolio:

> The pre-assessment is a synthesis of expository and literary text. In the interest of time, a combined performance task in ELA [English language arts] and scientific application of concepts through reading and writing will be administered. I will collect their notes to assess knowledge. In addition, listening and discussing will be used to gauge understanding. I will give them an end of the unit assessment as well as another performance task.

The performance task was the chemistry game, in combination with coloring the periodic table in the appropriate groups. A formal end of unit assessment was not provided by Beth in the spring. While all forms of assessment have their advantages and disadvantages, assessment was a pivotal component for all three teachers that was used to inform their instruction and the variety of materials, grouping and methods that were used to facilitate student success.

All of the teachers utilized assessment to inform their understanding, as seen through Megan's annotation on the first day of her second portfolio:

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This response shows how teachers can use assessment data to determine what needs to be done next to support each teacher (e.g., Jenny's reflection illustrated that she needed to extend instruction about the relationship between force and mass). The three teachers demonstrated the use of assessment in a variety of ways during the study. In the first unit, Beth utilized multiple types of assessments, including a pre-assessment that was "…combined with writing as a summary of what would happen to a ball being kicked by a soccer player across a grassy field bordered by a brick wall." This assessment was repeated at the end of the unit as a summative assessment. In addition, Beth spent a lot of time circulating around the class and informally assessing the student knowledge, and if there was any confusion, she would stop and reteach the concept in another way (as seen when the students did push-ups during the instruction of distance, rate and time formula). All students across all three classes were formally and informally assessed, with each teacher using their assessments as a means to enhance their teaching.

Beth was much more concerned about the process of what students learned, rather than their requisite memorization of facts. As she stated throughout the observations, while she was bound to taking the state test and other requisite district assessments, she had the freedom to create assessments that evaluated a multitude of components including executive function, teamwork, attention to detail, as well as their understanding of facts and figures.

Teacher Professional Growth and Development

All three teachers were very candid about the challenges that they faced within their profession, what would be beneficial for their professional growth and development, as well as how they felt the ePortfolio tool could support their professional growth and development now, or in the future. The creation and acquisition of resources were key, as many teachers found themselves trying to gather materials that would meet their student needs. This, in conjunction with limited amounts of time to collaborate with colleagues, along with the additional obstacles such as student behavior, continues to pose challenges for teachers. Teachers yearned for time to visit other classrooms and come away with professional development materials that they could easily tailor to their classrooms. The use of the ePortfolio was valuable in different ways for the teachers, with it serving as a tool for varying levels of reflection among the teachers.

Challenges faced by teachers. While Megan informally acknowledged the challenges students faced outside of school, she detailed that the two challenges she faces in differentiating curriculum for specific sub-groups of students are time and materials/resources. In regards to time, Megan clearly indicated that she does not have enough time to collaborate with her colleagues.

Jenny also noted several resources that she desperately needs to meet student needs. She had to create her own curriculum resources to assist her students. Jenny stated,

> To be honest, I do not have curriculum resources. You get hired, and you are like, 'okay, does someone have like a google drive, a dropbox or even a binder?' Like, anything they have done before, and the wheel just keeps having to be reinvented. I think that is so wasteful. That is if you had something to build off of, you would know how you could improve, and you have an idea of how the subject is taught.

Jenny was adamant that we need to make use of what we currently have available to us and ensure that we reach out to our colleagues; however, even with these efforts there is still a lot of time involved.

> I think that also contributes to teacher burnout, or high teacher turnover if they have to teach a different grade level. It is not an easy transition. You have to reinvent your curriculum every time… it changes without much support, and that is very difficult. Like when I joined TFA, they gave us a couple of online resources of things other eighth grade, seventh grade and sixth grade teachers have done before, but in that case it was like hundreds of things. Hundreds of different people putting information in. So you have like 12 options for teaching one concept. It is just a lot of sifting and trial and error so I do not have any resources basically.

Thus, the creation of curriculum and inherent planning take a tremendous amount of time on behalf of the teachers.

Megan stated several times throughout both units that she had a difficult class for the period that was being observed. As such, she constantly sought to improve her instructional practices to meet their needs. This was evidenced through the following annotation within her second portfolio in response to the prompt: "Based on the results of this activity, please discuss any changes you will make to your instruction in the future."

> One of the changes to my upcoming units will be the use of more active learning strategies and reduce the amount of time I spend lecturing. One of my goals is also to overcome the obstacles or barriers to use active learning strategies (i.e., lack of materials or equipment, too-much pre-class preparation, large class sizes, students' behavior during the activity, pressure to cover as much content in the time available and testing).

Megan consistently indicated that she had several things standing in her way in order to meet student needs, whether concrete or not. Despite the inherent challenges,

Desired professional development/training. Beth indicated that professional development for two-three days, or even ten days when someone comes to visit you and provide you with tips of the trade is not beneficial. She would rather go places to observe other teachers and come away with concrete methods and lesson plans that she can implement within her own classroom. Alternatively, it is very valuable when other teachers come together and share their projects/lessons, and then they would be put in a packet that everyone can take back to their classrooms, according to Beth. Usable lesson plans, especially those with manipulatives are extremely valuable. She pointed out that perception of good teaching is a really huge issue, as they (she and her colleagues) are often told to walk through one another's rooms, and while this is a "cute" idea, this is not very productive and tends to make people angry. Beth needs professional development that is useful, makes the best use of her time and, ideally, allows her to collaborate with her peers.

Jenny definitely understood and valued professional development; however, she said that it is more valuable to see best practices than being told, “this is the method” that you should use. Rather, it is critical, according to Jenny, that she being able to see how that best practice looks in the classroom. She noted that her TFA trainer “always had videos or demonstrations, or we acted out what students would be doing, and that was super helpful to see how it is implemented in the classroom, not just in theory” (Jenny, Interview). Jenny continued her discussion with noting that when she is given options for in-school training, she tends to go to the trainings that focus on how to improve instruction and assessment for ELL students. However, she noted the weaknesses of these trainings with the following, “I always used to walk out with a lot of papers explaining how you should do it (meet student needs), but we never practiced adapting my Science curriculum for it. They usually gave History or English examples. What does this look like in Science? How do I actually do this? So I think what would have helped me is like, ok, here is a video of it being used in the classroom” (Jenny, Interview). As Jenny indicated, it is critical that professional development opportunities translate to the science classroom, which is not the case in every circumstance. Jenny elaborated on this further when asked what additional resources would be beneficial:

> I would think that it would be nice to go to a STEM school. See what they are doing. We do not have the equipment, but what we could do might be comparable to that. Go to a problem based learning school, PBL school. See how they are structuring their day. Like if they want to do inquiry. Like our day to day structure. So it is just like if you want things to work, let us see who is doing it well. Let us do some school visits. Let us see how things are going, and what does successful problem based learning look like.

Again, the emphasis for Jenny is on seeing best practices that she and her colleagues can emulate in their classrooms that are (1) directly applicable to science and (2) ensure that student needs are being met.

Overall, Megan noted that the school does provide them with several professional development opportunities, and sometimes, they are on special education. Sometimes, the professional development seminars provide teachers with strategies that they can take back to their classroom, but Megan noted that you really need to "mold them to meet the specific needs of your students" (Megan, Interview). Megan stated within her interview that she feels she learns more from teachers by going into their classrooms and asking questions, such as, "What are you doing for this lesson? Okay. I can tweak it like this or I can do this" (Megan, Interview). She emphasized that collaboration among her peers was pivotal to her growth. Megan noted in regards to professional development that "Sometimes we get comfortable (with our teaching practices) and we have to come out of our comfort zone just to get out of that" (Megan, Interview). So, essentially it is the teachers' responsibilities to mold Professional Development to meet their students' needs and to collaborate with their colleagues, while not being afraid to take risks.

Utilization of the ePortfolio or similar tool to reflect on instruction. In summary, Beth felt that the ePortfolio had value in assisting her to monitor and reflect upon her instruction and assessment practices for students with special needs. Within her interview she stated that the portfolio did help her, because she looked through it. Beth noted that on every Sunday, she went through it, specifically looking at all of the videos:

> I saw so much I'd never seen before. I looked at the pictures, I remembered I did this – because I forget, since we're always changing our curriculum and what we do, I forget what we've done. I go 'oh okay, that was really great' and it's summer, but there I went 'oh dang, that was a really good assessment I did, I want to – I'm going to use that one again' or 'that was a really good little exercise we did' or 'oh, that went that way, what a change that was and that was really good' videos especially.

Beth went on to say that she was not really listening to the students when she was videotaping them, and when she went back to review it, she often found surprises and had the reaction, ‘oh, are you kidding me!’ She noted through her interview that the portfolio provided her with a valuable chance to go back and look through her work; however, she had some doubts about the tool itself, as she stated, “I always get the feeling that something like this is going to end up in the wrong hands, who might misinterpret what I’ve presented on there because I could only take a fraction of what’s going on. Luckily, there was stuff that I took away, right?” The ePortfolio was never intended to be an evaluation tool; however, it is clear that it could be misinterpreted that way.

Overall, Jenny felt that she definitely reflects on her instruction and assessment; however, she needs to do a better job in devising a system for reflecting upon her instruction and assessment.

> I need a better structure for specifically reflecting, but I make a lot of internal reflections that might not actually happen in actual writing. I feel like sometimes I am over-reflecting because if something does not go right, I try to figure out what were they not understanding, what was going wrong, and I redo it. I do not just move forward. For instance, ionic and covalent bonds, after the final lab and the quiz, there were so many misconceptions. We needed to spend a week re-teaching. I am not going to move forward until I see a higher level of mastery in this concept. So, I went back and we did remediation for ionic and covalent, and it really helped. This is just an example that I am really determined when it comes to understanding the concepts. Like when I see in-your-face misconceptions, or even tiny ones that might lead to bigger ones in the future, I try not to let anything slide, and I readdress them.

Jenny is always reflecting upon students’ understanding or lack thereof, to determine whether or not she needs to pause, re-teach, accelerate instruction and/or move forward with the next topic. She elaborates with the following statement.

> I am very flexible in that way. Like if we were supposed to move onto something new, I will not. If we need to stay on this particular topic and see more examples, we will do that. Today, I noticed that they are having trouble getting their

> sentences started for claim evidence reasoning (CER), and it is probably motivation, not an ability issue right now, because we have done CER all year long. So, I went back and I wrote in sentence starters, and made 90 new copies with sentence starters. So to address their low motivation, at least they are seeing an example of how it should be done.

So, essentially, Jenny relies heavily on observation. Her observations of her students working during class, as well as their written work are central to her internal reflection, which constitutes the majority of her reflection efforts. However, she noted that she needs a better system to capture these reflections.

When asked if the ePortfolio helped or would help Jenny with reflecting upon her instruction and assessment, she stated the following:

> I think it will. I also think it is useful when you are trying to show someone how you teach and what you do. When you get evaluated for example, they come in for 20 minutes. They do not come in and see a full picture of what is happening over a unit. I think a 10-day period is nice because they can kind of see the progression, and how we are building off of what we are learning, the different activities that we do. Not every other day is inquiry day, and how the inquiry helped them the next day. How the extension activities helped, or were able to be done, because of what led up to it. I also think it is helpful to be like this should have been done differently, and let us think about it now before I forget about it. I think it would also help if your principal is evaluating you, you could do your 10 days of collection, and then they come and do an informal and formal observation during those 10 days. Then they could see the missing pieces that they did not see otherwise because sometimes they come in, and it is just like you are not getting a really good idea of what is going on here.

Jenny consistently found potential with the tool and ways to extend it, including using it as part of teacher evaluation.

Overall, Megan found that observations, as well as other tools, were critical to her monitoring and reflecting upon her instruction. She noted the following as being key to the process:

> Checking for understanding; just asking them or just the questions that they are asking. You just see their look on their faces like - What? After the projects, I think I reflect on it and say---next time, I'm not going to use this. Maybe next

> time, I'm going to tell them to use this other thing or I'm not going to give them as much time because I think they can do it faster than two days. Maybe they can just do it in one period (Megan, Interview).

Essentially, prior to and concurrently with the portfolio, these items aided in her monitoring and reflecting upon instruction and assessment. Megan overcame a huge technical gap to be able to properly use the ePortfolio, so while it did have some inherent value, especially in regards to the question that asked about modifications and adaptations that teachers made from her perspective, in addition to the purpose of the activity and any changes that might be made next time, it was difficult to grasp at the beginning. Megan stated within her interview that these three components helped her think about how she could modify the activity. More specifically, it helped her think about the following questions in relation to the activity, "What can I do to get this concept across, this lesson across?" or "What else can I add to this?" Megan found that the ePortfolio was as valuable as observations of other teachers and the students themselves, which she mentioned as being valuable professional development tools. Megan stated that they were equal, "Because the portfolio makes you reflect on what you're doing and then the observation also gives you that feedback of what is it that they need. How can I change it?" Thus, overall the portfolio was valuable for the teachers in regards to monitoring and reflecting upon their instruction and assessment, although, it is just one tool that the teachers can use for this purpose.

Summary

This chapter presented the findings that resulted from an extensive qualitative data analysis. Emerging from the qualitative data analysis, the findings resulted in 6 central themes: 1) accounting for students needs and motivation; (2) pedagogical practices: fostering engagement and student interest; (3) scaffolding; (4) oral language and literacy; (5) using assessment as a teaching tool; (6) teacher professional growth and development. These central themes stemmed from three data sources: observations (field notes), ePortfolio artifacts and annotations (entries) and an interview with each teacher. Some of the central themes had several sub-themes and came from all sources of data that provided a fuller picture of each central theme.

CHAPTER 5

Conclusions

As a young girl, I was fascinated by my mom's stories of her experiences in elementary school with her teacher Ms. Kelley. What made my mother's elementary school experience unique was that she received her education in a one room school house, with 34 other students spanning grades K-5 in her hometown of New Canaan, CT. As a young child, I visited the Little Red School House, as it was so aptly named, several times with my mother when it was open for tours and activities by the New Canaan Historical Society. My mother told me how Ms. Kelley wrote on the chalkboard an outline of the daily instruction for each grade level. She recalled how Ms. Kelley would call each grade level up to the chalkboard one at a time to complete the lesson, with the exception of science, which was usually held outdoors. She explained how Ms. Kelley would strategically position herself so that she could also view the rest of the children, while taking a mental note of those that appeared to be struggling.

The thought of one teacher meeting the needs of 35 students that spanned across six grade levels fascinated me and planted the seed for a series of valued experiences to see how teachers meet the needs of diverse learners, particularly those with special needs. While my mother stressed how there were students in grades K-5, she said she never remembered students with special needs being present in the one-room school house. Her stories of learning within a one-room school house continued to resonate with me as I grew older, with the added question of how teachers meet the needs of students at varied academic levels, in addition to those with disabilities. As I listened to the stories my parents brought home from their own classrooms growing up, I left the dining room table continually inspired by the problems they tackled and the lives of the students and families that they impacted throughout their combined 51 years of teaching grades 3-5, which implicitly laid the foundation for this study.

This study was conducted to understand how three eighth grade science teachers took into account the ability and motivation of students with special needs in three inclusive eighth grade classrooms during science instruction. More specifically, I sought to detail how they planned and implemented curriculum, instruction, and assessment for this group of students utilizing differentiation, personalization, and/or UDL (CAST, 2015). An additional goal of this study was to understand how three eighth grade general education science teachers self-monitored and reflected upon their instructional and assessment practices for students, and how it supported and/or detracted from their ability to determine what they need to re-teach or extend for students.

Revisiting the Conceptual Framework

The conceptual framework described in chapter two delineates four components that frame this study. This study sought to reject the deficit theory, and based upon the findings of this study, it successfully did that. Within chapter two, the following three components of deficit thinking were identified as being directly related to the classroom and, hence, this study: victim blaming, oppression, and educability. In regards to victim blaming, teachers recognized that internal motivation was critical to student performance, they also recognized their role in elevating and sustaining student motivation. Furthermore, as Beth aptly stated in her interview, "I really do think all kids can be motivated." They acknowledged their role in facilitating motivation through engaging students in lessons that are hands-on and connect to the real world. However, as Adelman and Taylor (2006) detail, it is critical that students' perspective be taken into account within this process, which was not mentioned directly by any of the teachers, nor was it asked of the teachers. In addition, it was not seen within any observation or noted within the portfolios. Although, it is important to recognize that despite the depth of data within this study, it is still a subset, and accounting for students' perceptions or the "match" was not seen within any data source. With the variety of special education diagnoses' present, teachers focused on essential concepts within the content area to build foundational knowledge, while utilizing a variety of materials, methods and grouping strategies to meet student needs. For example, Megan taught the concept of volume to her students first, instead of starting with density, in order to provide them with the necessary background knowledge to succeed in the density unit.

Similarly, teachers did not embrace the component of oppression or educability within deficit thinking. They took the responsibility on themselves to put the appropriate supports in place to meet student needs, which was evidenced within their portfolio annotations about modifications or adaptations that they made to the assessment or instructional activity. An example of this is when Beth stated the following in her initial reflection in Portfolio Two about the modifications or adaptations planned for the unit for special education students, "I will read directions, clarify vocabulary, act out concepts, allow extra time, modify assessments and facilitate grouping." Furthermore, teachers actively put in place tools to elevate student responsibility for their learning. As an example, Jenny had students take Cornell Notes towards the end of the end of her spring unit after a video on chemical reactions to not only engage her students, but to provide them a structure which will make it easier for them to ask questions, as well clarify their misconceptions and monitor their learning. By activating students' background knowledge, scaffolding instruction, and ensuring that assessment is an ongoing process to inform instruction, all teachers believed that students could excel when the appropriate tools were put in place. However, student achievement was not fully defined by test scores for these teachers; rather, a students' ability to make progress was embraced as the definition of achievement by all three teachers, with Beth formidably endorsing it.

Gardner's (2006) Multiple Intelligences Theory also framed this study, in addition to the Thinking Curriculum by Resnick (2010). All three teachers strove to appeal to students' needs by providing them with multiple modalities throughout the lesson, with Jenny and Beth stressing these components more than Megan. However, teachers did not explicitly refer to these pieces as intelligences; rather, they saw them as strategies to engage learners in a variety of ways in order to have them master the material. Jenny detailed her use and importance of multiple modalities when she describes benefits of her hands-on IBEs at the beginning of class through her interview:

> After the IBE I go into explaining the material, identifying misconceptions, and I think that I've seen a lot of success with students that are English language learners and those who have IEP's because it allows for movement. They're able to receive the information in multiple modalities, so not just notes, like they get hands-on lab experience. They get to see things move, they get to see things change, they get to see cause and effect happen before their eyes. They're able to see patterns and colors, shapes and sizes. So regardless of language or ability having those additional like ways of getting information to them, and having them come to conclusions on their own before I teach them anything myself, I think also proves to be beneficial for them.

Within these hands-on activities, as well as inquiry-based approaches that were center stage in each of the teacher's science classrooms, students had the opportunity to actively collaborate with their peers, which is mentioned by Resnick (2010) as a necessary piece that needs to be explicitly taught to the students, but as seen above through Jenny's IBEs, can also be naturally developed among the students. Resnick (2010) also cites scaffolding as a necessary component in enabling students to not only learn subject matter, but think about and interpret it deeply. Jenny pointed out in her interview that,

> …the level of writing and conceptual understanding required is much more (with NGSS), I don't like to use the word rigorous, but it is a much higher expectation than the Cal[ifornia] standards had. It is more difficult for them. I have noticed especially with the big picture concepts and the crosscutting concepts making it interdisciplinary, it is a different type of thinking. I think inquiry helps with that type of thinking because we are always tying in different concepts into crosscutting concepts into the core ideas that we are supposed to be learning in class.

So, the addition of the NGSS (2013) place an additional challenging layer for students, yet, as Jenny mentioned, she had a strategy in place to help mediate this challenge for students. Furthermore, "rote learning" is not embraced by the Thinking Curriculum (Resnick, 2010), which while present as needed in each of the three classrooms to clarify and/or introduce subject matter, it was not a central component to instruction. Each teacher sought to provide access to a challenging eighth grade science curriculum to all of their diverse learners, including to students with special needs through multiple modalities that are delineated by Gardners' (2006) Multiple Intelligences, while providing the necessary scaffolds and tools to ensure that the instruction is delivered at a high level allowing for in-depth student thinking.

The fourth piece of the conceptual framework centered on learning progressions in science education (Berland & McNeill, 2010), with the data from each teacher clearly supporting the three exposed components. All teachers delineated clear objectives at the beginning of the unit, and the objectives for all teachers were stated multiple times (e.g., beginning of the lesson and in small groups), as well as visually put somewhere either on the board or via a handout. As stated previously, teachers also inherently scaffolded instruction, while ensuring that students had the necessary foundational skills to proceed to the more advanced concepts. To illustrate this, Beth did not begin a unit on chemical reactions right away, nor did Jenny, without providing explicit instruction on the periodic table, as well as the composition of elements in addition to hands-on explorations such as understanding static electricity. Beth repeatedly mentioned that she needed to provide a starting point for her students, despite the grade level curriculum that she was asked to produce. Each teacher took into account students' academic abilities, what aspects needed to be strengthened, while also doing their best to take into student motivation.

Overall, six central themes emerged from this study with some sub-themes emerging from the data that substantiated the majority of the central themes. These themes will be discussed in reference to the two research questions and associated sub-questions that were put forth for this study.

How Do Three General Education Eighth Grade Science Teachers Take into Account the Ability and Motivation of Students with Special Needs in Inclusive General Education Classrooms?

When I approached this first research question, I initially thought it would be more clear-cut and straightforward. Naively, I thought each teacher would succinctly define how they take into account students' abilities and motivation throughout their science instruction. Yet, the data clearly showed that various factors, whether internal (inside the school) or external (outside the school) either inhibited and/or enabled each teacher's ability to take into account the ability and motivation of students with special needs.

Internal Factors

Even before these three science teachers take into account the ability and motivation of students with special needs during science instruction, they need to have the requisite broad skillset. This skillset can continually be developed through applicable professional development that meets their needs. All three teachers indicated that they received professional development through their schools and overall, it was not beneficial for elevating their instructional and assessment practices for all students, including those with special needs. Through informal conversations with each teacher, I noted that the professional development was at a high level and did not address how to effectively transfer the information to the classroom. This was especially evident with RTI, as the teachers stated they were familiar with RTI and had some training on it; however, based on this study, the knowledge of RTI did not transfer to the classroom. Despite this assertion, no information on the specifics of the RTI training from each teacher were gathered. While each teacher completed a teacher preparation program, they did not have the benefit of learning the current TPEs within their teacher preparation programs, which embed UDL and MTSS in order to provide teachers with a set of tools to effectively meet the needs of all students within the classroom (California Commission on Teacher Credentialing, 2016). There are six TPEs with TPE 1, “Engaging and Supporting All Students in Learning” and TPE 4, “Planning Instruction and Designing Learning Experiences for All Students” specifically addressing UDL and MTSS in an effort to address the needs of all learners, including those with special needs. Thus, knowledge of these principles through a teacher preparation program might have resulted in slightly different findings in regards to professional development and the application of these approaches within the classroom.

While the best intentions might exist from the professional developer(s) and those who coordinate these efforts, it was not adequate for the teachers. Being told “this is the method” that you should use, as Jenny stated, without knowing how that method looks in the classroom is not beneficial. Rather than have someone come into your classroom and provide you with “tips of the trade,” Beth was adamant that teachers need to not only observe one another, but also come together and collaborate in order to share projects/lessons that worked well in classrooms. Essentially, teachers need to know that lessons work, and, according to Beth, the best way to know this is by talking to her fellow colleagues about what worked well in their classrooms.

Megan concurred and stated that she learns best, when she is able to go into other teachers' classrooms, observe them and ask questions about their practice.

While only Megan stated that they were sometimes provided with professional development that focused on special education, the material presented did not readily apply to each teacher's classroom. Jenny stated that some of the professional development that she went to targeted emergent bilinguals; however, she walked away with many papers, without explicitly knowing techniques on how to adopt them to best meet the needs of her students. In lieu of that, Jenny added that it was also beneficial when videos and/or demos are used, which is what she experienced when working with her Teach for America trainer.

Providing teachers with a packet of information that they obtain from their professional development and telling them to "tweak it" to meet their needs does not assist them in accounting for the ability and motivation of their special needs students. I speculate that this model of providing information, with a lack of follow-up and explicit guidance on how to apply it to individual classrooms is why there was no evidence on how RTI transferred to each classroom. The teachers stated that they needed time to visit one another's classrooms, develop lesson plans that meet the needs of their learners based on best practices and collaborate with their colleagues. Time is one of the biggest hurdles to overcome in order to meet the teachers' needs in this area.

Additionally, all teachers strove to provide students with reading materials that were at their level; however, this was difficult, especially with so many students reading well below grade level. In particular, Megan noted that she desperately needs high interest texts that are at the students' levels. She expressed that books/reading materials at their level are boring for them, including the textbook. More specifically, the textbook needs to be more visual. She stated that with the textbook, “It has a lot of information that they do not read” (Megan, Interview). Megan also indicated the importance of having colorful pictures (i.e., visuals) for them. She elaborated on this with the following, “That’s why I use the PowerPoint. I need visuals for them to understand” (Megan, Interview). Jenny also noted several resources that she desperately needs to meet student needs. Jenny had to create her own curriculum resources to assist her students. She stated,

> To be honest, I do not have curriculum resources. You get hired, and you are like, ‘okay, does someone have like a Google drive, a Dropbox or even a binder?’ Like, anything they have done before, and the wheel just keeps having to be reinvented. I think that is so wasteful. That is if you had something to build off of, you would know how you could improve, and you have an idea of how the subject is taught.

Jenny was adamant that we need to make use of what we currently have available to us and ensure that we reach out to our colleagues; however, even with these efforts there is still a lot of time involved.

> I think that also contributes to teacher burnout, or high teacher turnover if they have to teach a different grade level. It is not an easy transition. You have to reinvent your curriculum every time… it changes without much support, and that is very difficult. Like when I joined Teach For America, they gave us a couple of online resources of things that other eighth grade, seventh grade and sixth grade teachers have done before, but in that case it was like hundreds of things. Hundreds of different people putting information in. So you have like 12 options for teaching one concept. It is just a lot of sifting and trial and error so I do not have any resources basically.

Thus, creating curriculum, and the inherent planning that goes along with that, takes a tremendous amount of time on behalf of the teachers. Again, it would be advantageous to provide teachers with enough time to work together to create curricular resources and/or give student resources for them to modify or adapt to meet their students’ needs.

External Factors

When discussing this question, it is important to remember that these three teachers recognized the challenges faced by some of their students outside of school. This was especially apparent with Beth, who spoke of letting children sleep if they needed to sleep. She also understood their need for them to have ownership of a physical space in the classroom to do their work and study, often because they do not have those pieces at their home. All of the teachers did their best to ensure that students were engaged throughout science and that engagement was a central component, from their perspective to not only develop and sustain motivation, but increase it as well.

While Jenny also acknowledged the challenges that some of her students faced, she noted that the traditional classroom set-up does not meet the needs of all students, particularly those with special needs. In particular, she noted that there is an expectation at school, and in higher education, that everyone has access to Wi-Fi at their homes; however, this is not a reality for her population of students. While largely generated through informal conversations after observations, Megan explained that she struggled to get each student to not only see the value of homework, but to also complete it and return it to school. Thus, she managed to have students largely complete homework and projects in school, where they could receive the assistance that they needed. Megan definitely echoed the sentiments of the two other teachers, which solidifies the notion that all teachers recognize the challenges some of their students faced, especially when compounded with a disability.

Taking into Account Motivation and Student Ability

Beth, Jenny and Megan all stated that accounting for the motivation of their students, including their special needs students was a critical component of their instructional and assessment practices. Additionally, they all had positive attitudes towards students with special needs and wanted all students to do well, including students with special needs, regardless of the materials/tools/resources they had or desired to have. More specifically, Megan spoke candidly in her interview about the importance of providing students with special needs positive feedback, because she noted how they rarely receive it. She further detailed the importance of having confidence in her students with special needs and the importance of pointing out tasks that they do well. All teachers went directly to the students with special needs during independent work in a manner that was not intrusive, rather, they sought to check in to ensure that they understood the task and had the tools in front of them to be successful. Their approach was supportive, positive and non-threatening throughout every observation. Collectively, all three teachers agreed that providing students with hands-on activities and projects that connected to real-world experiences were essential in motivating students, including students with special needs. When students are able to see the value in what they are doing and how it can relate to their own experiences, they become inherently motivated according to Beth, Jenny and Megan. For Megan, this was intrinsically generated through her belief of her students, which allowed her to differentiate instruction. More specifically, taking the time to get to know her students, providing additional explanations as necessary, and asking them to try their best, were central to enhancing student motivation. For special needs students, she reminded them to ask for help when they needed it.

Whereas Jenny mentioned the polar opposites that exist in her classroom, in particular, she has a small group of students that are highly motivated although, although the majority of the class is not motivated (at least in the spring) and comes in with a negative attitude. More succinctly, she stated within her interview, “it has been hard to motivate students when their attitude is not in the right place.” Beth firmly believed that all students can be motivated, especially when the instruction and assessment that is planned is hands-on and engaging. While accounting for motivation was deemed to be a critical component in planning for and implementing instruction, as well as assessment, the teachers did not actively involve the students in figuring out what motivates them. Essentially, teachers used their own informal observations, knowledge of best practices and experiences to determine what motivates students to excel. They did not involve students in the process, which is a critical component to accounting for, maintaining and accelerating motivation among students (Adelman & Taylor, 2006).

Through their initial reflections, each teacher detailed her students' academic levels, as well as how many students had IEPs and broadly, the diagnosis or difficulty that led to that IEP. However, the teachers did not directly state whether through their interviews, within their portfolio annotations and/or indirectly through the observations, how they took students' individual diagnoses nor their IEP and/or 504 plans into effect prior to and during science instruction, beyond that they would examine the IEPs and 504 plans frequently. Rather, they indicated specific modifications for assessments or adaptations that they would use for all special needs students and, in most cases, this was coupled with emergent bilinguals within their portfolios. Upon further examination of the data and how it was collected, there would have been opportunity to understand this facet in greater detail through each interview, which is an inherent limitation of this study.

However, one could argue that teachers did take into account students' abilities, including those with special needs, as the data show how there was some support for differentiation, personalization, and very limited support for UDL. Teachers drew from practices that were aligned with all three approaches, yet some were enacted because they were deemed to be best practices for all learners, whereas others were specifically targeted for students with special needs and/or emergent bilinguals. For example, hands-on activities and projects that are authentic (i.e., tied to real world experiences), are components of both differentiation and personalization, yet they were put in place to benefit all learners, not just those with special needs. However, visuals and graphic organizers were enacted for students with special needs and emergent bilinguals. Both of these modifications fall under the representation principle of UDL. Essentially, students used practices from all three domains, yet only some were specifically targeted for supporting special needs students, while others were deemed appropriate for each diverse learner in the classroom.

How do Teachers Plan for and Implement the Curriculum for this Population of Students?

Overall, this was difficult to capture across the data. Curriculum was broadly defined as a body of knowledge, often guided by standards that assist teachers in planning what students need to learn. Curriculum resources are defined broadly to include: unit and lesson plans, activities/tasks/projects, as well as the various tools (i.e., graphic organizers) and assessments. More generally, curriculum resources imply written products that would assist teachers with what they need to teach, in addition to modifications and/or adaptations that are made to those written products when implemented. As previously stated, Megan and Jenny spoke to the challenges of not only finding curriculum resources, but ensuring that they could adapt those resources to meet student needs. While Beth did not directly state that she had difficulty locating curriculum resources, she stated how she had to supplement the textbook resources that she did have, especially for the chemistry unit, with material that was easier to understand.

In regards to curriculum, Megan was the only teacher that utilized a textbook, and the *Reading Essentials* book (Glencoe, 2016) that is associated with the textbook more prominently than her peers. In her initial reflection of her first portfolio she stated that she used the following resources: “teacher developed materials, internet resources, trade or textbooks, curriculum materials, along with CA Science Standards.” All of these items were noted within the initial reflection of her second portfolio, with the addition of NGSS literature and/or documentation. Megan recognized the limitations of the textbook and her current materials for students with special needs, citing the need for additional resources, such as texts that are at students’ levels within her interview, as well as the need for more consistent technology. Beth did have access to a set curriculum; however, it was too difficult for the majority of her students and she chose to supplement it with online resources and manipulatives. Beth’s goal was to focus on the foundational pieces of the grade level concepts, in order for students to form a bridge between the core and expected grade level concepts.

Beth noted the use of the following resources in her initial reflection: “curriculum materials, teacher developed materials, CA Science Standards and documents, along with internet resources.” These resources were all stated again within the initial portfolio within the second reflection, with the addition of NGSS literature and/or documentation. A critical point to note is the addition of the NGSS literature and/or documentation that was an added resource for both Megan and Beth during the second portfolio. Thus, this places an additional level of complexity in the teachers’ ability to plan and implement curriculum for students with special needs, especially with the limited guidance that the standards provide in supporting teachers to ensure that students with special needs are able to meet these standards.

Jenny did not have any set curriculum and created her own. She noted within her initial reflection within both Portfolios One and Two that she used the following resources: “teacher developed materials, NGSS literature and/or documentation, internet resources, curriculum materials, as well as CA science standards and documents." Jenny pointed out the time and energy she spent on creating classroom materials, and how helpful it would be if she was able to collaborate with others and share materials. While Megan did use guided notes on occasion, they were most prominent in Jenny's class, with students filling in only the necessary information (i.e., key terms) that was presented either orally or via power point. Jenny noted that this note taking process was critically to students being able to focus, as traditional note taking was very difficult for students.

How do Teachers Plan for and Implement Their Instruction for this Population of Students?

When submitting an instructional or assessment artifact within their ePortfolios, the teachers were required to answer several questions. One question specifically addressed diverse learners by asking, "Did you make any modifications or adaptations to this assessment for use with the following groups of students?" Groups of students referred to: students with special needs, emergent bilinguals, gifted students and/or another specific group that the teacher chose to identify. This question was complemented by the following question within the instructional portfolio, which stated, "Will you modify or adapt any aspects of the curriculum, instruction, or assessment in this unit, for the following groups of students?" and again, the reference to the "following groups of students" refers to students with special needs, emergent bilinguals, gifted students and additional sub-groups of students as designated by the teachers. Although, both of these questions did not ask whether teachers made these modifications or adaptations during the planning process, or during instruction. However, it can be inferred that some of these modifications or adaptations were made during the planning process, as the guided notes that were implemented in both Jenny and Megan's classroom had to be created beforehand. As an example, the set of guided notes in the form of Cornell notes with key questions on the left-hand side of the paper, which Jenny created for students to complete as they watched a Bill Nye video, had to be completed in the planning process.

Yet, modifications or adaptations such as supporting students with special needs with calculations and measuring, along with providing extra time on tests cannot be attributed solely to the planning, instruction and/or assessment processes. The majority of all three teachers' annotations that were completed in response to this question detailed how they made adaptations. Only a small portion of the annotations written by the three teachers in response to this question detailed modifications for students with special needs. While both Beth and Jenny stated that they modified assessments for students with special needs, I did not observe this in their classrooms. All students received the same assessments throughout both units as indicated in my field notes. Perhaps, Beth and Jenny modified a previous assessment they had made for another class for their current class. Regardless, they had a different definition of modification. As such, this question posed some limitations for the current study.

Questions 1. What are 3 examples of chemical reactions?	I. Chemical Reactions A. Everything is made of chemicals 1. Chemicals can react to form ____________ chemicals 2. Examples: TV, clothes, food B. Chemical Reactions 1. React to make new chemicals 2. Examples: Metal ______________, stomach __________________, candle ______________________ C. Reactions happen when electrons bond
2. What happened to the pennies in the "Try This"	II. Try This A. Mix pennies, vinegar and salt 1. Vinegar and salt reacted to ___________ __________the grime from the pennies III. Fire A. Chemical Reaction: when things like paper and wood _______________ with ___________________ in the air and give off heat IV. Try This A. Create a fire extinguisher 1. Vinegar and baking soda react to form ____________________ ___________________ Gas 2. This pushes out the water that was in the jar to put out the fire
4. What do you get when you mix vinegar and baking soda together?	V. Consider the following A. Sodium and Chlorine 1. When they are not bonded they can be deadly 2. But when bonded they form ________________ _______________, also called ____________ VI. Cool Scientist – Phil Grucci A. Pyrotechnicians: people who manufacture and use fireworks 1. __________________ create twinkles 2. __________________ create colors VII. Home Experiment
5. What happened to the balloon?	A. Mix vinegar and baking soda to fill a balloon 1. The balloon fills with _________________ _________________ VIII. Cold Packs 1) Chemical reaction that takes _________ __________________ 1. This makes the pack _______________ very fast IX. The Periodic Table of Elements A. Tells us about _______________________ B. Elements that behave in ____________________ ways are ____________________ together on the periodic table
Summary: What were some	clues that chemical reactions were happening? Hint: Think about the experiments.

Figure 10. Notes for viewing episode of Bill Nye show.

Beth. Beth noted 19 modifications or adaptations across the assessment and instructional artifacts that she submitted, as well as within the initial reflections in Portfolios 1 and 2. While twelve of these modifications/adaptations were noted for students with special needs, and at least one other subgroup, the remainder of the noted modifications/adaptations were for students with special needs. Beth noted that she needed to support students with special needs by encouraging additional participation in activities, assisting them with mathematical calculations and measurement, and allotting additional time. While social participation is a sub-theme under the central theme of personalization, the modification or adaptation in relation to participation was focused on getting students to participate in any way, rather than fostering social participation throughout the activity. As a whole, the students with special needs required an additional level of support, including during labs, as Beth noted during her entry for Day 4, Portfolio Two for an instructional activity in which she stated, “It was necessary to closely monitor students with extra support in following directions and safety with hot water.” While Beth sought to provide students in the classroom with the time and space to explore scientific concepts and take part in explorations, she also recognized when students with special needs required more guidance to get started, or move forward with an activity.

Jenny. Through her initial reflections for Portfolio One and Two, Jenny delineated several modifications or adaptations that she would be putting in place across both units.

> ELLs: guided notes, visual examples, kinesthetic hands on labs and investigation with more guidance, working in partners, repeating information, modified texts for reading assignments, additional practice. IEPs: information presented in multiple modalities: visual, auditory, and kinesthetic; guided notes, videos, labs, investigations, online simulations, working in partners, working in small groups, extra time, modified and shortened assignments, quiz questions read aloud to qualifying students, small group testing when required (Jenny, Initial Reflection, Portfolio One).

While targeted towards students with IEPs and emergent bilinguals, these modifications and adaptations were implemented for the benefit of all students, as verified by the observations and interview data. Jenny was extremely aware and cognizant of the diverse group of students she had in her classroom, and sought to utilize instructional approaches that would target everyone, not just a specific sub-group.

> Special Education and ELLs: adapted readings using Achieve 3000 at their individual Lexile levels [explain in brackets here], guided notes and graphic organizers (what's in blue on presentations goes into their notes), stamp activity trackers that help students keep track of their progress (homework, do-now, notes, practice, inquiry before explanation...) Gifted: opportunities for extension and

> elaboration in the engineering design challenge as well as outlets for creativity and innovation with the lack of restraints on project design (Jenny, Initial Reflection, Portfolio Two).

In her second portfolio, Jenny noted the opportunities for extension and elaboration that she had prepared for her gifted students; however, she did not specifically target gifted students with these opportunities. Rather, she made them available to her whole class, but like the pieces she noted that were targeted to those with IEPs as listed above, they were presented and applied to the whole class.

Megan. As stated previously, Megan was the only teacher that had a co-teacher within her classroom. She describes this in detail by stating the following within in her initial reflection for Portfolio Two.

> A collaborative model is being implemented in the classroom. A special education teacher will provide support and strategies to help students understand the lesson. Instructions will be repeated, visuals will be provided, close reading, hands - on-activities will be available, step by step instructions, more time will be given to complete assignments if needed, and peer support will be encouraged.

So, while Megan did the majority of the planning, especially in regards to what was being taught and the approach used to facilitate that content, she relied on the special education teacher to bring a variety of tools from her tool box to ensure the success of students with special needs. Yet, there was no evidence from the data of this study that the special education teacher provided Megan with any physical resources to support the students with special needs in her science classroom. While noting the modifications and adaptations made for students with special needs, Megan noted the support that the special education teacher provided, such as seen through the following annotation completed on the second day of the second portfolio, “A special education teacher was supporting the students’ learning by reading the directions aloud, providing them with more time and giving them step by step directions." She also stated that the special education teacher provided this support to emergent bilinguals as well.

Throughout Portfolios One and Two, Beth completed 11 entries that described the modifications/adaptations that she completed. Central to these modifications/adaptations were the following pieces: teacher demonstration, support from special education teacher, extra time, visuals, rereading of test directions, as well as more time to complete tests. Beth also noted within several entries the importance of breaking down and/or simplifying the directions for the emergent bilinguals and students with special needs, as well as study guides which she created, and were partially filled in by students as evidenced through observations, as well as providing students with textbooks for home and school as needed.

Summary of modifications or adaptations. The portfolio annotations that addressed modifications and adaptations were the only set of data that specifically addressed how teachers took in account special needs students when planning for and implementing instruction and assessment. The majority of these modifications were not specific approaches to ensuring that students with special needs were successful; rather, they were techniques to support those approaches. For example, extra time was mentioned by all three teachers, but does not fall under the auspices of differentiation, personalization and/or UDL, but rather supports the techniques and methods that are put forth by those approaches. This is also the case with each teacher noting that information was repeated for students with special needs, especially in regards to assessments. While visual supports (i.e., graphic organizers) were briefly mentioned within these annotations by both Jenny and Megan, along with the importance of pre-teaching necessary reading passages and vocabulary by Beth, which fall under UDL and differentiation, respectively, they were seen more extensively across the other data sources. While these techniques were noted by the teachers to support students with special needs, teachers also noted that they relied largely on the students' 504 Plans and IEPs when determining how to meet student needs. However, all three teachers did not receive these documents until the school year had gotten well underway. Overall, it was clear that the teachers focused on hands-on authentic learning and projects, in combination with elements from differentiation, personalization and UDL to meet the needs of all students, including those with special needs.

Differentiation, Personalization and UDL

While all three teachers noted specific modifications or adaptations that they enacted for students with special needs and/or emergent bilinguals, they mainly drew upon their philosophy of differentiation. For all three teachers, differentiation was not a myriad of components. Rather, for Beth, differentiation was manifested through project-based learning, as she stated that this specific approach provides all students with meaningful experiences. She broadened her definition of differentiation, by referencing scaffolding with the following math equation: 2*2x-3/6. Beth stated that with differentiation, she would support students in doing the first step of the equation, and then gradually help them complete the whole problem. Beth was clear that differentiation was something that she used in the planning process, and that she stated that she loved it and believed in it so much.

While Beth directly referenced differentiation in regards to her teaching philosophy, Jenny did not. However, she did reference components of differentiation such as inquiry-based teaching methods, as well as hands-on learning. Jenny emphasized that while labs were critical to science, they were not the only things that could be investigated. She elaborated on this by saying,

> It could be exploratory reading, sorting activities, citing patterns and trends to be able to explain a phenomenon they are observing and relate it to something they

> learned before in everyday life to make what they are learning very relatable based on their prior knowledge. (Jenny, Interview)

Jenny also spoke about the importance of embedding multiple modalities throughout her lessons, and in regards to differentiation, she spoke about the importance scaffolding instruction, by planning ahead with guided notes. Additionally, she cited the importance of, "Scaffolding labs, you know starting off more teacher-directed to more student-directed" (Jenny, Interview). Jenny also noted that she planned her groupings very carefully for the most part, giving those students support who needed it. She did not specify special education students in regards to providing support to those who needed it, but emphasized how she provided students with special needs preferential seating in the front of the classroom.

Megan's teaching philosophy was centered on ensuring that she incorporated real life practices within her classroom for specific sub-groups of students. She underscored the importance of understanding which students need more visual, auditory and/or kinesthetic activities (i.e., including multiple intelligences) within her planning. However, Megan also stated that she tends to embed visual modifications within her instruction, as, she is a value learner. "I have to have visuals. I mean I can sit and listen, but I actually have to write it down because if I do not see what I hear, it doesn't really make sense. So, I think most of us teach the way we learn" (Megan, Interview). Megan was the only teacher to bring this up, yet her assertion is informally solidified through my observations within her classroom. She always had power points with pictures, utilized videos and songs, along with thinking maps and graphic organizers. Every handout within Megan's class required students to draw a picture of some form as well.

Authentic hands-on activities and projects. All of the teachers strove to act as guides, and not lecturers, while doing their best to integrate activities and projects that they posited to be meaningful, authentic, hands-on and connected to the real world. Both components are associated with differentiation and personalization. All three teachers stated that these types of activities were central to ensuring that all students' needs were met during instruction, as they provided multiple entry points to meet the needs of all students. In addition, each teacher vehemently believed that when activities/tasks were connected to real-life scenarios, and were engaging, students were more apt to not only learn the concepts and terms presented but, develop a love of learning for the content matter. This point was exemplified through an annotation by Jenny in the concluding reflection of her first portfolio in response to the following question: *To what extent were you successful in engaging students in these practices in this unit?*:

> I believe I was mostly successful in engaging students in the practices within the unit. Students were most engaged in the investigations and project based learning assignments. The engagement in reading and textual assignments was lower, so I need to build-up the investment in the importance of textual evidence supporting the claims we make in regards to our experimental evidence. Students expressed enthusiasm and excitement for our investigations and projects.

Essentially, hands-on, authentic learning activities (i.e., activities that are connected to real world) lead to student engagement, which all three teachers felt elevated students' enthusiasm for the subject and supports their learning. Megan solidified this notion with the following annotation detailed in the concluding reflection from Portfolio Two, "There were more hands-on activities in this unit. Students were more engaged because they were able to see and touch the experiments. This meant more to them because it made more concrete sense." By actively engaging in hands-on activities that connect to the real world, all students, including special needs students were able to learn the material.

How do Teachers Plan for and Implement Assessment for This Population of Students?

While the central theme associated with assessment was using assessment as a teaching tool, assessment was embedded throughout the majority of the findings. Prior to each unit of instruction, teachers used assessment as a way to determine student's current understanding of the concepts that will be taught and whether they needed support throughout the unit. Megan detailed her pre-assessment for the unit in the spring with the following annotation from her second portfolio:

> Based on the [assessment] results I noticed that my students have a basic prior knowledge on the topic because only one student performed advanced and four proficient. The majority of my students have a basic knowledge (twenty-three), three performed below basic, and three far below basic. This data helped me plan my lessons including more hands on activities, labs, visuals, active notes, vocabulary reviews, questioning, videos and collaborative learning.

Based on the excerpt above, it is clear that Megan used the assessment as a teaching tool; however, it is hard to make the link between the assessment results and instructional methods cited. Perhaps, Megan also took into account her students' needs and interests with the suggested activities, although this was not confirmed. In addition, all three teachers assessed informally throughout the unit as well. Beth detailed her assessment process in more detail in her initial reflection from the second portfolio:

> The pre assessment is a synthesis of expository and literary text. In the interest of time, a combined performance task in ELA [English language arts] and scientific application of concepts through reading and writing will be administered. I will collect their notes to assess knowledge. In addition, listening and discussing will be used to gauge understanding.

All three teachers also used a variety of summative assessments to gauge student understanding of the concepts presented. Summative assessments ranged from traditional paper and pencil tests, to alternatives such as building a rocket in Jenny's class to show knowledge of force and motion, a density bottle in Megan's class to illustrate knowledge of density, as well as creating a structure to hold an egg for an egg-drop in Beth's class to reinforce engineering principles, as well as forces and motion concepts. Beth also utilized performance tasks. For the second unit, the performance task was the chemistry game, in combination with coloring the periodic table in the appropriate groups. A formal end of unit assessment was not provided by Beth in the spring. For Beth, all students' grades were primarily focused on students' completion of the academic tasks, along with their effort and progress throughout the unit. As grades were not associated with the understanding of the material, they were rather subjective. For Jenny, all students were allowed to retake any assessment, and while students were held back in any eighth grade subject that they achieved a D or below, this largely did not apply to special education students based on the information shared with me. Megan's grading structure solely relied on points earned for the completion of every assignment, as well as their understanding of the material on some summative and formative assessments. However, the points gained from each summative and formative assessment were adjusted for students with special needs based on their IEP goals. With reading and writing ability low across all three classes, literacy was emphasized with a particular focus on the students' understanding of vocabulary.

Vocabulary was an integral part of formative assessment, with all students being graded on their application of scientific vocabulary within any writing collected on a daily basis, such as in the form of lab sheets, as well as teachers' listening in on small group and partnership discussions during projects and hands-on activities to determine whether they are using scientific vocabulary appropriately. After a quiz, given via paper and pencil, and a lab on ionic and covalent bonds, Jenny made the determination that students needed to have an additional lab in order to fully understand the two concepts. She stated to me informally, that without collectively examining those two sources, which served as formative assessments, she might not have planned an additional lab to facilitate student understanding.

Summary – Planning for and Implementing Instruction and Assessment Across All Teachers

Again, all three teachers strove to not only address the instruction and assessment of students with special needs, but also the needs of all learners with elements from these three approaches. Throughout each interview, each teacher spoke about her instructional and assessment practices by addressing all learners, not specific sub-groups, which indicates that they seek to address the needs of all learners in a strategic, yet cohesive manner. As stated previously, Beth was the only one who noted through seven of her portfolio annotations specific instances where she put in place modifications or adaptations for special needs learners, thus compounding the fact that the teachers planned for and implemented instruction and assessment keeping in mind the needs of all learners, including those with special needs.

While there are subtle differences between several of the sub-themes or elements of these approaches, as a whole, each element was seen as important by the teachers in meeting the needs of all students. From ensuring that students had the requisite background knowledge, including an understanding of the vocabulary within the lesson to scaffolding instruction, while taking into account the motivation of the students, all are complementary of one another. Essentially, all of the elements found within the data set speak to the importance of these teachers' focus on foundational and eventually, higher level concepts, which are broken down and scaffolded to meet students' needs, along with providing essential tools in a collaborative environment. In regards to assessment, Beth and Jenny advocated for the importance of holistic progress, whereas, Megan focused more on traditional assessment to gauge student progress. Megan kept a detailed record of the points that each student earned for every assignment, whereas Jenny only recorded summative assessments, projects and lab-work, and Beth stated that she recorded some grades because it was required. Jenny emphasized how she wanted students to be excited about science and think of it as a career, and that progress, not a grade was most critical. Beth wanted students to love science, that was her first priority, in conjunction with ensuring that they made progress in science by the end of each unit and across the school year.

Across all teachers, there was evidence of the following elements of differentiation as found through the cross-case analysis:

1) Ensuring clear understanding of key concepts, skills and underlying themes presented within the curriculum (Santamaria, 2009).
2) A variety of grouping strategies depending on the content, student projects and evaluations (Tomlinson & Imbeau, 2014) and a variety of students working together within these groups, regardless of academic level; along with a variety of materials (Tomlinson et al., 2003; Tomlinson & Imbeau, 2014) and methods (Tomlinson & McTighe, 2006).
3) Breaking down specific strategies and concepts to build student independence (Lawrence-Brown, 2014). (Note: The description is synonymous with scaffolding.)
4) Fostering Engagement within the Lesson (Santamaria, 2009).
5) Initial and ongoing assessment of student readiness and goals (Tomlinson, 1995; Algozzine & Anderson, 2007; Tomlinson & Imbeau, 2014).

Yet, how those elements of were implemented varied slightly from teacher to teacher. For example, Beth allowed students to largely pick their own groups, whereas Jenny and Megan relied heavily on assigned seating. Beth would break down concepts as she went through each lesson, whereas Megan sought to teach these concepts upfront. As evidenced through observations, Beth's initial assessments were largely informal, documented through discussion and interaction within the classroom at the beginning of a unit, whereas Jenny and Megan strove to document them through paper and pencil in some form. Fostering engagement was associated with hands-on activities and projects, that were largely grounded in real world experiences, which was linked to increasing motivation by all teachers. However, as stated previously, no teacher sought to take into account their students' perceptions to understand whether the environment was a good match (Adelman & Taylor, 2006).

As Adelman and Taylor (2006) point out, when defining personalization, "…the key to a good match is ensuring that learning opportunities are *perceived by learners* as good ways to reach their goals" (p. 113). As this is a key component to personalization, no teacher truly personalized instruction for their students. However, as teachers recognize the importance of motivation, their next steps could be to elicit their students' perceptions to determine if a good fit exists for each student. Adelman & Taylor (2006) detail several key features of a personalized classroom, some of which were apparent across all three teachers' classrooms. All three teachers showed evidence of scaffolding, encouraged active collaboration among their students, and did their best to provide meaningful, authentic activities, although they enacted these components in slightly different ways. For example, Beth utilized manipulatives such as density cubes and Live Action Role Play to encourage collaboration among students, whereas Jenny drew upon her Investigation Before Exploration activities (IBEs) and Megan used her hands-on lab activities as the main source of collaboration among students. All teachers did their best to provide students with ample opportunities to practice the scientific concepts throughout each unit.

Across all teachers, there was limited evidence of the implementation of components from UDL. There are three principles under UDL: Representation, Engagement and Expression, with each having three separate guidelines, and twelve, eleven and nine checkpoints, respectively

(CAST, 2015). The "Language, Math, and Expressions" checkpoint under representation emerged strongly from the data from all three teachers. All teachers stressed scientific terminology within their classrooms, whether through discussion, word-walls or strategic questioning. Both Jenny and Megan also consistently used visuals to support their students' acquisition of science terms whether through their power points, thinking maps, guided notes and/or handouts. In addition, the Engagement Principle was supported through the teachers' efforts to implement hands-on activities and projects that were designed to support the guideline, "Recruiting Interest," and the associated checkpoint "Optimize Relevance, Value and Authenticity." The rocket project in Jenny's classroom, along with the egg-drop project in Beth's classroom, and the density bottle project in Megan's classroom, were implemented to engage students, so that they would not only value the activity, but see value in science as well. It is important to point out that UDL was not a topic within the interview, so this was a limitation of the study.

How Do Three General Education Eighth Grade Science Teachers Self-Monitor and Reflect Upon Their Instructional and Assessment Practices for Students?

All three teachers utilized the ePortfolio across two units of instruction. While Beth and Jenny easily adjusted to this new technology, it was difficult to grasp at first with Megan. Megan did not have that much experience with technology beyond creating power points and word documents on a Macintosh laptop that was about 10 years old. Beth found that the ePortfolio was valuable for reflecting upon her instruction, as she looked through it weekly and saw additional aspects of her classroom instruction, that she did not see when she was teaching. Like Beth, Jenny also made several internal reflections on the spot; however, she thought that the ePortfolio would be valuable in the future. She specifically identified the concluding reflection question of, "If you were to teach this unit again, what, if anything, would you change about your curriculum, instruction, or assessment? Why?" This question is inherently reflective, and thus, is valuable in planning future instruction and assessment.

While Megan believed significantly in keenly observing her students and modifying/adapting instruction as needed, she went one step further by noting that it is important to directly ask the students what they have learned, which allows her to reflect on the success of the lesson/activity. In addition to the question about possible changes highlighted by Jenny as being valuable, Megan also found the following questions to be essential components, "What was the purpose of the instructional activity reflected in the artifact? Did the activity achieve this purpose?" along with the adaptations/modifications question. So, while the ePortfolio was found to be immediately valuable for Beth and Megan in terms of reflecting upon their instructional and assessment practices for all students, it was found to be a potentially valuable tool for Jenny. The teachers relied heavily on observations of students, in conjunction with internal reflections to reflect upon their instruction and assessment practices. While the teachers did not directly state how their monitoring and reflection efforts supported what concepts/terms they needed to extend or reteach in the immediate future, they all alluded that it would (or in Jenny's case) could be very helpful in the future as they plan and implement curriculum, instruction, and assessment for all learners, especially those with special needs.

How Does This Monitoring Support What Concepts They Need to Re-Teach or Extend For Students?

This question was not adequately addressed through the data. Rather, teachers used their assessments, both pre-, post- and ongoing assessments throughout the unit to reflect upon what they needed to reteach or extend for students. Teachers repeatedly scanned the data that was available to them in order to monitor and reflect upon their instruction and assessment. While several of the questions were valuable for the teachers from the ePortfolio, the teachers did not specifically state that they were critical for them in understanding what needed to be re-taught or extended.

General Discussion

This study provided an in-depth analysis of how three eighth grade general education science teachers accounted for the ability and motivation of their students with special needs when planning and implementing curriculum, instruction, and assessment. More specifically, this study examined how they utilized elements of the following approaches: differentiation, personalization and UDL to account for students' abilities and motivation. In addition, a secondary goal of this study was to understand how teachers monitor and reflect upon their instructional and assessment practices for students, and how this monitoring and reflection assists them in understanding what needs to be re-taught or extended. In order to answer these questions, I conducted observations across two weeks in the fall during a physics science unit, and throughout a two-week chemistry unit in the spring, with some additional days falling outside of the set two week units. During these observations, I did remain neutral in my actions and comments, as teachers would often ask me for feedback on their lessons. However, I did not provide evaluative feedback; rather; I informed them of what I saw during the observation, asked reflective questions if time allowed, and sometimes provided suggestions of additional resources that they might think about for their next lesson(s). To create an informative study, I was fortunate enough to draw upon teachers' ePortfolios that were collected across those ten days for the fall and spring units, in addition to an expansive interview that was conducted in early spring with each teacher. These data sources yielded a complex story that revealed how teachers thoroughly account for the challenges that students face outside of the classroom, and deeply reflect upon their own skillsets, while finding training that matches their professional needs. Essentially, accounting for students' abilities and motivation is not clear cut, there are many layers.

Accounting for the Ability and Motivation of Students with Special Needs

Students with special needs was defined in this study as the following disabilities: autism, specific learning disability (dyslexia and processing disorders), and other health impairment (ADHD). To ensure that the academic needs of students with disabilities were met, teachers relied heavily on the students' IEP and 504 plans, once they received them from school personnel. It is important to recognize that within each disability listed above there are varying degrees of severity as well as levels of supports that are provided to the student inside and outside of the home, while also taking into account each students' past experiences. More specifically, Dixon, Yssel, McConnell and Hardin (2014) state "to differentiate instruction is to recognize students' varying background knowledge, readiness, language, and preferences in learning and interests, and then to act on that knowledge responsively in planning content dimensions, process dimensions and product dimensions" (p. 113). This study exemplifies this overarching statement by Dixon et al. (2014) since each teacher recognized the challenges faced by some students that supported the need for students to have ownership in the classroom (Beth), the need for and desire to change the traditional classroom set-up (Jenny), and the goal to provide additional academic supports in school, which might not be available at home (Megan). As such, each teacher noted the importance of being flexible in their planning and implementation of their curriculum, instruction, and assessment in order meet students' academic abilities.

There was no evidence within this study of each teacher fully examining the strengths and weaknesses of each individual student, with or without a disability within her classroom. Each teacher recognized the importance of accounting for student motivation, which was a large part of why they included hands-on, inquiry-based projects. Yet, they did not directly check with each student to see if he/she was motivated throughout instructional and assessment activities in science. Despite this, each teacher had a positive attitude towards all students, including those with disabilities. They wanted every student to feel included within the classroom, and to make progress.

Overview of curriculum, instruction, and assessment. Due to the recent transition to the Common Core State Standards (CCSSI, 2014), and the impending transition to the NGSS (2013) for these three teachers, each teacher informally commented that there is a lack of curriculum that is aligned to the standards. Thus, finding curriculum that is not only aligned to the standards but also provided methods/approaches to meet the needs of all learners was impossible. While Megan and Beth did have textbooks available to them, Jenny did not. Megan did have a textbook, but along with the textbook were workbooks, including a *Reading Essentials* (Glencoe, 2016) book which emphasized the same concepts of the textbook, but at a lower reading level. As many students struggled to read at grade level, Megan found this resource to be essential; however, even it was too hard for the students at times. Unlike Beth and Jenny, Megan did have a co-teacher (special education teacher) during the science period that was observed; however, this science teacher did not make suggestions to Megan as to what appropriate texts could be used, as well as other materials, based on the data from this study. Megan often found herself breaking apart the paragraphs within this workbook, and placing them sentence by sentence on a series of power points with embedded pictures. Similarly, Beth rarely used the science textbook, and instead utilized the record book (a workbook), which carefully teased apart the experiments that were given to the students, with enough space for them to write and draw pictures as necessary.

Beth preferred to supplement the textbook and workbooks with online materials, which is what Jenny preferred as well; however, Jenny also made her own materials. She found that making her own handouts, guided notes, labs, etc. were invaluable, because she could tailor any aspect of them (visual, directions, etc.) to meet the needs of her students. These teachers spent an inordinate amount of time choosing, adapting and aligning curriculum to meet the needs of their students. Throughout this process, each teacher was adamant that they would not lower any standard for their students, including those with disabilities. The teachers would spend extra time with students after-school or during their breaks to solidify math skills such as multiplication and division, as seen in Jenny's classroom during her force and motion unit. However, the teachers followed the standards and expected students to make progress in meeting those standards. Central to the planning process, in addition to curriculum, was to embed approaches such as differentiation, personalization and UDL to provide students with the necessary elements of those approaches to meet their needs.

Partially attributed to the challenges that these students have faced, all teachers were in firm agreement that hands-on learning that stressed meaningful, authentic activities were absolutely critical to raising levels of motivation, engagement and ultimately academic success. Thus, this study solidifies the findings of Tomlinson (2000) who notes the critical importance of authentic (real world) instruction, coupled with Tomlinson and Imbeau (2014) as well as Lawrence Brown (2004) who make the case of including hands-on learning that is authentic and connected to real world issues/problems in small groups. This is a critical component in the planning and implementation of curriculum and instruction to ensure that all students, not just students with special needs, exceed.

Building off of hands-on authentic learning, these teachers were grounded in their efforts to ensure that they broke down and/or scaffolded the material, by providing a variety of materials, groupings (small group, 1:1, etc.) and methods (i.e., workshop structure) to ensure that students did not necessarily master the concept at that moment but understood it. For all teachers, but especially Beth, students needed to show progress in their understanding of the subject matter, not mastery, which is something that is not in the forefront at this time. Beth also took into account students' effort throughout each unit, when providing grades to students and parents. Jenny's school offered an unlimited retake policy of all summative assessments, in order for students to elevate their grades, whereas Megan provided her students with several extra credit opportunities to raise their grades. Across all three teachers, assessment was initial and ongoing, with Beth and Jenny having the ability to offer a wider variety of choices than Megan, which could have been partially because she was the only teacher in a public school. At both charter schools, grades were not used as a mechanism to retain students. Beyond progress, it was essential to all of the teachers that their students saw value in what they were learning and that they enjoyed what they were learning, which stems back to their focus on hands-on, authentic learning that aptly connects to the real world.

Motivation. While all the teachers noted that they took into account motivation, they did not say how they took it into account beyond stressing the importance of hands-on authentic learning opportunities, and projects, in addition to fostering engagement and collaboration among the members of their classroom community. Both Beth and Megan explicitly spoke about the value of getting to know the students, providing them with opportunities to take initiative and explore within the content area. While Jenny did not say this directly, these items were observed throughout more than two-thirds of the observations. All three teachers took their role in molding not only the curriculum and instruction seriously, but their role in understanding what the student needs both within and outside of academics, just as seriously. Although, despite implicit evidence that teachers were taking into account student motivation and individual capabilities ("The Match")/creating motivated learners through their inclusion of hands-on, inquiry and project-based activities, it is essential as Adelman and Taylor (2006) note that, "…the *learner's perspective* is a critical factor in defining whether the environment is a good fit" (p. 113). So, while the teachers showed evidence of a personalized classroom, each learner's perspective was not addressed nor taken into account. Based on the data from this study, the teachers did not check through formal and/or informal means whether their students were indeed motivated throughout each unit of study. So, no formal conclusions can be reached as to whether personalization was truly an approach used in these classrooms, despite the existence of some characteristics of a personalized classroom being present across all three classrooms.

Addition of subtle techniques. In addition to the three approaches, and associated elements, the teachers also noted the importance of embedding several techniques to facilitate student success. Repeating directions, and providing extra time were delineated within the portfolio entries of all teachers as critical to ensuring success for diverse learners, including students with special needs.

Addressing the needs of all students. Each teacher stressed the importance of meeting the needs and abilities of their whole class whether implicitly or explicitly through the observations and interviews, with one exception. Teachers did denote modifications for assessments and adaptations for instruction that they made for specific sub-groups of students, including students with special needs for the adaptation or modification question within the initial reflection of the portfolio, as well as in the annotation questions for the instructional and assessment artifacts. However, only Beth specifically noted adaptations or modifications for students with special needs in response to only a portion of the questions, whereas Jenny and Megan referenced at least two or all the following subgroups: students with special needs, emergent bilinguals (English Language Learners) and gifted students.

This philosophy is in concert with principles behind differentiation, personalization and UDL. In addition, by not isolating students with special needs through their portfolio data, or within the interviews, Beth and Jenny embraced and implemented heterogeneous grouping in their classrooms. Students with special needs were not grouped together in these classrooms. Megan strove to include heterogeneous grouping; however, it was only implemented during hands-on activities, as she had a special education teacher work with the students with special needs in a group during the majority of activities. The efforts of these teachers to build a classroom community where no one was defined by a label, but rather supported in their progress through a myriad of techniques and approaches that were built upon hands-on, authentic learning is something that needs to be studied further.

Teacher Reflection and Self-Monitoring

While all three teachers saw inherent value in the use of the ePortfolio, their responses were limited in depth in regards to its overall value. While Megan and Beth saw immediate value in the tool, Jenny hesitated and stated that the tool could have potential. Jenny acknowledged that she strove to have a better system to reflect upon data, but she has not accomplished that goal yet. There were several questions that did inherently foster reflection, namely the two questions that asked teachers what changes they would make to future units within the concluding reflection, and what adaptations/modifications were made for specific sub-groups of students. Based on the data from this study, it would be beneficial to explore an additional follow-up question asking teachers how and when they will embed these changes into future units. Rather than use the tool to foster reflection, it was used more by the teachers to keep a record of their teaching across both units, with the opportunity to look back at it in the future to make decisions about curriculum, instruction and/or assessment.

Through the analysis of data, though, it became apparent that the teachers implicitly defined reflection as something that happened "on the spot" when observing students. The larger NSF study defined reflection much more thoroughly, with the reflection questions within the instruction and assessment annotations, along with the initial and concluding reflections in facilitating reflection essential steps in order for teachers to reflect on their instruction and/or assessment (Martinez, Borko & Stecher, 2012). Despite this potential incongruence, it was not a question that was addressed directly within the interview, nor was it included as a follow-up question. In a future study, it will be essential to understand each teacher's definition of reflection more thoroughly, which would have shed more understanding as to how they comprehensively reflect and monitor their instruction.

Implications and Recommendations

While this study sought to shed light on how three eighth grade general education science teachers took into account the abilities and motivation of students with special needs, as well as investigating how they reflected upon and monitored their instructional and assessment practices, the findings were much more complex. Teaching is not straightforward. Teachers need to be provided with time to collaborate with their peers on curriculum, instruction, and assessment that has been successfully used within the classroom rather than spend time being lectured to and provided with a variety of handouts that do not address how to modify or adapt the given approaches/methods to meet the needs of their students. Rather than investing resources into outside professional developers who do not have experience with the context of the school, or school system, it would be wiser to allocate time for teachers to collaborate and learn from one another.

More specifically, teachers truly need to have training on how to differentiate and personalize instruction for students with special needs within the context of the framework of whole class instruction. As seen in this study, teachers associated differentiation with authentic hands-on activities and projects, along with inquiry-based learning, and thus, as a first step, it is critical that they understand the depth of both approaches. Teacher would also benefit from a thorough understanding of UDL, along with individualization. Allowing teachers time to reflect upon students' personal learning and its' link to their classroom environments would be an integral next step for teachers' professional development. Ideally, teachers would have a thorough understanding of how to account for each student's motivation and abilities, or lack thereof, while keeping in mind the dynamics of the whole class. In addition, it is imperative that teachers receive follow-up support and applicable resources to enact the components of these two approaches. Additionally, teachers need some form of support on how to effectively elicit students' perceptions about their classroom experiences, specifically in regards to motivation, which will provide valuable information to enable them to more effectively personalize instruction. With the number of tasks that teachers need to accomplish throughout the day, they do the best that they can for their students based on the training that they receive, along with the time and resources that are given to them. Yet, more can always be done.

Teachers also need to be trusted to take the time to get to know their students to best meet their needs, while also being provided the space and flexibility to meld together a variety of approaches, such as these teachers did to best meet their students' needs. Within that space, teachers need to be provided with a myriad of resources, especially technology and literacy materials of varying levels that meet the needs of all their students. Teachers within this study valued the diverse talents of their students, and the challenges that they encountered. They strove to push the boundaries, by crafting activities and tasks that were hands-on and connected to the real world in order to facilitate motivation and engagement. However, a limitation of this study was the lack of consultation with the students as to how they perceived the classroom environment and its match for them. Just as curriculum and instruction need to be broadened to build in flexibility for the teacher to pull from a variety of resources, assessment needs to be redefined as well. Achievement needs to be thought of in the context of "progress," which is assessed through a variety of projects, tasks, and assessments, rather than a series of standardized scores. While progress can be broadly defined as a student's growth in understanding academic content, it should also be expanded to include his/her love for the subject and level of motivation to deepen his/her learning of the content matter. These suggestions and their associated implications would be monumental, and valuable shifts in how educational stakeholders think about how to successfully meet the needs of diverse learners, especially those with special needs. Finally, it is imperative that this information be disseminated to policymakers so that they begin to develop a keen understanding of the realities of the classroom, and the challenges in accounting for the needs of diverse learners.

Appendix A

Definition of Terms

There are a variety of terms, concepts, approaches, and diagnoses that are addressed within this study. The table below describes the specific terms as they are used throughout the study.

Term	Definition
Accommodation	When the format of the curriculum, an aspect of the environment and/or technology is changed to allow a student the ability to understand the content presented and/or complete the activities within the general education classroom. Students with special needs take the same tests, quizzes, etc. as their peers in the general education classroom (Disabilities, Opportunities, Internetworking, and Technology (DO-IT), 2015).
Adaptations	Accommodations and/or modifications made to ensure the success of a special needs student.
Adequate Yearly Progress (AYP)	An accountability system determined by the state or local education agency (district) as to how to determine if all students met the requisite standards in each content area.
Attention Deficit Hyperactivity Disorder (ADHD)	Attention Deficit Hyperactivity Disorder (ADHD) falls under Other Health Impairment within IDEA. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM V), defines ADHD "as a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, has symptoms presenting in two or more settings (e.g., at home, school, or work; with friends or relatives; in other activities), and negatively impacts directly on social, academic, or occupational functioning. Several symptoms must have been present before age 12 years."
Autism	The DSM-V provides the following diagnostic criteria for autism, "Persistent deficits in social communication and social interaction across multiple contexts as manifested by the following, currently or by history: (1) Deficits in social-emotional reciprocity; (2) Deficits in nonverbal communicative behaviors used for social interaction; (3) Deficits in developing, maintaining, and understanding relationships."
College and Career Readiness	A term coined by the Common Core State Standards Initiative which outlines what students must achieve in mathematics and English language arts/literacy in order to succeed in college and entry level employment.
Common Core State Standards	In-depth mathematics and English language arts/literacy standards that span grades K-12 that have been adopted by 42 states.
Content Standards	Clear expectations that are set for most subjects (specifically mathematics and English), that all students need to meet as evidenced by success on formative and/or summative assessments.

Term	Definition
Culturally and Linguistically Diverse Learners (CLD)	Any student that is representative of a racial/ethnic or linguistic minority group, with linguistic referring to any other language than English (Sullivan, 2011).
Differentiation	A teaching philosophy that takes into account the diverse needs of students, while providing instructional supports and adaptations to enable all students to meet grade-level curriculum standards (Tomlinson, 2000; Lawrence-Brown, 2004).
Disproportionality	"the extent to which membership in a given group affects the probability of being placed in a specific disability category" (Artiles et al., 2005 as cited in and adapted from Oswald, Coutinho, Best, & Singh, 1999, p. 198). This term is commonly used when referring to the overrepresentation of emergent bilinguals from low-income households in special education.
Dropout	The term dropout is most often associated with students who leave high school before graduating. The consequences of leaving high school before graduating are detrimental. Rumberger (1987) notes, "By leaving high school prior to completion, most dropouts severely limit their economic and social well-being throughout their adult lives" (p. 101).
Dyslexia	Dyslexia falls under the umbrella of specific learning disability. The International Dyslexia Association (IDA, 2002) defines dyslexia in the following manner: Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.
Emergent Bilinguals	A designation given to students who are tested for English proficiency, and as a result, require English-language support services to not only become proficient speakers, writers, and readers of English, but to ensure they can properly access the curriculum (Bailey, 2015).
Formative Assessment	Ongoing assessment that is undertaken by teachers to: (1) Understand what concepts students have retained; (2) Decide what modifications need to be made to classroom instruction in order for students to reach the prior or future learning goals set forth by the teacher (Black & Wiliam, 1998).
Implementation	The ability to carry out a lesson, instructional strategy, curriculum modification in the classroom, etc., after careful planning by the individual.
Inclusion	When a student with a diagnosed learning or behavioral disability is included within the general education classroom full time (Idol, 1997).
Individualized Instruction	Instruction that only accounts for individual differences among students, not motivational factors that can influence their willingness to learn (Adelman & Taylor, 2006). More specifically, "…*individualization* typically emphasizes detecting a student's deficiencies by monitoring daily performance on learning

Term	Definition
	tasks and then modifying instruction to address the deficiencies" (Adelman & Taylor, 2006, p. 129).
Instructional Strategies	Methods or approaches that a teacher undertakes to effectively meet the needs of all students by actively engaging them with the content in order for them to meet the grade level content standards and/or performance expectations.
Mainstreaming	When students with a diagnosed learning or behavioral disability spend part of their school day within a special education classroom, and the remainder of their day within the general education classroom (Idol, 1997).
Modifications	Changes in the curriculum that allow a student to fully participate in the general education classroom who might have been unable to do so due to the lack of understanding of the content (DO-IT, 2015). A modification changes the standards or expectations of the activities, assignments and/or assessments (FAPE, 2001).
Next Generation Science Standards (NGSS)	The NGSS bring together three dimensions from the Framework for K-12 Science Education (NRC, 2012): core ideas, crosscutting concepts, as well as science and engineering practices to form each performance expectation or standard.
Overrepresentation	"unequal proportions of culturally diverse students in special education programs" (Artiles & Trent, 2000, p. 514).
Performance Expectations	"Performance expectations are not learning goals for instruction, nor are they instructional strategies. As such, PEs do not dictate instruction. However, PEs do provide guidance for what students should learn in the classroom" (Krajcik, Codere, Dahsah, Bayer & Mun, 2014, p. 160). With PEs, it is recommended that students be assessed at the end of grade 5, 8 and 12.
Personalized Instruction	Instruction that accounts for motivation and individual differences among students (Adelman & Taylor, 2006).
Response to Intervention (RTI)	A series of tiers that students who are at risk for special education services proceed through, with the first tier being high quality instruction within the general education classroom, followed by intensive intervention in the subject area(s), and then if needed, progressing to the final tier, which is often a special education evaluation.
Risk Ratio	"…risk ratio is an epidemiological statistic, commonly used in analysis of binary outcomes, and is a measure of effect size commonly employed in medical research" (Sullivan, 2011). For the purposes of this study, a positive risk ratio meant that Emergent Bilingual students had a higher chance of being identified with special needs relative to the comparison group (often white, English proficient students). Essentially, a risk ratio is used to determine if there is a correlation between being Emergent Bilingual and being diagnosed with special needs.
Specific Learning Disability	A child will receive this diagnosis if he/she does not meet grade-level or developmental standards in at least one of the following domains: oral expression, listening comprehension, written expression, basic reading and/or fluency skills, reading comprehension, and/or mathematics calculation/problem solving; OR If offered Response to Intervention (RTI), the child does not

Term	Definition
	adequately make grade level and/or progress relative to his/her age, which is not the result of any of the following components: visual, hearing or motor disability, mental retardation, emotional disturbance, cultural issues, environmental and/or economic disadvantages, or second language learning (IDEA, 2004).
Standards Movement	A movement tied to keeping states accountable for their students' achievement by mandating the adoption of state and/or national standards (CCSS and NGSS), followed by methods of assessment and rewards or sanctions based on performance.
Students with Special Needs	Students that have been diagnosed with one of ten disabilities (specific learning disability, speech or language impairment, other health impairment, autism, intellectual disability, developmental delay, emotional disturbance, multiple disabilities, hearing or orthopedic impairment) using the procedures and guidelines set forth by the Individuals with Disabilities Act (IDEA, 2004). For the purposes of this study, students with special needs refers to: specific learning disabilities (including dyslexia and visual, verbal and/or auditory processing disorders), other health impairments (including ADHD), and autism.
Visual, Verbal and/or Auditory Processing Disorder	Visual, verbal and/or auditory processing disorders are comorbid diagnosis' along with learning disabilities.

Appendix B

Initial and Final Reflection Questions of Portfolio

Initial Reflection Questions

Please provide context so an educator could understand the planning, instructional and assessment practices in your science classroom.

1. What would you like to do ?

A) Complete initial reflections B) Upload initial artifacts

SKIP PATTERN HERE

→ If A proceed to initial reflection questions (2.1)

→ If B proceed to upload materials related to the initial reflection questions (2.2)

2.1 → Initial reflection Questions

2.1.1 What is the title or theme of this unit?

2.1.2 Which **core disciplinary ideas** will you cover in this unit for your students? (Mark all that apply)

PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and applications to info. transfer LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, dynamics	LS3: Heredity: Inheritance, variation of traits LS4: Biological evolution: Unity and diversity ESS1: Earth's place in the universe ESS2: Earth's systems ESS3: Earth and human activity ETS1: Engineering design ETS2: Links among STEM, and society Other (Specify): ______________________

2.1.3. Which **Science and Engineering Practices** will you cover in this unit? (Mark all that apply.)

a. Asking questions (for science) and defining problems (for engineering) b. Developing and using models c. Planning and carrying out investigations d. Analyzing and interpreting data e. Using mathematics/computational thinking	f. Constructing explanations (for science) and designing solutions (for engineering) g. Engaging in argument from evidence h. Obtaining, evaluating, and communicating information Other (Specify): ______________________

2.1.4 Which **crosscutting science concepts** will you cover in this unit? (Mark all that apply)

a. Patterns b. Cause and effect: Mechanism and explanation	e. Energy and matter: Flows, cycles, and conservation f. Structure and function g. Stability and change

c. Scale, proportion, and quantity d. Systems and system models	h. Other (Specify) : ________________

2.1.5 What **tools or resources** did you use to plan your science unit? (Mark all that apply.)

a. CA Science Standards Documents b. NGSS Literature and/or Documentation c. Books d. Technology (powerpoint, internet)	e. Curriculum materials f. Lab Guides- commercial g. Lab Guides - your own h. Other (Specify) :____________________

2.1.6 Which **Literacy Practices** will you emphasize in this unit for your students? (Mark all that apply)

a. Cite specific textual evidence to support analysis of science and technical texts b. Determine central ideas or conclusions of a text; accurately summarize text c. Follow precisely multistep procedures in experiments, technical tasks or when taking measurements d. Determine the meaning of symbols, terms, and domain-specific words in a scientific context e. Analyze the structure of a text, and how the sections contribute to the whole f. Analyze author purpose in providing an explanation, or describing a procedure or experiment g. Integrate information in words with that expressed visually (e.g., diagram, model, graph) h. Distinguish among facts, reasoned judgment based on research, and speculation i. Compare information from experiments, simulations, or multimedia with that from text j. Read science/technical texts independently in the grade level text complexity band k. Other (Specify): _____________________

2.1.7 Describe the typical structure and format of the lessons in this unit (e.g., daily "routine" and instructional activities, lecture, discussion, use of technology, etc).

2.1.8 Describe your assessment plan for this unit (e.g., pre-assessments, progress or benchmark tests, end-of-unit tests, other assessment activities)

2.1.9 Will you modify or adapt any aspects of the curriculum, instruction, or assessment in this unit, for the following groups of students? (Mark all that apply)

□ No Adaptations	□ Special Education	□ English Language Learners	□ Gifted	□ Other _________

SKIP PATTERN HERE
→ If "No Adaptations" proceed to submit survey)
→ If any adaptations selected proceed to 2.1.10

2.1.10 Please describe how you will modify or adapt your teaching for this unit for these groups.
2.2 → Artifact upload
2.2.1 Title of artifact (e.g., Unit Plan, Pre-Assessment)

2.2.2 What type of file are you submitting?

□ Image □ Document □ Video
→ Upload object (image, document, video). (1 Page + Additional)

2.2.3 Please provide any additional information or comment (beyond your initial reflections) necessary for others to understand this artifact in the context of your class [SKIPPABLE]
Concluding Reflection Questions

1. What would you like to do ?

A) Enter concluding reflections B) Upload concluding artifacts

SKIP PATTERN HERE
→ If A proceed to concluding reflection questions (2.1)
→ If B proceed to upload materials related to the concluding reflection questions (2.2)

2.1 → Concluding reflection questions

2.1.1. Which of the following **Science and Engineering Practices** did you cover in this unit for your students? (Mark all that apply)

a. Asking questions (for science) and defining problems (for engineering) b. Developing and using models c. Planning and carrying out investigations d. Analyzing and interpreting data e. Using mathematics/computational thinking	f. Constructing explanations (for science) and designing solutions (for engineering) g. Engaging in argument from evidence h. Obtaining, evaluating, and communicating information

2.1.2. To what extent were you effective engaging students in these practices in this unit?

2.1.3 . Which of the following **crosscutting concepts** did you cover in this unit? (Mark all that apply)

a. Patterns b. Cause and effect: Mechanism and explanation c. Scale, proportion, and quantity d. Systems and system models	e. Energy and matter: Flows, cycles, and conservation f. Structure and function g. Stability and change h. Other (Specify): ________________

2.1.4 . Which of the following **Core Disciplinary Ideas** did you cover in this unit? (Mark all that apply)

PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and applications to info. transfer LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, dynamics	LS3: Heredity: Inheritance, variation of traits LS4: Biological evolution: Unity and diversity ESS1: Earth's place in the universe ESS2: Earth's systems ESS3: Earth and human activity ETS1: Engineering design ETS2: Links among STEM, and society Other (Specify): ______________________

2.1.5 Were students able to reach your learning goals for this unit? If not, in what ways did they come up short of reaching the learning goals? What goals were most challenging?

2.1.6 . Which of the following **Literacy Practices** did you cover in this unit? (Mark all that apply)

a. Cite specific textual evidence to support analysis of science and technical texts
b. Determine central ideas or conclusions of a text; accurately summarize text
c. Follow precisely multistep procedures in experiments, measurements, or technical tasks
d. Determine the meaning of symbols, terms, and domain-specific words in a scientific context
e. Analyze the structure of text, and how sections contribute to the whole
f. Analyze author purpose providing an explanation, or describing a procedure or experiment
g. Integrate information in words with that expressed visually (e.g., diagram, model, graph)
h. Distinguish among facts, reasoned judgment based on research, and speculation
i. Compare information from experiments, simulations, or multimedia with that from text
j. Read independently science/technical texts in the grade text complexity band
k. Other (Specify): ___________________

2.1.7 If you were to teach this unit again, what, if anything, would you change about your curriculum, instruction, or assessment? Why?

2.1.8 How representative was this unit and class, of your instruction across other eighth grade science units and classes? What aspects were typical and what aspects were atypical?

2.1.9 How accurately do the contents of this portfolio represent your instruction in this class? Are there any aspects of your instruction that are not reflected in the materials you collected?

2.2 → Artifact upload
2.2.1 Type of artifact

2.2.2 What type of file are you submitting?
□ Image □ Document □ Video
→ Upload object (image, document, video). (1 Page + Additional)

2.2.3 Please provide any additional information or comments necessary for others to understand this artifact in the context of your class

Appendix C

Instructional and Assessment Artifact Annotations

Instructional Artifact Questions within the Portfolio

Instruction Artifacts:

1. Please provide a descriptive title for this instruction artifact (e.g., acceleration lab sheet)

2. What type of instructional artifact is this?

a. Lesson Plan	Objects / physical classroom features
b. Instructions / Warm-up	Live teacher-led classroom work
c. In-class assignment, Lab/Worksheet, Handout	Live student-led classroom work
d. Chalkboard or White board notes	Other (Specify)
e. Presentation (Projection/Smartboard Slides)	

3. What type of file are you submitting?

□ Image □ Document □ Video

→ Upload object (image, document, video). (1 Page + Additional)

4. What was the purpose of the instructional activity reflected in the artifact? Did the activity achieve this purpose?

5. Based on the results of this activity will you make any changes to your instruction in the future? (NOTE: this may include changes to upcoming units, or to the same unit next year) [SKIPPABLE]

6. Did you make any modifications or adaptations to this instructional activity for the following groups of students? (Mark all that apply)

□ No Adaptations	□ Special Education	□ English Language Learners	□ Gifted	□ Other __________

SKIP PATTERN HERE

→ If "No adaptations" submit artifact

→ If any adaptations proceed to 7

7. Please describe the modifications/adaptations you made.

8. Please upload a modified or adapted instruction artifact (if any). [SKIPPABLE]

□ Image □ Document □ Video

→ Upload object (image, document, video). (1 Page + Additional)

Appendix D

Model (Manual) of Instructional and Assessment Artifacts

Requirements for Portfolio Collection
What to do BEFORE the 10-Day Portfolio Period:

- ✓ Select the unit you will capture in your 2nd portfolio. Please choose a unit you anticipate will have 10 consecutive days of instruction with little or no interruption (or 6 days in block schedules).

- ✓ Update the e-QIS app on your tablet to the latest version. Go to the google playstore, search for "e-QIS", and tap on "Update". Let us know if you need assistance updating the app.

- ✓ Spend a few minutes reviewing the new features of the app – Remember the manual and training videos in the e-QIS HELP folder are on the tablet if you need them.

- ✓ Complete the initial folder before the start of the unit. This includes:

    - **Initial Reflection Questions:** Provide enough detail to give readers context to understand your students, classroom routines, and instructional and assessment practices. Please answer questions # 6, #7, and #8 in full again, as each portfolio should stand on its own.

    - **Initial Artifacts: <u>Upload AT LEAST two artifacts</u>** as substantive context for your unit. This includes a unit outline or written plan, and one or more of the following: chapter overview from teacher's textbook, unit pre-test, study guides, scoring rubrics, etc.

What to do DURING the 10-Day Portfolio Period:

- ➢ <u>Upload AT LEAST 1 instruction AND 1 assessment artifact, (at least 5 artifacts must be videos)</u> for each of the 10 days covered in your portfolio (6 in block schedules). It is important that you upload artifacts each day after class, or the day immediately after.

    - **Instruction artifacts: Pictures** of lessons or lab plans, notes, handouts, whiteboard, smartboard or chalkboard work, physical classroom features (e.g., materials, equipment, grouping). **Electronic Documents like word documents, pdf's, or powerpoints** of handouts, worksheets, lesson plans, or other material. **Videos** of individual or collaborative student lab work, teacher-led activities and demonstrations, whole group discussions, etc.

    - Assessment artifacts: These are samples of *student work you* use to gage student knowledge, whether formally graded or not. Examples include Pictures of a completed quiz, test, assignment, lab report, worksheet, poster, notebook entry, essay, vocabulary sheet, science project, etc. Electronic documents containing student work. Video of students giving presentations, discussing learned topics with partners, quizzing and giving others feedback, setting up and completing a lab, etc.

- Stop collecting daily artifacts after 10 days of instruction (6 in block schedules).

  Image and Video Quality: Please review artifact images before uploading. Pictures should be well lit and focused to allow reading printed text, student writing and work and, if applicable, any annotations you made for the student.

  - Images: Hold tablet steadily vertically (portrait) or horizontally (landscape) to best capture the artifact. If the picture is dark, blurry, or otherwise does not allow reading the text, please re-take the picture.

  Videos: Hold the tablet horizontally (landscape). Stand sufficiently close to the target student(s) so discourse or verbal interactions are clearly heard. If necessary, move closer or zoom in to show the work the students are doing (e.g., written mater or documents, lab materials, computer screens).

Artifact Annotation: Annotate each artifact thoroughly to offer readers context to understand the instructional or assessment activity, its objectives and rationale, and any adaptations you might have made for certain groups of students. Please look at the two model annotations below. Model (A) offers sufficient detail to understand the artifact in context, (B) does not. While not all artifacts you upload will require the level of detail in (A), please avoid cursory annotations like those shown in (B).

Model (A) – Enough Information Model (B) – Not Enough Information

Please provide a descriptive title for this instruction artifact (e.g., acceleration lab sheet).	
A guided worksheet on graphing distance v. time	Guided worksheet on graphing motion
What was the purpose of the instructional activity reflected in the artifact? Did the activity achieve this purpose?	
- The purpose was showing how motion can be measured and represented on a graph, as well as overlap among science and mathematics concepts. Specifically, I wanted students to understand that the slope of the graph represents the speed of the object at a given time and a positive/negative slope indicates a direction from the origin (the object either moves away from or towards). Students worked in small groups and helped teach each other, as I monitored and assisted struggling groups. A few of the stronger students were able to make these connections, but most did not meet the goals. This was a	- The purpose was to show that motion can be measured and represented on a graph.

precursor to students graphing their own movements in a series of planned motions, but more instruction will be needed before students can do this (especially individually).	
Based on the results of this activity, please discuss any changes you will make to your instruction in the future.	
- The activity was pretty eye opening. Students struggled with the material, but I think the struggles were more procedural than conceptual. It seems graphing skills need to be bolstered throughout the unit, and particularly discussed in a relevant application to our science class. When I asked students to explain some of the ideas verbally, they understood that the faster you are moving the further you will go over the same time period. This understanding did not translate to understanding the graphs. - - In the future, I will include an earlier lesson on graphs; it may have been helpful to do the first examples together. I could call on students to share their thoughts about parts of the graph, and work through difficulties with the collective expertise of the class prior to letting them work in groups. I could have also prevented it with earlier exit tickets focused more on graphs rather than just conceptual or formulaic (S=D/T) ideas.	- The students struggled with the material, but I think it was largely due to their struggles with the math and how to read graphs.
Please describe the modifications/adaptations you made.	
I created mixed ability groups and encouraged students to spread out throughout the classroom. This was especially effective for some of my ADD/ADHD students, who could spread out and move around. There were no curricular modifications or adaptations.	I created mixed ability groups.

What to do AFTER the 10-Day Portfolio Period:

1. Complete the reflection in the concluding folder at the end of your unit. This may be immediately after the 10 days, or some time after the 10 days.

2. **Upload at least two artifacts to the concluding folder**. These include end of unit tests, quizzes, or projects, AND AT LEAST one of the following: lesson plans you will review in the future, lab reports or projects, other materials that you might modify in future lessons/units.

3. Distribute and collect the student survey in your classroom to those students with signed consent forms.

4. Complete the teacher practice and teacher background surveys.

5. After completing the portfolio, we will contact you to schedule a final debriefing interview at your school. **We will collect surveys and materials at the meeting. You don't need to mail them to us.**

NEED HELP?
If you have any questions during portfolio collection, contact us at **eqis@ucla.edu**. Please leave a phone number where we can reach you and a good time to call you. A member of the research team will get back to you as soon as possible, typically within 24 hours.

Appendix E

Interview Questions

1. Please describe your teaching philosophy, especially in reference to specific sub-groups of students (e.g., special needs, emergent bilingual and gifted), as well as your understanding of differentiated curriculum, instruction, and assessment.
2. What type of teacher training (e.g., professional development) did you receive in regards to differentiation, and how might you have modified it to meet your needs better?
3. Please describe the curriculum resources that you have and would like to have in order to meet the needs of your diverse learners.
4. Please describe the planning involved in the creation of both units (lessons and assessments) for all students, the role student motivation plays in your planning, and how you accounted for requisite Science and Common Core Standards associated with the units.
5. What role does student motivation play in your instruction and assessment practices?
6. Please describe the specific tools that you use to monitor and reflect upon the efficacy of your instructional methods for students with special needs, and how the ePortfolio tool played a role in this process.
7. What challenges and successes have you found in differentiating curriculum, instruction and/or assessment during these two units, as well as across the year?

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