Improving Peer-to-Peer Learning for Students with Extensive Support Needs in Inclusive Classrooms

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Improving Peer-to-Peer Learning for Students with Extensive Support Needs in Inclusive Classrooms

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of

Doctor of Education
in
Educational Leadership: Special and Counselor Education

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Abstract

Inclusive learning opportunities lead to better outcomes for students with extensive support needs (ESN). In the absence of targeted intervention, however, students with ESN are unlikely to interact meaningfully with their peers or the general education curriculum. The literature describes evidence-based strategies in support of the meaningful inclusion of students with ESN in inclusive classrooms, including the use of technology to mediate learning experiences and nondisabled peers as learning “interventionists.” This dissertation introduces an intervention package, Technology-Assisted Peer-Mediated Academic Support (TAPMAS), incorporating Technology-Aided Instruction and Intervention (TAII) and Peer-Based Instruction and Intervention (PBII), as a model of how educators may support students with ESN in inclusive middle school science classrooms with equitable social and academic learning opportunities. This study utilized a multiple baseline across participant single case research design to determine whether a functional relationship existed between participation in TAPMAS and an increase in social interactions between four students with ESN and peer partners. Other research questions included whether participation might increase students with ESN’s identification of targeted science vocabulary and whether student and educator participants found the intervention acceptable and meaningful. Each student with ESN exhibited immediate and statistically significant increases in the number of observed occurrences of social interactions initiated. The degree participation in TAPMAS increased focus student’s identification of targeted science vocabulary was less conclusive, with one student showing improvement and the other three showing no
improvement. Results from post-study questionnaires indicated students and teachers found TAPMAS to be acceptable and meaningful.
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Chapter 1: Problem Statement

The National Council on Disability (2018) asserted “research demonstrates that inclusive education results in the best learning outcomes…” and that, “no research...supports the value of a segregated special education class and school” (p. 9). While this statement succinctly captured several decades of empirical evidence identifying the positive outcomes associated with inclusive education for students with disabilities, a conceptualized approach wherein students who experience disability receive special education supports at their local neighborhood school rather than placement in special programs or schools (Florian, 2019), the National Council on Disabilities statement is also shrouded in an awareness that some students continue to be disproportionately segregated to special education classes and schools, with minimal opportunities to interact with their nondisabled peers or opportunities to access and progress within the general education curriculum—two critical objectives laid forth in the Individuals with Disabilities Education Act (IDEA, 2004). Students who present with the most extensive support needs (ESN), an umbrella term encompassing discussion of students for whom continuous supports across multiple domains (e.g., academic and communication) are identified and to whom disability labels such as intellectual disability, autism, developmental disability, or multiple disability may be indicated (Taub et al., 2017), are often the student recipients of this disproportionality.

Informed by evaluation of data collected by the U.S. Department of Education’s (USDOE) Office of Special Education Programs (OSEP), the national trend has been toward increased rates of inclusion for all students with disabilities, with inclusion
measured as the percentage of the school day a student with disability was accessed within the general education setting as indicated by their Individualized Education Program (IEP) (Morningstar et al., 2017). Over the past decade, students with ESN have benefitted from only moderate increases in their access to the general education setting and “remain more likely to spend most of their school day in separate settings” (Morningstar et al., 2017, p. 8). Additionally problematic, there is evidence that even when students with ESN are assigned physical access to general education settings (i.e., their IEP indicates at least some percentage of time devoted to accessing general education settings), they are often not afforded appropriate learning opportunities that ensure their meaningful participation and progress in the general education curriculum (Carter et al., 2016; Roa et al., 2017). In other words, students with ESN continue to be disproportionately excluded from participation in general education settings and, even when granted opportunities to participate, are unlikely to receive appropriate support to ensure their participation is meaningful.

Problem of Practice

This study identifies a problem of practice wherein students with ESN who are assigned access to inclusive learning contexts (e.g., the student’s IEP identifies at least some access to the general education classroom) are not provided appropriate support to ensure their meaningful participation with nondisabled peers (e.g., social interactions) and opportunities to participate and progress within the general education curriculum.

This study was conducted within a school district that conceptualizes an alternative approach to the placement of students with ESN in special programs or classes
and, instead, serves students with ESN at their neighborhood school and with ample access to the general education context. This study sought to provide a model of how educators may appropriately support students with ESN with meaningful opportunities to engage with peers and the general education curriculum within inclusive settings. This research introduces an intervention package titled Technology-Assisted and Peer-Mediated Academic Support (TAPMAS), a combination of two evidence-based practices—Technology-Aided Instruction and Intervention (TAII) (Odom et al., 2015) and Peer-Based Instruction and Intervention (PBII) (Steinbrenner et al., 2020)—as a means for improving peer-to-peer learning arrangements in inclusive secondary classrooms to promote positive academic and social outcomes for middle school students with ESN.

**Background of the Problem**

In an exploration of this problem of practice, I have first situated the problem within its historical context, then described the problem within the current context of public education, including the social and academic facets involved as well as discussion of the developmental aspects pertinent to the problem. Finally, I provide validation that the problem exists through consideration of teacher perceptions, attitudes, and preparedness for supporting students with ESN in inclusive settings and critique of the predominant means of supporting students with ESN in inclusive settings: the assigning of one-to-one adult support.

Although the problem of practice is specific to the lack of appropriate support students with ESN with access to general education settings receive, I’ve elected to
include in the discussion as well students with ESN who are systematically excluded from general education settings. Each party are inextricably connected by their shared history and circumstance and, while there is ample evidence linking positive outcomes with access to inclusive general education settings for students with ESN, there remains both a lack of agreement as to what constitutes an inclusive education and whether inclusive education is even a solution to the “problem of special education” (Florian, 2019). I do not believe it is possible or appropriate to consider the plight of the student with ESN who is afforded access to the general education setting without concurrently considering the plight of the student with ESN who is not, simply because they live in a different zip code (see Brock & Schaefer, 2015). Relatedly, the problem of practice identifying shortcomings in support of students with ESN in inclusive settings has its beginnings in the exclusion of students with ESN, which has created the conditions for a wide gap between what is known to effectively support students with ESN in inclusive settings (the so-called research-to-practice gap) (Cook & Odom, 2013), uncertainty in our collective beliefs (as educators) about what students with ESN are capable of benefitting from (see Browder et al., 2008), and generalized uncertainty that we (educators) have the ability and capacity to appropriately support students with ESN in general education classrooms (Zagona et al., 2017). I’ll circle back to each of these points when substantiating the existence of the problem and its impact on students with ESN and public education broadly but offer, first, a discussion of why—beyond legal requirements—the inclusion and appropriate support of students with ESN within
inclusive general education classrooms is both imperative and adds clarity to the boundaries of the problem of practice within this research.

**Historical Context**

Poet Maya Angelou once quipped, “I have great respect for the past. If you don't know where you've come from, you don't know where you're going” (as cited in Cordova, 2014). As is likely true for every aspect of culture, this sentiment holds true in the sphere of public education, and special education in particular. It is difficult to imagine, for example, discussing the merits of the inclusion of students with significant disabilities in general education classrooms at the advent of the 20th century when students with ESN were widely excluded from education (Yell et al., 1998). Fast forward to the 1960s and 70s, and the possibility of the conversation—while still likely not yet possible in any tangible manner—was developing, with the parents of children with significant disabilities rallying against a public education system that had previously found their children to be “uneducable” (Gartner & Lipsky, 1987, p. 369) and relegated many to institutions (Blau, 2007; Rhodes, 2007).

The problem of practice identified here that students with ESN with access to general education settings are not afforded appropriate instruction and intervention to support their meaningful access to and progress within the general education curriculum, has deep roots and has existed in some form or another since at least the inception of special education law in 1975 (Public Law 94-142, later renamed the Individuals with Disabilities Education Act, or the IDEA). Since 1975, the debate in special education has predominantly been about the “what, where, and how” (Zigmond et al., 2009, p. 189) of
educating students with disabilities in public schools. And, while there have certainly been improvements regarding where students with ESN are provided educational opportunities, the debate nonetheless rages on. While not specifically the focal point of this research, the where of special education is an important foundation to considerations of the what and how of educating students with ESN because, I argue, the historical context of where students with ESN have been educated continues to influence our collective perceptions of what is possible for students with ESN, how we prepare our educators for teaching service, and how IEP teams make determinations of access and services for students with ESN. As is detailed in the next several paragraphs, the argument of where to educate students with ESN is still being debated and heavily influences what and how students with ESN are educated—regardless of where they receive education services.

**Current Context**

Early on, considerations of how best to educate students with disabilities were situated primarily around where students with ESN ought to be educated so as receive special education and related services (Sauer & Jorgensen, 2016). Prior to 1975 and passage of Public Law 94-142 (later reauthorized as the IDEA), students with ESN were historically excluded from public school or institutionalized (Gartner & Lipsky, 1987; Zettel & Ballard, 1979). Today, most students with disabilities are educated in public schools (Kurth et al., 2019). In fact, researchers have evaluated placement data provided to the federal Department of Education and found substantial increases in the amount of time most students with disabilities are experiencing within the general education
classroom (McLeskey et al., 2012; Williamson et al., 2006). McLeskey and colleagues (2012), for example, examined placement data from 1990-2008 and found a 93% increase in the amount of time spent in general education for students with high-incidence disabilities (e.g., learning disabilities, other health impairments, and emotional behavioral disorders). More recently, other researchers (see Morningstar et al., 2017) have verified that trends continue to indicate most students with disabilities have benefitted from increased access to general education settings in the past decade. Unfortunately, the same research has identified that students with more extensive learning needs (e.g., students with ESN) continue to be restricted to segregated special schools or classes. So, while not excluded from public education or (generally) institutionalized, general education settings continue to remain elusive to many students with ESN (Kurth et al., 2019).

Today, the IDEA (2004) mandates that all public-school agencies must provide students with disabilities a free and appropriate public education (FAPE) and dictates that an IEP must be developed for each student who qualifies for special education services (Yell et al., 1998). Additionally, the IDEA defines a core aspect of special education as the delivery of specially designed instruction, adapted to the needs of the student that result from their disability, “to ensure access of the child to the general curriculum, so that the child can meet the educational standards...that apply to all children” (IDEA, 2004, Section 300.39). The IDEA further stipulates that students with disabilities must, “to the maximum extent appropriate...be educated with children who are nondisabled...and [that] removal of children with disabilities from the regular educational environment occurs only if the nature or severity of the disability is such that education in
regular classes with the use of supplementary aids and services cannot be achieved satisfactorily” (§300.114). Supplementary aids and services are defined in IDEA as “aids, services, and other supports that are provided in regular education classes, other education-related settings, and in extracurricular and nonacademic settings, to enable children with disabilities to be educated with nondisabled children to the maximum extent appropriate” (§300.42) and may include supports for physical accessibility, instructional supports, social, behavioral, communication needs, and collaborative supports (Kurth et al., 2019). The mandate that students with disability be educated in the regular (i.e., general education) classroom and with nondisabled peers whenever possible is commonly referenced as the least restrictive environment (LRE) mandate.

Ironically, it is, arguably, misinterpretation of the very mandate (LRE) intended to ensure equitable access for students with disabilities that has resulted in the perpetuated segregation of students with ESN rather than increased their access to meaningful involvement in inclusive educational settings as intended by Congress (Ryndak et al., 2014). In recognition of this misinterpretation of the IDEA’s LRE mandate, some have called for a systemic shift away from thinking about where students should be educated to how they are educated (Ryndak et al., 2013), or as Jackson et al., (2008-2009) identified, a shift from just thinking about the context of where learning happens to “context plus curriculum” (p. 189). In other words, while access to general education settings is an important consideration—it is, after all, challenging to benefit from the positive outcomes associated with being present in inclusive general education
classrooms without being present in general education classrooms (Jackson et al., 2008) —, access alone is insufficient (Wehmeyer, 2006).

In summary, the IDEA clearly prioritizes access to inclusive learning opportunities (i.e., participation in the general education curriculum with nondisabled peers). The IDEA also stops short of prescribing or even describing an operational definition or road map for it, however, which has allowed for heated debate within the research community as to what constitutes inclusion (Florian, 2019) and what it means to include students with ESN (Kurth et al., 2019; Sauer & Jorgensen, 2016). Discussed throughout the body of literature regarding how best to support students with ESN are considerations that go beyond just where students will be educated, or even what and how they will be educated. A review of the literature relevant to this problem of practice and forthcoming research problem will be provided in the next chapter. In the next few paragraphs, I present arguments as to why students with ESN must be afforded access and opportunity to participate in and progress in general education settings and, for those already assigned access, why it is imperative that appropriate structures be in place within the general education setting to ensure opportunities for meaningful social interactions and in-roads to the same general education curriculum as their peers. Specifically, I will discuss social inclusion as a human right, provide an entry into discussion of how students with ESN can benefit academically from participation in inclusive learning contexts, and, pertinent to this problem of practice, provide a context as to why they are often not allowed participation or inclusion.
**Social Inclusion as a Human Right**

Social inclusion is a human right (Cobigo et al., 2012) and discussion of the current context of the problem of practice identifying that students with ESN require appropriate supports and intervention to ensure their meaningful participation in inclusive general education classrooms would be remiss without discussion of this basic human right as a preeminent contextual factor. The entirety of special education law is, after all, civil rights law and intended to improve equity (Littleton, 2020). Specifically, IDEA identifies additional goals of public education as to prepare students for future learning opportunities, independent living skills, and opportunities to be productive and involved members of their community (Sec. 300.1 (a), IDEA, 2004).

As stated previously, the IDEA has dramatically improved the quality of life for countless students over the past five decades. At the same time, it has also served to solidify many cultural conceptualizations about disability and, unintentionally, provided a platform for the institutionalized segregation of students with ESN (Sauer & Jorgensen, 2016). Considering the problem of practice identified in this research requires a return to a foundational principle of the IDEA: social inclusion is a human right that must be available to all students.

Specific to the problem of practice within this work, which focuses on supporting secondary (e.g., middle school) students with ESN, another significant factor comes into play: social inclusion is also a developmentally critical aspect of adolescence and human development (Caskey & Anfara, 2007). Even as the IDEA has served to frame how public education conceptualizes disability, disability does not preclude development...
(Kliwer et al., 2006). Considered another way, the needs of the developing human are not concerned by an IEP team’s decision that a student with ESN will best access education in a setting separate from their typically developing peers. Rather, the developing human, particularly the developing adolescent, seeks connection with their peer group. The presence of disability does not change this basic human need. The needs of the developing human with ESN will, however, be deeply impacted by what the IEP team determines as the student’s LRE, and the supplementary aids and services identified to support the student with meaningful participation in the general education classroom.

As students age and develop, participation and interaction with peers plays a critical role in how they experience education. As students grow and mature, the complexity of peer interactions matures as well (Carter & Hughes, 2005) and the relative significance of peer interactions intensifies (Hartup & Stevens, 1997). At the same time, it is well understood that students with ESN often struggle with social skills and connecting with and interacting with peers (Carter & Hughes, 2005; Myles et al., 1993). In the absence of intentional instructional structures to ensure meaningful social participation in the general education curriculum, students with ESN are at risk for social isolation from peers (Clarke & Kirton, 2003; Cooper et al., 2009) and experience fewer opportunities to participate in positive social interactions with their nondisabled peers and general education teachers (Harjusola-Webb et al., 2012). Ironically, that students with ESN require intentional structures in order to benefit from access to general education settings is often used as evidence that the general education setting is not appropriate for
the student and that they would be better served in a more homogenous setting (e.g., with other students who present similarly) (Sauer & Jorgensen, 2016).

If the spirit of the IDEA’s intention that students with ESN be provided supplementary aides and services, which may include instructional supports aimed at bolstering the social, behavioral, communicative, and collaborative involvement of students with disabilities (Kurth et al., 2019), is to be met, educators must embrace evidence-based interventions that intentionally support meaningful participation. One such means of doing so, and an intervention discussed extensively in this document and critical to the design of this study, is through the use of PBII.

**Presuming Competence and Academic Inclusion**

Beyond trends in where and how students with ESN receive educational services, there is evidence that all students benefit from access to general education and access to highly qualified general education teachers (Mason-Williams et al., 2017), rigorous general education curriculum standards (Bacon et al., 2016), and the tendency for higher expectations that come with involvement in the general education setting (Kurth & Mastergeorge, 2010). While not on par with determining students “uneducable” (Gartner & Lipsky, 1987, p. 369) as in the days of PARC v. Commonwealth of Pennsylvania (1972), there remains disagreement today as to the degree to which students with ESN can benefit from the general education curriculum. Even as the IDEA pushes IEP teams to consider all available resources (e.g., supplementary aids and services, such as instructional supports, social, behavioral, communication needs, and collaborative
supports), supporting students with ESN with academic progress in the general curriculum can present additional challenges beyond social inclusion.

In support of students with ESN, educators may struggle with how to provide access to the general education curriculum, and the challenges only increase as students' progress into middle and high school and the curriculum becomes more challenging (Carter, 2018). As evidence, IEP goals for students with ESN have been found to tend to focus on the core symptoms of the disability rather than on participation and involvement in the general education curriculum, noting the divide only increases as students enter middle and high school (Kurth & Mastergeorge, 2010). Relatedly, when adolescent (e.g., middle school) students with ESN are provided experiences in general education, experiences are often cursory and focused on nonacademic involvement, such as recess, lunch, and physical education (Rao et al., 2017). Others have found evidence of the IEP commonly being presented as if it were an alternate, stand-alone curriculum unto itself, with limited connection to the general education curriculum (Kurth et al., 2019) and, in some instances, IEP goals for middle school students tied to grade-level standards for much younger children (e.g., kindergarten through fourth-grade standards) (Kurth & Mastergeorge, 2010). This limited focus on general education content may be based on assumptions that students with ESN may not benefit from the general education curriculum (Greenspan & Wieder, 2006).

This can create the conditions for a sort of circular justification for the segregation of some students (Jackson et al., 2008-2009; Sauer & Jorgensen, 2016): the student lacks access to appropriate supplementary aids and services (e.g., instructional, social,
behavioral, communicative, and collaborative supports, such as found in evidenced-based practices like PBII and TAII) that could provide for meaningful participation in and progress in the general curriculum, which prompts IEP teams to develop goals overly-focused on characteristics of the disability (Kurth & Mastergeorge, 2010), which may then be used as justification as to why the student requires a more restrictive environment and the alleged benefits of segregated instruction (Heller et al., 1982). Why can’t the student with ESN benefit from the general education curriculum? Because the IEP team could not identify supplementary aids and services to provide access and participation. Why could the IEP team not identify appropriate supplementary aids and services? Because, this circular reasoning offers, of the student’s disability.

Donnellan (1984) stated that the “least dangerous assumption” (p. 148) is to assume students are capable of learning and identified this assumption as most likely to lead to higher expectations. Jorgensen (2005) similarly proposed that the least dangerous assumption is to presume a student is competent to learn general education curriculum and to design educational programs and supports based on that assumption. Beyond assumptions, there is ample evidence students with ESN can learn a variety of academic content reflected in the general education curriculum (Browder et al., 2008; Browder et al., 2006) and demonstrate improved academic achievement by participation in inclusive programs (Kurth & Mastergeorge, 2010; Sermier Dessemontet et al., 2019).

While a key argument throughout this research is that access alone is not enough, it is, nonetheless, of critical importance to ensuring students with ESN are able to participate and progress within the general education context and curriculum (Kleinert et
al., 2015). The context in which students with ESN are most likely to gain access to the general education curriculum is, after all, within the general education classroom (Jackson et al., 2008). Even more preferable to just accessing context is “context plus curriculum” (Jackson et al., 2008-2009, p. 189).

Validation the Problem Exists

To validate this problem of practice, I offer three points to consider: (1) the number of students impacted is significant, (2) both special and general educators report feeling ill-prepared to support students with ESN within general education settings, and (3) the prevailing means of supporting students with ESN, assigning adults to work one-on-one alongside, is neither supported by the research as an effective practice nor developmentally appropriate for secondary (e.g., middle and high school) students with ESN.

Number of Students with ESN. Data from the U.S. Department of Education (USDOE) indicates approximately 1-2% of students who qualify for special education services are considered to have ESN (Kurth et al., 2019). According to the USDOE’s reported 7.2 million students received special education services in 2021 (National Center for Education Statistics, 2022), which by my calculations results in a range of between 72,000 and 144,000 students nationally who may be subjected to disproportionality of access and participation, either because they are wholistically excluded from access to general education settings or, specific to the problem of practice identified here, they are assigned access but do not receive appropriate support to ensure their meaningful participation and progress within the general education curriculum.
**Educator Preparedness.** General education teachers often express feeling ill-prepared and with limited preparedness to effectively support students with ESN in their classrooms (Hutzler et al., 2019; Peebles & Mendaglio, 2014; Zagona et al., 2017) and report a diminished sense of teacher efficacy and higher rates of burnout related to supporting inclusive educational settings (Boujut et al., 2017). Some special educators, likewise, have reported low preparedness to work with students with ESN (Ruppar et al., 2018). On Fowler and colleagues (2019) recent large-scale survey, “The State of the Special Education Survey Report,” which reported the perceptions of over 1,000 educators, only 8% of special educators identified their general education colleagues as prepared to work with students with exceptionalities to meet IEP goals. Also impactful to the problem of appropriately supporting students with ESN in inclusive classrooms—given that special educators are typically tasked with implementing student-specific interventions in general education classrooms (Lamar-Dukes & Dukes, 2005)—, 31% of special educator respondents to the same survey reported they, too, felt ill-prepared.

**Lack of Resources and Capacity.** Special education and general education teachers often lack the resources and capacity to develop individualized instruction and intervention for students with ESN, which may lead to a bias against the appropriateness or feasibility of supporting students with ESN in inclusive settings (Agran et al., 2020).

Unfortunately, resource and capacity limitations are not a new phenomenon in public education and, since the 1950s, schools have turned to paraprofessionals as a means of providing educational support in schools (Jones & Bender, 1993). One common way in which educators have attempted to fill the resource and capacity void related to
providing access to the general education setting for students with ESN is by assigning paraprofessionals as one-to-one supports for students with ESN in inclusive settings—a practice that has sounded caution from some researchers (Carter et al., 2016). As Brock and Anderson (2021) discussed, the number of paraprofessionals employed in the U.S. is now larger than the total number of special education teachers. According to the U.S. Department of Education (2019) more than 433,000 full-time special education paraprofessionals are currently employed working with students ages 6-21. Notably, most paraprofessionals are working one-to-one with students with disabilities at least weekly (Chan et al., 2009). While challenging to report exactly which students these paraprofessionals are regularly working with, it seems safe to assume that a chunk of this time is devoted in support of students with ESN.

Paraprofessionals play a critically important role in education, especially in support of students with disabilities (Brock & Anderson, 2021), yet are typically not provided prerequisite training and their ongoing supervision and involvement with educational teams can be limited (Biggs et al., 2019; Fisher & Pleasants, 2012). Perhaps in part to this limited preparedness, when paraprofessionals are assigned as the primary or exclusive source of assistance to students with ESN—a practice Giangreco identified as “ubiquitous” over a decade ago (2010, p. 2)—they may inadvertently hinder the very social and academic gains they are present to promote. Others have similarly highlighted that the close proximity of adults can have the effect of suppressing adolescent interactions (Carter et al., 2016) and, as discussed in greater detail in Chapter 2, assigning an adult to work directly with an adolescent student may not be developmentally
appropriate. Interestingly, Walker et al.’s, (2021) systematic review of the effectiveness of paraprofessional-delivered interventions reported improved outcomes for students with ESN in inclusive settings when paraprofessionals were provided appropriate support and particularly when the support focused on social and communication interactions with peers without disabilities in the inclusive setting.

Finally, the prevailing practice of assigning adults (e.g., paraprofessionals) as the primary means of intervention for supporting students with ESN in inclusive settings—while already potentially problematic—is likely an unsustainable practice as teaching and support staff shortages are at a crisis level and remain one of the hardest hit sectors of employment post the COVID pandemic (Cooper & Hickey, 2022). With a predicted special education teacher turnover rate 46% higher than other teachers (Carver-Bailey & Darling-Hammond, 2017), coupled with shortages across the sector of public education, one might predict continuing or exacerbated challenges with relying on assigning adults to students with ESN in inclusive settings.

In conclusion, while inclusion in general education contexts, rich in opportunities for socially-constructed meaning-making and social connections (McDonnell et al., 2002), affords a “qualitatively different” experience than the segregated settings many students with ESN are placed into (Kurth et al., 2014, p. 5), access to and placement within general education classrooms alone is not enough to ensure students with ESN are able to meaningfully participate with their nondisabled peers or gain appropriate access to the general education curriculum. The combination of educators reporting feeling ill-prepared to support students with ESN in general education classrooms coupled with
evidence of a prevailing practice of assigning adults (e.g., paraprofessionals) to students with ESN points to a gap between what is known to be effective and what is practiced—a phenomena known as the research-to-practice gap (Carnine, 1997). Further exacerbating the challenge of appropriately supporting students with ESN with meaningful opportunities to participate in the general education setting and progress in the general education curriculum, public education (and special education in particular) is experiencing a staffing crisis—both in enticing individuals willing to work in special education and also in retaining current staff. If public education is to truly meet the spirit of the LRE mandate and provide the promise embodied within the research supportive of inclusive education for students with ESN it is imperative that educators be equipped with the resources, tools, and knowledge to ensure meaningful participation and access to general education curriculum for all students.

Statement of the Research Problem

Educators require strategies for engaging all learners in the general education classroom if the true spirit of the IDEA is to be realized and students with ESN are to be provided appropriate instructional opportunities within inclusive classrooms. Interventions capitalizing on resources already available to educators, such as access to natural peer supports (e.g., typically developing peers in general education classes) and now ubiquitous access to technology (Hamilton & Hattie, 2020), are necessary to affect positive change within inclusive classrooms and to improve teaching strategies that better ensure appropriate and meaningful learning experiences for students with ESN. The TAPMAS intervention presents one such way to overcome educators’ lack of confidence
and skill to support students with ESN in their inclusive classrooms. The research problem posed in this work identifies a research-to-practice gap (Carnine, 1997) between what is known to be supportive to students with ESN in inclusive settings and what is commonly practiced. Specifically, this research problem is based on three observations as identified from the background of the problem: (1) While students with ESN have experienced increased access to general education contexts in recent years, students with ESN require intentional and targeted support to meaningfully participate in and progress within the general education curriculum, (2) assigning adults to work directly beside students with ESN is often developmentally inappropriate, lacks empirical evidence as likely to lead to positive outcomes, and requires an often-untenable level of special education staff, and (3) educators require models and instruction for how to implement evidenced-based practices in support of students with ESN in inclusive settings and which they report are replicable and have high social validity.

From these observations, the research problem this research seeks to answer is whether an intervention package combining aspects of two evidenced-based practices—Technology-Aided Instruction and Intervention (TAII) (Odom et al., 2015) and Peer-Based Instruction and Intervention (PBII) (Steinbrenner et al., 2020)—can be implemented within inclusive classrooms to improve peer-to-peer learning arrangements to promote positive academic and social outcomes for secondary school students with ESN and which teacher participants find acceptable and socially valid.
Significance of the Research Problem

The significance of the research problem posed is conceptualized in a couple of ways. First, the research problem is significant in that it proposes a means to ensuring students with ESN are provided meaningful access to the general education curriculum and structured opportunities for social interactions with peers. These objectives are both developmentally appropriate (discussed in greater detail in the next chapter of this work) and legally required within the IDEA. As students with ESN conclude their journey through public education and, relatedly, special education, the purpose of special education shifts to focus on the transition from public school to adulthood. Section 300.43 of the IDEA (IDEA, 2004) identifies IEP teams must, for all students 16 and older and receiving special education services (or earlier if the IEP team determines it is appropriate to do so), identify measurable post-secondary goals in the areas of employability, further educational opportunities, and, when appropriate to the student, independent living. Similar to Jackson et al.’s (2008) assertion that the context in which students with ESN gain access to the general education curriculum is by being in the general education classroom, the significance of the research problem posed here is here identifies that the context necessary to prepare students for future educational opportunities, employability, and independent living is by ensuring their meaningful access to and participation in general education and with scaffolded support to ensure students with ESN have meaningful access to the general education curriculum and scaffolded support to interact with and learn with their peers.
This research problem is also significant in that it proposes a means for educators to support students with ESN with access to the general education curriculum and social interactions with their peers in a way that employs resources and technology readily available within inclusive learning communities, specifically the evidenced-based practices of Technology-Aided Instruction and Intervention (TAII) (Odom et al., 2015) and Peer-Based Instruction and Intervention (PBII) (Steinbrenner et al., 2020). It is proposed that introducing an intervention package incorporating both TAI and PBII may also effectively increase staffing capacity by offering an alternative to the practice of assigning adults as the primary intervention for students with ESN enrolled in general education classes.

The advantages PBII offer over adult-mediated instruction include a more favorable teacher-student ratio that provides ongoing corrective feedback and practice often not available to students with disabilities in general education classrooms (Utley, 1997) and increased opportunity for students with disabilities to generalize social and academic skills by interacting with and within a range of individuals and settings (Chan et al., 2009). While the abundance of peers available in classrooms is appealing on its own merit, peer-to-peer interactions are often considered more authentic and relatable than that of teacher-to-student supports (Havnes, 2008), providing an opportunity to learn in a “naturalistic setting” (McConnell, 2002, p. 367). This may be particularly true for middle school students as they navigate social development and a natural desire to belong to a peer group and gain peer approval (Caskey & Anfara, 2007).
Similarly, TAIIs are considered particularly supportive to students with ESN in that they can be structured and presented to limit distractions from extraneous sensory stimuli, to provide consistent and predictable responses, and to offer clearly defined tasks (Tseng et al., 2020). As Hamilton and Hattie (2020) reported in their meta-analysis of the research relating to the use of technology as instructional/intervention tool, TAIIs have shown to be especially effective at supporting students who have special learning needs, with the largest effect sizes observed when technology was used as video review of traditional lessons, when interactive video was used to supplement learning, and when technology was used in support of students with unique learning needs. Each of these areas notably align well with the intervention proposed in this research.

**Presentation of the Methods and Research Questions**

The following research questions guided this study:

1. Is there a functional relationship between implementation of Technology-Assisted and Peer-Mediated Academic Support package (TAPMAS) delivered within inclusive middle school classrooms and increased social interactions initiated by middle school students with ESN to their nondisabled peers?

2. Does implementation of TAPMAS lead to residual carry-over in occurrences of social interactions in the general education classroom for students with ESN post-intervention?

3. Does implementation of TAPMAS intervention lead to an increased use of instructed academic language for students with ESN?

4. Do teachers and students find the methods of this research acceptable and usable?
These research questions will be investigated using a multiple baseline (MB) across participants single-case research design (SCRD), wherein the participants performance between baseline and intervention will be compared to determine if a functional (i.e., causal) relationship exists between the independent variable (implementation of the TAPMAS intervention package to middle school students in inclusive science classrooms) and dependent outcome variables (social interactions between students with ESN and nondisabled peers and academic use of instructed science vocabulary by students with ESN). Further details relating to the methods of this research will be discussed in Chapter 3.

Definition of Key Concepts

In this subsection, I identify key terms relevant to the research problem posed in this work. These terms include students with extensive support needs (ESN), Technology-Aided Instruction and Intervention (TAII), Peer-Based Instruction and Intervention (PBII), and multiple baseline (MB) across participant single case research design (SCRD).

Peer-Based Instruction and Intervention (PBII)

Throughout the literature, there are a number of similar titles and definitions used to describe the assigning of peers (e.g., classmates) to act as interventionists (Chan et al., 2009) to implement instructional programs, behavioral interventions, or facilitate social interactions (Brock et al., 2016; Carter & Kennedy, 2006; Garrison-Harrell et al., 1997; Laushey & Heflin, 2000), including terms such as peer-mediated instruction (see Carter et al., 2016), peer support arrangements (see Brock et al., 2016), peer-mediated
instruction and intervention (see Utley, 1997), and peer-assisted learning (see Fuchs & Fuchs, 2005). For clarity, the umbrella definition provided by The National Clearinghouse on Autism Evidence and Practice (NCAEP) Review Team (Steinbrenner et al., 2020) was used in this work. The NCAEP identified Peer-Based Instruction and Intervention (PBII) as an evidenced-based practice and provided the following definition:

Intervention in which peers directly promote autistic children’s social interactions and/or other individual learning goals, or the teacher/other adult organizes the social context (e.g., play groups, social network groups, recess) and when necessary, provides support (e.g., prompts, reinforcement) to the autistic children and their peer to engage in social interactions. (p. 29)

In PBII arrangements, peers take on responsibilities such as modeling expected behaviors, implementing prompting procedures, and reinforcing target behaviors (Chan et al., 2009). As will be discussed in greater detail later in this work, learning is inherently a social endeavor and PBII can afford an effective means of supporting students with disabilities with opportunities to meaningfully connect with their peers, both socially and academically (Carter et al., 2016). Beyond social gains, research on PBII has additionally noted increased academic engagement (Carter et al., 2008) and increased academic proficiencies (Jimenez et al., 2012; Utley, 1997).

**Technology-Aided Instruction and Intervention (TAII)**

Like discussion of PBII, Technology-Aided Instruction and Intervention (TAII) is referenced in the literature under a variety of titles and may also be identified as
computer-mediated instruction, instructional technology, or computer-based instruction (Snyder & Huber, 2019). For clarity, the definition provided by The National Clearinghouse on Autism Evidence and Practice (NCAEP) Review Team (Steinbrenner et al., 2020) is used in this work as an umbrella for the varieties of ways in which technology has been employed in support of students with ESN. The NCAEP identified Peer-Based Instruction and Intervention (PBII) as an evidenced-based practice and provided the following definition:

Instruction or intervention in which technology is the central feature and the technology is specifically designed or employed to support the learning or performance of a behavior or skill for the learner. (p. 29)

From this working definition, TAII learning is conceptualized for the purpose of this research as an alternative to face-to-face learning that uses technology to present learning materials and create interactive environments that allow students to learn flexibly at their preferred pace and time (Hu et al., 2007; Pennington, 2010).

**Multiple Baseline (MB) Across Participants Single-Case Research Design (SCRD)**

The research questions were investigated via a multiple baseline (MB) across participants single case research design (SCRD). Single case research design is an experimental research approach wherein outcome variables are measured prior to an intervention and compared with measurements taken during and after the intervention (Kratochwill et al., 2010). Experimental, rather than correlational or descriptive, the intended rationale of SCRD is to document causal (i.e., functional) relationships between a researcher-manipulated independent variable (i.e., an intervention) and change in a
dependent (i.e., outcome) variable (Horner et al., 2005; Horner & Spaulding, 2010; Levin et al., 2003). By design, the participant’s, which may include a single subject (or case) but typically includes anywhere from 3 to 8 participants (Horner et al., 2005), performance serves as the baseline for which their performance post intervention can then be compared and functional relationships between independent and dependent variables can then be determined (Kratochwill et al., 2010; Kratochwill et al., 2021; Kratochwill & Levin, 2014; Ledford & Gast, 2018; Ledford et al., 2022). The goal of SCRD is to determine if an intervention is more effective than the current baseline or “business-as-usual” (Kratochwill et al., 2010, p. 3) condition, for whom the intervention was effective (for whom a functional relationship between the independent and dependent variable was observed), and the specific conditions under which a functional relationship was observed (Horner et al., 2005; Kratochwill et al., 2010; Kratochwill & Levin, 2014; Ledford & Gast, 2018). Within this design, baseline serves as the foundation wherein behavior is measured repeatedly across adjacent conditions (phases): baseline (A) and intervention (B) (Ledford & Gast, 2018). Each phase transition from A to B is an opportunity for the researcher to observe the effects of the treatment and replicating treatment across several participants concurrently allows the researcher to quickly assess treatment effectiveness (Morgan & Morgan, 2008).

For decades, SCRD methods have been employed within special education (Ledford & Gast, 2018; Ledford et al., 2022; Moeller et al., 2015) and are increasingly accepted as a valid experimental approach (Ledford et al., 2022). SCRDs are often selected for research within special education because this methodology permits the study
of a small number of participants serving as their own control (Kennedy, 2005) and may be particularly appropriate for studying participants who present with low prevalence disorders and for whom other traditional group designs, such as randomized control trials requiring a large number of participants for adequate statistical power, may not be appropriate (Odom et al., 2005).

**Students with Extensive Support Needs (ESN)**

Students with extensive support needs (ESN) are students for whom ongoing pervasive supports are identified across academic and daily living domains, and to whom disability labels such as intellectual disability, autism, developmental disability, or multiple disability may be indicated (Taub et al., 2017). Students with ESN may participate in Alternative Assessments Based on Alternate Achievement Standards (AA-AAS) (Taub et al., 2017). Students with ESN have historically been referred to as the 1% of students with severe or profound disabilities (Kennedy & Horn, 2004). In Oregon, students with the most significant cognitive disabilities are likely to take the Oregon Extended Assessment (or ORExt) (Oregon Department of Education, 2021).

**Summary of Chapter 1**

This chapter identified a problem of practice wherein students with extensive support needs (ESN) placed in inclusive general education settings are not provided appropriate intervention supports ensuring equitable participation with nondisabled peers and opportunities to progress in the general education curriculum. National trends in the placement of students with ESN in more inclusive environments were presented. Previous research, including national trends in the over application of paraprofessional
assignment to students with ESN in general education classrooms—and the unintended negative consequences of such action—, as well as research identifying students with ESN are unlikely to engage with nondisabled peers (Chung et al., 2012) or engage in robust academic work (Rao et al., 2017) in general education settings without intentional intervention were provided as validation this problem exists.

The purpose of this study was presented as an example for educators of how the combination of two evidence-based interventions, Peer-Based Instruction and Intervention (PBII) and Technology-Aided Instruction and Intervention (TAII) might be employed as an appropriate social and academic intervention for application within general education classrooms for students with ESN. An intervention package called TAPMAS (Technology-Assisted and Peer-Mediated Academic Support), was introduced and presented as a means of providing students with ESN equitable and appropriate opportunities to interact with nondisabled peers and make progress within the general education curriculum. Chapter 1 concluded with key definitions of the concepts associated with the proposed study. Next, Chapter 2 presents a theoretical framework, a review of the research literature, and finally, a summary of the methodological literature related.
Chapter 2: Literature Review

The research questions posed in this study guided the investigation of the effects of an intervention package, TAPMAS, combining Technology-Aided Instruction and Intervention (TAII) learning and Peer-Based Instruction and Intervention (PBII), and the degree to which participation in the intervention lead to increased social interactions, increased use of taught science vocabulary, and the acceptability and usability of the intervention by participants. Inherent to these research questions are the belief that peer interactions are important (to all students and specifically to students with ESN) and that students with ESN benefit both socially and academically from opportunities to learn alongside their peers.

In this chapter, I present the theoretical frameworks employed in my conceptualization of the problem of practice and, relatedly, in how I investigated the research problems identified. I begin this chapter with a discussion of the developmental distinctiveness common to middle school-aged students, and specifically as this pertains to social and academic growth during this period of development and the complexity of development when disability is present. I will then discuss the theoretical foundations of social constructivism and Social Learning Theory (Bandura, 1977, 1986, 2005), through which this research study was considered before moving into the conceptual instructional framework of Universal Design for Learning (UDL) (CAST, 2011), which is central to the inclusive nature on which this proposed research is built. After each section, I will discuss how aspects of the framework fit within my research and then offer a critique of the framework. I conclude this chapter with a synthesis of the literature review specific to
these frameworks and their relevance to my research and a literature review of the methodology employed in this research study and which will be discussed at greater length in Chapter 3.

**Developmental Perspective**

Humans are constantly developing and changing throughout the lifespan (Bronfenbrenner, 1977). While not technically a theoretical framework, it is important to consider the developmental perspective of any framework employed in regard to human behavior with an understanding that developmental needs, and therefore behavior, change over time. Middle school delineates a unique period of human development. Developmental psychologists define early adolescence as the stage of the life cycle representative of 10- to 15-year-olds, the age range typical of middle school students, as a period of human growth and development marked by distinct characteristics regarding physical, cognitive, moral, psychological, and social-emotional development (Caskey & Anfara, 2007). During this period of development, peer relationships assume an increasingly important role in the lives of youths (Hillman, 1991), with social development marked by a strong desire to belong to a group and to gain peer approval (Caskey & Anfara, 2007). This distinction is important to the research proposed here and the theoretical frameworks through which the problem of practice and this research are viewed in that middle school students may be particularly vulnerable to the effects of PBII and, conversely, adult-driven intervention. As discussed in Chapter 1, the presence of adults can stifle adolescent interactions (Carter et al., 2016) and assigning adults to support students with ESN can have the effect of decreasing social interactions and
academic inclusion (Giangreco, 2010). Interventions designed to support peer interactions for students of this age must include careful consideration of the developmental imperative students have to connect with one another. Social Learning Theory (Bandura, 1977), discussed as a key theoretical framework in the next subsection of this paper, identifies the relationship between the individual and their environment as critical to the learning process. It is important to consider the environmental impact of adult- vs peer-driven intervention for students of this age.

While considerable diversity exists among adolescents also categorized as having ESN, substantial limitations in social interactions are a prevalent consideration (Carter & Hughes, 2005); in the absence of intentional supports, students with ESN are at risk for social isolation from peers (Clarke & Kirton, 2003; Cooper et al., 2009) even when physically in the same room (Chung et al., 2012). As students enter adolescence, the complexity of peer interactions intensifies, requiring adolescents to perform skills related to establishing and sustaining reciprocal relationships, adjusting to the communication needs of others, using inferential and figurative language, and monitoring their own social behavior (Carter & Hughes, 2005). As adolescents grow and age, they spend more of their time with peers, intensifying the influence of peer interactions on adolescent development (Hartup & Stevens, 1997). There is evidence that adolescents with disabilities follow this same developmental trajectory and likewise benefit from the same peer interaction opportunities (Carter & Hughes, 2005). Importantly, interactions with peers contribute not only to social development but also academic growth (Carter & Hughes, 2005).
The presence of disability can add complexity to an already multifaceted period of development, so much so that in some instances the disability may become “an idea that precludes the possibility of human development…” (Kliwer et al., 2006, p. 175).

Historically, the fact that students with ESN may struggle to adapt to changing contexts and expectations has been used as evidence of the need to segregate students from general education (see *PARC v. Commonwealth of Pennsylvania*). With the best of intentions—and in the absence of well-planned support and interventions for students with ESN—educator’s attempts to bolster the student against disability may unintentionally neglect the developmental imperative of peer interactions and connections to detrimental social and academic ends.

**Theoretical Framework**

In this section I will discuss the theoretical frameworks that serve as the foundation for the research study: social constructivism and Social Learning Theory. I then introduce an instructional conceptual model called Universal Design for Learning (UDL). I discuss how the theoretical models inform the conceptual model, and then discuss how the components of this research study, TAI and PBII, fit within UDL. In Figure 1, I provide a visual representation of how these frameworks work together in this study. For each section, I discuss implications relevant to my study as well as critique and opposing viewpoints.

Next, I provide a relevant review of these components as they relate to my research study and discuss how these are appropriate intervention components for use in support of students with ESN. Finally, I share a review of the methodological research
relevant to the methods proposed in consideration of my research questions: MB across participants.

**Figure 1**

*Concept Map of Theoretical Framework*
Social Constructivism

Viewed through a lens of social constructivism, all learning and understanding are inherently socially mediated (Committee on How People Learn II, 2018; Palincsar, 1998). In other words, learning is participation in social interaction with others (Havnes, 2008). Social constructivism emphasizes the role of social interaction, the use of cultural tools (e.g., language and language related symbols), and history in children’s development.

Contrasting earlier behaviorist interpretations of learning developed in the first half of the 20th century which focused on external stimuli and behavioral responses to them (Reimann, 2018), social constructivism highlighted that “learning does not occur in a social vacuum” (Maynard & Martini, 2005, p. 3) and stressed that the social context of learning plays a significant role in the individual’s experience and subsequent learning.

As can be viewed in Figure 1, this study draws upon social constructivism’s central focus that learning is socially mediated and constructed and carries this theme forward into Social Learning Theory (Bandura, 1977).

Implications of Social Constructivism. Important to the research proposed in this work, the incorporation of peers as instructional intervention (e.g., PBIs) has emerged largely separate from behaviorist teachings, with strong roots in developmental research and naturalistic frameworks (Strain & Odom, 1986) such as constructivism.

A major contribution of social constructivism is the view that learners are not passive, and that effective learning occurs when the learner is actively involved in the construction of knowledge (Chalmers & Hunt, 2013). Each of these contributions are
important to discussion of Universal Design for Learning (UDL) discussed later in this chapter. Social constructivism’s emphasis on learning as a socially situated endeavor is further reflected in some aspects of Social Learning Theory, as discussed in the following section.

**Critique of Social Constructivism.** As discussed, social constructivism emerged largely as a critique of earlier behaviorist theories and tends to downplay the significance of behaviorist interpretations and intervention strategies (Chalmers & Hunt, 2013; von Glaserfeld, 1997). A critique of social constructivism is its tendency toward extreme relativism and over-reliance on defining behavior (and, subsequently, learning) as entirely socially predicated (Chinn, 1998). At its extreme, social constructivism values meaning and knowledge as it relates to social consensus, rather than on objective and measurable reality (Solomon et al., 1996). As a teaching method, some have argued that social constructivism appears to be unguided, and overly relies on student meaning-making rather than objective truths (Chalmers & Hunt, 2013).

An extreme social constructivist stance is problematic to the methodology of this study. I have nonetheless included it here for two reasons: First, PBIs developed largely from within the naturalistic methods common to the constructivist paradigm (Strain & Odom, 1986) and, second, social constructivism’s strength is that it provides a clear delineation of learning as socially mediated and constructed. In this way, social constructivism bolsters the relative value of interventions such as PBIs for students with ESN.
In the next section, I discuss Social Learning Theory (Bandura, 1977), which also developed as a response to behaviorist principles, also situates learning as a social endeavor (albeit in a different way), but which is far less relativistic in its stance.

**Social Learning Theory**

Social constructivism developed as a critique of behaviorist theory and psychoanalysis (Falk & Kim, 2019). Extreme behaviorism determined learning to be entirely the result of an individual’s response to environmental influences (i.e., stimuli) and extreme psychoanalysis determined learning as driven exclusively by the forces within the individual’s (e.g., thoughts and desires) (Falk & Kim, 2019). As a response, Social Learning Theory frames learning as the triangular interplay between the individual’s behavior, personal factors (e.g., cognitive functioning, motivation), and environmental challenges (Lo Schiavo et al., 2019). As viewed from Social Learning Theory, a person’s behavior both influences and is influenced by personal factors, as well as the social environment in which the individual is functioning. Learning, therefore, is socially mediated and, at the same time, influenced by factors both innate to the individual and environmental factors external to the individual.

In contrast to social constructivism however, Social Learning Theory is the study of how people acquire new behavior and so is behaviorists in that sense (Brown, 2020). As identified by Bandura (1977), the backbone of Social Learning Theory is that learning occurs predominantly when individuals observe and imitate the behavior of people around them. So, while partially informed by social constructivism, Social
Learning Theory serves as the predominant theoretical framework for understanding and observing the behavioral act of learning key to the research proposed here.

**Implications of Social Learning Theory.** This research study is centered around supporting students who present with unique cognitive and social communication skills. As identified earlier in this paper, students with ESN are noted to require ongoing pervasive support across academic and daily living domains (Taub et al., 2017) and often experience limitations in social skills (Carter & Hughes, 2005; Myles et al., 1993). Social Learning Theory acknowledges individual differences (e.g., cognitive skills, communication skills) and provides a framework for conceptualizing how the learner is impacted by their specific environmental context (and vice versa).

In Chapter 1, I discussed the long-standing debate in special education about “what, where, and how” students with disabilities ought to be educated (Zigmond et al., 2009, p. 189). Application of Social Learning Theory is important to this debate and to the rationale for this research study for several reasons. First, who students with ESN spend their time with and the activities in which they engage form the basis for the relationships they establish (Jackson et al., 2008). As stated, a key component of Social Learning Theory is that humans learn by watching and emulating those around them (Bandura, 1977). As shared in Chapter 1, general education provides a “qualitatively different” experience than segregated, special classrooms for students with ESN (Kurth et al., 2014, p. 5), in large part because of who students with ESN have access to watch and emulate. Who students spend time with at school can also create a triadic relationship between the student with ESN, their nondisabled peers, and the instructional
opportunities they are able to access. Ruppar et al., (2018), for example, observed literacy instruction at the high school level and found that students with significant intellectual disabilities were 10 times more likely to be exposed to academic literacy when peers without disabilities were present.

Who students spend their time with and the activities they engage in also impact their beliefs in their ability to influence events that affect their lives, a concept Bandura defined as self-efficacy (Bandura, 1997). Through the process of interacting with their environment, individuals develop an “interpretive framework” that “establishes their view of the world, the self, and the self’s place in the world” (Elliot et al., 2001, p. 505). Notably, self-efficacy can be influenced by perceptions of issues beyond the control of the individual (Bandura, 2005). In Chapter 1, I discussed the prevailing trend of adults being assigned to work one-on-one with students with ESN (Carter et al., 2009; Carter et al., 2016). Social Learning Theory can be applied to explore the impact on the student’s self-efficacy when they are working with an assigned adult versus when they are partnered with a peer. In line with this statement, researchers have noted that students consistently indicate a preference for peer-teaching practices over more traditional instructional arrangements (i.e., teacher-led) (Maheady et al., 2001).

The implications related to who students with ESN spend their time with at school and the activities they engage in are of critical importance and form the basis for this research study’s design. This study seeks to provide evidence on how the use of technology can improve peer-to-peer learning arrangements in inclusive classrooms to promote positive academic and social outcomes for middle school students with ESN.
The rationale for including students in the general education context is solidly rooted in the theoretical underpinning that students with ESN benefit from structured opportunities to observe and imitate the learning behaviors of their nondisabled peers.

**Critique of Social Learning Theory.** As further part of the debate around the “where, what, and how” of special education (Zigmond et al., 2009, p. 189), some have argued that students with ESN do not benefit enough from involvement in general education and ought to be educated in segregated, special education classrooms or programs (see Kurth et al., 2014). Such arguments are typically based on the alleged benefits of smaller class sizes, instruction provided at the student’s individual level, instruction focused on the student’s functional level (see Ayres et al., 2011) and the belief that segregation shields the student from damage to their self-esteem (Heller et al., 1982). Notwithstanding the body of evidence that students with ESN experience better outcomes when taught in general education contexts than those taught in separate settings (Kurth et al., 2019), such arguments appear to critique Social Learning Theory by valuating adult-driven interventions as more valuable.

In line with the growing body of evidence in support of inclusive educational practices, it is the position of this research study that students with ESN benefit more from opportunities to partner with, observe, and imitate their nondisabled peers.

**Universal Design for Learning (UDL)**

As visually represented in Figure 1, Universal Design for Learning, or UDL, a framework put forth by the Center for Applied Special Technology (CAST, 2011) is situated below the theoretical frameworks of social constructivism and Social Learning
Theory and serves as the conceptual model for the intervention proposed in this research study. There is considerable alignment between UDL, social constructivism, and Social Learning Theory; most evident, each is built from the premise of learner variability and the social nature of learning (Fovet, 2020). As an instructional framework, UDL can be used for designing “flexible instructional environments” (Rao & Meo, 2016, p. 1) which proactively integrate supports addressing learner variability and can be used to design curriculum to a wider range of learners, including students with and without disabilities (Rao et al., 2017). As Rao and Meo (2016) reminded, learning variability is a part of every classroom and goes well beyond whether students receive special education services or not. As the author’s stated: “variability is not limited to any particular category of student” (p. 1). Even so, given its applicability to supporting diverse learners also identified with disabilities the application of UDL has been closely linked to inclusive practices (Lowrey et al., 2017).

Developed by the Center for Applied Special Technology (CAST), UDL aims the instructional focus on identification and removal of socially constructed and culturally situated barriers in the curriculum (Center for Applied Special Technology, 2011). Identified as a scientifically valid framework in both the Higher Education Opportunity Act of 2008 and the Every Student Succeeds Act of 2015, UDL is recommended by both acts for use in instructional design (Lowrey et al., 2017).

The UDL framework is based on three primary principles: multiple means of representation, action and expression, and engagement (CAST, 2011). As described by Rao and Meo (2016) these principles are based on brain research on cognition and
learning and the various ways in which humans process information. As Kennedy et al. (2014) highlighted, the principles of UDL are left intentionally broad to provide for application in a variety of educational contexts and in support of any student(s). Still, the framework offers a level of detail in the considerations for educators: the 3 principles are underpinned by 9 guidelines and 33 checkpoints (Capp, 2017).

The first principle of UDL, multiple means of representation, is central to the research proposed here. Multiple means of representation prompt practitioners to consider the multiple ways of representing knowledge during the learning process (Capp, 2017). Courey et al. (2013) define representation as designing instructional materials that make content accessible to the greatest number of diverse learners. CAST (2018) describes multiple means of representation as providing options for students in how they access perceptual content information (e.g., customizations in how visual and auditory information might be presented to students), provisions for the use of language and symbols (e.g., clarifying vocabulary and symbols, clarifying syntax and structure, supporting the decoding of text, and illustrating through multiple media), and providing students multiple options for comprehension (e.g., strategies to support the activation of background knowledge and strategies to maximize transfer and generalization of new learning).

The second principle of UDL, multiple means of action and expression, aims to offer flexibility in how students might demonstrate their learning (Capp, 2017). CAST (2018) delineates that practitioners consider options for physical action, options for expression and communication—including options for using technology for
communication—, and strategic support of students’ executive functions (e.g., planning and strategy development).

The final principle of UDL, multiple means of engagement, focuses on providing students with control of their education and choice of activities (Capp, 2017). This principle of UDL is based on the belief that there are multiple ways students can be engaged and motivated to learn and recognition that not all attempted forms of engagement will be optimal for all learners (Capp, 2017). CAST (2018) prompts practitioners to plan using strategies that optimize student autonomy and relevance, value, and authenticity for the learner.

In the past decade, UDL has been a commonly employed conceptual framework. A Google Scholar search of the terms UDL and intellectual disability/disabilities returned over 4,000 hits. A database query (EBSCOHost using Academic Search Premier, Education Search Complete, ERIC, Professional Development Collection) of peer reviewed journal articles inclusive of the search terms UDL, Universal Design for Learning and extensive support needs, and/or intellectual disability/disabilities, reported 63 articles from within the past 10 years.

**Implications of UDL.** The TAPMAS lessons at the heart of this research project are designed through the lens of UDL. Informed by the understanding that learning is socially mediated and that all students, including students with ESN, benefit from meaning making alongside their peers and opportunities to observe and imitate the learning of those around them, UDL provides an instructional framework that describes what these theoretical underpinnings can look like in a classroom. For example, Social
Learning Theory theorizes that learning occurs within the triadic relationship between an individual’s internal capacities, the behavior of the individual, and the context of their environment (Bandura, 1977); UDL identifies that educators should design learning activities that allow for a range of means to engage in learning materials, a range of ways in which individuals can express their learning, and a range of ways in which students might engage in their learning (CAST, 2018) so as to provide meaningful instructional access points to as wide a range of students as possible (Rao et al., 2017).

Some students will require more scaffolding than might typically be provided by an educator attempting to employ UDL principles. The implication of UDL to this research is that it serves as a useful starting point. The purpose of this research study is to provide an additional example of how to take the principles of UDL, informed by the theoretical underpinnings of social constructivism and Social Learning Theory, and meld them into an effective intervention package inclusive of evidence-based practices (i.e., technology-assisted learning and PBIIs) and usable to the implementing educator.

Critique of UDL. There is a paradox inherent to the application of the UDL framework specific to special education (Kennedy et al., 2014): On the one hand, UDL is intended to ensure instructional access points and meaningful learning opportunities for all learners; On the other hand, special education is mandated to provide individualized instruction for students who qualify. It is therefore interesting to consider the problem of practice identified early in this paper: students with ESN are often excluded from participation and involvement in general education and placed in segregated classrooms or afforded limited--generally nonacademic--access to general education. Viewed from
within the UDL framework, one could argue that students with ESN are systematically excluded from general education because the system has failed to design learning experiences inclusive of learner variability. In other words, barriers to participation in general education could be thought of as the result of an “inflexible, “one-size-fits-all” curricula...that raise[s] unintentional barriers to learning” (CAST, 2011, p. 4). However, in recognition of the potentially contradictory expectation that students who qualify for special education ought also to receive specially designed instruction—defined by the IDEA (Sec. 300.39 (b) (3)) as the adapting, as appropriate, the content, methodology, or delivery of instruction—, the argument could also be made that UDL is not wholly appropriate for designing instruction for students with disabilities.

One possible means of rectifying this potential friction between UDL and the individualized adaptation required for students receiving special education may rest in the use of technology, and multimedia instructional strategies. As Wehmeyer (2006) emphasized, access to general education should focus on consideration of not just where, but how and what students are taught, stating: “when instructional content is truly designed to be accessible for all students, up-front and not after-the-fact, using both technology and pedagogical strategies, then we can begin to make progress in ensuring access to the general curriculum” (p. 324). Although not obviously intentional, one could argue Wehmeyer has essentially described UDL and the use of TAII as an example of multiple means of representation.
Review of the Research Literature

In this section, I focus on the relevant literature supporting the use of PBII for students with ESN and the social and academic outcomes for students with ESN. I then discuss the relevant literature supporting TAI and the social and academic outcomes for students with ESN. After each section of discussion, I provide a brief synthesis of the research and a critique.

Peer-Based Instruction and Intervention (PBII) in Support of Social Skills

Deficits in social communication are a defining characteristic of individuals with autism spectrum disorder (ASD) and are likewise noted for students with intellectual disabilities (Hutchins & Prelock, 2014). As Harjusola-Webb et al. (2012) noted, students with ESN often experience fewer overall opportunities to participate in positive social interactions with their nondisabled peers and general education teachers. While this is almost certainly due to the lack of access to general education as discussed thus far in this paper, it is important to also note the interplay between behavioral and safety concerns some students with ESN may exhibit in some settings—when appropriate support is lacking. Doss and Reichle (1991) refer to concerns relating to a student’s behavior as “challenging behavior,” defined as behavior that results "in self-injury or injury of others, causes damage to the physical environment, interferes with the acquisition of new skills, and/or socially isolates the learner" (p. 215). Exclusion from general education as the result of social behavior is not new to special education (see Gartner & Lipsky, 1987; PARC v Commonwealth of Pennsylvania, 1971). Often, students with ESN receive social skills training via pull-out small group instruction or one-on-one (e.g., the student is
removed from general education to receive the service) from an adult provider. A failure for taught skills to generalize from these settings to the general education classroom is frequently noted (MacFarland & Fisher, 2019). PBII promote prosocial behavior and social skills through increased opportunities for conversational turn-taking (Harjusola-Webb et al., 2012) and—because social skills practice occurs with peers in the general education classroom by design—PBII lead to an increase in the generalization of social skills (MacFarland & Fisher, 2019). Unlike adult-mediated approaches, PBII facilitates learning in natural social contexts with peers and precludes the additional steps required to transfer learning from adults to peers in natural social contexts (McConnell, 2002).

Still, some educators may be tempted to place the onus of responsibility for expected social behavior on the student with the disability and therefore argue that general education does not represent the student’s least restrictive environment. This argument falls short in several ways: it neglects the legal mandate that all students participate in and make progress in general education through the application of special education and related services (IDEA, 2004); it situates disability as within the individual rather than socially constructed and culturally situated; and it fails to account for the effects of evidenced-based interventions such as PBII on social behavior.

**Peer-Based Instruction and Intervention (PBII) in Support of Academic Skills**

Though mostly used to address social development and communication development (Zhang & Wheeler, 2011), support for the use of PBII for improved academic development has also been documented (Bene et al., 2014). As an evidence-based practice, PBII delivered in varied forms (e.g., cooperative learning groups, peer
instruction, peer tutoring, peer initiation, or play interactions) are recognized as effective interventions to address social and joint attention development, communication development, play, and school and academic outcomes in students with ESN (Steinbrenner et al., 2020). As introduced in this work’s first chapter, PBII also supports academic growth for students with ESN. Research on PBII have noted increased academic engagement (Carter et al., 2008) and increased academic proficiencies in academic tasks such as writing spelling words, solving mathematical equations, oral reading, and task completion (Jimenez et al., 2012; Utley, 1997). Specific to secondary learners (e.g., students in Grades 6-12), a variety of PBII called peer-assisted learning strategies (PALS) remains a widely recognized evidenced-based strategy for supporting struggling high school readers (Fuchs et al., 1999).

In addition, several researchers have conducted meta-analyses investigating the use of PBII and academic benefit for students with disabilities (Wexler et al., 2015). Okilwa and Shelby (2010) reviewed 12 studies published between 1997 and 2007 and reported that PBII—defined in the review as peer tutoring, peer-assisted learning, or reciprocal peer tutoring—were effective at improving academic outcomes for students with disabilities regardless of content area (e.g., language arts, mathematics, science, etc.). The authors did not specify how students in their research qualified for inclusion in the studies, stating only that the students included in their analysis were “special education students” (p. 453). Stenhoff and Lignugaris/Kraft (2007) reviewed 20 studies published between 1980 and 2005 that investigated PBII for students with “mild disabilities” (p. 10) in Grades 7-12, defined as students with learning disabilities,
attention deficit/hyperactivity disorder, or behavior disorder. Their research also found PBIIs improved academic performance. Finally, Kunsch et al. (2007) reviewed 17 studies published between 1978 and 2006 investigating PBIIs for students with learning disabilities. Three of the 17 studies were specific to students in Grades 6-12. Again, the authors found evidence of positive academic effect because of PBIIs, although notably the effect sizes were greater for younger students (e.g., those in primary school) and greatest in the area of mathematics. It is important to note that none of the studies reflected in these meta-analyses included students with ESN, in large part because of the exclusion of single-case research in search criteria due to the inability to calculate an overall effect size from such studies (Wexler et al., 2015). On the one hand, PBIIs are clearly shown to be effective in supporting students with disabilities. On the other hand, more research in this area appears needed.

As Maheady et al. (2001) concluded, there is no mystery as to why PBII are effective and efficient: peer-teaching systems work “because they create[d] more learner-friendly instructional environments” (p. 7). More specifically, the authors concluded, PBII “establish[ed] more favorable pupil-teacher ratios within the classroom, increased student on-task time and response opportunities, provided additional opportunities for pupils to receive positive and corrective feedback, and enhanced pupils’ opportunities to receive individualized help and encouragement” (p. 7). In their 2016 research on the efficacy of peer supports on social and learning experiences for students with severe disabilities, Carter and colleagues (2016) found evidence: compared to students exclusively receiving traditional, adult-delivered support, students who participated in
PBII experienced increased interactions with peers, increased academic engagement, more progress on individualized social goals, increased social participation, and a greater number of new friendships. Viewed from within the UDL framework, PBII appear to provide students with additional means of engaging with their learning by providing a greater amount of individual choice and autonomy (CAST, 2018) than they might experience from other instructional methods.

**Implications of Peer-Based Instruction and Intervention (PBII) Supports.**

Peer-Based Instruction and Intervention (PBII) are foundational to the research in this study. Humans are a social species (Odom, 2019) and social inclusion is a human right (Cobigo et al., 2012). Considering the evidence that students with ESN rarely interact with their nondisabled peers in the absence of specific intervention (Carter et al., 2016) and the evidence provided in this research study that PBII are shown to meaningfully improve both social and academic participation and achievement for students with ESN, the implications of PBII are of critical importance to students with ESN and for the educators who seek to support them. Relatedly, it seems nearly impossible to meet the spirit and purpose of the IDEA that students with disabilities be educated with their nondisabled peers without application of some form of PBII.

**Critique of Peer-Based Instruction and Intervention (PBII).** There are at least two major critiques specific to the argument against employing PBII in supporting students with ESN with better access to general education. First, some have argued (see Fuchs & Fuchs, 1999) that while students with ESN may benefit from “social competence” and “friendships” (Fuchs & Fuchs, 1999, p. 301), they won’t receive
appropriate instructional opportunities in general education or—by proxy—from working with peers in peer-mediated arrangements. What students with ESN really need, some have argued, is instruction provided in smaller, special classes where students are provided individualized instruction at their level and without the possibility of comparison between themselves and their nondisabled peers (Heller et al., 1982)—essentially the opposite of PBII and inclusive learning opportunities. This argument, while dated, has recently gained renewed vigor with findings from a 2022 multinational meta-analysis finding neutral—or, in some cases, negative—effects associated with inclusive education (Dalgaard et al., 2022). It should be noted, however, that the study’s authors note challenges with the confounding nature of trying to separate inclusive education and special education placement, furthering an argument central to this study: just having access to general education is not enough. As Dalgaard and colleagues identified, their findings indicate inconsistencies in how students with disabilities are educated and point to the need for an individualized approach specific to each student’s needs.

A second critique of employing PBII to support students with ESN in general education classrooms is that PBII only support the student with disability and—like arguments against inclusive learning environments in general—may not benefit the nondisabled peer. While not conclusive, there is evidence indicating mostly positive or neutral effects on the academic achievement and social functioning of typically developing students when students with ESN are included in the general education classroom (Hehir et al., 2016; Kart & Kart, 2020). There is also evidence of reduced bias
and increased acceptance of students with ESN by their nondisabled peers when students with ESN are included (Hehir et al., 2016; Kart & Kart, 2020).

**Technology-Aided Instruction and Intervention (TAII)**

Technology-Aided Instruction and Intervention (TAII) is described as an application of technology that has been shown in the literature to lead to positive outcomes for students with disabilities (Hamilton & Hattie, 2020) and is considered an evidenced-based practice (Steinbrenner et al., 2020). For this research, TAII is defined as an alternative to face-to-face learning (Hu et al., 2007; Pennington, 2010) in which technology is specifically designed or employed as instruction or intervention to support learning or performance of a behavior or skill (Odom et al., 2015; Steinbrenner et al., 2020).

Within the UDL framework, the use of technology in the delivery of instruction is one way in which educators can provide students an opportunity to interact flexibly with content that doesn’t depend upon a single sense (e.g., sight, hearing, etc.) and can provide a structure for activating or connecting to prior knowledge, highlight patterns and connections, and maximize transfer and generalization (CAST, 2018). Employing TAII as an instructional or intervention structure is supportive to students with ESN in that content can be presented intentionally, with limited distractions from extraneous sensory stimuli, to provide consistent and predictable responses and clearly defined tasks (Tseng et al., 2020).

In an investigation of the various forms of technology common to education, Hamilton and Hattie (2020) found the largest effect sizes when technology was used as
video review of traditional lessons, when interactive video was used to supplement learning, and when technology was used in support of students with unique learning needs. Video presentations have been used to support students with disabilities with a range of learning initiatives, including the presentation of new academic content (Kennedy et al., 2014; Kennedy et al., 2015) and prompting in support of following multi-step directions (Snyder & Huber, 2019), two areas that can present challenges to educators when instructing students with ESN.

A popular form of TAII incorporating multimedia video presentations (e.g., auditory and visual stimuli presented together) (Snyder & Huber, 2019), and a format from which I drew much inspiration for this research, are Content Acquisition Podcasts (CAPs) developed by Kennedy and colleagues (Kennedy et al., 2014; Kennedy et al., 2015; Weiss et al., 2016). Like the previous discussion of PBII and their potential to effectively improve teacher-to-student ratios, CAPs are also discussed as useful to this end (Kennedy et al., 2016; Romig et al., 2018). While not yet specifically employed to the benefit of students with ESN, I was intrigued by the theoretical underpinnings of the CAPs model. Conceived of the cognitive sciences, particularly Mayer’s (2008, 2009) Cognitive Theory of Multimedia Learning (CTML), which is in turn born in large part from Baddeley’s (1992) model of working memory and Sweller et al.’s (2011) theory of cognitive load, CAPs are instructionally designed to reduce extraneous demand on the learners’ ability to simultaneously store and process complex information (Sweller et al., 2011), a cognitive process described by Baddeley (1992) as working memory (WM). Working Memory, which Baddeley portrayed as the “temporary storage and
manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning” (p. 556) ultimately allows the individual to store newly synthesized information as long-term learning (Freedman & Martin, 2001).

Working Memory is considered limited in both capacity and duration (Baddeley, 1992); therefore, when students are presented novel information instruction must consider the cognitive load placed on students’ WM (Sweller et al., 2011). Given that research suggests students with ESN often score lower on measures of WM (Kercood et al., 2014; Schuchardt et al., 2010), the CAPs model presented as a good fit for my research and provided a helpful model from which to build from.

**Implications of TAIi.** Technology-Aided Instruction and Intervention (TAII), and Kennedy and colleagues CAPs, was critical to the conceptualization of this research project, with the primary intervention component (TAPMAS lessons) modeled closely after the CAP model. CAPs are designed to reduce WM demands and cognitive load by scaffolding new learning with relevant visual supports and scripts that contain only essential information that are synced to distinct images that illustrate the content being taught (Kennedy et al., 2014); Even so, the literature is limited when it comes to initiatives such as CAPs being employed to support students with ESN. It is plausible researchers have previously determined, or presumed, that students with ESN present with too much of a gap between their WM capacities and the capacity to design technology-assisted learning initiatives (such as CAPs) to meet the need effectively. A primary initiative of the intervention presented in this work is to investigate the effects of
marrying a technology-assisted structure with intentional peer-mediation may present one way of appropriately implementing technology-assisted learning to students with ESN.

**Critique of Technology-Aided Instruction and Intervention (TAII).** A primary critique of TAII is found in the confusion of which technologies qualify as TAII and which do not. Given the ubiquitous use of technology in today’s classrooms (Hamilton & Hattie, 2020), it seems likely that some educators may find navigating available technology-related educational tools in search of evidence-based practices a challenge.

Relatedly, not all of what may be considered technology-aided instruction or intervention is equal in its effectiveness (Hamilton & Hattie, 2020). In an investigation of the relative effect size of various technology tools that might be considered technology-aided, Hamilton and Hattie (2020) found that tools such as social media, mobile phone usage, and watching television had an inverse effect on learning. If one were to consider the use of these technologies as examples of what is meant by TAII, many educators are likely to bristle at their use in their classrooms. By the definition put forth in this study, technologies such as these would not qualify as TAII because they have not been evidenced to lead to positive student learning outcomes. This distinction is important because the use of technology in classrooms has become ubiquitous (Hamilton & Hattie, 2020) and, without a clear understanding of how to employ technology to the benefit of student learning, some educators may inadvertently cause more harm than good when attempting to use technology instructionally. To the untrained eye, for example, a resource such as YouTube (www.youtube.com) or Khan Academy (www.khanacademy.com) may seem a reasonable use of technology in a classroom.
While this may be true, Kennedy and colleagues (2015) cautioned that such resources may not be appropriate for students with learning differences. The authors deconstructed freely available digital resources (e.g., Khan Academy, YouTube, etc.) and found that such resources often required the viewer to have prior knowledge on the subject, often contain an overwhelming amount of information presented rapidly, and lacked advance organization that followed a hierarchical order that might benefit a student with a disability. Kennedy and Wexler (2013) presented a similar caution, noting that such services are unlikely to be beneficial (e.g., allow students to learn) for students with disabilities in that they are not designed with the specific needs of such students in mind. Such cautions would seem most prudent when considering students likely to struggle with working memory (WM), such as students with ESN.

**Review of the Methodological Literature**

In this section, I review the literature specific to the research methodology employed in this study. This methodological review will conclude Chapter 2 and transition this discussion into Chapter 3 and the methods conducted within this work.

The research questions posed in this study were investigated via MB across subjects (participants) single-case research design (SCRD), a quantitative research approach wherein outcome variables are measured prior to an intervention and compared with measurements taken during and after the intervention (Kratochwill et al., 2010). SCRD methods have been employed for several decades within special education (Ledford & Gast, 2018; Moeller et al., 2015) and are increasingly accepted as a valid experimental approach (Ledford et al., 2022). Often selected for research within special
education because they permit the study of a small number of participants serving as their own control (Kennedy, 2005), SCRDs may be particularly appropriate for studying participants who present with low prevalence disorders and for whom other traditional group designs, such as randomized control trials requiring many participants for adequate statistical power, may not be appropriate (Odom et al., 2005). A MB across participants design also supports demonstration of experimental control by allowing for comparison of behavior change that occurs when and only when the intervention is introduced to each participant (Ledford & Gast, 2018). It is for these reasons that I have selected this method of research to analyze the research questions posed in this study.

Experimental, rather than correlational or descriptive, the intended rationale of SCRD is to document causal—or functional—relationships between a researcher-manipulated independent variable (i.e., an intervention) and change in a dependent (i.e., outcome) variable (Horner et al., 2005; Horner & Spaulding, 2010; Levin et al., 2003). By design, the participants’ performance serves as the baseline for which their performance post intervention is then compared and functional (causal) relations between independent and dependent variables can then be determined (Kratochwill et al., 2010; Kratochwill & Levin, 2010; Ledford & Gast, 2018). The number of participants may include a single subject (or case) but typically includes anywhere from 3 to 8 participants (Horner et al., 2005). The goals of SCRD are to determine if an intervention is more effective than the current baseline or “business-as-usual” condition (Kratochwill et al., 2010, p. 3), for whom the intervention was effective, and the specific conditions under
which a functional relationship was observed (Horner et al., 2005; Kratochwill et al., 2010; Kratochwill & Levin, 2010; Ledford & Gast, 2018).

Within MB across participants design, baseline serves as the foundation wherein behavior is measured repeatedly across adjacent conditions (phases): baseline (A) and intervention (B) (Ledford & Gast, 2018). Each phase transition from A to B is an opportunity for the researcher to observe the effects of the treatment and replicating treatment across several participants concurrently allows the researcher to quickly assess treatment effectiveness (Morgan & Morgan, 2008).

Using this method, analysis of student outcomes was assessed both visually and statistically based on the What Works Clearinghouse (2020), or WWC, guidelines for SCRD studies (Kratochwill et al., 2010). Kratochwill et al. (2010) identified six factors to examine across phases using visual analysis: level (mean), trend (direction of best fit line), variability (standard deviation from line of best fit), immediacy of effect (i.e., change in level between last three data points in one phase and first three data points in subsequent phase), overlap (i.e., percent of data points in one phase that are within the range of data points in previous phase), and consistency across similar phases. To establish a functional relation with visual analysis, a minimum of three demonstrations of effect (changes in the dependent variable that co-vary with changes in the independent variable) is recommended at (at least) three points in time (WWC, 2020).

In addition to visual analysis, as suggested by the WWC (2020), statistical analysis of the change from baseline to intervention was also calculated. Researchers have proposed criticism related to relying solely on visual analysis (see Fingerhut et al.,
2021) and have recommended statistical analysis as an additional means of calculating effect size for single-case experimental designs (Brossart et al., 2018). At the same time, researchers have cautioned that statistical analysis must be correctly identified based on the research questions (Fingerhut et al., 2021) and that there remain questions as to precisely which analysis methods are best (Brossart et al., 2018). Tau-\( U \), a nonparametric method used to calculate nonoverlap between phases and trends within the intervention phase and as a description of intervention effect size (Parker et al., 2011), has shown promise as a reliable analysis tool in single-case experimental design (Brossart et al., 2018). Fingerhut et al., (2021) provide a decision-making flowchart (see p. 106) to support researchers in selecting the correct analysis tool. Following this guidance, which specifically guides researchers to evaluate potential baseline trends prior to analysis, Tau-\( U \) was selected as the appropriate statistical tool for evaluating phase change from baseline to intervention for each participant as well as a properly averaged overall effect size for this study (Vannest et al., 2016). Tau-\( U \) calculations were conducted using an online calculator freely available at www.singlecaseresearch.org/calculators/tau-u (Vannest et al., 2016).

**Summary of the Research Literature and Application to the Study**

In this chapter, I discussed the theoretical frameworks of social constructivism and Social Learning Theory as a lens to describe the problem of students with ESN not being provided supports to meaningfully participate with their nondisabled peers and the general education curriculum. I used these frameworks to discuss how learning is socially situated and how students with ESN can differentially develop a sense of self-efficacy
depending on where and with whom they spend their time at school (e.g., in general education or in segregated classrooms) and that students with ESN benefit from opportunities to learn alongside their peers, observing and imitating the learning habits they witness in others. I then discussed the conceptual instructional framework of UDL and how this framework is informed by the theoretical frameworks. I also provided a visual representation of these theoretical and conceptual frameworks in Figure 1.

Next, I provided a literature review for the two evidence-based components that make up this research study: TAI and PBII. The research literature reviewed in this chapter helped to demonstrate how each of these components fit within UDL and their appropriateness for supporting students with ESN.

In the last section of my literature review, I reviewed the methodological literature relevant to my proposed study. I described how a single-case MB across participants will be used to explore my research questions and, specifically, whether implementation of a package intervention combining TAI with PBII.
Chapter 3: Methods

This study sought to provide evidence on how the use of technology can improve peer-to-peer learning arrangements in inclusive classrooms to promote positive academic and social outcomes for middle school students with ESN. The two intervention components of this problem of practice, the use of Technology-Aided Instruction and Intervention (TAII) and Peer-Based Instruction and Intervention (PBII), are both currently available to practitioners and yet not consistently employed in classrooms in support of students with ESN. There are three parts to this research problem: (a) there is a research-to-practice gap between the use of PBII and TAI and the prevailing practice of supporting students with ESN via adult-driven interventions (e.g., the assigning of paraprofessionals to support students with ESN in inclusive classrooms as the predominant intervention), (b) TAI implemented in support of students with ESN have focused primarily on social communication and daily life activities (Fage et al., 2018), and (c) TAI have not been paired with PBII with the intent of supporting students with ESN with both social and academic participation in inclusive classrooms.

The purpose of this study was to investigate the effects of an intervention package called Technology-Assisted and Peer-Mediated Academic Support (TAPMAS) on the social and academic performance of students with ESN in inclusive middle school science classrooms to investigate the following research questions:

1. Is there a functional relationship between implementation of Technology-Assisted and Peer-Mediated Academic Support package (TAPMAS) delivered within inclusive middle school classrooms and increased social
interactions initiated by middle school students with ESN and their nondisabled peers?

2. Does implementation of TAPMAS lead to residual carry-over in social interactions in the general education classroom for students with ESN post-intervention?

3. Does implementation of TAPMAS intervention lead to a measurable increase in the accurate identification of instructed academic language for students with ESN?

4. Do teachers and students find the methods of this research acceptable and usable?

**Research Methods**

The first and second research questions posed in this study, whether implementation of TAPMAS science lessons would have a functional impact on observed social interactions initiated by focus students to their peers, were investigated using a quantitative research method, multiple baseline (MB) across participant, single-case research design (SCRD). This design allowed for comparison between the baseline condition—focus student’s performance on the dependent variable of social interactions before introduction of TAPMAS intervention—and focus student’s performance after the TAPMAS intervention was introduced. Investigation relating to the first research question included close examination of the phase change between each focus student’s baseline performance and their performance at intervention; Investigation of the second research question looked specifically at whether any positive effects observed as a result
of the TAPMAS intervention might lead to carry-over, or residual, effects in the occurrences of social interactions observed in the student’s inclusive science classrooms after students had completed participation in the TAPMAS intervention (identified in this research as a third, maintenance phase of the study). Relatedly, the third research question posed, the degree to which focus student’s identification of instructed academic language might increase because of their exposure to the TAPMAS intervention, was investigated via pre- and post-tests of academic language administered during the baseline (pre-test condition) and intervention (post-test condition) phases. In the pre-test condition, students were assessed on their identification of academic language before exposure to the TAPMAS intervention; in the post-test condition, focus students were assessed on their identification of academic language after they had received instruction on the assessed academic language as part of the TAPMAS intervention. Finally, the fourth research question, the acceptability and usability of the study by the study participants, was investigated via post-study questionnaires.

The MB across participants design was selected because the focus students participating in this study are identified as members of a unique group (i.e., students with ESN) who present with low prevalence disorders (such as Autism) and for whom other traditional group designs, such as randomized control trials requiring a large number of participants for adequate statistical power may not be appropriate or feasible (Odom et al., 2005). For unique populations, SCRDs are often selected as an appropriate method because the students can serve as their own control (Kennedy, 2005) and the design can be used to document a causal (i.e., functional) relationship between an independent
variable, such as an intervention, and a dependent variable (Horner et al., 2005; Horner & Spaulding, 2010; Levin et al., 2003). The uniqueness of the focus participants of this study, the over-arching aim of this study to provide an example to other educators of how technology might be used to improve peer-to-peer learning in inclusive learning environments for other students with ESN, and the research question requirement to investigate whether a functional relationship was evident between an independent variable and identified dependent variables led this study’s investigators to conclude a quantitative SCRD method was the most appropriate method to use. MB across participants, specifically, presented as an appropriate fit because the participating focus students served as their own controls, and allowed the researchers to investigate the study’s primary research questions adequately and appropriately (e.g., with negligible potential negative impact and, optimistically, high social validity) and provided at least three demonstrations of intervention effect at three or more points in time, thus meeting design standards for SCRD (Kratochwill et al., 2021).

As an experimental, MB across participants design, this research investigated the effects of an independent variable, the TAPMAS intervention package, and its effects on two dependent variables: (1) occurrences of social interactions initiated by focus students to their peers (the primary dependent variable of the study) and (2) percent of correct vocabulary responses on tests of science vocabulary by focus students (the secondary dependent variable). For clarity and brevity, the primary dependent variable is thus forward identified as DV 1: Social Interactions and the secondary dependent variable will be identified as DV 2: Correct Responses.
Multiple baseline (MB) across participants involves replication of comparison across a baseline phase and an intervention phase across participants that are both functionally similar and functionally independent of one another (Ledford & Gast, 2018). Meeting this requirement, the focus students in this study were functionally similar (students with ESN and meeting the inclusion criteria set forth later in this document) and functionally independent in that each student was enrolled in a different science class period of the school day, thus preventing exposure effects or benefits. To demonstrate experimental control, measurement of the primary dependent variable, DV 1: Social Interactions, was collected concurrently for each focus student at baseline and continuously throughout the baseline and intervention phase, with each focus participant entering the intervention phase at a different point in time. In other words, data collection pertaining to DV 1: Social Interactions began at the same point in time (i.e., on the same day) for all focus participants and was collected continuously (i.e., daily) for all focus participants throughout the baseline and intervention phases. As required of SCRD, a minimum of five data points, investigated visually for any potential phase trends that might indicate participant improvement in the absence of intervention, were collected prior to students entering the intervention phase of the study (Kratochwill et al., 2021). Once in the intervention phase, the SCRD design standard minimum of at least five data points was likewise collected to “allow documentation of a convincing, within phase, pattern of participant responding” because of introduction of the intervention (Kratochwill et al., 2021, p. 95).
While not explicitly required to meet SCRD design standards specific to MB across participants, this study did include a follow-up investigation of DV 1: Social Interactions for a third, maintenance, phase (see Research Question #2). Data collection for maintenance phase involved the continuous collection of data pertaining to DV 1: Social Interactions after the required minimum five data points showing intervention effect had been collected for participants within the intervention phase. Unlike other SCRD, such as A-B-A-B design, MB across participants does not require withdrawal of an intervention to demonstrate intervention effect because MB across participants compares baseline condition (A) and intervention (B) across several participants rather than within a single participant (Ledford & Gast, 2018). When initially designing this study, I was curious as to what lasting effect the TAPMAS intervention might have for focus students after the intervention was over. However, as will be discussed in the results section of this document later, minimal data was obtained for the proposed maintenance phase because the general education teacher for three of the four focus participants requested that the intervention continue, thus preventing data collection post-intervention.

Data pertaining to the secondary dependent variable, DV 2: Correct Responses, was also collected concurrently for all participants and continuously throughout the study. However, because the data collection design specific to this variable involved weekly vocabulary pre- and post-tests, there was no requirement of at least five data points at either baseline or intervention phases and no emphasis that data trends not be volatile prior to students moving on from baseline to intervention.
Participants

**Focus students.** Four focus students (students with ESN) were identified and selected for this study based on the following inclusion criteria: (1) students qualified for special education services under the special education categories of Intellectual Disability (ID), Autism Spectrum Disorder (ASD), and/or Other Health Impairment (OHI); (2) the student’s IEP indicated they were designated to participate in required state science assessment (required of all students in Oregon in their fifth, eight, and eleventh-grade years) and designated either to participate in the Oregon Extended Assessment—a modified assessment designated for students with the most significant cognitive disabilities (Oregon Department of Education, 2021)—or, the student was designated to take the standard Oregon science assessment but had previously demonstrated limited to no mastery of knowledge and skills as indicated by Level 1 performance on the Oregon Statewide Assessment System (OSAS) science assessments (OSAS Science Assessment Information for Teachers, 2022); (3) students had an academic class schedule that assigned them to a general education science class for the spring quarter of the 2021-2022 school year (the quarter this study took place) and that did not coincide with other focus students being in the same class at the same time; (4) students exhibited an attendance history indicative of a likelihood of full intervention participation; and (5) students provided their assent to participate and their parent/guardian provided written consent.

Four focus students ultimately met inclusion criteria and agreed to participate in the study. Initially, five focus students had met inclusion criteria and were proposed to be included in this study. During the process of gaining student assent, however, a
prospective eighth-grade focus student who met inclusion criteria declined to provide their assent and was therefore not included in this study. Three of the four focus students were sixth graders, and one was an eighth grader. The sixth-grade students who met inclusion criteria and were included in this study are referenced by the names Ophelia, Alden, and Greysen. The eighth-grade student who met inclusion criteria and was included in this study is referenced by the name Bailey.

Ophelia, Alden, and Greysen (sixth-grade students) had the same science teacher who taught from the same physical classroom but during different periods of the day: Alden had science first period, Greysen third period, and Ophelia fifth period. Bailey, the eighth-grade student, attended science fifth period but with a different science teacher and in a different physical classroom.

**Ophelia.** Ophelia was a 12-year-old, sixth-grade female who qualified for special education services under the categories of Other Health Impairment (OHI) and Intellectual Disability (ID). Her IEP included speech (articulation), language (focused on determining key ideas and details of short stories), reading, writing, and math goals. Progress notes pertaining to her IEP goals reported her reading skills were typical of roughly kindergarten to 1st grade level and noted her math skills as one-to-one (also roughly early primary level). Ophelia’s IEP team had determined participation in the Oregon Extended (alternative) Assessment as most appropriate for her.

**Alden.** Alden was a 12-year-old, sixth-grade male who qualified for special education services under the eligibility category of autism spectrum disorder (ASD). Alden’s IEP included language, social communication, reading, writing, and math goals.
Progress notes pertaining to Alden’s IEP goals reported he was reading (decoding) and comprehending at about a middle 4th grade level. Alden’s progress toward his social communication goal indicated he benefited from routine and was initiating and responding to peers in his small group social communication group about 40% of opportunities. Alden's IEP team had determined participation in the Oregon Extended (alternative) Assessment as most appropriate for him.

Greysen. Greysen was a 12-year-old, sixth-grade female who qualified for special education services under the category of OHI. Her qualifying health condition was Down Syndrome. Greysen’s IEP included language, social communication, reading, and math goals. Progress notes pertaining to Greysen’s IEP goals reported she was reading (decoding) and comprehending at about a middle fifth grade level and that she was reluctant to read aloud or offer responses without clear response options presented to her. Progress toward her language goal indicated she was working toward independently categorizing objects and pictures. Generally, Greysen’s IEP team noted an increase in her reluctance to participate socially in class. Greysen's IEP team had determined participation in the Standard Assessment as most appropriate for her.

Bailey. Bailey was a 14-year-old, eighth-grade male who qualified for special education services under the category of ASD. Alden’s IEP included social communication, self-management, study skills, reading, and math goals. Progress notes pertaining to Bailey’s IEP goals reported a relative strength in reading decoding and that, overall, he was reading at about a 3rd to 4th grade level. Bailey’s self-management and social communication goals indicated he was working on engaging with peers in
expected ways and responding to peers by asking “wh” questions. Bailey’s IEP team had
determined participation in the Oregon Extended (alternative) Assessment as most
appropriate for him.

**Peer support participants.** Peer student support participation was determined
using the following inclusion criteria: (1) the peers were enrolled in the same science
class as a focus student (student with ESN), (2) students were identified by their
classroom teacher or a special educator as a student who would likely be effectively at
providing academic and social support to classmates with ESN, (3) students provided
their assent to participate, and (4) the student’s parent/guardian provided written consent
to participate.

For each of the four focus students, two peer support students were identified and
invited to participate as peer support participants. In total, eight peer support participants
met inclusion criteria and agreed to participate. Five were identified as female and three
as male. The study was designed so that each focus student would work one-on-one with
a focus student but have a second, alternate peer also assigned to them and ready to
participate should the initial peer be absent, elect to discontinue in the research, or be
otherwise unavailable. The decision of which of the pair of students assigned to each
focus student would initially be selected to work with the focus peer and which would be
designated as the alternate was determined based on contextual information specific to
the situation. In some instances, one peer student was present on the first day of
intervention for a specific focus student and the other was not. In others, a peer support
participant was selected over another because they happened to be seated close to the
focus student and so re-arranging the class seating arrangement would be less impactful to the flow of the classroom and the students. In any case, I discussed the decision of which student would first participate with the focus student and which would be the alternate with the peer support participants to not leave one feeling isolated, confused, or left out.

**Teacher Participants.** This research enlisted the support of four educators, two general education science teachers and two special educators.

**General Education Science Teachers.** Each of the two science teachers, one a sixth-grade science teacher and the other an eighth-grade science teacher, identified as female. The sixth-grade teacher reported this was her first year of teaching and that she had limited experience teaching students with ESN, whilst the eighth-grade teacher had more than 10 years of science teaching experience in the participating district and reported having had more experiences supporting students with ESN. Each general education science teachers participated in this study by meeting with me prior to the study’s initiation, meeting with me throughout the study and providing input to the design of TAPMAS lessons throughout and completing a post-survey questionnaire about their experiences. Each teacher openly offered to meet consistently (at least weekly) with me to discuss the study’s progress and to provide input to TAPMAS lessons. At times, these partnering meetings occurred during the teacher’s in-school prep period, however teachers primarily made themselves available to the researcher before or after school.

**Special Education Teachers.** One of the participating special educators, who case managed the eighth-grade focus student, identified as male and reported having been a
special educator for 7 years, all within the participating district. The other participating special educator, assigned as case manager for the three other participating focus students (the sixth-grade focus students), identified as female and reported having been a special educator for 12 years, three of which occurred while working in the participating district. Both special educators reported having previously supported students who qualified for special education services under a variety of eligibility categories and including students with ESN.

**Setting**

All students and staff participating in this study attended a suburban northwest Oregon middle school. According to data from the Oregon Department of Education (2019), the participating district in this study was comprised of roughly 10,000 students and the middle school at which this research was conducted enrolled roughly 500 students. Of distinct importance to the design and application of this study, the hosting district for this study had, approximately 10 years prior to this study, transitioned to an inclusive practices model for serving students with disabilities. In practice, this model shift eliminated within the district all special programs and special classrooms previously designed for the purpose of categorically placing students with disabilities together (e.g., the district previously had program classes for students who qualified under the special education eligibility category of autism spectrum disorder). Instead, the district’s model provided special education services and support at the student’s neighborhood school and with as much access to the general education environment and curriculum as appropriate to the student whenever possible. Special education programs (as in the student’s
Individualized Education Program, or IEP) were therefore built around the student, rather than requiring the student to be placed in a different environment for their IEP to be implemented.

Each of the four participating focus students of this study attended the same neighborhood middle school (grades 6-8) and received educational services, including special education services, within their inclusive neighborhood school. The school schedule was arranged around a six-period day with each class period 55-minutes in length. This study was conducted within two general education science classrooms, one a sixth-grade classroom and one an eighth-grade classroom.

**Science Classrooms.** The number of students assigned to each of the class periods was relatively consistent between sixth- and eighth grade and ranged from 19-24 students assigned per science class period. Qualitative differences in the way the sixth and eighth grade classrooms were arranged, made use of physical space, and how students were arranged within the spaces. While the two classrooms were essentially of the same size and each appeared to have been designed to be used as science classrooms and included typical science classroom artifacts such as eye-washing stations, sinks, etc., use of the physical space within the two classrooms differed in that the sixth-grade classroom was arranged so that students were seated in table groups of two and placed in rows facing the front of the classroom. In the sixth-grade classroom, student desks were primarily arranged in rows, with individual tables seating one or two students clustered across the rows with breaks between the tables to allow for students and staff to walk between. In this classroom the teacher primarily taught from the front of the room and
typically used a projector and projector screen mounted to the front wall of the classroom to present whole-group instruction to students. The eighth-grade classroom, by contrast, included larger (and taller, counter-height), square tables dispersed around the room and were arranged so that three to four students sat together at larger tables with students facing each other. In the eighth-grade classroom, the teacher employed a large-screened monitor (i.e., a TV) on a mobile stand near the front of this classroom—used in a comparable way as the projector and screen in the sixth-grade classroom—and tended to move about the room during instruction.

**Procedures**

**Assent and Consent.** Prior to involvement in this study, written consent was obtained from the parents/guardians of all participating students (focus and peer). I met with each focus student and peer support student individually and provided an overview of the study’s purpose and pertinent details of what the study would entail, including the use of video recording in support of data collection. Students assented verbally to participate in the study and peer support participants assented verbally and in writing. This information was provided using student friendly language and visual support. Students were given specific information about what they could say in case they wanted to withdraw from the study, and that participation was voluntary throughout the duration of the study. During the intervention, the researcher periodically checked whether the participants wished to continue participating in the research project.

**Recruitment of Focus Students.** Focus students were initially identified for possible inclusion in this study based on the inclusive criteria discussed previously in the
participants section of this document. Once a list of possible student participants was
determined based on these criteria, the parents/guardians of students were contacted by
phone (or, as in one case, via a Zoom (www.zoom.com) meeting that happened to already
have been scheduled between parent and myself), and (a) provided an overview of the
study’s purpose and methods, (b) informed of the inclusion criteria for participation in the
study, (c) informed that their student met inclusion criteria, and (d) a presented a request
that the provide their consent for their student to participate. Each of the
parents/guardians contacted expressed interest in their student participating; However,
one parent, whose student would later elect not to participate, expressed some concern
that their student may not wish to participate. Once parents had provided their verbal
consent, they were also provided follow-up written information and their written consent
was obtained. Written consent was primarily garnered using a district-purchased digital
signature collection software called Adobe Sign. Once parents had provided their
consent, I partnered with the parent to determine the most appropriate way to introduce
the study to their student and ensure student assent. I then met individually with each
focus student for whom parents had provided written consent and shared the study’s
purpose and invited them to participate (i.e., provide their assent). Of the five students
initially identified as meeting inclusion criteria, four gave their assent. One eighth-grade
male, declined to give his assent. This student expressed to me (paraphrased here) that he
interacted adequately with his peers in science class and was doing well with the science
curriculum and did not think he would benefit from participation in the study. I provided
the student an opportunity to ask clarifying questions about the study but continued to
decline his assent and, therefore, did not participate. His parents were notified of his decision not to participate.

**Recruitment of Peer Support Students.** Peer support students were initially identified for participation in this study as determined by the inclusion criteria discussed in the participants section of this document. Once a preliminary list of possible students to include was garnered from the general education science teachers (see inclusion criteria), I sent the parents/guardians of potential student participants an introductory email detailing the general purpose and methods of the study and informed they were being contacted because their student had been selected as meeting the inclusion criteria by the student’s science teacher. The email detailed that I would follow up with them via a phone call. A draft copy of this letter can be made available upon request. Several of the parents/guardians responded to this email and expressed interest in their student participating. Roughly a week later, I began contacting, via phone, the parents/guardians of potential peer support participants. In situations where calls went to voicemail, the researcher left details as to the purpose of the call and their contact information. Once parents were contacted, I provided additional information and clarifications related to the study. Initially, the parents/guardians of 10 potential peer support students were contacted. One parent, who unfortunately did not speak directly with the researcher, expressed confusion at the purpose of the inquiry, stated in a voice message that their student did not have a disability, and declined to provide their consent. The researcher was unable to reach this parent directly to provide clarification. The parent/guardian of two potential peer support students expressed interest in their student participating but
were later notified that their student would be unable to participate due to a change in the structure of the study (which was due to one potential focus student electing not to participate, although parents/guardians were not made aware of this to protect the identity of the student).

Once parents/guardians provided verbal and written consent for their student to participate, I met individually with potential peer support students and provided an overview of the purpose and methods of the study. Each of the students who met inclusion criteria and whose parents provided their consent also provided their assent. Students were then provided a copy of the Assent to Participate in Research (Ages 13-17 or Sensitive Population) as submitted to the Portland State University Institutional Review Board (IRB) as a condition of university permission to conduct this research. A copy of this document, and the requisite parent consent document, can be provided upon request.

**Data Maintenance.** To maintain confidentiality of participants, the names of focus students within this document and supporting data collection documents were changed. All guidelines proposed by Portland State University’s (PSU) Institutional Review Board (IRB) were followed and IRB approval was granted prior to connecting with students or families or conducting this research.

Data collected as part of this research project did not require personally identifiable information pertaining to peer support participants, specifically, to be reported. As such, there was no requirement to change the names of peer support participants to protect their identity within this document, with three exceptions: (1)
personally identifiable information was collected as part of garnering peer support student assent and related parent/guardian assent, (2) examples of student learning are discussed and represented in the appendix of this paper and students were asked to write their names on these documents, and (3) peer support student’s perspectives were surveyed at the conclusion of this research project; however, their responses were reported collectively rather than individually in the results section of this work. Evidence of student learning shared in the appendix of this document has been redacted to remove student names or personally identifiable information. All assent and consent documents pertaining to peer support participants were kept on a USB drive accessible only to me and backed up to a password protected Google Drive.

As part of student recruitment, parents were asked to provide their written consent by signing documents electronically using a district-approved and purchased software called Adobe Sign. Adobe Sign (www.adobe.com/sign) allows users to send, sign, and manage PDF documents securely. As part of Covid-19 and related district and state health protocols, parents and teachers were encouraged to meet virtually and restrict person-to-person interactions as much as possible. Adobe Sign was purchased by the district to support school teams with collecting signatures for legal documents in a manner that did not require passing papers amongst persons or direct person-to-person contact. To gather the required written consent, Portland State University Institutional Review Board (IRB) documents were uploaded to my work-provided Adobe Sign account and sent to parents/guardians provided email addresses. Written consent gathered
via Adobe Sign was then returned to my school-provided and secured email address, then saved to a USB drive accessible only by me (and available to the IRB upon request).

**Technology-Assisted and Peer-Mediated Academic Support (TAPMAS) lessons.** TAPMAS lessons were designed by me for this research project employing several aspects of lesson planning, lesson design, and lesson delivery as described by Kennedy et al.’s (2015) design of Content Acquisition Podcasts (CAPs). Like CAPs creation, TAPMAS lesson creation occurred in three phases: Preparation, Production, and Publishing. The next few paragraphs provide a step-by-step process for how TAPMAS lessons were created, including figures outlining the steps for each phase of TAPMAS production and a figure outlining an example of a completed TAPMAS lesson used as part of this research.

The primary focus of the Preparation phase was to identify one clear topic or concept to be delivered as part of each TAPMAS lesson. In consideration of time constraints and a desire that TAPMAS lessons supplement and integrate with rather than replace general education instruction, each TAPMAS lesson was designed to take students an estimated 10 minutes to complete. With this time limit in mind, the study design included that each TAPMAS lesson would include one essential science vocabulary or concept per lesson. As will be discussed further, students participated in one TAPMAS lesson for each session (day) for which they were assigned to the intervention phase of the study. Science vocabulary that were ultimately used in this research are available in Appendix B (6th-grade specific) and Appendix C (8th-grade specific).
As suggested in Kennedy et al. (2015), Google image search (google.com/images) was used exclusively to find copyright-free photos or other images for use in designing TAPMAS lessons. TAPMAS lessons used for this research were created using Microsoft PowerPoint 2016 (part of the Microsoft Office 2016 suite), running on a Microsoft Windows 11-based desktop computer. An external desktop USB microphone was connected (Insignia, model NS-CBM19) and used for all voice narrations for TAPMAS lessons. Replicating the procedures used in this research are likely to be very similar when employed on other computer types (e.g., Apple computers) or with other versions of Microsoft PowerPoint (a quick web search indicated the recording feature presented in this work is available on PowerPoint 2016, PowerPoint 2019, PowerPoint 365, and the updated version of PowerPoint 2013). Of note, Microsoft PowerPoint is often freely available to educators and students or access to it is often provided as part of employment as an educator. PowerPoint was selected for use here because it allows for a relatively easy recording feature that allows users to play through slides at a user-determined pace, incorporate simple animations (such as an arrow pointing at a specific area of the screen), record voice-over narration, and then output the final product as a .mp4 file type (an audio-visual coding format that is commonly used for streaming and video playback and easily played by many modern devices such as computers and laptops).

On the desktop computer used for this research, a digital file folder system was created to store images to represent targeted science vocabulary/concepts and, later, the completed TAPMAS lessons. To do so, a document folder was created for each week for which the study would run and for which grade level the folder was for (e.g., Week 1,
Grade 6; Week 2, Grade 6, etc.). Within each week’s folder, another folder was created and titled for the specific vocabulary/concept for which relevant information would be stored to it (e.g., Digestion, Excretion, etc.). Within each vocabulary/concept folder, two additional folders were created, with one labeled as Images and the other as TAPMAS Lesson. In this way, and because the study design was for one TAPMAS lesson for each day of intervention, each week’s folder would have five folders within it, with each folder containing an Images folder and a TAPMAS lesson folder. The only variation to this system was if the school week contained less than five school days for a given week, in which case the week’s folder for a particular week might only include four subsequent vocabulary/concept folders.

With much inspiration from Kennedy et al.’s (2014) example of how to create CAPs, TAPMAS lessons were then created in three phases: (1) Preparation, (2) Production, and (3) Publishing. In the next few paragraphs, the steps used for completing each phase will be presented and discussed. Then, an example of a TAPMAS lesson is presented in Figure 5 as a visual aid to the completion of this three-phase process.

**Phase 1: Preparation.** The primary objective of the first phase, Preparation, is to begin the process of homing in on the most essential content to be incorporated into the TAPMAS lesson. For this research, essential content was determined in partnership with the general education science teachers wherein the general education teacher provided an overview of the scope and sequence of upcoming lessons and learning targets. Essential content was then determined in partnership between the general educator and me using the criteria presented in Step 1.0 of Figure 2.
The structure of TAPMAS lessons was consistent, with each lesson consisting of 8-10 slides and following a very similar presentation: title slide, graphic organizer slide, a vocabulary prediction slide, two to three definition slides, a question slide, a final definition slide, and an end or closing slide. The steps to the creation of these slides are presented in Step 2.0 of Figure 2. The sameness in how TAPMAS lessons were created was intended to feel predictable to students and reduce the amount of cognitive energy required for attending to new learning. As often as possible and appropriate, TAPMAS lessons built on each other from one day to the next and connected learning from one lesson to the next. For example, when students were presented learning about related topics (e.g., various organ systems within the human body), the topic similarities and relationship were connected across lessons and defined as part of the larger concept (e.g., organ systems).
Figure 2

Phase 1: TAPMAS Lesson Preparation

Step 1.0: Identify ONE clear vocabulary or concept to be taught in TAPMAS lesson.

1.1 Select only the most essential content.
1.2 Consider if vocabulary can be easily represented graphically (e.g., represented by a picture/image).
1.3 If vocabulary/concept is too complex, or can't be easily represented graphically, break it down into smaller, more concrete parts.
1.4 Create or have access to the Cognitive Content Dictionary (CCD) resource/document (the version used for this research is available upon request from the lead author)

Step 2.0: Create PowerPoint slides for TAPMAS lesson. Each TAPMAS lesson follows the same structure. The specific number of slides for a given TAPMAS lesson may vary.

Note: do not include potentially distracting digital transitions between slides

2.1 Create a clear title page slide introducing the TAPMAS lesson’s topic.
2.2 Create a page with a graphic organizer of the supplies students will need during TAPMAS lesson.
2.3 Create a Vocabulary Prediction slide.
2.4 Create 2-3 Definition slides.
2.5 Create a Question slide.
2.6 Create a Final Definition slide.
2.7 Create End/Closing slide.
Phase 2: Production. With essential vocabulary selected for inclusion and a rough structure for TAPMAS lesson design created, Phase 2, Production, could commence. The primary focus of the Production phase was to search out the graphic representations of the essential content and vocabulary determined in Phase 1. The steps used in the Production phase are detailed in Figure 3.
Step 3.0: Select images that represent the topic as closely as possible.

3.1 Select one eye-catching image per key idea. Use google.com/image or another internet search engine to find copyright-free photos or other images. Save the image(s) to a folder you create for this TAPMAS lesson. Store all saved pictures in the same folder. 

Note: in some instances, it may be appropriate to use more than one eye-catching image per key idea. In such cases, be thoughtful that any secondary images used to not detract from the key idea of the first.

3.2 Select medium to large images that fill most of the viewable space of the slide without becoming distorted or fuzzy. Avoid cluttered images with words or distracting details. The pictures selected should have a central focal point that limits the need for viewers to move their eyes across the screen or spend cognitive energy interpreting.

3.3 Some of the slides will be the same for all TAPMAS lessons and therefore use the same images; specifically, the slides for step 2.2 (Graphic Organizer slide), steps 2.3 and 2.6 (slides directing students to use the CCD), and step 2.7 (End/Closing slide). In addition to content-specific images, download and save to your computer images that represent (1) students working in pairs and (2) an image showing a pencil (each of which can also be found within the ClipArt option of PowerPoint). These will serve as visual supports to ensure students understand they will be working in pairs and will need supplies.

3.4 Ensure you have a copy of the CCD saved as a picture file on your computer (e.g., a .jpg file extension) for inserting into PowerPoint. Many operating systems (e.g., Microsoft Windows) also have built-in screen capturing features that will allow capturing a word document as an image file. In Windows, this is accomplished using The Snipping Tool, which is built-in to the Windows operating system.

Step 4.0: Insert images and key text to the appropriate slides.

4.1 For the title page slide, simply insert a text box and type the vocabulary to be introduced in the TAPMAS lesson. Note that no image is inserted to the Title page slide.

4.2 On the Graphic Organizer slide, insert a text box near the top of the page that reads "Things You'll Need." Insert images depicting the three tools students will need: a partner, a pencil, and a copy of the CCD.

4.3 On the Vocabulary Prediction slide, insert a copy (.jpg image) of the CCD. Enlarge the CCD image to cover as much of the slide page as possible. Over the CCD image, insert a text box in the first column and provide the targeted vocabulary for the students. Insert a rectangle over the "Prediction" section of the CCD. Right mouse click on the rectangle and increase the size of it to 3 pt font and select red as the border color.

4.4 On the first Definition slide, insert the image you selected and saved to represent the lesson's vocabulary. Insert a text box above the image and provide a succinct and accurate definition for the vocabulary (this is the definition students will, later, save to their CCD).

4.5 On the next Definition slide(s), either insert the same image again (if the focus of instruction remains focused on the image/vocabulary) or use secondary images as appropriate.

4.6 The Question slide can also include the same image or a new image of vocabulary. 

Note: this slide is intended to promote discussion between students in the form of a question; the image and narration therefore may use the same image as previous or present a new image that promotes discussion, such as a nonexample.

4.7 On the Final Definition slide, again insert an image of the CCD. This time insert the same red rectangle but highlight the last three sections of the document (Final Meaning, Draw a Picture, and Use in a Sentence).

4.8 On the End/Closing slide, insert a text box and write the words "Thank You!"
**Phase 3: Publishing.** Once essential content was selected (Phase 1), images searched out and stored on the computer and images and text inserted to appropriate slides (Phase 2), the final phase, Phase 3: Publishing, was conducted. The details of how TAPMAS lessons were published are presented in detail in Figure 4.
Figure 4

Phase 3: Publication of TAPMAS Lesson

Step 5.0: Prepare narration for each slide.

5.1 Ensure your computer has a microphone connected to it.
5.2 For each slide, find the notes section (at the bottom of each slide, where PowerPoint reads "Click to add notes").
5.3 Enter the text that will be narrated for each slide.
5.4 Plan to keep the amount of text, and related narration to only the length of time necessary to share essential information. Most TAPMAS slides are 20-30 seconds in narration length, although some may be as long as 1-2 minutes.
5.5 As you write text for narration, practice reading it out loud using intentional pacing and clear pronunciation. It may be helpful to imagine that you are speaking to your students during practice readings.

Step 6.0 Record PowerPoint presentation as a video.

6.1 Select the "Record" tab from the top menu in PowerPoint
6.2 Select the "From Beginning" option. PowerPoint will automatically go to a full screen layout with your first slide presented on the left and the text you entered as notes for the slide on the right. Along the top of the screen there will be recording control options. The center of these controls is a red circle that denotes the "record" button. Once you click record, this button becomes a red square (and serves as the stop recording button).
6.3 Click the red record button. PowerPoint will initiate a 3-second countdown and then begin recording. Once recording has begun, a runtime counter will begin in the top navigation pane. You can stop the recording (by clicking on the red square "stop" button) and either start again, start over (for the slide you are currently on or the entire presentation), or use the pause button (located just to the right of the the start/stop button) if you need additional time at any point during recording.
6.4 If you are unhappy with narration for a slide you can do a retake. To the left of the start/stop button there is an icon depicting an arrow in the shape of a circle and a down arrow. Select the down arrow and then select either "Retake video on current slide" or "Retake video on all slides."

Note: if you select to "Retake on all slides," the program will delete all previous narrations and you will have to start over.

6.5 Once you have finished narration for the current slide, click the red "stop" button.
6.6 Navigate to the next slide using the slide navigation panel in the lower left corner. Once you navigated to a new slide, the same recording options will be available at the top of the page as on the previous slide.
6.7 Record narration for the next slide; Repeat this process until narration is complete for all slides.
6.8 Once satisfied with narration recordings, export narrated presentation as a video by selecting the "Export" button located at the top of the screen and to the right of the start/stop button.

6.9 Select where you want the video to export to on your computer. Use the "Browse" button to open a navigation window and indicate where you would like the video saved on your computer. Click the red "Export Video" button; PowerPoint will automatically save your narrated presentation as a video file with an .mp4 file extension.
The default settings for saving video files within Microsoft PowerPoint 2016, as were used here, is to output saved files as .mp4 files, a common file extension used for audio/video presentations and playable on most modern computers and laptops, as well as other devices like tablets and phones, at 1080p resolution. The .mp4 files were then copied to my work-provided laptop computer and played directly from this computer for student viewing. As video recording for the benefit of ensuring interobserver agreement was an established condition of this research project, using the researcher’s computer allowed for the added benefit of simply using the laptop’s built-in webcam for video recording in a nonobtrusive manner.

Figure 9 presents a representation of a completed TAPMAS lesson used in this study. The far-left column of Figure 5 delineates the titles of the various slides (Title Slide, Graphic Organizer Slide, etc.). The next column to the right displays the graphic information for each slide (what was visually presented to students for each slide), followed by each slide’s narrative content (the audio information recorded to each slide, respectively). Finally, the far-right column of the figure depicts the recording length of each slide.
### Figure 5

**Example of TAPMAS Lesson**

<table>
<thead>
<tr>
<th>Slide Title</th>
<th>Slide Graphic</th>
<th>Slide Narrative Content</th>
<th>Slide Length (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title Slide</td>
<td></td>
<td>&quot;Today we will be learning about something very important to our bodies: Cells. Did you know there are an estimated 37 TRILLION cells in your body? Let's learn what cells are.&quot;</td>
<td>16</td>
</tr>
<tr>
<td>Graphic Organizer Slide</td>
<td></td>
<td>&quot;First, let's make sure you have what you need. You'll need three things for this lesson: 1) your learning partner, 2) something to write with, and 3) a copy of your Cognitive Content Dictionary. If you do not have any of these three things, please pause the video and ask your teacher for help.&quot;</td>
<td>24</td>
</tr>
<tr>
<td>Vocabulary Prediction Slide</td>
<td></td>
<td>&quot;Because we are learning about cells today, you can see the word cell written in the first column here on my Cognitive Content Dictionary (it's written in red just to make it easier to see). In a moment, write the word &quot;cell&quot; in your Dictionary. Then, take a moment and discuss with your partner your prediction of what a cell is. Write you and your partners prediction in the box (highlighted here in red). Once you are done discussing and writing your prediction you can unpass the video and continue. Ready? Go ahead and pause the video and talk with your partner now.&quot;</td>
<td>84</td>
</tr>
<tr>
<td>Definition Slide</td>
<td></td>
<td>&quot;A cell is the basic unit of life. Does this match your prediction?&quot;</td>
<td>27</td>
</tr>
<tr>
<td>Definition Slide</td>
<td></td>
<td>&quot;In living things, one cell or many cells are responsible for carrying out all of the processes an organism (like you!) needs to do in order to stay alive.&quot;</td>
<td>27</td>
</tr>
<tr>
<td>Definition Slide</td>
<td></td>
<td>&quot;Our bodies are made up of TRILLIONS of cells. Because they are so small, we would need a special tool called a microscope to see them. On the left is a picture of a student looking through a microscope. On the right is an actual picture of human cells taken through a microscope and with a special kind of light.&quot;</td>
<td>29</td>
</tr>
<tr>
<td>Definition Slide</td>
<td></td>
<td>&quot;Inside each cell are smaller parts called organelles. Organelles are the smaller parts within the cell with their own job.&quot;</td>
<td>25</td>
</tr>
<tr>
<td>Question Slide</td>
<td></td>
<td>&quot;What is the difference between a cell and an organelle?&quot;</td>
<td>14</td>
</tr>
<tr>
<td>Question Slide</td>
<td></td>
<td>&quot;A cell is the basic unit of life, but organelles are smaller parts within the cell with their own job. The organelles each play a role in the survival and function of the cell.&quot;</td>
<td>14</td>
</tr>
<tr>
<td>Final Definition Slide</td>
<td></td>
<td>&quot;Okay. So now that you've learned about cells, let's complete your Dictionary. Go ahead and pause the video and complete the parts of your Dictionary highlighted here in red. Notice that the definition of a cell, the basic unit of life, is provided here for you. Ready? Pause the video now.&quot;</td>
<td>42</td>
</tr>
<tr>
<td>Closing/End Slide</td>
<td></td>
<td>&quot;Thank you for learning about cells today! You did great! See you next time!&quot;</td>
<td>6</td>
</tr>
</tbody>
</table>
Cognitive content dictionary. Built into TAPMAS lessons, students were prompted to use a variation of a Cognitive Content Dictionary (CCD) (Project GLAD, 2021), a charting strategy commonly used within the Guided Learning and Acquisition (GLAD) teaching framework, as a means of shared note taking and meaning making within TAPMAS lessons. See Figure 6 for an example of the CCD used in this study. Also available in Appendix A.

Figure 6

Cognitive Content Dictionary

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Prediction:</th>
<th>Final Meaning or Definition</th>
<th>Draw a picture of it</th>
<th>Use it in a sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I think this is related to...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I think this is about...</td>
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</tbody>
</table>
As presented in Figure 6, the CCD structure used in this study included five columns: Vocabulary (far left column), Prediction, Final Meaning, Picture, and Sentence (far right column). Embedded throughout TAPMAS lessons, student pairs were instructed to record core vocabulary in the space provided in the CCD Vocabulary column and to then make a prediction, collectively as a pair, as to the definition or meaning of the vocabulary in the Prediction column. Students were encouraged to link their predictions to prior knowledge and to make educated guesses if appropriate. Later in the TAPMAS lessons, final meanings of core vocabulary were provided, and students were instructed to return to their CCD and record the final meaning in the Final Meaning column. Finally, student pairs were prompted to draw a picture of the word or concept using their own example (in the Picture column), and then use the word/concept in a sentence (and record this in the Sentence column). The TAPMAS lessons included both verbal and visual support to guide students toward completion of these tasks.

All required scripts and prompts for peer and focus students to follow were built into the TAPMAS lessons and prompted students to initiate tasks as appropriate to the lesson. For example, the TAPMAS included directions for students to pause the video, refer to and engage with their CCD, and to add their collective thoughts and responses to it. Students were also provided with a writing utensil to accompany their use of the CCD.

**Student Participation in TAPMAS Intervention.** Figure 7 presents a visual representation of student TAPMAS participation during baseline condition and then at intervention (and maintenance). Along the far-right side of the figure are listed the
baseline, intervention, and maintenance phases of the study. At the top of the figure, students with ESN (the study’s focus participants) are visually depicted as separated from their peers and with few social interactions. While initially hypothesized as such prior to starting the study, observational data collected for this study (and discussed later in this document) clearly captured that the focus students with ESN, while physically present in general education classrooms along with their nondisabled peers, were effectively not interacting socially with their peers while in science classes. As depicted by the dotted black line flowing from the students with ESN box in the top (baseline) row of Figure 7, focus students were then paired with their study participating peer support student and assigned a learning space within the general education classroom wherein they could participate in the TAPMAS intervention together. Once student pairs had successfully completed participation in the TAPMAS lesson.
Figure 7

Visual Overview of Study
**Student Technology Access.** Student pairs accessed TAPMAS lessons using my school district issued Microsoft Windows-based laptop. I was present for all TAPMAS intervention sessions and was able to pre-load TAPMAS lessons (originally created on a separate desktop computer and then transferred to the school district issued laptop). I would then queue the TAPMAS video for students, check that the laptop’s volume was set appropriately for student use, and then prompt students to press play when they were ready. I would then move away from the students to allow them to independently access TAPMAS lessons. Once students had completed the TAPMAS lesson, they would indicate to me that they were done, and I would gather up the laptop and prompt and support students to return to classroom activities (see Figure 8 for procedural steps and fidelity checklist). I was present for 100% of TAPMAS lessons and ensured that these procedural steps were followed with 100% accuracy.

**Figure 8**

*TAPMAS Procedural Steps and Fidelity Checklist*

<table>
<thead>
<tr>
<th>Procedural Steps for TAPMAS Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students are assigned by general educator to work in pairs (one student with ESN and at least one participating peer partner)</td>
</tr>
<tr>
<td>2. Students are provided an instructional space to work together in the general education classroom.</td>
</tr>
<tr>
<td>3. Students are provided access to necessary technology (i.e., computer capable of producing auditory and visual information sufficiently).</td>
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<tr>
<td>4. Student pairs are provided a paper version of Cognitive Content Dictionary (CCD).</td>
</tr>
<tr>
<td>5. Student pairs are provided a writing utensil (i.e., a pencil).</td>
</tr>
<tr>
<td>6. Students are observed to engage in TAPMAS lessons entirely (i.e., they watch the entirety of the video presentation).</td>
</tr>
<tr>
<td>7. Students are observed to complete the CCD as evidence of their shared learning.</td>
</tr>
<tr>
<td>8. Students submit their completed CCD to lead researcher.</td>
</tr>
<tr>
<td>9. Students are prompted/supported to re-engage with classroom instruction.</td>
</tr>
</tbody>
</table>
**Student Participation in Science Vocabulary Assessments.** To address whether participation in the TAPMAS intervention might lead to a measurable increase in the correct identification of instructed academic language (DV 2: Correct Responses), focus students participated in weekly pre- and post-tests of science vocabulary (that was also embedded within TAPMAS lessons). Student participation on these tests involved me working one-on-one with each focus student in a shared learning space. While each of the focus students in this study were assigned to a full academic class schedule, each also spent portions of various academic classes in this shared learning space either working with one-on-one with a paraprofessional or special educator, independently engaged in a learning task, or with a small group. In collaboration with each student’s assigned special educator, I was able to administer the science vocabulary tests to focus students during these times. The science tests were designed to be brief, and students were able to finish them in under a minute.

I administered nearly all pre- and post-test to participants individually, with the exception being a few of the tests administered to Greysen by a collaborating speech and language pathologist with whom Greysen was familiar and comfortable working with. For all tests, test questions were presented to students on the same touch screen tablet (a 10.4” Samsung Galaxy Tab S8 Plus) and accessed via a Chrome browser and internet access. During tests, I sat across a table from the focus student being assessed. Test questions were presented visually (e.g., on the tablet screen) one at a time and the test question read to the student exactly as presented visually on the test. The student was then prompted to point to or touch their response to the test question. Once the student
touched the screen to indicate their response, the test would automatically go to the next test item. If the student indicated their response but did not touch the screen to indicate, I prompted them to touch the screen to indicate their choice. It was possible for a student to go back and change their response if they accidentally touched the screen, however, this was not noted as required during this study. Using the example presented in Figure 5, the test question was presented visually to the student then read to the student (“Touch the picture of a human cell.”). I would then pause for a moment and then say, “Which one,” while motioning with a hand over the three possible choices. Participants did not receive feedback on their responses; however, intermittent praise was offered to the participant for responding patiently (Wu et al., 2020). As will be discussed later in the results section, it was necessary to present test items in a slightly different way to Alden as he seemed to prefer to click his response as quickly as possible. For Alden, the test item was presented, and the directions read but with the tablet slightly out of his arms reach (although still visible to him). This allowed Alden a moment to consider his response before selecting.

Instruments and Measures

Data Collection for DV 1: Social Interactions. Serving as the primary dependent variable for this study, social interactions were measured as observed occurrences of social interactions initiated by the focus student to their peer partner. Social interactions are defined for the purpose of this study as a focus student acknowledging or interacting with another student using verbal or nonverbal communicative behaviors. Examples of verbal social interactions included greetings,
talking about upcoming events or activities, providing information, assisting with an assignment by asking or answering questions, or introducing a student to other classmates (Carter et al., 2005). Allowable examples of nonverbal communication included pointing, gesturing, and facial expressions directed at another for the purpose of communication including eye contact (Wu et al., 2020).

Observational data collected pertaining to DV 1: Social Interactions were recorded using partial interval recording (PIR), wherein a trained observer recorded an occurrence for the respective interval if the target behavior (verbal or nonverbal social interactions initiated by the focus student) occurred at any time during the interval (Ledford & Gast, 2018). Using the Social Interaction Observation Recording Tool created for this research project (see Figure 9), observers recorded the occurrences of social interactions they observed. Each observational session used for collecting data for DV 1: Social Interactions was 10-minutes in length, with the total time divided into 40 individual intervals. Each interval was then further delineated to specify 10-seconds for observation and 5-seconds devoted to data recording. Vocal, gestural, or physical stereotypic behaviors deemed nonfunctional to communication were not recorded as social interactions. However, as can be observed in Figure 9, separate rows were included for coding whether a verbal social interaction or a nonverbal social interaction (or both) may have occurred during a given interval. In other words, an interval would be recorded as having contained a social interaction regardless of whether the observation was of a verbal or nonverbal occurrence (or both). Although results were shared as the combination of either verbal and nonverbal communication, the decision to delineating
between verbal and nonverbal initiations on the observation form was determined supportive to observer’s accuracy during observations and aided the initial work of practicing the procedures for this study and ensuring interobserver agreement (IOA) would maintain at adequate levels.

**Figure 9**

**Social Interaction Observation Recording Tool**

<table>
<thead>
<tr>
<th>Intervals 1-10</th>
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<tr>
<td></td>
<td></td>
<td>Verbal</td>
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<td>Nonverbal</td>
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<tr>
<td>Intervals 21-30</td>
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<td>Verbal</td>
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<td>Nonverbal</td>
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<tr>
<td>Intervals 31-40</td>
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<td>Verbal</td>
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<td>Nonverbal</td>
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<td>38</td>
<td>39</td>
<td>40</td>
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</tr>
</tbody>
</table>

Each interval is 15 seconds in length (10 SECOND OBSERVATION and a 5 SECOND RECORDING OF DATA) for a total of 10 minutes.

Start Time: __________

Today's Date: __________

Student Initials: __________

Observer #1: __________

Staff Initials: __________
Observation Cuing and Timing Video Tool. To assist observers in following protocol related to the partial interval recording method and accurately collecting data to the Social Interaction Observation Recording Tool, an audio/video cuing support tool (i.e., audio/video tool) called the Observation Cuing and Timing Video Tool was created. This tool was created using an app-based video creation program called InShot, available as a limited free version or unlimited paid version on the Google Play store; However, those wishing to create a similar tool could also do so with several free or subscription-based apps widely available in the Google Play store, The Apple App store, or on Windows-based computers via the Microsoft Store. The InShot app-based software and the entirety of the Observation Cuing and Timing Video Tool was run and created on a Samsung Galaxy S22 Ultra smart phone.

In following with the procedures outlining use of the Social Interaction Observation Recording Tool, the Observation Cuing and Timing Video Tool was 10 minutes and 17 seconds in length and incorporated visual and auditory cues for each of the 40 intervals embedded within each 10-minute observation session, plus several seconds at the beginning of the video devoted to reminding observers to be sure to have a copy of the paper-based interval recording sheet (see Figure 3) and to be sure to indicate their name and the day’s date on the observation form. The tool was designed with a black background throughout, with vibrant colored text to catch the attention of the observer and better ensure compliance with the observation protocol. During the observation portion of each interval the screen displayed the word OBSERVE in vibrant green; when it was time to switch to recording data for the interval, the screen displayed a
seesawing, red-lettered RECORD. Along with each visual prompt, I narrated auditory directions to accompany. In this way, observers could, using an in-ear Bluetooth or wired earbud, and either a personal computer or personal device (e.g., a tablet such as an iPad or personal smart phone), play this observation video tool during in vitro classroom observations and not lose their place or become easily distracted. In the same way, observers also made use of this tool when recording data from video recording for use in calculating interobserver agreement (IOA). At the conclusion of the video, narration was provided to the observer to indicate that the observation period had ended and to return the paper observation recording form to me. For this research, specifically, a copy of the Observation Cuing and Timing Video was saved to my personal smart phone (a Samsung Galaxy S22 Ultra) and used exclusively for both in-class observations and observations of pre-recorded sessions (and IOA calculations). A digital copy of this observation tool is available upon request.

**Interobserver Agreement (IOA).** For the primary dependent variable of social interactions initiated by students with ESN, interobserver Agreement (IOA) was calculated. A participating special educator was recruited from within the school at which this research was conducted to serve as a second observer. The second observer also served as the case manager for three of the four focus students in this study, however, was not physically present in science classrooms with the four focus students during this study. While some observations not inclusive of a second observer did take place in vivo (e.g., in live time in science classrooms) opportunities to observe and calculate IOA were obtained entirely using video recordings of focus students and their peer partners in
science classrooms and involved both observers watching the videos at the same time and in the same room. Observers were thoughtful not to interact with each other during observations and positioned themselves to not allow viewing of their written responses on the observation response form designed for and used in this study (see Appendix D). IOA was performed in this way to allow for IOA calculations in live time and, if needed (e.g., IOA fell below 90%), provide opportunity for observers to review the observation video again and record their observations a second time using a separate observation recording form.

Interobserver Agreement (IOA) was calculated as point-by-point agreement (or interval-by-interval) and calculated as the number of agreements between observers for each interval divided by the number of disagreements, plus the number of disagreements, multiplied by 100. Figure 10 displays the formula used to calculate this IOA.

**Figure 10**

*Formula and Calculation of Interobserver Agreement (IOA)*

\[
\text{IOA} = \left( \frac{907}{907 + 53} \right) \times 100 = 94.48
\]

IOA was calculated for 37% of observations at baseline condition and 30% of observations at intervention phase, exceeding design standards for SCRD (Kratochwill et al., 2013). Across conditions and participants, IOA was calculated (using the equation presented in Figure 10) as 94.48% and remained consistent when calculated for each participant individually (calculated as 94.97%, 93.75%, 96.79%, and 92%, respectively,
for Ophelia, Alden, Greysen, and Bailey). The 94.48% IOA was sufficiently above established requirements for SCRD (Hartmann et al., 2004; Kratochwill et al., 2021) and results indicated strong agreement between observers, bolstering the trustworthiness of the data collected.

**Data Collection for DV 2: Correct Responses.** The secondary dependent variable for this study was the percentage of correct vocabulary responses on weekly pre- and post-tests of science vocabulary. It was hypothesized that focus student performance would improve measurably once students entered the intervention phase of the study and were exposed to new vocabulary. The weekly pre- and post-tests supplied an investigation of student performance during the week(s) they were in baseline compared to periods when they were in intervention.

The vocabulary items selected for pre-, and post-tests were selected from the science lessons that students were already assigned to participate in as part of their general education science curriculum and as determined by their general education science teacher. According to the participating general education science teachers, these general education lessons were selected to align with grade-level Next Generation Science Standards (National Research Council, 2013).

Not all science vocabulary reflected in the general education curriculum were selected for inclusion in vocabulary tests, however. TAPMAS lessons were designed according to specific principles and guidelines (see discussion of these parameters in the section discussing TAMPAS lesson design) and therefore included one key vocabulary word or concept for each lesson (and one lesson designed for each school day). For this
reason, weekly vocabulary tests included one vocabulary word or concept for each instructional day of that school week which, typically, meant that weekly vocabulary test consisted of five vocabulary items.

Vocabulary inclusion criteria were further informed, at my discretion, by whether prospective vocabulary could readily be represented visually or not. As it was necessary to answer this research projects second question of whether participation in TAPMAS lessons might increase science vocabulary, it was necessary that there be close alignment between the content of TAPMAS lessons and the corresponding weekly vocabulary tests. Vocabulary determined to be abstract or overly complex and which might present as challenging or unclear to represent visually were, therefore, not included for TAPMAS lessons or vocabulary tests. As an example, one of the sixth-grade general education units included teaching about human body systems (broadly), which was determined to be too abstract and complex to represent in one clear and coherent image. Specific to this example, TAPMAS lessons and corresponding vocabulary tests instead focused on specific body systems (e.g., the digestive system), for which specific visuals could be established and represented.

Data for DV 2: Correct Responses was collected as part of weekly pre- and post-tests on science vocabulary. Pre- and post-tests were administered during baseline and intervention phases, with pre-tests occurring at the beginning of the week (typically Monday) and post-tests occurring at the end of the week (typically Friday). Once science vocabulary for a given week were determined (the methods of which are described in the introduction of DV 2: Correct Responses), science vocabulary tests were created survey-
style using Survey Monkey (www.surveymonkey.com) a free, web-based survey creation tool. Survey Monkey was selected for this task because it allowed for test items to be presented as picture selection choices (rather than text). Figure 10 shows an example of how science vocabulary test items were arranged within Survey Monkey and presented to focus students for assessment.

Figure 11

Sample of Sixth-Grade Science Vocabulary Test Presentation

2. Touch the picture of a human cell.

As can be viewed in the example provided in Figure 11, each test question included one correct response and two incorrect distractor choices. The position of questions, as well as the position of answers within each question, were randomly arranged in each data collection session to minimize testing effect as a potential threat (Wu et al., 2020). As discussed previously during discussion of science vocabulary selection, copyright free images used to represent science vocabulary were gathered via Google image searches (www.google.com) and stored locally to my computer before then being uploaded to Survey Monkey for survey (i.e., test) creation. Note that while the
images in Figure 11 are presented here in black and white, the actual test items were presented in color.

Weekly pre- and post-test typically consisted of five science vocabulary test questions. Each test also included one question asking the student to enter their first name for organizational reasons. Once the results of the test were scored, however, the student’s results were coded using the name associated with them in this document and the original information was deleted to protect their identity in the result of a data breach.

Pre- and post-tests consisted of the same test, with the same vocabulary presented in the same structure/order at the beginning of the week and then again at the end of the week. If a student were in baseline for both the pre-test and the post-test for a given week, they would take the same test twice and without any intentional exposure to the vocabulary assessed. However, if the student were in the intervention phase, the pre-test would test their science vocabulary without any intentional exposure, but the post-test would assess their science vocabulary after they had been exposed to that week’s TAPMAS lessons and the embedded science vocabulary instruction within. Over the course of the study, this allowed for a comparison of each student’s performance before they were exposed to vocabulary instruction within TAPMAS lessons and their performance after.

**Science Vocabulary.** Targeted science vocabulary/concepts implemented within TAPMAS lessons were derived from the general education, grade-level curriculum already designed, and lesson planned by the general education science teacher. No
adjustments to general education content or general education classroom lesson design were suggested to the general education teacher. However, to ensure each TAPMAS lesson incorporated a single vocabulary/concept per lesson—important to the structure of how this study’s secondary dependent variable of assessing the use of instructed academic language embedded within the lessons—targeted vocabulary and concepts pulled from the general education curriculum to be included in TAPMAS lessons (and therefore on weekly vocabulary assessments) were selected by me. So, while the academic content used in this research was pulled from general education curriculum and at student’s grade-level, the scope of TAPMAS lessons did not necessarily incorporate exactly all science vocabulary or content planned by the general education science teacher. Essential vocabulary/concepts were selected but the complexity and depth of the vocabulary/concepts were not reduced from that of the grade level standard and what all other students were working toward. Figure 2 provides details for how vocabulary was selected for each TAPMAS lesson and Figure 5 provides an example of a completed TAPMAS lesson with the targeted science vocabulary embedded.

While a core criterion for the inclusion of science vocabulary and concepts was that it be part of the general education curriculum, Kennedy et al. (2015) further detailed that key vocabulary and concepts be carefully paired with “one eye-catching image per key idea” (p. 5) and that extraneous text or content that might distract students from meaning making be excluded. Vocabulary and concepts selected for TAPMAS lessons were therefore further considered for inclusion based on the degree to which the vocabulary or concept could be visually represented. Given the unique learning needs of
the focus students selected for participation and this study’s conceptual foundation in Universal Design (UDL), it was of particular importance that all vocabulary and concepts selected for inclusion in the study could be clearly and concretely visually representable. At my discretion, if a vocabulary or concept could not be clearly represented visually, it was either excluded from inclusion or, if appropriate, broken down into components that could be clearly represented visually. For example, one of the science concepts present in the eighth-grade general education curriculum was energy. Energy, as a stand-alone concept, is challenging to represent visually. Energy was therefore differentiated into different types of energy (e.g., thermal, mechanical, nuclear, sound, etc.) which could more readily be represented visually.

Visually representing vocabulary was of further importance to this research project given that one of the research objectives was to assess the degree focus student’s gained science vocabulary knowledge as part of their participation in TAPMAS lessons, which was assessed using visual assessment prompts (to reduce unintentionally assessing other skills such as reading ability). The same visual representations incorporated in TAPMAS lessons were used in weekly pre and post vocabulary assessments.

This study sought to supplement classroom instruction and align TAPMAS lessons and the embedded targeted vocabulary with what was being instructed in each classroom at the same time it was being instructed to all students. As such, the basal structure of both TAPMAS and corresponding weekly vocabulary assessments relied heavily on the general education science teacher’s lesson planning. While each teacher indicated a strong general sense of what they would be teaching next, each also expressed
that their lesson planning would remain flexible and was subject to change. TAPMAS lessons (and corresponding weekly vocabulary assessments) were therefore required to be created as the study was underway and created on a week-by-week schedule. To better ensure the general education teacher found the selection of vocabulary/concepts acceptable, I consulted with each general education science teacher the week prior to finalizing design for weekly vocabulary assessments and TAPMAS lessons. This allowed for last-minute adjustments as to which vocabulary/concepts would be assessed and included in TAPMAS lessons as necessary.

A paper-based data collection form was used for each observation session and provided observers space to demographic information related to the specific observations (their name, the date, the initials of the student they were observing) and space for recording whether they did or did not observe social interactions, defined in the subsequent procedures section of this work, at each interval. While the observation form did prompt observers to code whether they observed verbal or nonverbal social interactions, it was the total of both verbal and nonverbal interactions that was ultimately recorded; the purpose for asking observers to record these separately was to support researchers with inter-observer agreement and to review the forms in greater detail as needed for determining agreement.

**Social Validity**

Following completion of the intervention phase of this study, I interviewed the participating general education teachers, special education teachers, and peer support students. The participants were asked to report on the usability and acceptability of the
intervention. Additionally, the educators were asked the extent to which they would be likely to design and implement a similar intervention in the future and student participants will be asked if they would consider participating in similar future intervention supports.

**Maintenance.** After progressing through baseline and intervention phases, study participants entered a maintenance phase. In addition to investigating if a functional relationship exists between TAPMAS lessons and occurrences of social interactions initiated by focus students to their peers, this study also sought to investigate whether participation in the TAPMAS intervention might lead to a residual change in the occurrences of social interactions initiated by focus students after the intervention phase had concluded. This MB design study already provided sufficient evidence of experimental control via a minimum of six phases with at least three data points per phase (Kratochwill et al., 2021), in concordance with guidance from the WWC (2020) for SCRD studies (Kratochwill et al., 2010).

The purpose of this maintenance phase was to investigate the amount of possible carryover from the intervention to the general classroom as it related to the dependent variables. Essentially, I was curious as to how the other educators (i.e., participating general education and special education teachers) might choose to incorporate all or some of the intervention once the rigor of the intervention component was complete and students had, as I hypothesized, shown an increase in social communication and science learning. In the planning and development of this study, I predicted several possible outcomes to the maintenance phase: (1) teachers could find the intervention undesirable
or a poor fit for their classroom and choose not to continue with any portions of the intervention once the rigor of the intervention phase was complete, (2) teachers could determine the intervention appropriate for the focus students and continue to support peer partnerships specifically for the benefit of the focus students, or (3) teachers could find the intervention package desirable and acceptable to all students in the classroom and elect to incorporate all or some of the intervention class-wide. As will be discussed in greater detail in Chapter 4 and when discussing the results for each focus student’s data at maintenance phase, data for the maintenance phase is presented as a mixed bag of results. While this variability was partially due to some unexpected student attendance issues likely resulting as residual impact from the Covid pandemic, there was also a level of planned ambiguity as to what the maintenance phase would look like heading into the study. This resulted, primarily, in the maintenance phase serving as a sort of modified version of the intervention phase. Whereas the intervention phase was conducted with specific rigor and tight parameters of implementation (see Figure 1), the maintenance phase included involvement in TAPMAS lesson intervention but with less rigor regarding how students participated. For most of the focus students (the three sixth-grade focus students), the general education teacher ultimately elected to implement TAPMAS lessons class-wide (rather than specifically to focus students and participating peer support students). For one student, Ophelia, this led to her participating with a small group of peers in a naturalistic way and will very little guidance or prompting from me or the classroom teacher. Alden, on the other hand, continued to require a higher degree of structure in order to benefit from the class-wide implementation of TAPMAS. Neither
Greysen nor Bailey entered the maintenance phase. Further discussion of this phase will be discussed in detail in Chapter 4.

Given that the maintenance phase resulted in the participation of all students (in the sixth-grade classrooms at least), it was not feasible to video capture students’ social interactions at this phase as I did not have parental consent or student assent from all students in the classroom to do so. While I was still able to capture real time observational data from being present in the classroom, I was not able to record student interactions for the purpose of ensuring IOA specifically at maintenance phase. This did not, however, reduce overall IOA procedural guidance requirements.

**Data Analysis.** Data analysis of student outcomes will be conducted both visually and statistically based on the What Works Clearinghouse (WWC; 2017) guidelines for SCRD studies Kratochwill et al. (2021) identified, visual analysis included investigation of six factors including level (mean), trend (direction of best fit line), variability (standard deviation from line of best fit), immediacy of effect (i.e., change in level between last three data points in one phase and first three data points in subsequent phase), overlap (i.e., percent of data points in one phase that are within the range of data points in previous phase), and consistency across similar phases. Finally, to establish whether a functional, or causal, relation is evident with visual analysis, the data were examined to determine if they met criteria for SCRD, as outlined by Kratochwill et al. (2021) of at minimum three demonstrations of effect observed at three or more points in time. Additionally, as suggested by the WWC panel (2017), statistical analysis using Tau-\( U \), a non-parametric method for measuring data nonoverlap between baseline and
intervention phases (Brossart et al., 2018; Parker et al., 2011), were conducted along with visual analysis for each focus student participant.

Next, I discuss my role as an education professional and researcher and how I controlled threats to the validity of the results shared within this document.

**Role of the Researcher**

I am licensed as a school psychologist and, thus, my training as an educator is steeped in applied behavior analysis. More importantly, my professional work history of nearly two decades has occurred exclusively within an inclusive learning environment. As a result of my experiences, I willfully admit that I am biased in my belief that students with disabilities can and should be educated with their peers and within general education classrooms to the maximum extent possible. While this bias is in-line with the body of research supporting inclusive learning practices as superior to that of segregated, special programs (see Kurth et al., 2014, for example), it is nonetheless my personal bias as well. I take issue with the language of IDEA that stipulates opportunities for learning with nondisabled peers and opportunities to progress in the general education curriculum for students with disabilities should only be provided as much as “appropriate” (IDEA, Section 300.42) because I find appropriate too subjective. My years of formal education have provided me a lens for understanding human behavior as contextual and interactive to the individual’s environment. My anecdotal professional experiences of the past decade have afforded me uncountable opportunities to witness observable changes in how students interact with and learn from and with one another when provided inclusive learning opportunities. I have worked with teams who have supported students to reach
goals that others said they could not. Too often I have witnessed definitions of “appropriate” vary from adult to adult, often disregarding, in my opinion, the needs and rights of the student in favor of the system’s equilibrium. I would much prefer that educational teams consider the opportunities afforded to students with disabilities as needing to happen to the maximum extent possible.

And finally, I recognize that being a White, male, English speaking member of the currently dominant culture frames both how I see the world, and my views of what it means to learn, how systems of education should operate, how I view problems within education, and how I conceptualize dis/ability. I do not identify myself as a person with a disability, for example, and so do not propose to speak for what persons with disabilities need—or even want. My researcher stance as it pertains to the complexity of dis/ability, and the purpose of this research study, is in consideration of the human experience—in all its various shapes, sizes, and unique abilities.

I acknowledge that my prior education, knowledge, and experiences have influenced the way in which I have identified a problem of practice, developed research questions, and designed and implemented this research study. I have strategically controlled my biases within the methodology of this research, including close consideration of both potential internal and external threats to validity. As a quantitative, experimental SCRD research methodology, the role of the researcher in MB design is typically discussed in terms of validity, accuracy, and reliability (Ledford & Gast, 2018). Although not specific to SCRD, these potential research issues do present some unique challenges to SCRD (Ledford & Gast, 2018).
Internal validity is the degree to which a study establishes a functional (i.e., causal) relationship between the treatment and the observed outcome (Perone & Hursh, 2013). Stated another way, internal validity is the believability that results are due to the independent variable and not some other factor (Ledford & Gast, 2018). As Kratochwill et al. (2010) identified, well-structured SCRD research can rule out major threats to internal validity via demonstration of experimental control through phase repetition and effect repetition. The MB design employed in this research study involved an intervention effect replication across multiple participants and meets quality standards for demonstration of intervention effect according to the WWC Criteria for Designs that Meet Evidence Standards (Kratochwill et al., 2010). Embedded in the WWC Standards is a criterion that the independent variable is actively manipulated by the researcher with measurement of the dependent variable occurring after manipulation (Kratochwill et al., 2010). In this research study, I’ve safeguarded internal validity by staggering the point at which the intervention treatment was introduced to focus student (students with ESN). This increased the likelihood that observed effects immediately after introduction of the intervention were due to the intervention and not factors extraneous to the research.

Pre- and post-tests of targeted science vocabulary (DV 2) were also shared. To minimize threats to validity pertaining to this measure I operationalized the testing procedures prior to gathering data and presented each test to the focus students (students with ESN) in as standardized a manner as possible.

I controlled for threats to external validity—the degree to which the outcomes of a study are generalizable (Ledford & Gast, 2018)—by describing the setting, participants,
and procedures in close detail, including inclusion criteria for focus students and peer support students. As Kratochwill et al. (2010) noted, when participants are included in a study based on need versus random selection, selection bias can present as a threat to external validity. I controlled this threat by detailing who my participants were and how and why they were selected for participation in this study.

Finally, I took steps to control the potential for observational bias. As Wolery (2011) quipped, humans are terrible data collectors but are often superior to other available options. I controlled the impact of human error and bias in observation by video recording observation sessions during the intervention phase of this research, training a second observer, and then calculating and sharing interobserver agreement (IOA) for the primary dependent variable (social interactions).
Chapter 4: Results/Analysis

The purpose of this study was to provide evidence on how the use of technology might improve peer-to-peer learning arrangements in inclusive classrooms to promote positive academic and social outcomes for middle school students with ESN. An intervention package, Technology-Assisted and Peer-Mediated Academic Support (TAPMAS), was designed for this study and delivered to students with ESN and their study-participating general education science classroom peers and then evaluated for effect.

Specifically, this study sought to answer the following research questions:

1. Is there a functional relationship between implementation of a technology-assisted and peer-delivered intervention (Technology-Assisted and Peer-Mediated Academic Support package—TAPMAS) delivered within inclusive middle school classrooms and increased social interactions initiated by middle school students with ESN to their nondisabled peers?

2. Does implementation of TAPMAS lead to residual carry-over in occurrences of social interactions in the general education classroom for students with ESN post-intervention?

3. Does implementation of TAPMAS intervention lead to an increased use of instructed academic language for students with ESN?

4. Do teachers and students find the methods of this research acceptable and usable?
In this chapter, the results of each research question will be addressed in order. Data for each research question will be presented, analyzed, and interpreted. Finally, a discussion of study limitations will conclude the chapter.

**Analysis of data**

To investigate the first research question posed, whether a functional relationship existed between the TAPMAS intervention (the study’s independent variable) and observed occurrences of social interactions initiated by students with ESN to their peer partners (the study’s primary dependent variable), a multiple baseline (MB) across participants single case research design (SCRD) method was used. Data was collected for four middle school students with ESN (focus students), Ophelia, Alden, Greysen, and Bailey. Following this method, all four students started in the initial baseline data collection phase at the same time (on the same day) and then, once a consistent baseline was established in the data, each student entered the subsequent intervention and maintenance phases at different points in time (different days). This staggering of when students entered the intervention and maintenance phases allowed for evidence of experimental control and comparison of the occurrences of social interactions for each student at baseline and then again at intervention and maintenance. With each student serving as their own control, comparison of the phase change from baseline to intervention allowed for investigation of the functional relationship between intervention (TAPMAS) and the occurrences of social interactions generated by focus students to their nondisabled peers.
Results for Research Question #1: Functional Relationship Between TAPMAS and Social Interactions

A visual analysis was conducted to determine if there was a functional relationship between the TAPMAS intervention and this study’s primary dependent variable, social interactions (Ledford & Gast, 2018). In addition to visual analysis, statistical analyses were also conducted using Tau-\(U\), a non-parametric method for measuring data trends within and non-overlap between phases to calculate an effect size for SCRD studies (Brossart et al., 2018; Parker et al., 2011) for each student. Statistical analysis was conducted using a free, web-based calculator provided by Single Case Research (www.singlecaseresearch.org) (Vannest et al., 2016).

Social interactions, for the purpose of this study, were defined as any verbal or nonverbal observable interaction initiated by the focus student to any of their class peers (assigned as part of this research or not, although careful consideration was focused on interactions between the focus student and their research-assigned peer). For an interaction to be coded and included, the focus student was required to observably express in some way, verbally or nonverbally, that they were attempting to communicate with their peer. In other words, occurrences were not coded if a peer verbally or nonverbally communicated to a focus student, but the focus student did not reciprocate the interaction in an observable way. Examples of verbal social interactions could include greetings, talking about upcoming events or activities, providing information, assisting with an assignment by asking or answering questions, or introducing a student to other classmates (modeled after the work of Carter et al., 2005). Examples of nonverbal
communication could include pointing, gesturing, facial expressions directed at another for the purpose of communication including eye contact (modeled after the work of Wu et al., 2020). Data collection of social interactions between focus students and their peer partners were conducted as 10-minute observation periods at the beginning of each student’s science class.

Figure 12 provides a visual display of results for the primary dependent variable, occurrences of social interactions initiated by focus students (students with ESN) to their nondisabled peer partners and visually presents the four demonstrations of effect at four points in time indicating a functional relationship between TAPMAS and improvement in social interactions. In the next several paragraphs, in discussing individual focus student’s data, demonstrations of effect at different points in time are identified each time a student moved from one phase to another (from baseline to intervention, for example) and in consideration that each student entered intervention phase at different points in time. With four participating focus students, each beginning at baseline at the same point in time (on the same day) and then entering intervention at different points in time, this study demonstrated an experimental effect of the intervention at four different points in time (Ledford & Gast, 2018). Statistical analysis of performance for each student is also provided.
Figure 12

Occurrences of Social Interactions by Focus Students to Peers

![Graph showing occurrences of social interactions by focus students to peers over sessions for different individuals. The graph is divided into three sections: Baseline, Intervention, and Maintenance. Each section shows the number of intervals with occurrences of social interactions for each individual. The individuals are named Bailey, Greysen, Alden, and Ophelia.]
Figure 12 displays each focus student’s data separated vertically into tiers. The top tier, tier 1, displays the data for the first focus student, Ophelia. The next tier down, tier 2, displays data for the second focus student, Alden, followed by Greysen in tier 3, and finally Bailey in tier 4 at the bottom of the figure. The horizontal x-axis indicates sessions for the study by number and the vertical y-axis reports the number of observation session intervals for which occurrences of social interactions by the focus students to their nondisabled peers were observed. Each tier is divided by vertical solid black lines to indicate a baseline phase, an intervention phase, and a maintenance phase (although only two students progressed to this final maintenance phase, which shall be discussed further). As can be viewed in Figure 12, all four focus students began the study on the same calendar day (at session 1) and the collection of baseline data was continuous even as students entered intervention phases at different points in time. Importantly, it should also be noted again that focus students for whom this data was collected were each in separate general education sciences classes when the data was collected. Of note, Ophelia, Alden, and Greysen were all sixth-grade students and each had the same classroom teacher (but for different class periods of the day) and the same supporting special education teacher. The fourth student, Bailey, was an eighth-grade student and had a different classroom teacher and supporting special educator. As will be discussed, as the first student (Ophelia) progressed into intervention and then maintenances phases, the classroom teacher found it desirable to apply the treatment of the intervention to their entire science classes rather than just to study-participating students. This will be
discussed further when considering the participant’s acceptability and usability of this research.

**Ophelia.** During the baseline condition (phase), the occurrences of social interactions observed for Ophelia were consistent, with a mean 0.5 social interactions across all baseline sessions (3 total social interactions observed over 6 sessions) and with a range of 0-3 social interactions observed during this phase. Interobserver agreement (IOA) for observations of Ophelia was calculated as 94.97% and noted to be sufficiently above established requirements for SCRD (Hartmann et al., 2004; Kratochwill et al., 2021).

During the intervention phase, the mean number of social interactions increased to 20.93 social interactions per observation sessions (293 total social interactions over 14 intervention sessions) with a range of between 16 and 28 social interactions observed. The percentage of nonoverlapping data (PND) between the conditions was 100%, indicating there was no overlap of data points between baseline and intervention and that all data points in intervention showed improvement over baseline (Vannest & Nicci, 2015). Data trends in both conditions were flat, differentiated only by their level. As can be viewed in Figure 12, there was a far wider range observed during intervention; however, the overall trend of the data remained consistent across the entire intervention phase set. Ophelia was absent for one session at baseline (session 3) and data collection was interrupted by required state-mandated reading and math testing at sessions 8 and 17.
At session 18, Ophelia shifted to maintenance phase. This phase differentiated from intervention in two important ways: first, Ophelia was no longer assigned to work with a study-participating peer and instead worked organically with peers from class who volunteered to partner with her and, second, the classroom teacher elected to incorporate TAPMAS lessons class wide, rather than only to study-participating students as was the case during intervention. This represented an exciting and important shift in final aspects of this study’s design and will be discussed further when considering a secondary dependent variable of this study, the degree to which involvement in TAPMAS intervention might lead to residual carryover effects related to social interactions post-intervention, as well as the social validity of the study and the degree to which participants (particularly educators, in this case) found the study to be useful and meaningful.

When considering any carryover effects of social interactions post-intervention, several non-participating general education students were noted to approach me during the intervention phase and ask if they, too, could participate in the study. Although I had to explain to them the tight methods I was employing, it was heartening to observe students seeking opportunities to participate and support their peers. This observation was made primarily regarding Ophelia’s class, although also noted for Greysen’s.

In addition to visual analysis, phase change from baseline to intervention was also calculated via Tau-\(U\) (Vannest et al., 2016). Tau-\(U\) calculations allow for investigation of both within phase trends as well as between-phase differences resulting from an intervention (Brossart et al., 2018) and are reported within the range of -1 and +1 and as
agreement between two variables’ rank orders increases, Tau-U approaches +1 (Brossart et al., 2018). In other words, the stronger the trend between, in this case, time (the x-axis; observation sessions) and observed score (the y-axis; occurrences of social interactions), the more Tau-U scores approach +1 and the larger the effect size of the intervention becomes.

As Fingerhut et al. (2021) and Vannest et al. (2016) cautioned, it is imperative to investigate baseline phase for possible trends prior to calculating possible phase changes between baseline and intervention, as evidence of a within-phase trend at baseline could indicate a smaller effect size attributable to the intervention or require use of a corrected baseline (Fingerhut et al., 2021). I investigated the possibility of baseline trend by calculating results both with and without a corrected baseline. Calculated results did not change between these two calculations, indicating there was no requirement to adjust baseline prior to continuing with Tau-U calculations. Tau-U calculations of the between-phase change from baseline to intervention indicated a statistically significant change (Tau-U = 1; p-value = 0.002), indicating the observed change in performance from baseline to intervention (occurrences of social interactions) was very unlikely to be due to chance and, instead, was attributable to the effects of the intervention.

**Alden.** During the baseline condition (phase), the occurrences of social interactions observed for Alden were consistent, with a mean of 0 social interactions observed (over 8 total observation sessions, including sessions 1-6 and sessions 11 and 12). Interobserver agreement (IOA) for observations of Alden was calculated as
93.75% and noted to be sufficiently above established requirements for SCRD (Hartmann et al., 2004; Kratochwill et al., 2021).

As Alden’s baseline performance was very consistent through sessions 1-6, an attempt was made to move Alden into intervention at session 7. Unfortunately, Alden experienced a lengthy illness at session 8 and missed the next several days of school as a result (sessions 8-10). It was therefore determined that Alden should return to baseline for a period prior to moving to intervention. Alden’s results at session 7, at which point he was observed to engage in 3 social interactions, were originally intended to be included as the beginning of intervention phase. As such, Alden was exposed to intervention at session 7; however, after re-establishing a return to consistent baseline at sessions 11 and 12 (a return to a mean of 0 interactions observed once again), Alden was considered to have entered intervention officially at session 13. Once at intervention (beginning at session 13 and continuing through session 21), the mean number of social interactions observed increased to a mean of 9.88 social interactions per observation sessions (79 total social interactions over 8 intervention sessions) with a range of between 17 and 7 social interactions observed. The percentage of nonoverlapping data (PND) between the conditions was again 100%. Data collection for Alden was interrupted at session 18 due to state-mandated reading and math testing on these dates.

Data trend at baseline for Alden was consistently flat (notwithstanding the discussed anomaly at session 7). During intervention, the data trended generally downward, however. Finally, Alden entered maintenance phase at session 23 and continued at session 24. As can be observed in Figure 12, Alden’s social interactions
abruptly returned to baseline condition-like performance (0 social interactions observed) as soon as the rigor of the intervention phase was reduced, and Alden entered what was intended to be a maintenance phase (starting at session 23). As discussed previously when discussing Ophelia’s data, Ophelia and Alden’s classroom teacher (same teacher, different class periods) had advocated for all students in the classroom to participate in TAPMAS lessons, rather than only the students selected to participate in this study. So, while I had the requisite number of data points at intervention for Alden, I was still creating TAPMAS lessons for the final sixth-grade student to enter intervention phase, Greysen, and could therefore easily allow Alden to continue with a modified version of intervention. In observation of the observed benefits for Alden at intervention (identified as increased social interactions at intervention), I determined to modify the maintenance phase for him and returned to a level of structure and support closer to the intervention phase beginning at session 23. At session 23, I prompted a peer naturally seated near Alden to partner with Alden. As such, session 22 essentially represents a full withdrawal of prompting and support for Alden to engage in the TAPMAS intervention and session 24 represents a modified version of maintenance phase.

In addition to visual analysis, phase change from baseline to intervention was also calculated via Tau-\(U\) (Vannest et al., 2016). I investigated the possibility of baseline trend by calculating results both with and without a corrected baseline. Calculated results did not change between these two calculations, indicating there was no requirement to adjust baseline prior to continuing with Tau-\(U\) calculations. Tau-\(U\) calculations of the between-phase change from baseline to intervention indicated a statistically significant change
(Tau-$U = 1$; $p$-value $< 0.001$), indicating the observed change in performance from baseline to intervention (occurrences of social interactions) was very unlikely to be due to chance and, instead, was attributable to the effects of the intervention.

**Greysen.** Greysen also experienced parent-reported health issues during participation in this study, although this primarily impacted participation at baseline. During the baseline condition (phase), the occurrences of social interactions observed for Greysen were also consistent and flat, with a mean of 0 social interactions observed (over 11 total observation sessions, including session 1, sessions 3-6, sessions 9-11, and sessions 13-15). Greysen was absent from school due to parent-reported illness at sessions 2, 8, and 12 (as well as session 18, although that was during intervention). Data collection was also interrupted at sessions 7 and 17 due to state-mandated science testing on these dates. Interobserver agreement (IOA) for observations of Greysen was calculated as 96.79% and noted to be sufficiently above established requirements for SCRD (Hartmann et al., 2004; Kratochwill et al., 2021).

Greysen entered intervention at session 16, at which point a significant increase in social interactions was observed (11 social interactions observed at this session). Data collection was then briefly interrupted by a required state science testing day (session 17) and then a day of illness-related absence for Greysen (session 18). Greysen continued in intervention phase again at sessions 19-23. During these intervention sessions, Greysen was observed to engage in between a range of 6 and 21 social interactions, which calculated to an average of 12 social interactions per session during this specific period and a similar average of 11.83 social interactions per session when also including results
from session 16. So, while Greysen’s participation in intervention was briefly interrupted at onset, her overall response at intervention resulted in a well-defined increase in social interactions and consistent, 100% nonoverlapping phase change between baseline and intervention.

Of note, Greysen did not enter a maintenance phase. This occurred for two reasons, the first a practical one and the second an ethical one. First, the length of the study was nearing conclusion and running into school-calendar based challenges. Second, after consultation with Greysen’s classroom teacher, special educator, and university supervisor, there was concern that, while Greysen had responded very well to intervention, she could likely not respond as well to maintenance due to her demeanor as a student and her tendency to adhere to established structure and routine. A similar decision was made regarding Bailey (discussed next) and an experience he had with the sudden withdrawal of intervention and subsequent return to baseline performance (i.e., zero social interaction occurrences). Given that Greysen had responded so well to intervention according to the data, and anecdotally and subjectively appeared much more comfortable in class and with interacting with peers, it was determined that the potential risk of her exiting intervention was outweighed by the positive effect of staying in intervention.

In addition to visual analysis, phase change from baseline to intervention was also calculated via Tau-\(U\) (Vannest et al., 2016). I investigated the possibility of baseline trend by calculating results both with and without a corrected baseline. Calculated results did not change between these two calculations, indicating there was no requirement to adjust
baseline prior to continuing with Tau-\(U\) calculations. Tau-\(U\) calculations of the between-phase change from baseline to intervention indicated a statistically significant change (\(\text{Tau-}\(U = 1\); \(p\)-value < 0.001), indicating the observed change in performance from baseline to intervention (occurrences of social interactions) was very unlikely to be due to chance and, instead, was attributable to the effects of the intervention.

**Bailey.** Bailey presented differently from the other study focus students in terms of his baseline performance, specifically, and regarding some of the qualities of his social interactions with peers at both baseline and intervention. During the baseline condition (phase), the occurrences of social interactions observed for Bailey were inconsistent, with a range of between 0 and 9 social interactions observed at this phase (for an average of 1.57 social interactions per session during baseline). Even so, IOA for observations of Bailey was calculated as 92\% and noted to be sufficiently above established requirements for SCRD (Hartmann et al., 2004, Kratochwill et al., 2021).

Interestingly, a visual review of the data for Bailey at baseline seems to indicate a possible pattern to observed social interactions: several peaks or spikes in observed social interactions (at sessions 3 and 9, for example, and to a lesser degree at session 14) were observed, followed by periods of much lower occurrences following. Of note, the possible trend in data indicated a steady decline in this pattern over time, however. No distinguishable reasons were uncovered which might explain the varying performance observed during baseline, although it is possible the presence of a researcher/observer in the classroom caused some additional anxieties for the student. This seems additionally likely considering the declining trend observed as sessions passed. The quality of the
social interactions observed for Bailey during baseline may also provide some insights: unlike the other three focus students participating in this study, Bailey was observed—at times—to attempt many connections with his peers. This research did not differentially code for positive and negative interactions between students and was only looking for social occurrences, regardless of the perceived qualities of these interactions. Had this research been designed to specifically look for and collect data specifically on perceived positive interactions, many of Bailey’ social interactions would likely have been coded as negative (or, at least, not positive) interactions. So, while not specifically addressed by this research, it is important to note that Bailey was observed to engage with peers with frequency; at times, however many of these interactions were not what most observers would likely report as positive or expected social behaviors. Specifically, Bailey was observed to attempt to engage with peers in unexpected ways and often used language that appeared meaningful and interesting to him but possibly not to his peers. On a few occasions, Bailey was observed to physically move the arm or hand of his peer when they attempted to navigate the computer the pair were using, prompting coaching from me and redirection from his special education teacher. This presented challenges to researchers in determining whether observed behaviors met the social interaction criteria set forth in the research proposal and will be discussed later when considering study limitations.

Bailey was absent at session 16 and participated in the required state science testing at session 17. He began intervention at session 18 and—apart from another absence at session 20—continued in intervention through session 23. The overall trend of social interactions observed during intervention was positive and included a range of
between 9 and 23 social interactions per observation session (for an average of 16.8 over all intervention sessions). Eighty percent (4/5) sessions at intervention were nonoverlapping with baseline. Bailey’ first session at intervention (session 18) included the same number of observed social interactions as session 3 of baseline (9). As can be observed in Figure 12, however, the trend in observed social interactions indicated a strong upward trend the longer Bailey was in intervention. Of note, Bailey was paired with one peer-partner for sessions 18 and 19 and a second individual peer-partner for sessions 20-23. This may partially explain the slight regression from session 19 (17 social interactions observed) to session 20 (15 social interactions observed). Equally possible, however, was the fact that an absence occurred between the two. Bailey appeared generally to benefit from consistency in exposure to intervention and demonstrated increasing benefit from intervention over time. Relatedly, although not directly evident in Figure 12, the quality of Bailey’ interactions with his peers also improved the longer he was in intervention. In other words, Bailey was noted to more consistently engage in expected social interactions as his experiences in the intervention continued (e.g., his verbal and nonverbal communications were more often reciprocated by peers, on-topic, and appeared physically and socially more comfortable to peers).

In addition to visual analysis, phase change from baseline to intervention was also calculated via Tau-\(U\) (Vannest et al., 2016). I investigated the possibility of baseline trend by calculating results both with and without a corrected baseline. Calculated results did not change between these two calculations, indicating there was no requirement to adjust baseline prior to continuing with Tau-\(U\) calculations. Tau-\(U\) calculations of the between-
phase change from baseline to intervention indicated a statistically significant change (\(\text{Tau-}U = 0.99; p\text{-value} = 0.001\)), indicating the observed change in performance from baseline to intervention (occurrences of social interactions) was very unlikely to be due to chance and, instead, was attributable to the effects of the intervention.

**Interpretation of Findings for Research Question #1: Functional Relationship Between TAPMAS and Social Interactions**

For each focus student, observed occurrences of social interactions generated by the focus students to their partnered peers (verbal and nonverbal, collectively) increased immediately and substantially upon introduction of the TAPMAS intervention. Visual analysis of the increase in occurrences of social interactions occurred for each student at phase change between baseline and intervention, resulting in visual demonstration of effect at four different points in time. Using a Tau-\(U\) calculator (\[\text{www.singlecaseresearch.org/calculators.tau-u}\]) (Vannest et al., 2016), the data were evaluated for potential baseline trend. Finding the baseline trend to be sufficiently flat (i.e., did not indicate trend prior to intervention), there was no requirement to correct baseline prior to continuing with quantitative analysis (Fingerhut et al. 2021).

Quantitative analysis was then conducted for each participant’s phase change from baseline phase to intervention phase. For each participant, the phase change from baseline to intervention was statistically significant, indicating that the change in the occurrences of social interactions observed at intervention were very unlikely to have resulted by chance (\(p\text{-values} < .05\)). Finally, an overall effect size across the participants was calculated, resulting in a Tau-\(U\) of 0.99 (\(p\text{-value} < 0.001\); 90% confidence interval 0.743<
Vannest and Nicci (2015) described Tau-U results larger than 0.80 as large or very large. The Tau-U for this study, then, represents a very large effect size. Given that the 90% confidence interval included a score just below the 0.80 effect size Vannest and Nicci qualified as large or very large, however, results can more accurately be described as moderate to very large (Vannest & Nicci, 2015).

These statistical results further support visual analysis and demonstrated that there was a functional relationship between TAPMAS and the primary dependent variable of Social Interactions. This functional relationship resulted in an immediate and consistent increase in the observed occurrences of social interactions initiated by focus students to their peers because of the TAPMAS intervention.

Results for Research Question #2: Carryover Effects in Social Interactions

The second research question posed by this study was the extent to which involvement in the TAPMAS intervention might lead to carryover or residual effects in social interactions after the intervention phase of the study was complete, as measured by observations of occurrences of social interactions between students with ESN and their general education science peers during the maintenance phase of this study. Conclusion of the intervention phase was designed to be after the appropriate minimum number of session observations needed to determine intervention effect, five per Kratochwill et al. (2021), had been collected and intended as a means of further assessing the social validity, or real-world usefulness, of the TAPMAS intervention. When I first designed this study, I was curious as to what would happen after intervention: would student social interactions return to baseline-like conditions, or would something new develop post-
intervention (for example, perhaps involvement in the TAPMAS intervention would foster residual inter-personal relationships after)? While not designed as a true withdrawal design (e.g., a complete removal of intervention and return to baseline conditions) (see Ledford & Gast, 2018), I had considered several possible scenarios that could unfold, including a return to status quo of the baseline condition. It was also possible, I speculated, that something new—such as a continuation of all or part of the TAPMAS intervention—could develop organically.

As the intervention unfolded and Ophelia, the first focus student to enter intervention phase, was nearing the conclusion of the intervention phase, the sixth-grade general education teacher requested that Ophelia continue with intervention rather than shift to maintenance phase. The sixth-grade general education teacher also inquired if the TAPMAS lessons could be made available to each of her sixth-grade science classes, rather than just the focus student and participating research peer. This request made practical sense for two reasons. First, I was continuing to develop TAPMAS lessons for the other two sixth-grade focus students who were on the verge of or already moving into intervention phase. In other words, it was not more labor to create TAPMAS lessons for Ophelia (and her classmates) to engage with because I was already creating them for Alden and Greysen. And second, having all students engage in TAPMAS lessons made more sense—to the opinion of the general education teacher and my own—because doing so created a more congruent classroom experience for both the teacher and students. In other words, having all students in the room engaged in the same task at the same time was determined to be more seamless and created less potential distraction within the
classroom. The general education teacher also proposed their opinion that the TAPMAS lessons offered value to other learners in the classroom as well, noting that students had done performed as well as hoped on a recent vocabulary assessment and that perhaps TAPMAS lessons would help (unfortunately, vocabulary assessment data pertaining to this wondering was not made available at the time of this writing, however). So, TAPMAS lessons became the class warm-up activity for all sixth-grade science classes (including those without any of the focus students for this research) and all students were paired up, or worked in small groups, and engaged in TAPMAS lessons for the first 10-minutes of each class.

Regardless, whereas this research was designed to include a maintenance phase, the maintenance phase essentially became a less rigorous version of the intervention phase. During intervention I controlled variables such as which students focus students partnered with (i.e., research participating peers), where students were seated to engage in TAPMAS lesson, and closely monitored intervention fidelity. Once the required number of session observations were obtained at intervention, however, focus students were permitted to partner with any peers in the room and be seated wherever the classroom teacher permitted and control of the presentation of TAPMAS lessons, at sixth grade specifically, was substantially transferred to the classroom teacher.

This was not the case at eighth grade, however: Bailey (the eighth-grade focus student) only engaged in TAPMAS lessons as part of intervention and, due to illness-related absences and the conclusion of research, did not benefit from an opportunity to shift to a maintenance phase.
Interpretation of Results for Research Question #2: Carryover Effects in Social Interactions

As introduced in Chapter 3, the maintenance phase was intentionally designed with some planned ambiguity during study design to allow for responsiveness as the study unfolded. Specifically, it was hypothesized in development that the general education teachers could find the TAPMAS intervention undesirable and therefore elect not to use any parts of the intervention beyond the requirements I set forth in the intervention phase. This may have resulted in, essentially, a withdrawal-type design in which students could have returned to baseline-like conditions. In actuality, the general education teacher for the sixth-grade students (representing 3 of the 4 focus students in this study, and all of the sixth-grade students) found the TAPMAS lessons to be beneficial and, in close collaboration with myself, determined to implement the intervention class-wide rather than determining to only include focus students and participating and assigned peer support students into the maintenance phase or—worse—to not support continuation of any components of the TAPMAS intervention at all beyond the intervention phase. This resulted in a modified version of the intervention phase—marked by less rigor and strict adherence to the fidelity and intervention checklist identified for the intervention phase (see Figure 8)—serving as the parameters of the maintenance phase.

In addition to the attendance-related challenges of an early post-Covid reality resulting in two of the four focus students not progressing into a maintenance phase, this resulted in a mixed bag of results specific to how implementation of TAPMAS led to
residual carry-over in occurrences of social interactions in the general education for student with ESN post-intervention. On the one hand, there was compelling evidence that students may benefit significantly from a less stringent and rigorous version of intervention (e.g., this modified maintenance phase), such as the results observed for Ophelia. While not the same pronounced benefit, Alden also benefitted in that without at least some of the additional structure provided by the modified maintenance phase, he returned quickly to pre-intervention performance and with no apparent benefit to TAPMAS lessons being delivered whole group. On the other hand, neither Greysen nor Bailey was able to progress to maintenance phase, presenting a challenge to determining, overall, whether implementation of TAPMAS necessarily led to residual carry-over in occurrences of social interactions. What can be stated, for the two students who did progress to maintenance, there was residual carry-over in the occurrences of social interactions, albeit with caveats.

Finally, as further evidence of the residual or carry-over effects of the TAPMAS intervention, two of the focus students (Ophelia and Greysen) were noted by their special educators to be reluctant to attend or stay in their science class prior to the intervention. This reluctance to attend was noted prior to the study’s data collection (during study design) and observed initially at the onset of data collection. At the onset of the study, Ophelia was observed to plead that a familiar adult (special educator, paraprofessional, or myself) attend class with her and if familiar staff attempted to leave the room, she would often follow and ask that they return. Greysen was noted to typically request to work at a table outside of the classroom prior to the intervention. Once the intervention began, and
after the students became initially familiar with it, each student was noted to require less adult support and to stay in class and engaged in expected schoolwork for most of their science class period.

To a lesser extent, Bailey may also have exhibited a slightly increased likelihood of being and staying in his science class as expected. His special educator shared during the study that prior to the study beginning he had been attending science classes with some regularity and would sometimes participate socially with peers while in class (although almost exclusively these interactions were reflective of his preferred topics and sometimes of the unexpected variety). Just prior to the study commencing, Bailey had begun to exhibit resistance to attending class and required more adult support to attend and stay in class. While initially this was evident during baseline data collection as well, Bailey seemed to ease back into a pattern of greater participation and attendance as the study continued into intervention. I investigated the possibility of potentially confounding events or experiences that might overlap this period for Bailey by speaking with his special educator and science teacher and was not made aware of any such co-occurring events. After gaining familiarity with the intervention components, Bailey was noted by his special educator to be less resistant to attending class and as discussed previously, his social interactions with peers anecdotally became more socially acceptable as time passed and he progressed within the TAPMAS intervention.

**Results of Research Question #3: Use of Academic Language**

The third research question posed by this study was whether implementation of (exposure to) TAPMAS intervention might lead to an increased use of instructed
academic language for students with ESN. TAPMAS lessons were designed with targeted science vocabulary embedded in the lessons. As criteria for science vocabulary inclusion, science vocabulary was required to be easily depicted visually (i.e., in pictorial form). Increased use of instructed academic language for focus students was then measured pre and post at baseline and pre and post at intervention. Pre-test at baseline represented students’ performance at the beginning of each school week and without explicit exposure to the assessed vocabulary and post-test at baseline represented students’ performance at the end of the school week, also without explicit exposure to assessed vocabulary (note that explicit instruction is discussed here as exposure to TAPMAS lessons; students may have been exposed to assessed academic vocabulary through their normal science class experiences). Pre-test at intervention represented students’ performance at the beginning of the week and without explicit exposure to assessed vocabulary as well. Post-test at intervention, however, assessed students’ performance at the end of the week and with explicit exposure to assessed vocabulary through student’s participation in TAPMAS lessons (which included the assessed vocabulary and provided explicit exposure to them). In other words, the pre- and post-tests at baseline represent a control condition while the post-test at intervention represented the intervention condition, thus allowing a pre- and post-test performance comparison and discussion of the extent to which exposure to TAPMAS lessons affected student performance on this measure of science vocabulary identification.
Table 1 displays pre- and post-test science vocabulary results for each of the four focus students and their relative performance at both baseline and intervention phase. Results are reported as the percentage, rounded to the nearest hundredth, of correct responses for each student at each phase and pre- and post-test condition. Below each percentage score, the fraction of correct responses and number of trials from which the percentages were calculated was also provided. For example, the first student results listed in Table 1 are for Ophelia. The column immediately to the right of Ophelia’s name displays the percent of correct responses they exhibited for the pre-test condition at baseline (20%) and displays that Ophelia correctly identified 1 of 5 (1/5) trial items at this condition. From left to right, this same information is then displayed for Ophelia for the post-test condition at baseline, then, moving from left to right, the pre-test condition

<table>
<thead>
<tr>
<th>Focus Student</th>
<th>Baseline</th>
<th></th>
<th>Intervention</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Correct</td>
<td>% Correct</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(correct responses/# of trials)</td>
<td>(correct responses/# of trials)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Ophelia</td>
<td>20</td>
<td>60</td>
<td>23.53</td>
<td>76.47</td>
</tr>
<tr>
<td></td>
<td>(1/5)</td>
<td>(3/5)</td>
<td>(4/17)</td>
<td>(13/17)</td>
</tr>
<tr>
<td>Alden</td>
<td>50</td>
<td>50</td>
<td>41.67</td>
<td>33.33</td>
</tr>
<tr>
<td></td>
<td>(4/8)</td>
<td>(3/6)</td>
<td>(5/12)</td>
<td>(4/12)</td>
</tr>
<tr>
<td>Greysen</td>
<td>60</td>
<td>50</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(3/5)</td>
<td>(4/8)</td>
<td>(2/8)</td>
<td>(0/8)</td>
</tr>
<tr>
<td>Bailey</td>
<td>20</td>
<td>27.27</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(3/15)</td>
<td>(3/11)</td>
<td>(1/5)</td>
<td>(1/5)</td>
</tr>
</tbody>
</table>
at intervention, then finally the post-test condition at intervention. Of importance, the students are also listed in the first column of Table 1 in descending order by when they entered the intervention phase of the study: Ophelia was first to enter intervention, then Alden, then Greysen, then Bailey. This primarily explains the different number of trial opportunities reported at each condition for the students. As will be discussed further in the next section when considering the implications of these findings and again later when discussing study limitations, attendance and student participation behaviors also impacted the number of trial opportunities for some of the students.

While evaluation from pre-test to post-test at baseline and at intervention is important, the primary objective in collecting this data was to investigate whether participation in the TAPMAS lessons, inclusive of targeted science vocabulary, would increase student’s science vocabulary knowledge. As such, the primary focus of evaluating this data was to compare each student’s post-test performance at baseline with their post-test performance at intervention and to see if their performance increased from one to the other.

**Ophelia.** Ophelia exhibited an increase in assessed science vocabulary after exposure to TAPMAS lessons. She improved from 60% correct responses at post-baseline (correct responses on 3 of 5 trials, without explicit exposure to assessed vocabulary) to 76.47% at post-intervention (correct responses on 13 of 17 trials, with explicit exposure to assessed science vocabulary within TAPMAS lessons).

**Alden.** Alden showed no improvement in assessment of science vocabulary as a result of exposure to TAPMAS lessons. He correctly identified 50% (3 of 6) of assessed
science vocabulary at post-baseline (without explicit exposure to assessed vocabulary). At post-intervention, Alden correctly identified 33.33% (4 of 12) assessed vocabulary with exposure to assessed science vocabulary within TAPMAS lessons.

**Greysen.** Greysen showed no improvement in assessment of science vocabulary as a result of exposure to TAPMAS lessons. She correctly identified 50% (4 of 8) of assessed science vocabulary at post-baseline (without explicit exposure to assessed vocabulary). At post-intervention, Greysen correctly identified 0% (0 of 8) assessed vocabulary with exposure to assessed science vocabulary within TAPMAS lessons.

**Bailey.** Bailey showed no improvement in assessment of science vocabulary as a result of exposure to TAPMAS lessons. He correctly identified 27.27% (3 of 11) assessed science vocabulary at post-baseline (without explicit exposure to assessed vocabulary). At post-intervention, Bailey correctly identified 20% (1 of 5) assessed vocabulary with exposure to assessed science vocabulary within TAPMAS lessons.

**Interpretation of Results for Research Question #3: Use of Academic Language**

The results as to whether implementation of TAPMAS intervention led to an increased use of academic language for students with ESN are therefore inconclusive. While one student, Ophelia, did perform better on assessment of science vocabulary post exposure to the TAPMAS intervention the other three focus students, Alden, Greysen, and Bailey, showed either no positive effect or a decline in performance post-TAPMAS exposure. As discussed for each individual student, these results were impacted by individual response styles (Alden) and both behavioral and attendance challenges (Greysen and Bailey). Anecdotally, Ophelia generally responded best to all aspects of the
TAPMAS intervention and given this overall positive effect, her performance on these science vocabulary assessments may have benefitted as well. Given the potential impact of how the other students engaged in assessment, it is possible that the other students’ performance was underestimated by these assessments. Nevertheless, in the next several paragraphs are my interpretation of why these results occurred, including observations of both statistical and behavioral nature.

First, results presented in Table 1 provide an example of the somewhat precarious statistical nature of the results obtained. There was variability in the number of test opportunities across conditions, with some testing conditions having as much as three times the number of trials (or possible correct responses) as others. As mentioned previously, some of this was by design and the result of when each student entered intervention. Still, this did create the conditions for some of the percentages reported to be calculated based on small sample sizes and with potentially more dynamic results. As an example, Ophelia correctly identified 20% of pre-test responses at baseline, calculated based on her correctly identifying one of five (1/5) possible correct responses over five test questions (trials). Two columns to the right for Ophelia, the table reports a similar percentage of correct responses (in this case, 23.53% correct pre-test responses at intervention phase). However, this result is based on a significantly larger sample of trials, as the number of trials (or possible correct responses) was much smaller at pre-test (5) than post-test (17)—the latter of which would essentially result in a smaller margin of error and a likely more accurate representation of true performance. So, while results from larger sample sizes can be considered more accurate representations of each
student’s performance, viewers should note that results calculated from smaller sample (trial) sizes are therefore potentially more volatile and the student’s percentage of correct responses were subject to change with only minimal differences to their actual performance on the measure. In other words, a student’s percentage of correct responses could increase or decrease rather dramatically with only one or two variations in responses because of the small number of opportunities from which the percentage was calculated.

The clearest example of this is viewable in the data obtained for Bailey. In the second column for Bailey (see Table 1) we see that he correctly identified targeted science vocabulary on 3 of 11 attempts (27.27% correct responses) at post-baseline (i.e., the end of week assessments at the baseline condition). In the final right column for Bailey, we see that he correctly identified targeted science vocabulary for 20% of trials at post-intervention (i.e., end of the week assessments at the intervention phase)—which, hypothetically, should have shown increased performance as a result of exposure to TAPMAS. However, given the small number of trials Bailey was able to participate in at post-intervention (5), his percentage of correct responses could have easily doubled, from 20% correct to 40% correct responses—which would have resulted in a change from baseline to intervention of nearly double (27.27% to 40%)—had he correctly responded at even one additional trial opportunity at post-intervention. Relatedly, this same logic could also have impacted the positive results reported for Ophelia: if she had correctly identified even one additional item at post-baseline, her performance at post-intervention
would have been roughly equivalent to her performance at post-baseline (80% and 76.47%, respectively).

In addition to the limitations imposed by the small sample sizes, Alden, Greysen, and Bailey each exhibited behaviors which likely impacted their performance on these assessments. Although Alden’s performance remained relatively constant across testing conditions, I became aware of a testing behavior in which he responded primarily to the presence of a specific color rather than to the content more broadly, as the test was designed to measure. It is therefore possible that his decline in performance was related more to the presence or absence of this color than his actual science vocabulary acquisition.

Greysen also presented with testing behavior that did not support her performance. Specifically, she often refused to provide a response to trial items, which resulted in her responses being recorded as incorrect responses. There were attempts to remedy this unexpected testing condition, including asking a preferred adult (a speech and language pathologist) to deliver the trial items to her and attempts to incentivize her participation, however she became more resistant to participation as the study went on—which resulted in her post-intervention data reporting she correctly responded to 0 of 8 trials. Also, while challenging to show in the data, Greysen experienced some attendance challenges related to her health and seemed to struggle with engagement in the bi-weekly science tests additionally after having been absent. Anecdotally, Greysen’s performance in class would seem to stand at odds with the results obtained for her here in this section. Her teachers, and at least one peer, noted that she had become more talkative and
engaged in science class presumably, in the perception of these others, as a result of her participation in this study. The statistically significant increase in social interactions observed in relation to this study’s primary research question supports these anecdotal observations. Nevertheless, within the parameters set forth for evaluation of this research question, I was unable to show that Greysen had increased her use of targeted science vocabulary using this testing measure.

In addition to the statistical challenges imposed as a result of fewer opportunities Alden, Greysen, and Bailey each exhibited consistent performance at the baseline pre- and post-test conditions, with Alden’s baseline performance remaining constant at 50% correct responses, Greysen’s performance decreased from 60% to 50% correct responses, and Bailey showed very modest improvement from 20% to 27.27%. Their performances from post-test at baseline to post-test at intervention, however, did not indicate growth consistent with Ophelia’s. Evaluation of the results indicated moderate performance decreases from post-test at baseline and post-test at intervention for Alden (50% baseline to 33.33% at intervention) and Bailey (27.27% baseline to 20% at intervention) and significant performance decline for Greysen (50% at baseline to 0% at intervention). Of note, several likely impactful student behaviors were noted for Alden, Greysen, and Bailey that may have influenced performance for each of these three stimuli. These observations will be discussed further when considering study limitations.

First, it became evident during assessment that Alden was particularly fond of a particular color (red). At times, Alden’s selection of items appeared to be influenced by whether the color red was present or not and, since selection of test stimuli was not
controlled for color, Alden’s results may best reflect his preference for certain stimuli rather than his actual science vocabulary knowledge or whether he benefited from participation in TAPMAS lessons.

Greysen experienced attendance-related challenges and exhibited some testing refusal behaviors which significantly impacted her participation and, therefore, performance on tests of science vocabulary. She was reluctant to participate in vocabulary assessments throughout the study unless attended by her speech-language pathologist (SLP). Unfortunately, her SLP was not consistently available to Greysen during vocabulary tests. In the absence of her SLP, Greysen was very reluctant to respond to test item prompts and would typically shake her head to indicate no. This was particularly evident and impactful to Greysen’s performance on post-tests during intervention phase, as she refused to participate and therefore did not correctly identify any vocabulary at this condition (0/8). Greysen had additionally elected to continue wearing a health-protocol mask during the entirety of her involvement in the study which, paired with her typically quieter manner of speaking, did create some challenges with hearing her responses. Students were allowed to either verbalize their responses or point/touch their responses on the tablet used for assessment, however the quietness of her voice and mask wearing certainly did not help regarding her participation.

Finally, Bailey also exhibited behavioral challenges that likely impacted his performance on this measure of science vocabulary learning. Specifically, Bailey was prone to self-initiate to sharing about high-interest topics during testing and would sometimes require additional redirection to attend to the test items and to look at the
items before quickly selecting an item without appearing to consider the accuracy of his response first. While this very likely led to an underestimation of his science vocabulary knowledge, Bailey’s performance was consistent across baseline and intervention. Unfortunately, this consistency in response-style may have masked any positive influence his participation in TAPMAS may have had on his science vocabulary learning. Future research should focus on additional ways to assess students who may present with resistance or reluctance to more traditional assessment constructs.

Results for Research Question #4: Acceptability and Usefulness of TAPMAS

The fourth research question posed by this study addressed the degree to which teachers and students found the methods of this research acceptable and usable. At the conclusion of the study participating teachers and students completed questionnaires regarding their experiences and perceptions of the study. Peer student and teacher questionnaires were provided to participants digitally via Google Forms sent through the school district provided Google accounts for students and staff while focus students were provided a post-study questionnaire that was delivered individually and presented in the form of conversation between the students and the lead investigator.

Peer Student Questionnaire Results. Seven participating peer support students completed the Peer Student Questionnaire. Students were provided the questionnaire digitally to their school-provided email. Personally identifiable information was not requested or gathered for this questionnaire and students were informed that their responses were confidential. While there were eight participating peer students in this
study, one participating peer student unenrolled from school immediately following participation and their input to this questionnaire was therefore unable to be obtained.

The Peer Student Questionnaire consisted of five items of Likert-type scale responses for each question, with a range of five response options of 1 (not at all), 2 (a little), 3 (some), 4 (mostly), or 5 (very much). Peer students were asked to indicate: (a) the degree of their enjoyment in participating in the study, (b) their understanding of the directions provided during the study, (c) their observation of whether the study increased the number of social interactions between the students and their study partner, (d) the degree participating in the study may have increased their science learning, and (e) their willingness to participate in similar studies in the future.
Table 2

Peer Student Questionnaire

<table>
<thead>
<tr>
<th>Peer Student</th>
<th>Did you enjoy participating in this study?</th>
<th>Did the directions provided in the study make sense?</th>
<th>Did participating increase social interactions between you and your study partner?</th>
<th>Did participating increase your science learning?</th>
<th>Would you be willing to participate in a similar study in the future?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer Student 1</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Peer Student 2</td>
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<td>4</td>
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<tr>
<td>Peer Student 3</td>
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<td>4</td>
</tr>
<tr>
<td>Peer Student 4</td>
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<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Peer Student 5</td>
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<td>5</td>
<td>4</td>
<td>2</td>
<td>4</td>
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<td>4</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Median</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: The Peer Student Questionnaire consisted of five items of Likert-type scale responses for each question, ranging from 1 (not at all) to 5 (very much).

Results from the Peer Student Questionnaire are provided in Table 2. As can be viewed, 6 of the 7 (85.7%) respondents reported they enjoyed or very much enjoyed participating in the study while one student responded that they enjoyed participation “some” (rated a 3 on the five-point scale). Six of 7 students indicated the directions provided for participation in this study made sense or very much made sense. One student responded that the directions made “some” sense (rated as a 3 on the five-point scale). All students reported they had observed some or much increase in the number of social interactions between themselves and their study partner (focus student). The degree to which student’s felt that involvement in the study had increased their own science
knowledge was a mixed bag, with one student indicating “very little”, two indicating “a little”, and two indicating “some” or “moderate” science learning (indicated as 3s and 4s on a five-point scale). All but one of the student respondents indicated they had “some” to “a lot” of interest in possibly participating in a similar study in the future (one indicated “very little” interest in doing so).

Not reflected in the Peer Student Questionnaire but noted during the intervention phase for research question #1, in two of the general education classrooms (the classes attended by Ophelia and Greysen, specifically), several different general education students, over several days, approached me and expressed interest in joining the research project. In the case of Ophelia, some of these additional general education students were observed to group together as learning partners with Ophelia and become just as active of participants as the study-assigned peers once the rigor of the intervention phase was complete.

**Staff Questionnaire Results.** Each of the four staff who participated in this study responded to a post-study Staff Questionnaire (two general educators and two special educators). Results are provided in Table 3. The Staff Questionnaire consisted of two items of Likert-type scale responses with a range of Not likely, I’m not sure, Somewhat likely, or Very likely as response options and one item with response options related specifically to observed changes in student behavior and with response options of I observed no positive change in student behavior, I observed a little positive change in student behavior, I observed some positive change in student behavior, or I observed a lot of positive change in student behavior. Together, these three items asked respondents to
indicate their perceptions to: (a) the degree of positive change in behavior they observed of students during intervention, (b) how likely they were to recommend this intervention to other educators, and (c) how likely there were to consider implementing all or some of the intervention components into future classroom structure and instructional planning. Participating staff were additionally asked to identify which of five statements best reflected their current perception of the feasibility of continuing forward with components of the intervention post-study: 1. “I feel confident I could implement the entirety of the intervention in my classroom or classroom support”; 2. “I feel confident I could implement parts of the intervention in my classroom or classroom support”; 3. “I would need additional support in the form of coaching or modelling in order to implement all or some of the intervention components”; 4. “I would need additional support in the classroom in order to implement the intervention”; and 5. “I am not planning to implement any aspects of the intervention in my classroom”. Finally, participating staff were also provided with one open-ended prompt to briefly describe behavioral changes observed as a result of students taking part in the study.
<table>
<thead>
<tr>
<th>Educator 1 (Special Educator)</th>
<th>Did you observe a positive change in the behavior of students who participated in this intervention?</th>
<th>How likely are you to recommend this intervention to other educators?</th>
<th>How likely are you to consider implementing all or some of the intervention components in the future?</th>
<th>Describe any positive behavioral changes you observed from students as result of this study:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed a lot of positive change in student behavior</td>
<td>Very likely</td>
<td>Very likely</td>
<td>I'm confident I could implement parts of the intervention in my classroom or classroom support.</td>
<td>&quot;Ophelia, Greysen, and Alden were consistently in class for the duration of the period&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Educator 2</th>
<th>Did you observe a positive change in the behavior of students who participated in this intervention?</th>
<th>How likely are you to recommend this intervention to other educators?</th>
<th>How likely are you to consider implementing all or some of the intervention components in the future?</th>
<th>Describe any positive behavioral changes you observed from students as result of this study:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed a little positive change in student behavior</td>
<td>I'm not sure</td>
<td>Somewhat likely</td>
<td>I'm confident I could implement parts of the intervention in my classroom or classroom support.</td>
<td>&quot;It was good to see Bailey working alongside peers in a positive way&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Educator 3 (Special Educator)</th>
<th>Did you observe a positive change in the behavior of students who participated in this intervention?</th>
<th>How likely are you to recommend this intervention to other educators?</th>
<th>How likely are you to consider implementing all or some of the intervention components in the future?</th>
<th>Describe any positive behavioral changes you observed from students as result of this study:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed some positive change in student behavior</td>
<td>Somewhat likely</td>
<td>Somewhat likely</td>
<td>I'm confident I could implement parts of the intervention in my classroom or classroom support.</td>
<td>&quot;Peers were patient and willing to help Bailey understand what needed to be done in class&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Educator 4</th>
<th>Did you observe a positive change in the behavior of students who participated in this intervention?</th>
<th>How likely are you to recommend this intervention to other educators?</th>
<th>How likely are you to consider implementing all or some of the intervention components in the future?</th>
<th>Describe any positive behavioral changes you observed from students as result of this study:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed a lot of positive change in student behavior</td>
<td>Somewhat likely</td>
<td>Somewhat likely</td>
<td>I'm confident I could implement parts of the intervention in my classroom or classroom support.</td>
<td>&quot;Ophelia went from barely attending class to participating for whole class periods with minimal prompting&quot;</td>
</tr>
</tbody>
</table>
Responses showed all participating staff observed positive behavioral changes in students who participated, with 75% (three of the four participants) indicating they observed some to a lot of positive behavioral change (one indicated they observed a little positive change). Three of the four respondents reported they were somewhat or very likely to recommend this intervention to other educators and all four reported they were somewhat to very likely to consider implementing all or some of the intervention components in their future classroom structure and instructional planning. All four participating staff reported feeling confident they could implement parts of the intervention in their classroom or classroom supports.

While not a designed component of the study, two of the staff supporting the sixth-grade students with ESN additionally offered their unsolicited appreciation for the study and remarked to me that the study had had a profound effect on the participation of Ophelia and Greysen. One of the teachers, a special educator, shared that Ophelia had exhibited a consistent pattern of expressing she did not want to go to science class prior to the study and would typically ask to work in a separate location, where she would often attempt to engage in other, more preferred activities, rather than attend class with her peers. Greysen’s science teacher similarly offered that Greysen almost never spoke to peers in class prior to participation in the study and typically engaged only with worksheet activities during instructional times. While anecdotal, Greysen attended Outdoor School (a field science opportunity for Oregon students in fifth or sixth grade to learn about science curriculum outdoors and immersed in nature) shortly after participating in this study and as was, as shared by her science teacher, noted by several
camp staff and her peers to be very interactive and seemingly open to sharing her science knowledge with others. Shared with permission, the special educator assigned to both Greysen and Ophelia offered in summary: “Participation in the study changed the trajectory of their education and really sets them up for success in high school.”

**Focus Student Questionnaire Results.** Finally, focus students were also provided a post-study questionnaire and prompted to indicate their responses to each of four questions by indicating their response as either “no”, “a little bit”, or “yes”: (a) did they like being in this study, (b) did they learn about science during the study, (c) did they talk more with other kids in class during the study, (d) would they like to do a study like this again someday. The Focus Student Questionnaire was supplied to focus students individually and conversationally by me. Results of the Focus Student Questionnaire are displayed in Table 4.

**Table 4**

*Focus Student Questionnaire*

<table>
<thead>
<tr>
<th>Focus Student</th>
<th>Did you like being in this study?</th>
<th>Did you learn about science in this study?</th>
<th>Did you talk more with other kids in class during this study?</th>
<th>Would you like to do a study like this again some day?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ophelia</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Alden</td>
<td>A little bit</td>
<td>A little bit</td>
<td>A little bit</td>
<td>A little bit</td>
</tr>
<tr>
<td>Greysen</td>
<td>Yes</td>
<td>A little bit</td>
<td>A little bit</td>
<td>A little bit</td>
</tr>
<tr>
<td>Bailey</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Note:* The Focus Student Questionnaire was provided to focus students individually and conversationally. Students were prompted to respond to each question by indicating an answer of No, A little bit, or Yes.
As viewed in Table 4, the results from the Focus Student Questionnaire reported half of the focus students (Ophelia and Greysen) reported they liked being in the study, with Alden responding they liked it a little bit and Bailey responding they did not like it. While subjective, Bailey exhibited a tendency to respond in the negative to most questions before, during, and after the study; nevertheless, their responses, while tending toward the negative, were honored and shared here. This appears evident in how he responded to this questionnaire, for example. Bailey responded to the first question (“Did you like being in this study?”) in the negative but then, after additional opportunities to respond to questions, responded that he would like to participate in a similar study in the future (“Would you like to do a study like this again someday?”). Ophelia, Greysen, and Alden responded they had learned about science as a result of being in this study (Bailey responded he had not) and all four students responded they had talked more with other kids while participating in this study (two responded “yes,” and two “a little bit”).

Interpretation of Results for Research Question #4: Acceptability and Usefulness of TAPMAS

Results from post-study questionnaires showed students and teachers found TAPMAS to be acceptable and meaningful. Of note, most student participants reported they enjoyed taking part in the study and most indicated they would be interested in participating in future studies, should they become available. Participating educators seemed to report less certainty about future study participation (as measured by how likely they were to recommend this study to their peers).
Interestingly, although observational data of the occurrences of social interactions between focus student and their peers at baseline and intervention showed a clear and marked increase (see Research Question #1), the peer students and educators rated their perceptions of this increase in volume as somewhat less positive. For example, none of the seven peer students rated the quality of social interactions as “very much” improved (equating as a rating of 5 on the respective question of the survey) and two of the four participating educators reported they observed “some” or “a little” positive change in focus student behavior (including social interactions) as a result of the TAPMAS intervention. Of note, both peers and educators reported positive effects in this regard: peer students reported a median score of 4 (with a range of 3 to 4) out of a possible 5 when reporting whether the quality of social interactions had improved, and two of the four educators reported they observed “a lot” of positive change. Even so, there did seem to be a slight disjoint between the data results collected as part of Research Question #1 and the results obtained in the survey and specific to Research Question #4. This may be due to the fact the primary focus of this research was to investigate if participation in TAPMAS intervention led to increased social interactions (i.e., the number of social interaction occurrences) rather than the qualities of these interactions.

**Study Limitations**

Several study limitations were noted either during data collection or during analysis of the data, including some unexpected (undesirable) student behaviors, attendance-related challenges, and the logistical challenge of how educators wishing to
potentially replicate the TAPMAS intervention under real-world conditions might realistically do so. I’ll discuss each of these in the next several paragraphs.

First, and as presented previously when discussing student data, unexpected student behaviors were noted during data collection relating to social interactions (Research Question #1) and during pre- and post-tests assessing science vocabulary (Research Question #3). The challenge noted specific to Research Question #1 was specific to observations for Bailey and his social interactions with peers. While he was observed to interact with peers more often at intervention, his social interaction behaviors were challenging in that they could be socially unexpected, or even undesirable (meaning his peers likely did not appreciate some of his interaction attempts). Interobserver agreement (IOA) was consistent between observers, however, indicating observed and recorded behaviors—while unexpected—met the criteria of this research and were therefore included. While the purpose of this study was to increase social interactions as a result of the TAPMAS intervention, its purpose was not to increase socially undesirable behavior. This presented as a study limitation in that I should have included criteria for differentiating between expected, or prosocial, behavior and negative or unwanted social interactions. Had I done so, it is likely that the number of occurrences coded as qualifying verbal or nonverbal interactions for Bailey would have been lower. However, given his consistent presentation throughout the study (meaning from baseline to intervention), I am confident Bailey would still have shown a similar increase from baseline to intervention (albeit with less qualifying occurrences observed at each phase).

Anecdotally, I saw less unexpected/unwanted behavior from Bailey the longer he had
exposure to the intervention so I expect he would have shown more occurrences of verbal and nonverbal expected behaviors the longer the intervention phase was implemented. Subsequent research would likely benefit from further specifying the quality of social interactions criteria to include.

Also discussed previously, I observed student behaviors during the weekly pre- and post-tests that were problematic and likely underrepresented focus student science vocabulary knowledge. As I shared earlier, Alden seemed to prefer to respond to the presence of a particular color that may or may not have been present in the test stimuli. Had I been aware of this test-taking style, it may have been helpful to present stimuli that all included this color to eliminate this as a response variable. More generally applicable to the focus students in this study, however, I also found that the newness of me being the person assessing them may have thrown the students off. Future research trying to replicate this design may find it helpful to train familiar staff to provide such assessments. Results specific to the assessment of science vocabulary were also impacted by student absences, which I will discuss next.

While an inclusion criterion to this study was that all participating students had previously exhibited solid school attendance, this study was nevertheless impacted by student absenteeism—affecting particularly several of the focus students. Because the data collected for this study was collected in the Spring of 2021 and Oregon public schools were still in the midst of returning to pre-Covid pandemic attendance rates there may not be much that future research might address specific to this concern, other than not collecting data immediately after a world-wide pandemic. Still, this did present as a
limitation to the study, specifically in that student absences impacted data collection relating to the weekly science vocabulary tests and, for Greysen and Bailey (and to a lesser degree, Alden), impacted the time available for students to enter and experience the maintenance phase associated with the primary dependent variable.

Finally, while I went to great lengths here in this document to outline specifically the steps I took to design, create, and deliver TAPMAS lessons, this study was borne of an assumptive stance that educators would benefit from an achievable and replicable model for how they might employ aspects of Universal Design for Learning (UDL) (CAST, 2011) through the incorporation of Peer-Based Instruction and Intervention (PBII) (Steinbrenner et al., 2020) and Technology-Assisted Instruction and Intervention (TAlI) (Odom et al., 2015)—while also presenting results of this study, of course). While I may very well have met this rather lofty aspiration—and there is evidence provided in the post-study survey information from participating educators to allow for some optimism—it is unknown to me how likely educators might be to actually take what I’ve presented here and implement it in their own classrooms. My background experiences as a school psychologist and special educator of nearly 20 years were beneficial to how this research was conceptualized and developed. For this study, I designed, created, and mostly delivered TAPMAS lessons. Future research targeting implementation by classroom teachers (or classroom teachers and special educators working in tandem), including fidelity of implementation, is needed if an intervention package like this one is to be rolled out more broadly. Given the size of my role in this research project I can also say that there is a learning curve involved in each stage of designing TAPMAS lessons.
Given this acknowledgement, it is also likely that future implementation attempts, and likely future research associated, should include a coaching support model throughout.
Chapter 5: Discussion/Conclusion

Research has shown greater academic and social outcomes for students with ESN when they are provided access to inclusive educational settings (Mansouri et al., 2022). Presumably in recognition of the documented benefits of the inclusion of students with disabilities in inclusive general education settings, districts across the country have substantially increased rates of inclusion in general education settings, measured as the amount of time students are assigned to spend in general education settings, for many students with disabilities (Williamson et al., 2019). Even in the face of more inclusive trends overall, however, students with ESN continue to experience a trend of “persistent exclusion” (Mansouri et al., 2022, p. 5) and remain more likely to be segregated from their nondisabled peers (Morningstar et al., 2017) as evidenced by the U.S. Department of Education’s (2021) 43rd Annual Report to Congress on the Implementation of IDEA report that approximately one half of students with intellectual or multiple disabilities spend less than 40% of their time in regular (e.g., general education) classrooms per day.

Students with ESN who are assigned access to general education classrooms are likely to encounter additional systemic challenges, such as educator beliefs that social inclusion is more important than academic inclusion (Ballard & Dymond, 2017), that students with ESN can best access general education by participating in alternate curricular instructional activities outside of the general education classroom (Bacon et al., 2016), or that students with ESN will be better served in specialized programs (see Kauffman et al., 2020)—even in the absence of evidence in support of segregated settings as more beneficial for students with ESN (Gee et al., 2020). In recognition of both the
benefits of inclusive education for students with ESN and the numerous challenges to educators desiring to do so, this research sought to provide a model of how educators could plan for the meaningful social and academic inclusion of students with ESN through implementation of an intervention package (TAPMAS) which incorporated both Peer-Based Instruction and Intervention (PBII) and Technology-Assisted Instruction and Intervention (TAII)—two resources readily available to educators in inclusive learning environments—with the aim of increasing social interactions between students with ESN and their typically developing general education peers and increasing focus students use of instructed academic (science) vocabulary, while effectively reducing staffing demands which might otherwise require one-to-one staff to support the inclusion of students with ESN in their inclusive general education classrooms.

While some students with ESN are afforded opportunities within inclusive general education classrooms, the focus students of this study included, challenges remain—both real and perceived—as to how best to ensure students with access to general education maximally receive support they need to flourish socially as well as academically. Previous research has found that in the absence of intentional structures, such as the TAPMAS intervention introduced here, to support meaningful academic and social learning opportunities, students with ESN are at risk for social isolation from peers (Clarke & Kirton, 2003; Cooper et al., 2009), even when physically in the same room as their peers (Chung et al., 2012), and are therefore less likely to be part of the classroom community (Giangreco, 2020). Educators charged with appropriately supporting students with ESN in inclusive general education classrooms must also grapple with long-
standing, system-wide issues such as staffing shortages and poor wages, some of which were further worsened by the Covid-19 pandemic (Cooper & Hickey, 2022). Many districts now struggle to fill open staffing positions, and some may have attempted to resurrect the conventional staffing structure of assigning paraprofessionals—typically non-licensed adults who work under the supervision of special educators—to implement special education services within general education settings to students with ESN. As correlational evidence, the number of paraprofessionals employed in the U.S. today is now larger than the number of special education teachers, with more than 433,000 full-time special education paraprofessionals employed working with students ages 6-21 (U.S. Department of Education, 2019) and most are assigned one-to-one with students with disabilities at least weekly (Chan et al., 2009). On paper, the practice of assigning paraprofessionals to support individual students can support special educators with a documentable structure for the delivery of special education services. In practice, assigning paraprofessionals to students with ESN can produce the unintended consequence of further alienating students with disability from their peers and the general education curriculum (Carter et al., 2016; Giangreco, 2010), especially for middle and high school students for whom peer acceptance and inclusion is central to their development (Caskey & Anfara, 2007).

Paraprofessionals play a vital role in public education; Even so, it is imperative that educators strategically consider how and when paraprofessionals are employed to the support of students with ESN to avoid the potentially detrimental effects of such efforts. Instead, the assigning and proximity of an adult to a student with ESN may decrease the
number of social interactions they have with their peers (Carter et al., 2016) and can negatively affect their access to the general education curriculum and the classroom teacher (Walker et al., 2021). Arguably more important than whether students with ESN attend general education classes with the support of an adult or not is what it is that students with ESN are expected to do and learn. This research is intended to provide one way in which educators can better ensure that students with ESN are afforded opportunities to meaningfully interact socially with their peers and to learn and progress within the general education curriculum.

**Synthesis of Findings**

This research was primarily focused on the design and implementation of an intervention package created for this study titled Technology-Assisted and Peer-Mediated Academic Support (TAPMAS) and its effects on the social and academic progress of four students with extensive support needs (ESN) in their inclusive (e.g., general education) science classrooms. Each of the focus students in this study attended the same middle school within a middle school of a suburban school district. Two of the focus students were identified as male and two were identified as female. Three of the four were sixth-grade students and one was an eighth-grade student. The sixth-grade students, while all attending the same school and with the same general and special education teachers, each attended science class independent from the others at different periods of the school day.

This research was guided by four research questions: (1) was there a functional relationship between implementation of a technology-assisted and peer-mediated intervention package (TAPMAS) and increased social interactions initiated by focus
students to their nondisabled peers, (2) did implementation of TAPMAS lead to residual or carry-over occurrences of social interactions for students with ESN post-intervention, (3) did implementation of TAPMAS lead to an increase in instructed academic (science) language for students with ESN, and (4) did teachers and students find the methods of this research acceptable and usable?

Research questions #1 and #2 were investigated via a multiple-baseline single-case research design (SCRD) wherein baseline information was gathered pertaining to the focus student’s verbal and nonverbal social interactions, then again during the intervention phase of the study, and a third time during a maintenance phase (post-intervention phase). Baseline data was collected concurrently for all students (e.g., they all started baseline on the same day) and then each student entered the intervention phase of the study at different points in time to show intervention effect and experimental control. Research question #3 was investigated through application of pre- and post-tests of targeted science vocabulary at baseline and intervention phases. This allowed for a comparison of students’ performance on these assessments at baseline (prior to their receiving explicit instruction on the targeted vocabulary) and then again at intervention and after the students had been provided explicit instruction on targeted science vocabulary as part of the TAPMAS intervention (targeted vocabulary were imbedded within TAPMAS lessons). Finally, research question #4 was evaluated through post-study questionnaires collected from participating students and educators.

Results of this study’s primary dependent variable of occurrences of social interactions (research question #1) indicated an immediate and significant positive
increases in observed occurrences of social interactions initiated by focus students to their peer support partners. The baseline condition for three of the four focus students indicated essentially zero social interactions were occurring prior to introduction of the intervention. Baseline for the fourth student, eighth-grade student Bailey, included some interaction with peers however these interactions were often noted as not subjectively positive in their quality. Nevertheless, as soon as the intervention, TAPMAS, was introduced, each student’s social interactions immediately increased markedly. This jump was also observed for Bailey and, while partially anecdotal, his social interactions were noted to both increase over time and become more prosocial in nature as the intervention phase continued.

Overall, the intervention yielded a Tau-\(U\) calculated effect size of 0.99 (90% confidence interval 0.743 < 1), \(p\)-value < 0.001) indicating a moderate to very large effect for the intervention on occurrences of social interactions initiated by focus participants to their peers. Previous research, for example Biggs et al., (2018) and Carter et al., (2016), have identified peer-support arrangements as beneficial to increasing social participation for students with ESN in inclusive learning contexts. The results obtained in this research are consistent with previous research and provide further evidence that student social participation does increase when educators provide intentional structures for participation.

Results for research question #2, regarding whether implementation of TAPMAS might lead to a residual carry-over effect on social interactions post-intervention (i.e., increased social interactions observed in the classroom naturally after the rigor of the
intervention was complete) were inconclusive, in part due to some unexpected attendance challenges that effectively reduced the time available to complete the study but more so because only two of the four students entered the maintenance phase of the study as originally intended. Instead, the study morphed slightly during implementation when one of the general education teachers, the teacher for the three sixth-grade students, asked that the TAPMAS intervention be delivered class-wide rather than delivered just to the focus students and participating peer support students. While this shift did not bode particularly well for reporting specifically on the primary dependent variable of social interactions precisely as originally intended, it did supply positive feedback relating to the degree of social validity for the intervention in that the teacher saw the benefit of the intervention used more broadly in the class.

Results from the pre- and post-tests on targeted science vocabulary were inconclusive. One student, Ophelia, showed improvement on the study’s measure of use of targeted science vocabulary from baseline to intervention; However, results for the other three students indicated no measured positive change as a result of explicit science vocabulary instruction imbedded within TAPMAS lessons.

Finally, results from the post-study questionnaires, provided to all participating students and educators, reported that participants generally found the methods of the study acceptable and usable. Students generally reported that they enjoyed participating in the study and noted positive social interactions as a result, with some also indicating that the study increased science learning. All participating educators reported observations of positive change in focus student’s behaviors because of their participation
in the study and each indicated they felt confident they could implement at least parts of the intervention design in their future classroom support. When asked for open-ended description of their observations, participating educators shared: “students were consistently in class for the duration of the period,” “(Student) went from barely attending class to participating for whole class periods with minimal prompting,” “(Student)…work[ed] alongside peers in a positive way,” and, “Peers were patient and willing to help (Student) understand what needed to be done in class.”

Situated in Larger Context

Brown v. Board of Education of Topeka (1954), the landmark Supreme Court case which found the segregation of students based on race to be unconstitutional, was a major victory for the Civil Rights Movement (Yell, 2022). Still applicable nearly 70 years later, Chief Justice Earl Warren commented:

Today, education is perhaps the most important function of state and local government…In these days, it is doubtful that any child may reasonably be expected to succeed in life if he is denied the opportunity of an education. Such an opportunity, where the state has undertaken to provide it, is a right that must be available to all on equal terms. (*Brown v. Board of Education*, 1954, p. 493).

Years later, through the unstinting efforts of parents and advocacy groups in the courts and legislatures, the Brown decision served as a major contributor to the foundation from which The Education for All Handicapped Children Act of 1975 (Public Law 94-142, i.e., Special Education) was built (Yell et al., 1998). As a result, students with intellectual or other disabilities could no longer be disallowed a public education
because of their disability (see *PARC v. Commonwealth of Pennsylvania*, 1972). Public schools were, instead, required to provide students with disabilities a free and appropriate public education (FAPE) that guaranteed their equal access to public education in their least restrictive environment (LRE)—a concept some have argued has been misappropriated as a means of continuing to segregate students with disabilities (Sauer & Jorgensen, 2016)—, the core tenets of which define that children must, “to the maximum extend appropriate,” be educated with nondisabled peers and that children “only be removed from regular education environments when the nature or severity of the child’s disability is such that education in regular classes with the use of supplementary aids and services cannot be achieved satisfactorily” (IDEA, 2004, Section 300.114).

As discussed throughout this paper, students with ESN are still caught amid the battle of where and how they ought rightfully to access their constitutionally protected right to public education. Nearly 70 years after the Brown decision found that separate is not equal, and 47 years forward of Public Law 94-142, students with ESN continue to be disproportionately restricted from general education contexts (Morningstar et al., 2017), and, for those who are granted access to general education, often experience a cursory version of it (Rao et al., 2017)—restricted by the view held by some as only able to glean from the social benefits of doing so (Ballard & Dymond, 2017).

If the spirit of the IDEA’s mandate that students with disabilities, including students with ESN, be educated alongside their nondisabled peers and in the general education context, through the provision of supplementary aides and services—which may include instructional supports aimed at bolstering the social, behavioral,
communicative, and collaborative involvement of students with disabilities (Kurth et al., 2019)—, educators must embrace evidence-based interventions to intentionally support meaningful academic and social participation. It is not enough for students to merely be present, and it is insufficient to conclude that students with ESN only benefit socially from their inclusion in general education classrooms. Yet, the benefits of being socially included by one’s peer group should not be understated, especially for middle school students. Of critical importance to this research, the presence of disability does not preclude human development (Kliwerer et al., 2006) and a prime aspect of human development for adolescent humans (e.g., middle school students) is acceptance by and inclusion from their peers (Caskey & Anfara, 2007). Stated another way, it doesn’t matter to the developing human whether the adults in their life determine they do or do not have a disability; they developmentally require to be included in their peer group.

Beyond social inclusion, students with ESN can and do benefit academically from access to the “qualitatively different” general education context compared to the segregated settings many students with ESN are placed into (Kurth et al., 2014, p. 5). Even so, it is not enough just for students with ESN to just be present in general education classrooms (see Chung et al., 2012). For all students who qualify for special education, educators are required to develop goals for the student to “enable the child to be involved in and make progress in the general education curriculum” and which, at the same time, “meet the child’s needs that result from the child’s disability” (IDEA, 2004, Section 300.320)—two requirements that can feel at odds with each other and which
often cause educators to be at odds with each other about (see Kauffmann & Hornby, 2020).

In recent years, Universal Design for Learning (UDL) has emerged as a means for educators to unpack what it means to meaningfully plan for the inclusion and support of all learners and to, perhaps, lift public education beyond the constraints of the long-embedded “myth of the normal child” (Baglieri et al., 2011, p. 2142): the idea that belonging in a classroom requires some predetermined, perhaps arbitrary, prerequisite set of skills or knowledge. Instead, UDL provides educators a framework to guide instructional opportunities for all learners by planning for students to engage in curriculum through multiple means of engagement, representation, and action and expression (CAST, 2018), rather than designing learning opportunities for the mythical “normative center” (Baglieri et al., 2011, p. 2138) and then requiring special educators to adapt and modify curricular content on the backend—or else use the need for adaptation and modification as evidence that the student with disability must be educated somewhere other than the general education classroom. While important for all learners, the framework of UDL is of critical value to learners who experience and express their learning in more evidently unique ways, such as students with ESN, and was a foundational conceptual framework for this research.

This study was conducted within an educational context unique in the world of public education. Specifically, the host district’s model was one of inclusive practices, with nearly all students within the district who also qualified for special education services provided special education and related services at their neighborhood school. In
the designed absence of special programs or classes for students who qualified under certain disability categories common to most public school district (for example, classes specifically for students who qualify under the category of autism spectrum disorder or intellectual disability), individualized programs were instead designed around the individual student’s needs. This afforded an organically greater opportunity for students with disabilities—including students considered students with ESN—access to and participation in general education contexts as there were simply fewer barriers to doing so. Specifical to the students involved in this research, students with ESN were already placed at their neighborhood school, had already had several years of a variety of experiences in general education classrooms, already had some peer connections, and were already assigned to general education science classrooms prior to the onset of this research.

Even with general education more easily accessible, however, this study found that the students with ESN within the study consistently struggled with social and, relatedly, academic participation in their general education science classes prior to the study beginning (as measured by virtually no social interactions observed during baseline and observation that students with ESN were almost exclusively engaging in parallel learning tasks). As is typical to most other public schools, the predominant pre-study support available to students with ESN in their general education classrooms was an assigned paraprofessional who attended class alongside and presented accommodated or modified learning activities designed, often in isolation from the general education teacher, by the special education case manager. Prior to implementation of the TAPMAS
intervention, the students with ESN in this study were observed by their supporting special educators to often communicate a desire to leave the classroom and work in a separate setting such as a small office or hallway space and almost always they would work on parallel academic tasks of reduced complexity or breadth (e.g., highly accommodated or modified learning tasks). In other words, and in line with previous research discussed in this paper, in the absence of proper intervention students with ESN were present in the classroom but lacked opportunity for meaningful participation and progress within the general education curriculum. These pre-study staff observations were reflected in the data collected as part of this research’s primary dependent variable, social interactions between students with ESN and their typically developing peers. In the absence of specific intervention, namely the TAPMAS intervention introduced in this research, the study’s focus students (students with ESN) were observed to almost never initiate interactions, verbal or nonverbal, to their peers during observation sessions. Access to the general education classroom alone was not enough to ensure students with ESN meaningful opportunity to connect with peers or—given the social nature of learning (see Social Learning Theory) and the status quo of students with ESN working primarily on sometimes parallel (sometimes not) and uniquely designed learning targets—, interact with or progress in the general education curriculum. Instead, the students with ESN in this study required more rigorous and intentional planning and structure for their authentic inclusion in the classroom. The TAPMAS intervention provided this structure.
Implications

Like nearly all districts across the country, the host district was rebounding in a post-Covid world and grappling with many of the same staffing challenges rippling through public education broadly. These challenges undoubtedly exacerbated conditions and added more stress to staff working tirelessly to co-design classroom learning opportunities inclusive of the learning needs of students with ESN and provide the individualized services identified on the IEPs of the students on their caseload.

In recognition of these challenges, and rooted in the theoretical frameworks of social constructivism and social learning theory and the conceptual framework of UDL, the purpose of this study was to provide a model to educators of how they might use existing and plentiful examples of the supplementary aids and services—in this case, peer supports and technology-assisted learning—to effectively increase teaching capacity through an instructional design intended to ensure meaningful social interactions between students with ESN and their peers and strategically introduce academic vocabulary likely to lead to increased student learning. The intervention model needed to be simple (or as simple as designing complex learning opportunities can be) and user-friendly (i.e., acceptable and usable) so that teachers might incorporate aspects of the intervention into their future teaching work and be likely to tell other educators about it and students would want to engage in it again.

In many regards, and particularly regarding the primary dependent variable of social interactions between students with ESN and their peers, the TAPMAS intervention
introduced in this research significantly increased social interactions. Although not reported as clearly in the data collected about the use of targeted science vocabulary, there were other indicators that students were learning additional academic content that they might not have otherwise. Here I am reminded, for example, of Ophelia’s tendency to ask to leave class prior to the TAPMAS intervention and how she stayed for the entirety of class during and after. The comments provided by Greysen’s science teacher about how involved and outgoing she was on an outdoor science expedition (Outdoor School) immediately after her participation in the study also come to mind. While not the data I was seeking to report as evidence, these observations are evidence of student learning, nonetheless. Furthermore, these results might be different now given a little further distance from the Covid pandemic.

There are several implications of this study that exist at both the local level and beyond and which are primarily found in relation to details of further implementation. At the local level, there are implications from this study that apply to the school and district from which the data was collected. The host district has already taken steps to ensure students with ESN, and all students who experience disabilities, are provided access to the general education context—at much higher rates than most others—and, as Wehmeyer (2006) astutely pointed out, the best place to gain access to the general education curriculum is by being in the general education classroom (and not in self-contained settings). The path forward then inclines quickly, as the host district knows well, from providing inclusive access to doing inclusion well, or, as Jorgensen (2018) frames it, creating an authentic inclusive education. While “no practice will work for
every single student” (Cook & Odom, 2013, p. 137), the results of this study provide evidence of how this intervention can be employed to the benefit of students with ESN to increase social interactions within inclusive classrooms and further the journey toward creating a more authentic inclusive education for all.

Carnine (1997) discussed years ago the long standing “research-to-practice gap” (p. 513) and offered as the antidote “educational research could and should be a vital resource to teachers, particularly when they work with diverse learners” (p. 513). There is no shortage of evidence-based practices (EBPs) shown to benefit diverse learners, including students with ESN. The research initiative presented in this dissertation, TAPMAS, was, in fact, built on two such EBPs (PBII and TAI). The research-to-practice gap exists as a breakdown between what is known to be effective and the actual implementation of the practice (Cook & Odom, 2013). The formula for success, according to Cook and Odom (2013), is the identification of effective interventions multiplied by effective implementation. Further complicating matters, however, not only must effective interventions be deemed appropriate to students and selected but so, too, must the context of where implementation will occur and the perspectives and vested interests of various invested members (e.g., educators, students, administrators, etc.) be carefully considered and incorporated within implementation (Metz, 2015). In other words, it is not enough to just select an intervention, evidenced-based as it may (should be); it must also fit within the local context.
An implication of this study, then, is how the educational leadership within the host school and district might benefit from the results of this study and employ it along the path forward. What might the educators within this individual school or district do with the findings of this study? What gaps might they see in moving forward (i.e., scaling up) with this work? The National Implementation Research Network (NIRN) identifies four stages of implementation and a helpful framework for discussion of the implications of this study: Exploration, Installation, Initial Implementation, and Full Implementation (Metz et al., 2014). As this framework identifies, it is important to consider if more program development work might be required prior to moving toward full implementation, even with existing evidence-based or evidence-informed practices. In full transparency, this research was conducted with input from other invested participants (e.g., general and special educators) but could have been more so. I have provided evidence of how an intervention package, TAPMAS, can be effectively implemented at a local level and lead to positive change for students and, importantly, the students and educators found the methods of this intervention acceptable and usable. From the post-study questionnaires, teachers indicated they felt they could implement at least parts of TAPMAS intervention in their classrooms. Still, as the research-to-practice gap has exemplified for decades, it is not enough to just tell educators what is effective and tell them to employ practices; they need opportunity to see it in practice and receive feedback on their progress toward implementation. And, equally important, to provide their input as to how well any potential intervention fits within pre-existing parameters and perceptions of hopeful outcomes. The first implication of this work then is to circle back...
to the users and more fully consider their input before moving forward. Relatedly, I discussed as part of the study limitations what I observed as a potential gap between the capacity for educators to replicate the design and delivery of TAPMAS lessons, noting that I created them for the purpose of this study and that it was an effortful process, especially in the beginning. A related implication for moving forward then is to circle back and determine the level of coaching or modeling teachers may need in order to replicate aspects of this intervention into their daily work.

Beyond the local level, an undeniable implication of this study is the massive, at times undervalued or appreciated, value and power of students as advocates and supports to each other that was discovered anew through this project. While reassuring to receive post-study input from the participating peer support students that they found the methods acceptable, the greatest implication of this study may be the observation of additional (non-study participating) general education students coming forward—of their own volition—to ask if they, too, might be allowed to participate in the study and be supportive to their peers. In my nearly two decades of supporting students within an inclusive learning community I attest that it is not the students who require convincing that inclusive practices are appropriate. To paraphrase the words of President John F. Kennedy (1963), children are our most valuable resource and best hope for the future. If the path forward and away from a research-to-practice gap is in the details of implementation (see NIRN’s Active Implementation Framework, for example), then we must ask the children for their input.
References


https://doi.org/10.1177/1540796917698832


https://doi.org/10.1016/j.rasd.2017.01.002  
https://digitalcommons.law.byu.edu/cgi/viewcontent.cgi?article=1233&context=ejlj

https://doi.org/10.1002/pits.22386

https://doi.org/10.1177/0022466915594368

https://doi.org/10.1177/1540796915591988


Education for All Handicapped Children Act of 1975, 20 U.S.C. §1401 *et seq*


Fovet, F. (2020). Beyond Novelty – “Innovative” accessible teaching as a return to fundamental questions around social justice and reflective pedagogy. In: S.


IDEA (2016). *Thirty-five years of progress in educating children with disabilities through IDEA-- Pg 10*. Retrieved from https://www2.ed.gov/about/offices/list/osers/idea35/history/index_pg10.html


https://doi.org/10.1177/001440291207800303


https://doi.org/10.3390/educsci10090258


https://doi.org/10.4324/9781315150666

https://doi.org/10.1177/00144029221137656


https://doi.org/10.1016/j.matcom.2018.10.006

https://doi.org/10.1177/1540796917711668


https://doi.org/10.1146/annurev.psych.49.1.345


https://doi.org/10.1016/j.beth.2010.08.006


https://doi.org/10.1080/13603116.2014.899635


https://doi.org/10.1177/1088357610378291


Ryndak, D., Jackson, L. B., & White, J. M. (2013). Involvement and progress in the general curriculum for students with extensive support needs: K–12 Inclusive-
Education Research and Implications for the Future. *Inclusion, 1*(1), 28–49. https://doi.org/10.1352/2326-6988-1.1.028


https://doi.org/10.1352/1944-7558-124.4.374


## Appendix A

### TAPMAS Lessons and Weekly Vocabulary for Sixth-Grade Students

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6th-Grade Focus Students

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Ophelia Alden Greysen

TAPMAS

Lesson

Vocabulary

Assessed

6th-Grade Focus Students

Baseline

Intervention
## Appendix B

### TAPMAS Lessons and Weekly Vocabulary for Eight-Grade Student

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