CITES | Literature Review

Teaching, Learning, & Assessment Practices for Inclusive Technology Systems

Center on Inclusive Technology & Education Systems

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IDEAs that Work

U.S. Office of Special Education Programs

Abstract

This article presents a literature review on utilizing technology for teaching, learning, and assessment instructional practices based on the CITES Framework of Instructional Practices for Teaching, Learning, and Assessment (TLA). It discusses the importance of educator technology competencies (T.1), student-centered learning (T.2), and teachers' own enhancement of their technology skills (T3). Additionally, it examines the role that technology plays in flexible, accessible, and relevant learning opportunities (L.1) and the power of students making their own independent choices about technology options (L.2). This article also discusses the need for accessible assessments (A.1), the importance of special educators to take part in large-scale assessment decision-making (A.2), and the necessity of all stakeholders to guide data-driven decision making (A.3). Findings are interpreted and evaluated against Every Student Succeeds Act (ESSA) standards.

Keywords: *assessment, assistive technology, independent choice, student-centered learning, teaching, technology*

Introduction

In 2015, the Every Students Succeeds Act (ESSA) advanced equity and opportunities for Students with Disabilities (SWD) and demanded the implementation of evidence-based and research-based interventions within education systems. ESSA demands implementation of these practices for all students, including SWD.

The Center on Inclusive Technology & Education Systems (CITES) is a project under CAST that partner with school districts from across the country to better integrate education technology (EdTech), information technology (InfoTech), and assistive technology (AT) for best supporting students with disabilities (CITES, 2021). Recently, CITES developed the Instructional Practices Technology, Learning, and Assessment (TLA) Framework to guide districts on best implementing these practices, which are divided into teaching, learning, and assessment practices (CITES). Each practice is further divided into specific actions (https://cites.cast.org/).

Purpose

The purpose of this paper is to review the literature that supports the TLA Framework and its implementation within school districts. The research questions to be answered are:

1. What are some different ways teachers can learn to develop and reach technology competencies, best use technology to support student-centered learning (SCL), and enhance their technology skills to support instruction (T.1, T.2, T.3)?
2. How can students use technology to engage in learning opportunities and also understand the technology options they have in order to make independent choices about these options (L.1, L.2)?
3. How can educators design assessment accessibility and accommodations for SWD (A.1), and how can district leaders ensure special educators and AT professionals are involved in decision-making about large-scale assessments (A.2)?

4. What are ways all stakeholders can use data-driven decision-making regarding instructional, programmatic, and systemic decisions (A.3)?

Method

Articles used for this review were located using Education Research Complete, ERIC, PsychInfo, Psychology and Behavioral Sciences Collection, and Social Sciences Citation Index. The online databases were selected due to their relevance to the topic. A combination of keywords and Boolean searches were conducted. The following keywords and variations were used in the search: *accessibility, applications, assessment, assistive technology, augmented reality, collaboration, communication, competencies, data-driven decision, disabilities, independent choices, iPad, video modeling, student-centered learning, technology,* and *Universal Design for Learning*.

Studies were included if they: (a) included data on K-12 programming, (b) included SWD in their study, (c) were published peer-reviewed articles in full text, (d) published in the last 11 years, and (e) were available in English. Studies were excluded if they: (a) were focused on postsecondary settings, (b) were grey literature, and (c) were about SWD in self-contained settings. After the initial search was conducted, duplicates were removed. Afterwards, articles were screened for titles and abstracts to identify eligible articles. Full texts were then screened and coded based on inclusion criteria. Data from the included studies was extracted, summarized, and analyzed. Extraction of data included recording first author, year of publication, study design, participant characteristics, intervention, outcome measures, and key findings. Data was then examined in relation to the TLA Framework and coded under actions within the framework. Lastly, articles were measured against ESSA Levels of Evidence.

Results

Results of this study produced a total of 18 studies. See Table 1 for more information.

Table 1: Study Design Representation

Design	Frequency
Quasi-experimental with comparison groups	2
Pre-post comparison	1
Synthesis	1
Survey	4
Single case	3
Conceptual framework	2
Other	5

Teaching

Technology has revolutionized the way educators teach and the way students learn. With these new technologies in place within the school setting, it is important for teachers to find ways to develop, achieve, and train on technology competencies, especially assistive technology (AT), in order to best support student progress (T.1). It is critical for educators to be competent in technology, including AT integration, in order to ensure they are meeting the needs of the heterogeneity of students with disability (Zhou et al., 2012). Educators must also find meaningful ways to use technology in best supporting student-centered learning (SCL) for all students, including those who use AT (T.2). SCL is an approach to learning where students are independently responsible for their individual learning (Lee & Hannafin, 2016). Districts often provide varying degrees of professional development access for teachers surrounding technology integration, many times based on funding, which can leave educators with little support on effective technology integration practices within teaching (Hartmann & Weismer, 2016). With this in mind, and with the fact that technology is rapidly evolving, teachers need to take responsibility for enhancing their own technology skills to best support teaching students (T.3).

Technology Competencies (T.1)

In one study by Jones et al. (2019), rated moderate using the ESSA Levels of Evidence, researchers examined the effects of an AT scavenger hunt training that took place at a university's AT lab. The AT scavenger hunt training aimed to improve AT competency skills for preservice teachers. The participants of the study were 35 general education preservice teachers in a southern university teacher preparation program. The training, the AT scavenger hunt, was not an official component of a class or a curriculum at the university; rather, it was an additional learning opportunity offered to the students. The researchers chose 20 different AT competency skills adapted from an article by Smith et al. (2009) that originally identified 111 AT competencies appropriate for educators. Jones et al. (2019) chose 20 of those competencies that would be appropriate for general educators who will be working with students with visual impairment (VI).

Jones and colleagues measured for proficiency of the 20 AT competencies they chose at pretest and posttest, while also measuring the number of AT software and devices that participants could identify at pretest and posttest. Pretest and posttest measures were equivalent and utilized the same 4-point Likert scale derived from the original scale created by Smith et al. (2009). The researchers provided 15 minutes to complete the pretest at the university's AT lab using a computer or iPad. Then,-participants were given 60 minutes to complete the AT scavenger hunt at the AT lab. The scavenger hunt itself was given in paper format. Participants, during the activity, learned about different AT, which mainly focused on AT for VI, including a talking calculator, AT for magnification, optical character recognition or Scan to Read for reading documents out loud, screen readers, and more. After the scavenger hunt training was complete, participants took the posttest in Qualtrics.

Results of the posttests showed the means of all 20 items on the measure improved after training occurred. This demonstrates that at posttest, participants increased their AT competency skills in AT and were also able to name more AT devices and software. An analysis of Variance (ANOVA) and η2p was utilized for determining variance of AT competency skills due to the factor (the training). Significant effects were found due to the training, F (1,33) = 83.58, $p < .00001$, $\eta^2 = .72$. The mean number of AT devices and software that participants were able to identify at pretest was 2.94, and 6.82 at posttest, t (34) = 81.65, $p = .11$. At posttest, participants were also able to name more AT devices and software.

As such, there are ways for teachers to reach AT competencies by using simple, cost-effective methods such as the training method that Jones et al. (2019) proved to be effective for their participants. Jones and colleagues discuss that the more educators understand AT, the more they are likely to implement AT in a meaningful way with their students. This directly benefits the SWD that educators teach. Jones et al. (2019) demonstrated the AT scavenger hunt training effectively increased participants' AT competency skills and their ability to identify AT software and devices. Their results demonstrate that effective training on AT can be influential in the knowledge and understanding of AT for educators. The effects of a simple training, such as the one demonstrated in this study, can be mirrored in teacher-preparation programs. A simple, short duration and inexpensive training on AT can make a difference in the teachers' understanding and competency of AT.

TLA Framework T.1 discusses how AT technology competencies can be developed by teachers themselves on ways to best use AT. Educators can directly identify the competencies themselves or restructure them from previous research such as the competencies developed by Smith et al. (2009) that were used in the study conducted by Jones et al. (2019). Regardless of where and how AT competencies are developed, Jones and colleagues demonstrated an effective manner of training on AT competencies, and educators can use this as an example in learning AT competencies as well.

In another study by Atanga et al. (2020), rated a promising level of evidence as indicated by ESSA, researchers conducted a survey research study to better understand teachers’ knowledge and perceptions of AT. The study included a total of 62 teachers of students with learning disability (LD) from elementary and middle schools that completed the survey. Of the participants, 23% identified as general education teachers, 10% as special education teachers, and 68% as both general and special education teachers. Researchers utilized a standard multiple regression for analysis of the influence of three predictor variables along with a covariate (i.e., the teachers' ratings of AT knowledge). They also performed a sample test on participants' perceptions of AT training to examine if perceptions were different from neutral ratings.

Of the participants, 83.1% reported they had no AT course during college, and 13% indicated they completed only one AT course during college. Of the total number of participants, 71% stated they had professional development workshops that focused on iPad applications. Results demonstrate that teachers who had completed an AT course during their TPP self-reported higher proficiency in AT competencies. Teachers who self-reported understanding iPad reading apps also had higher AT competency proficiency.

Atanga et al. (2020) outlined how their participants were interested in AT implementation in the classroom, yet they were not proficient in AT competencies, which correlated with a lack of training. Despite the motivation for wanting to implement AT, teachers must be proficient in AT to effectively use AT within classroom settings. Educators must be proficient in how to identify, recommend, and utilize AT for SWD, along with skills on how to train students on the AT. Given the motivation to implement AT in classrooms as documented by Atanga and colleagues, the next step for the field would be to provide teachers with the means and support to develop and work on their technology competencies. Atanga and colleagues discuss that school districts should investigate modes of obtaining funding to provide training for educators on improving AT competencies. Funding for ongoing AT professional development is crucial to ensure educators continue to be competent in their AT skills to best serve their SWD, as indicated by TLA Framework T.1.

Researchers in a study conducted by Zhou et al. (2012), which has a promising ESSA Level of Evidence, investigated the self-perceptions of AT competencies of educators who work with students with visual impairments (VI). The researchers used a survey research design study. The researchers administered a survey to participants who were recruited from public schools, residential schools, state special education agencies, and other similar settings. The survey measured 111 AT competencies that were originally developed by Smith et al. (2009). Similar to the study by Smith and colleagues, a four-point Likert scale was utilized for measuring the teachers' self-perceived level of AT proficiency for each AT competency. Findings indicated that 1.43% participants had no confidence in teaching using AT, 18.81% had limited confidence, 39.05% had some confidence, 31.2% were confident, and 9.52% were very confident.

Zhou et al. (2012) aimed to provide a national outlook on the self-perceptions of educators who work with students with VI. Clearly indicated from their study, large gaps exist that need to be addressed in the self-perceived confidence levels regarding AT usage. Zhou and colleagues discuss that as the heterogeneity of students with VI increases, and as technology increases in complexity, AT proficiency is more relevant than ever. Educators of SWD in both general and special education settings need to demonstrate AT proficiency in order to be able to work with SWD who require AT usage, such as those with VI. To help fill this gap, it is essential for teachers to work on developing and/or training to reach AT proficiency through technology competencies as indicated by the TLA Framework T.1. Universities should include courses on AT for teacher preparation. Professional organizations should also provide AT training to help educators reach AT competencies on an ongoing basis. Educators must take technology competencies seriously and learn how to develop and maintain their AT competencies to best support their diverse learners' needs.

Student-Centered Learning (T.2)

In a study by King-Sears and Johnson (2020), rated a moderate ESSA Level of Evidence, researchers investigated the effects of using a Universal Design for Learning (UDL) based scientific instruction for high school students with and without disabilities. The students had placement in both general education inclusive classrooms and self-contained classrooms. In their pretest posttest quasi experimental study, students in both the treatment and control groups completed pretests and posttests, which were the same versions of a science examination that matched a state chemistry exam. The UDL-based intervention included videos to demonstrate how to approach the science learning objectives, a self-management checklist, and a student workbook that featured videos and practice problems. It also included a laminated strategy sheet with additional supports, such as a periodic table of elements.

The results of the study demonstrated higher performance of the treatment group that received the UDL-based intervention in comparison to the control group, which received "business as usual" instruction on the same science learning objectives. Results of the Wilcoxon signed-rank test that compared the treatment group's pretest to posttest scores were significant ($z = 3.92$; $p < .001$). Pretest to posttest mean scores for the treatment group improved from a 0 at pretest to a 17 at posttest. Results of the Mann-Whitney U test that compared posttests of the treatment group to posttests of the control group were significant ($U = 77.5$, $p = 0.38$), demonstrating a higher performance for the treatment group as compared to the control group. The results of their study suggests that UDL-based interventions have the potential to be effective for students with and without LD in both inclusive and self-contained settings.

King-Sears and Johnson (2020) demonstrated effectiveness of a UDL-based intervention that provided students with opportunities to direct their own SCL. By providing video models in the intervention, students in the study had a resource to go back to and re-watch if they felt the need to. They also had a self-management checklist to promote self-monitoring. The intervention also included scaffolding techniques, which reduced supports needed by the students as the students' fluency increased. These components of videos, self-management techniques, and scaffolding strategies all place an emphasis on SCL. In and of itself, utilizing the UDL-based intervention that King-Sears and Johnson used for their study promotes SCL and simultaneously resulted in higher scores for their participants in comparison to the control group. This study is critical in examining the power that SCL using technology has in supporting effective instruction, as outlined in TLA Framework T.2.

Researchers in a study by Kellems et al. (2020), which has a strong ESSA Level of Evidence, investigated the effectiveness of a math intervention that utilized a video modeling and AR intervention. The intervention measured performance on completion of mathematical tasks for seven middle school students with specific learning disability (SLD). The participants, who all had IEP math goals, were enrolled in general education math skills. In their multiple baseline probe design, participants completed a pretest and posttest the researchers had created themselves with target math skills, which included: (a) adding, subtracting, multiplying, and dividing integers, (b) converting measurement units using ratios, and (c) calculating rate of change. Students were able to access videos of a female researcher performing the target skills and recorded with voiceover using the AR application called AURASMA app. The participants used an iPad to hover over a trigger image, which activated the video to play. The trigger images were all placed into a booklet, which allowed students to choose which video models they wanted to watch, re-watch the videos if they chose to, and pause as they saw fit for their learning needs.

Results of the study demonstrated that all seven participants acquired the four target skills during posttest after intervention, reaching 100% accuracy in all skills, thus demonstrating a functional relationship between the video and AR-based mathematics intervention and the percent of correctly completed steps for each mathematics problem for the participants in this study. Participants also took part in a social validity questionnaire concerning whether they found the intervention useful and functional. All participants who completed the social validity questionnaire indicated they enjoyed the intervention, it assisted them in learning new skills, and the AR application was easy to use.

In their study, Kellems et al. (2020) thus demonstrated the effectiveness of a video and AR-based math instruction that promotes SCL for SWD. Students in the study had the option to watch the videos they felt the need to view in order to acquire the target skills, re-watch as they saw necessary, and pause as they needed to as well. By placing SCL at the forefront of mastering math skills, such as within this study by Kellems and colleagues, teachers are promoting motivation and engagement of students which can increase drive for SCL, as outlined in TLA Framework T.2.

Teachers Take Responsibility for Their Own Tech Skills (T.3)

An evaluation approach by Boyd et al. (2015) was created using evidenced-based research for assessing iPad applications used for communication skills for students with autism spectrum disorders (ASD). The study demonstrates a rationale as related to ESSA Levels of Evidence. The researchers discuss that both general and special education teachers need strategies to assist SWD they teach, yet also require methods for evaluating these strategies. For their article, they focused specifically on evaluating iPad applications, emphasizing the power iPads have due to their social acceptability, accessibility, affordability, user-friendliness, customization capabilities, and availability. The researchers present that evaluation of iPad applications for a student should be based on key elements including: (a) the ability of the app to customize to an individual user's needs, (b) necessity of motor skills needed to access the application, (c) reasonable time period for provision of intervention through the application, (d) proof of research that supports the application, and (e) affordability of the application. Boyd and colleagues discuss that unlike other communication AT, such as Picture Exchange Communication System (PECS), which has been available for a longer period of time, the iPad is a relatively newer device. They discuss that formal evaluation for iPad operation is not yet standardized and thus, it is the responsibility of educators to ensure appropriateness of the device and the applications used on the device meet the needs of SWD.

Learning skills, such as evaluating technology, is necessary for teachers in the general and special education settings. For educators, it is critical to take responsibility in enhancing technology skills in order to support SWD, as indicated by TLA Framework T.3. Educators of SWD can use the evaluation framework developed by Boyd et al. (2015) for assessing appropriateness and effectiveness of iPad applications.

In an article by Demo (2017), which demonstrates a rationale as related to ESSA Levels of Evidence, the researcher compares Samsung applications and Toca Boca iPad applications in relation to the ASD population. The author examines the overwhelming number and variety of applications available on the market, especially those marketed for ASD and other disabilities. Demo stresses the importance of being intentional when choosing applications for individuals with ASD, and that educators can download applications first for trial before recommending them or using them with students.

Demo discusses the disadvantages of choosing applications directly from the Apple App Store or Google Play Store based on general keywords such as "autism apps." By using keywords such as these, Demo argues applications will appear that contain the word autism in the title or as a keyword for the application, but it may not necessarily be an app suited for the ASD population. Instead, Demo suggests using credible resources that have evaluated applications, such as Autism Speaks' search engine specifically created for apps that are preferred by individuals with ASD themselves. Demo gives another example, *Autism Apps* developed by *Touch Autism*, which contains a database of applications for ASD along with reviews, descriptions, and videos of the application in order to make better decisions on choosing applications for individuals with ASD. By using approaches such as those outlined by Demo (2017), teachers can take responsibility for enhancing their technology skills by evaluating the most appropriate apps to use for best supporting SWD, as the TLA Framework T.3 emphasizes.

Kimm et al. (2020), which demonstrated a strong ESSA Level of Evidence, is yet another supporting research study regarding TLA Framework T.3. Kimm and colleagues conducted a survey design research study to investigate the technology competency levels of preservice special and general educators. Participants included 243 preservice educators who took the survey, which was created based on the 2017 ISTE Educator Standards. The survey was measured on a scale of 1 to 5, where 1 indicated no familiarity with the target technology competency that participants were being asked about, and 5 indicated high familiarity and functional skills with the competency. Results of this study demonstrated that participants consistently self-rated their technology competency levels below 3, indicating that preservice educators do not feel proficient when it comes to technology competencies as measured by ISTE standards.

It is interesting to note results also demonstrated that preservice teachers who had team-teaching experience had higher scores on the competencies as compared to those who have not had that experience before, perhaps due to the collaboration between preservice teachers and their sharing of knowledge and methods of using technology within instruction. Furthermore, results showed that special education preservice teachers who have experience in collaboration had the highest level of confidence of all other groups of preservice educators. Kimm and colleagues discuss this may be due to the fact that special preservice educators had the advantage of taking a course on AT, since IDEA mandates AT for SWD. General preservice teachers, on the other hand, did not take this course.

Kimm et al. (2020) discuss how teacher preparation programs (TPPs) should be preparing preservice special and general education teachers on technology competencies in order to ensure they are ready to teach students of all disabilities. However, the researchers discuss that change of this magnitude within TPPs may require extensive policy changes, funding, and long periods of time in order to provide more technology proficiency instruction.

In the meantime, teachers must take charge of their own technology skills in order to learn best practices for supporting their students, as the TLA Framework T.3 stresses. By taking their technology skills learning into their own hands, educators can ensure that even if TPPs are consistently falling short of providing enough technology training, teachers are still learning the skills they need for best supporting their students. Furthermore, Kimm and colleagues discuss how the preservice teachers who have had collaboration experience show higher proficiency in technology competencies, which can be advantageous to educators. By taking responsibility for enhancing technology skills and then collaborating with their colleagues in school settings, educators can share the knowledge with each other on what they know and what they’ve experienced, without relying on any formal training through their TPP.

Learning

Providing technology with the UDL framework in mind allows SWD the opportunity to increase their achievement (Izzo & Bauer, 2015). Thus, encouraging students to actively engage in flexible, accessible, collaborative, and relevant learning opportunities is critical. With the many types of technologies available, students should understand what options they have and make independent choices about those options that best suit them in different situations. Teachers can provide online assessments on the preference of students' learning styles, so the students become aware of how they prefer to learn, such as through audio, visual representations, or written instructions (Sulla, 2018). This can help facilitate students to make independent choices. Within the classroom, AT provides the opportunity for students to access curriculum and independently work towards their individualized student learning objectives (Hartmann & Weismer, 2016).

Flexible, Accessible, Collaborative, and Relevant Learning Opportunities (L.1)

Coyne et al. (2012) conducted a pretest posttest quasi-experimental research study, which demonstrated a moderate ESSA Level of Evidence. The study investigated the effect of a technology-based UDL literacy instruction for 16 students in grades K-12 who attended inclusive, separate, and substantially separate (self-contained) classrooms. The intervention consisted of three main components. Firstly, it included four UDL digital story books developed by the researchers that were scaffolded and targeted comprehension, phonemic awareness, phonics instruction, vocabulary, and fluency. Secondly, along with those e-books, the intervention included another library of e-books by WiggleWorks (1996). Thirdly, the instruction included phonemic awareness interactive games and exercises by Island Adventure (1997) and Ocean Adventure (1997). Researchers used a combination of these three components for the technology based UDL literacy instruction.

At the beginning of intervention for the treatment group, teachers and staff mainly provided modeling and one-on-one instruction. In one to three months' time, students in the treatment group were navigating the software independently and inputting responses by themselves. For students who were in the control group, they were receiving "business as usual" literacy instruction without the use of the technology based UDL intervention. Results indicated the treatment group had significantly higher gains in reading comprehension than the control group as measured by the Woodcock-Johnson Test of Achievement III Passage Comprehension subtest, which demonstrated the effectiveness of a technology-based UDL intervention for literacy instruction for students with ID.

It is clear in this study by Coyne et al. (2012) that students demonstrated the ability to engage in flexible, accessible, collaborative, and relevant learning opportunities, as stressed in TLA Framework L1. By using a new technology-based intervention they had not been exposed to previously to improve reading comprehension, students in the treatment group demonstrated flexibility and accessibility in learning. By learning how to use the intervention independently over time, students in the treatment group demonstrated engagement in relevant learning opportunities, since learning independently is always a relevant skill for students. Lastly, Coyne and colleagues reported many of the students became “experts” on the intervention with time and helped other peers who were interested in using the materials, which demonstrates collaboration amongst the students.

Ok et al. (2021) investigated the effects of a video modeling augmented reality (VM-AR) intervention on the improvement of phonics for three first-grade students with severe reading difficulties in a single case research design. This study demonstrated strong evidence in relation to ESSA Levels of Evidence. The VM-AR intervention used the application called HP reveal, which the interventionists administered one-on-one for 20-minute sessions, four days a week, over the course of five weeks. Results demonstrated a significant growth in phonics for all three participants during intervention and five weeks post-intervention during maintenance phase. Average scores during baseline for all participants was 3.7 but increased to 19.8 average score during intervention, so there was an average improvement of 16.1 points between baseline and intervention. The participants had a mean score of 24.5 for the maintenance phase, which took place five weeks post-intervention. Weighted Tau-U scores across participants from baseline to intervention was 0.93 ($CI_{95\%}$ [0.6382, 1], p = 0.000), indicating a large effect. A functional relationship was established between VM-AR intervention and student phonics performance. Social validity interviews indicated participants also expressed positivity toward the intervention. Based on study results, technology-based phonics instruction may be a useful technique for improving student phonics knowledge and maintaining it afterwards.

In relation to TLA Framework L.1, students engaging actively in accessible learning opportunities includes utilizing the availability of increasingly affordable and accessible technologies such as videos and AR. Participants in this study were able to engage in these everyday technologies to improve their phonics levels, making this everyday technology relevant to the participants. TLA Framework L.1 also stresses that students engage in flexible learning opportunities, which technologies such as VM and AR can provide, by delivering other modalities of learning such as visual feedback, auditory feedback, and tactile operation of the technologies. Furthermore, there is flexibility in the participants being able to access the VM-AR intervention several times at their convenience without having to rely on teacher assistance.

Students Making Independent Choices (L.2)

One study by Holyfield et al. (2019) utilized a single subject alternating treatment design to examine engagement of participants to a high-tech visual display (VSD) on a touch screen in comparison to a low-tech color-printed picture symbol. This study demonstrates strong evidence in relation to ESSA Levels of Evidence. Participants included three elementary students with multiple disabilities. Results indicated that all participants were more engaged with the high-tech VSD in comparison to the low-tech isolated pictures as measured by seconds of gaze toward each AAC option. The researchers used visual analysis and nonoverlap of pairs (NAP) between conditions for data analysis. NAP values between 0.93 and 1.0 were considered strong effects, and 0.66 and 0.92 were considered medium effects. Results showed overall higher levels of gaze towards the high-tech VSD AAC in comparison to the low-tech AAC. In comparing NAP values of the high-tech AAC to the low-tech AAC, NAP was 1 for one participant (p = .009), 0.84 for the second participant (p = .076), and 0.94 for the third participant (p = .022). This demonstrates strong effects for two of the participants and a medium effect for the other.

Holyfield et al. (2019) demonstrated how their participants could show levels of engagement towards one AAC in comparison to the other. They discuss that practitioners should be evaluating engagement towards different AAC options for all individuals with disabilities they are working with. Measuring engagement can potentially mean faster and more thorough learning of the AAC. In relation to TLA Framework L.2, even students who struggle with communication challenges can be assessed for preferences when it comes to different technology options. Students should be able to make independent choices about which options might be most useful for them. By providing students with the opportunity to show interest in different technology options, practitioners are setting the stage for their students to utilize the technology more effectively and with greater enthusiasm.

In a study by Wei et al. (2021), which demonstrates a rationale according to ESSA Levels of Evidence, researchers investigated different ways of engaging SWD in reading. One of the main findings is providing students the option of making choices when it comes to reading. Researchers report educators can model what decision-making looks like when it comes to choosing books. For example, educators can model how to choose a book and model how to set reading goals for the book chosen. By providing modeling on how to make choices, and not just providing choices, SWD can learn on the *process* of how to make choices.

Wei et al. (2021) also discussed technology-based instruction, which can help SWD learn since technology can provide equal opportunities for SWD that may struggle with aspects of learning within school. Examples of technology include computer-assisted instruction, text-to-speech for reading, Read and Write, and Nature Reader. Technology choices can also help SWD explore other options when it comes to reading. This study by Wei and colleagues is significant, since students should understand what options they have, including AT as mentioned in their study, and have the option to make independent choices about what is best for them in different situations as indicated in the TLA Framework L.2.

Assessment

Assessment accommodations are essential for SWD to ensure their inclusion in academic success (Cawthon, 2011). Providing accommodations with testing for SWD can level the playing field for them. Educators should seek to design inclusive and accessible assessments and should also provide assessment accommodations for students that best showcase what they know and understand.

Regarding large-scale assessments, a major factor for low achievement for SWD is due to limitations on statewide assessments (Abedi et al., 2012). Leaders at the district level should collaborate with state-testing officials to ensure special education and AT professionals are involved in the decision-making processes for large-scale assessments, since they have experience with accessibility and accommodations in relation to assessment.

When thinking about AT outcomes, all stakeholders and their respective perspectives should be involved, since viewpoints can differ significantly (Satterfield, 2016). All stakeholders involved should apply what information they obtain from data to best inform instructional, programmatic, and systemic decisions. For example, educators and therapists within schools can collect data on AT usage and monitor student outcomes that can help improve future decision-making for achieving student learning outcomes (Satterfield, 2016). Increasingly, technologies are becoming more equipped with data-collection features within their product design, such as speech-generating devices that commonly collect user data on the device itself (Satterfield, 2016). Technology developers who create technology for SWD can utilize this data to make practical decisions about design. It is crucial for technology developers to design technology while integrating accessibility features, so as not to leave individuals with disabilities without the opportunity to access information required to interact with the world around them (Izzo and Bauer, 2015).

Procure and Design Inclusive, Accessible Assessments (A.1 & A.2)

In one study by Cawthon (2011), which demonstrated promising evidence in relation to ESSA, the researcher examined types of assessment accommodations in real-world scenarios. The accommodations were geared for students who are deaf or hard of hearing (SDHH). The researchers conducted a survey research design where participants, who were educators, replied to a set of three study scenarios asking for participants' testing accommodation recommendations they thought best fit each scenario. Participants included 372 teachers and other educational staff that taught SDHH across the U.S. Data utilized for this study was derived on the third annual National Survey of Assessments and Accommodations for Students who are Deaf or Hard of Hearing (hereafter, National Survey).

Researchers administered the survey online and through mailed paper versions. Each participant responded to three different scenarios that were presented about different assessment scenarios. One example asked about what testing accommodations they would recommend for a student who was 12 years old, in the 7th grade, and had an interpreter during classroom instruction time in their mainstreamed classroom setting. The scenario proceeded to state this student is reading at a second-grade level with a fifth-grade level in math. Participants were then asked to choose from a series of choices what type of accommodations, if any, they would provide for the student. Response options included extended time, interpreted test directions, interpreted test items, student-signed response, no accommodations, and there was an option for open-ended responses as well.

Results demonstrated the three most common accommodations that educators chose were interpreted test items (55%). The fewest accommodation responses that participants chose were alternate assessment (30%) and student-signed responses (16%). Three months after educators participated in the survey, researchers contacted 81of those participants again (22% of all initial participants) to ask them the same questions again, with the aim of measuring for reliability of responses. Results indicated that extra time was the most consistent in test-retest responses, with Cronbach's alpha ranging from .59 to .67 depending on the scenario. Findings from the study demonstrate the complexity of choosing accommodations for SWD.

Cawthon (2011) discusses the importance of assessment accommodations for the inclusion of SWD within the school setting. The author emphasizes the critical role educators play in providing these assessments for students, which directly aligns with TLA Framework A.1. It is apparent educators in this study were aware of accommodations that are needed for SDHH and indicated which ones they are most likely to choose. Educators must continue to be aware of the importance of procuring and designing inclusive, accessible assessments and making assessment accommodations that best enable students to demonstrate their knowledge, as indicated by the TLA Framework A.1 and A.2.

In another study by McMahon et al. (2015), researchers conducted a comparative design to investigate the effect of a digitized podcast as a science testing accommodation for SWD within and between student groups across three testing conditions. This study demonstrated strong evidence in relation to ESSA Levels of Evidence. Random assignment placed participants into three experimental testing conditions, which were standard-test administration, teacher-controlled read-aloud traditional group delivery, and student-controlled read-aloud podcast delivery through a mobile device. End-of-the-year assessments were administered. The participants of the study included 47 middle school students with reading disabilities, 16 of whom were identified as SWD receiving special education services. The podcast assessment modification was created in the 2009 version of Garageband to record and put together test questions. Image and video content were also added in another software that created an enhanced podcast, so questions were clearly identifiable and selectable by students using imagery.

A factorial analysis of variance (fANOVA) with test conditions and student status as fixed factors was conducted, and both student groups had statistically significant gains based on the testing condition they were randomly assigned to. Results of fANOVA demonstrated statistical significance that relate to testing conditions F (1,45) = 6.23, p = .016, η^2 = .13 These results indicate that podcast delivery is a feasible option for testing accommodations.

For the study sample (N = 47), the mean for standard administration without any accommodations was 46.30 % correct (SD = 22.89), teacher-controlled read-aloud condition was 54.46% correct (SD =20.07), and the podcast condition was 57.46 % correct (SD = 19.87). The mean difference between student scores between the podcast condition and the standard test condition was +11.67 % points (SD = 18.75). This demonstrates that the student-controlled podcast delivery accommodation increased student achievement scores, t (1, 46) = 4.08, p <.001. Effect size was positive with Cohen's d = .59.

Results of this study indicate that providing accommodations for science assessment makes assessments more inclusive for SWD. In fact, students with and without disabilities both had higher scores with the student read-aloud testing modification. Teachers also reported students were behaving more positively during the student-controlled podcast condition in comparison to the traditional assessment and the teacher-controlled read-aloud condition.

For practitioners, the types of assessment features used for this study are UDL-based assessment features. Findings from this study by McMahon et al. (2015) demonstrate that SWD increased their achievement scores on science assessments utilizing an assessment accommodation, which was the student-controlled read-aloud podcast delivery mode. In relation to TLA Framework A.1, teachers should focus on designing inclusive, accessible assessments, and include testing accommodations and options that best enable student knowledge and understanding. McMahon and colleagues take their study one step further by discussing that the accommodations they used for their participants for this science assessment can also be updated and applied to other types of assessments, such as mathematics and other subjects.

Include Special Educators and AT Professionals in Assessment Decision-Making (A.3)

One study by Abedi et al. (2012), which demonstrated promising ESSA Level of Evidence, investigated the limitations of statewide assessments that are major factors for low scores on assessments for SWDs. Though SWDs have disability-related challenges or lack of access to the general education curriculum, a large component of poor performance on statewide assessments as compared to their peers without disabilities may be due to accessibility matters on the assessments. The state assessments that are being utilized today can potentially not consider the needs of SWDs. Abedi et al. (2012) examined the effects of features within two statewide standardized assessments on the performance outcomes of eighth grade SWD. The investigators retrieved test components from these two exams from different states and examined features related to knowledge, linguistic levels, word density, and textual/visual characteristics. The researchers obtained the data for this study based on a broader study conducted by Abedi et al. (2010) that examined nine eighth-grade assessments in three U.S. states. The researchers utilized multiple discriminant analysis to investigate the effect of accessibility on student performance levels. Results demonstrated that text-based and visual-based characteristics of state examinations have the largest effect on the performance outcomes of SWDs.

In relation to TLA Framework A.2, these issues with statewide assessments, such as those investigated in Abedi et al. (2012), can be easily modified with little to minimal costs to states. The researchers in this study added that changing these features of examinations would also not change the examined construct either. By incorporating special education and AT professionals in the decision-making about statewide assessments, these issues can be resolved and potentially avoided in the future. Researchers in the study also emphasized that changes to the text-based and visually-based features of state exams would serve as an advantage to all students, and not just SWDs.

In a study by Shaheen and Lazar (2018), researchers conducted a quantitative content analysis to investigate education technology plans and technology accessibility statutes at the statewide level. Their research study demonstrated a rationale in terms of the ESSA Levels of Evidence. The researchers discussed that accessibility for SWD in schools at the federal level is apparent and reliable. They sought to better understand the role of K-12 technology accessibility across all 50 states by examining whether K-12 technology accessibility is mentioned in statutes and technology plans at the state level, and includes SWD when designing the process for new digital environments. Shaheen and Lazar obtained primary source documents for their study and sought to retrieve these documents from all 50 states, yet many of the states lacked technology accessibility statutes and technology plans altogether. The population was K-12 statewide technology accessibility statutes and policies. The results of this study demonstrated that only 38% (*n* = 19) of all 50 states had technology accessibility statutes, of which only 47% (n = 9) discussed education and only 10.5% (*n* = 2) mentioned K-12. Only 54% (*n* = 27) states had education technology plans, and SWD were only discussed in 56% (*n* = 15) of those plans. In summary, the researchers found that although many states do target technology accessibility at the statewide level, more than half do not. The researchers note that over time, more and more SWD will be included in general education classes, and the need for technology accessibility will continue to increase. The need for integrating technology in education will increase. The more that technology accessibility is talked about, the more educators will be exposed to it, and thus more likely to ensure implementation.

Shaheen and Lazar (2018) demonstrated the lack of technology accessibility mentioned at the statewide level in over half the United States, which is problematic. Technology accessibility, including accessibility for assessment, is crucial for the success of SWD and to avoid lawsuits and disability discrimination against districts. Though Shaheen and Lazar focus on technology accessibility as a whole, accessibility for assessment is a large component of statewide policy. As more statutes within states include technology accessibility in general, accessibility for assessments using technology will also be included. The researchers discuss that state-level educators and personnel should focus efforts on technology accessibility. To do this, they can involve special educators and AT specialists in the process of designing accessibility, including accessibility for assessments, as TLA Framework A.2 emphasizes. By including special educators and AT personnel in the overall design process of accessibility in state policy, the professional recommendations of specialists who know accessibility best are included.

Special educators and AT specialists can play an instrumental role in gathering resources, creating professional development, and bringing in their expertise to help inform state statutes on the inclusion of technology accessibility, including accessibility for assessment. For school districts who have already integrated technology accessibility at the state level, special educators and AT specialists from their districts can share their ideas, trials, and experiences for other districts to learn from. The more state leaders better understand technology accessibility, including accessibility for assessment, the more likely they are to include them in state statutes and thus provide more opportunities for SWD to succeed in schools.

Data to Drive Instructional, Programmatic, and Systemic Decisions (A.3)

An experimental study by Powell (2012) examined the differences in scores for students with mathematics difficulty who take a high-stakes mathematics test in multiple-choice format versus construction-response format. This study demonstrated strong evidence in terms of the ESSA Levels of Evidence. Powell examined two test-response formats as an accessibility accommodation which included multiple-choice format and constructed-response format. Participants of the study included 149 students from 19 third-grade classrooms from 31 schools in a Southeast region within the U.S. The participants were students who were identified as having a mathematics difficulty (MD), as measured by Wide Range Achievement Test-Revised (WRAT), specifically on the WRAT-Arithmetic. Participants also demonstrated a reading difficulty as measured by WRAT-Reading. Participants were randomly assigned to take the Iowa Test of Basic Skills (ITBS) Level 9 standardized test in either multiple-choice format or constructed-response format. During both versions of the assessment, the test items were read aloud twice for students, a standard accommodation that is found in the ITBS level 9 administration booklet for students who struggle with reading difficulties. Students in the study took the ITBS over the course of two weeks, in 30-minute group testing sessions on school grounds, in a quiet location near the regular classroom. Powell utilized a correction procedure since multiple choice can include a possibility of guessing correct answers. A one-way analysis of variance (ANOVA) was utilized for data analysis. The response format was the factor (multiple-choice and constructed-response), and a post hoc power analysis was conducted afterwards. Data analysis determined a significant main effect in favor of students who took the assessment in multiple-choice format, with F (1, 147) =7.35, p = .008. A significant effect size was demonstrated, with students who took the examination in multiple-choice format outperforming those students who took the assessment in constructed-response format. Though there may be a possibility that students who had the multiple-choice format had an option to discriminate between possible and impossible responses, they still demonstrate understanding of mathematical competence, despite not constructing a response independently. The results of this study suggest that multiple-choice formatting on mathematics standardized assessments is a useful accommodation for students with MD.

In relation to TLA Framework A.3, all stakeholders should apply what is learned from data to drive instructional, programmatic, and systemic decisions. The results from Powell (2012) demonstrated that providing accommodations such as multiple-choice test response modifications for assessments can benefit SWD. By using data from this study to inform assessment decisions, stakeholders of all levels can ensure level playing fields for SWD during assessment procedures. It provides a differential boost that is useful for SWD, more so than their peers without disabilities.

In a research synthesis by Scalise et al. (2018), which demonstrated a rationale in terms of ESSA Levels of Evidence, researchers investigated accessibility of assessing students in online environments in regard to STEM objectives. Their participants included students with a broad range of disabilities. Researchers looked for common themes on accessibility accommodations in digital spaces as related to STEM, keeping their audience in mind as school administrators, policy makers, assessment developers, and educators.

Their findings resulted in a wide range, but a few salient ones as related to this particular paper will be discussed here. One important theme discussed by Scalise et al. (2018) was focused on the fidelity of implementing testing accommodations for SWD. Another theme that emerged in findings of this article is about simplifying language provided within assessments for STEM. This can include reading aloud, dictionaries, and other types of tools to better support SWD. A specific type of language modification most often used with SWD is read-aloud accommodations for testing. These accommodations help to increase scores for SWD in math and other areas of testing. Furthermore, technology can help to provide an option as a read-aloud accommodation through text-to-speech.

In relation to TLA Framework A.3, using data to drive instructional, programmatic, and systemic decisions for all stakeholders is key. Ensuring fidelity of implementation for testing accommodations, as indicated by Scalise et al. (2018), ensures teachers are well aware of how to implement testing accommodations. Furthermore, it ensures data that is obtained from assessments is valid for data-driven decision-making. Scalise and colleagues' determination of common accessibility for SWD in STEM included simplified language and read-aloud accommodations, which can help stakeholders see these are the most common and utilized accommodations in the literature for testing SWD. This is important to make note of as stakeholders are involved in data-driven decision-making regarding testing accommodations for SWD within schools.

Conclusion & Implications

This study reviewed recent literature that best supports the TLA Framework developed by CITES relating to teaching, learning, and assessment instructional practices. Through technology, curriculum can be explored by all types of learners in ways that may not have been possible before (Hartmann & Weismer, 2016). Teachers should develop and be proficient at technology competencies to understand how to explore technology for the learners they teach. They can base these technology competencies on previously researched standards. Teaching students using technology should focus on SCL practices. SCL stresses that with the specific and unique background students have, they are able to identify tools and resources to use for their learning and also monitor their own progress with learning (Lee & Hannafin, 2016). Teachers must maintain and constantly enhance their technology skills. Since technology is constantly and rapidly evolving, it can be a good strategy for educators to employ learning about a technology's function rather than the specifics of the brand or product name, such as learning how to access "tablets" instead of "iPads," or voice recognition software instead of DragonDictate (Peterson-Karlan, 2015).

Learning opportunities for students should be flexible, accessible, collaborative, and relevant. Using technology integration, thoughtfully laid-out learning goals, inclusive learning strategies, and environmental considerations, learners of all capabilities can be provided with an equitable and meaningful learning experience. (Hartmann & Weismer, 2016). By providing students with technology tools to assess their preferences for learning, UDL principles are upheld by offering differing learning options that they can thus make a choice from (Sulla, 2018). Independent choices for students are instrumental for student progress.

Technology assessments can provide students the ability to self-assess and be more conscientious of their particular strengths and weaknesses (Satterfield, 2016). Assessments in general should be inclusive and accessible. Large-scale assessments should include special educators and AT professionals who can include their expertise on accessibility for standardized testing. Stakeholders involved in assessment within any capacity should apply what they learn from data to drive instructional, programmatic, and systemic decisions. For example, school administrators, therapists, and educators, must reflect on the costs of AT while manufacturers must focus on user satisfaction, user functionality, and instructional use (Satterfield, 2016).

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