Digitability's Impact: Support of the Efficacy of Digitability (formerly Autism Expressed)

Abstract This year, 300,000+ adolescents with autism will enter high school and begin their pursuit to independence. However, there will be few resources addressing the formative needs of adolescents with autism as they pursue their transition in a technology driven society and economy. This creates a critical barrier to progress during transition planning. Currently, ~80% of people with cognitive disabilities are experiencing unemployment in an economy where ~75% jobs require some degree of technological literacy. There is a great need for specialized training for students with special education needs recognized by parents, educators and special education administrators. Digitability's pre-employment/transition program is the only comprehensive workplace readiness training program that includes solutions for academic, social/emotional and vocational skill development in a digitally literate economy. Digitability is based entirely on evidence-based practices including, but not limited to Applied Behavioral Analysis (an FDA approved form of treatment for behavioral health), and modeled using frameworks like Bloom's Taxonomy of Cognitive Development. The impact of this research resulted in insights to the engagement of students with autism to acquire digital life skill sets to be used in the pursuit of their post-secondary transition. This project showed that implementation of the Digitability program as an intervention improves digital media literacy skills of students with autism in grades 6 – 12 in a special education environment.

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Project Narrative – Technical Content

"Many families with children with autism describe leaving high school as falling off a cliff because of the lack of services for adults with an autism spectrum disorder," said senior study author Paul Shattuck, Washington University. "So much of media attention focuses on children. It's important for people to realize autism does not disappear in adolescence" (Goodwin, 2012)

There are more than 1.5 million individuals in the United States with an autism Spectrum Disorder (ASD), a prevalence that grows 17% annually. Between 2002 and 2008, the prevalence of autism increased 78% and the estimated prevalence of ASDs among children aged 8 years in the United States is 11.3 per 1,000 (one in 88), (CDC, 2012). "Rapid advances in the fields of cognitive and affective developmental neuroscience, developmental psychopathology, neurobiology, genetics, and applied behavior analysis have contributed to a more optimistic outcome for individuals with ASD" (Dawson, 2008, p775). Early diagnosis and intervention programs are now improving IQ, language ability and social interaction for students with autism. Such evidence coupled with awareness and advocacy efforts denote that students will have increased capabilities and educational opportunities. *However, the increased use of technology to improve educational outcomes focuses mainly on early developmental interventions. There are little to no resources in the market focusing on the formative needs of adolescents with autism to improve transition outcomes in a technology driven society and economy. More than 50% of students with an ASD, who had left high school in the past 2 years had no participation in employment or post-secondary education (Pediatrics 2012; 129:1042–1049).*

Our technology driven society and economy have dramatically changed the definition of essential life skills. Digital literacy is becoming increasingly imperative to independence, as well as providing a multitude of job prospects for students. Reports assert, "technological literacy is an essential component of job readiness, citizenry, and life skills" (Baker & O'Neil, 2003). The Secretary's Commission on Achieving Necessary Skills (SCANS) report and the American Association of the School Administrators include competency in the use of computers and other technologies as an essential skill for students in the 21st century (US Department of Labor, 1992; Uchida, Cetron, & McKenzie, 1996). Not to have the opportunity to develop these essential skills is to be denied access to and participation in the most vital information and communication modalities of today's society. Currently, there is no other scalable curriculum making digital media literacy accessible to students with autism or other developmental disabilities. This is creating a critical barrier to progress during transition planning and limiting post-secondary outcomes for these students, further supporting an existing paradigm of pigeonholing students with autism into unemployment or low-wage paying jobs.

To increase transition outcomes for this large and growing population, Digitability is an interactive curriculum designed and developed by experts in the area of autism, education, behavior and technology. Digitability is the first and only online learning system that systematically teaches essential and marketable digital life-skills directly to students with autism and other special education classifications in an engaging online environment. The Digitability curriculum utilizes the principles of research-based methods such as Applied Behavior Analysis (ABA), as well as Instructional Scaffolding and Bloom's Taxonomy of Cognition.

The educational methods rooted in our product have been successful in teaching a range of technological skill sets such as sending and receiving email, using word processing and presentation software, creating and maintaining a blog, video and photo editing and website design, when implemented by a facilitator in a low-incidence, special education classroom supporting students with autism at Title 1 Schools.

In 2012, a group of MBA candidates from The Wharton School of Business performed research for Digitability to determine the market interest, appropriate pricing and marketing strategy. The team surveyed parents, school administrators and therapists regarding their interest in the program, features they prefer, and willingness to pay. 65% of respondents indicated that they were unsatisfied with current transition services. The survey provided favorable results with 90% of respondents indicating that the digital skills provided by Digitability are important, very important, or somewhat important. Comparatively, interest in Digitability's services quickly gained implementation of the beta platform from a wide variety of educational settings such as The School District of Philadelphia, Pediatric Wellness Network of New Jersey, United Cerebral Palsy and The DC Public Library. Initial feedback from the use of our beta indicated both a strong potential to scale impact of digital literacy outcomes.

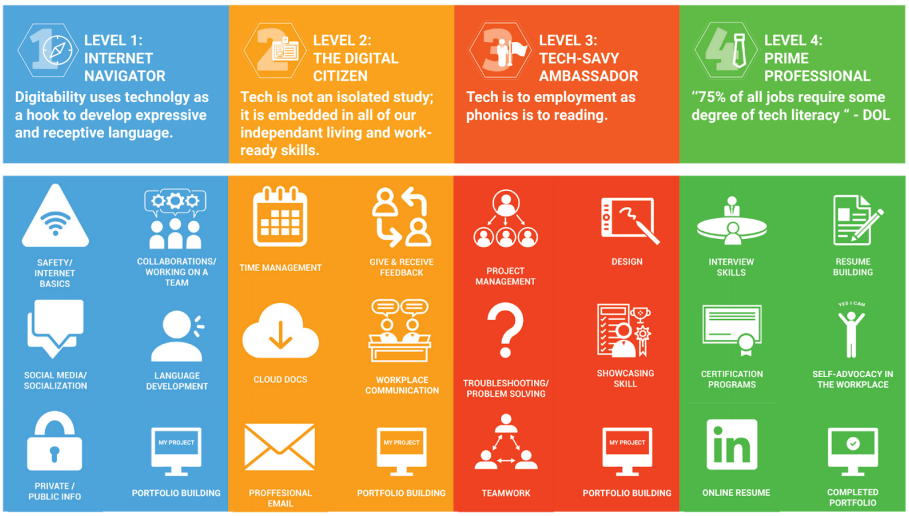
"For students with autism, computerized instruction has been effective in teaching sentence structure, social problem solving, vocabulary and increasing communication initiatives and relevant speech in naturalistic interventions" (ASHA, 2006). In a study done by Mazurek, Shattuck, Wagner, and Cooper (2012) providing a first look at the prevalence and correlates of various types of media interaction, among youths with ASD ages 13-17, report "solitary screen-based media use represents a primary and preferred activity for a large percentage of youths with ASD." *The efficacy of computerized instruction grants us an opportunity to increase technological literacy for special education students and shape this inherent affinity into skills that increase transition outcomes.* Moreover, a current SRI-led study found that individuals with an ASD who attend college, are significantly more likely to choose Science, Technology, Engineering, Mathematics (STEM) majors (Wei, Yu, Shattuck, Mccracken, & Blackorby, 2012).

Likewise, The New York Times captured the application and success of shaping the individual with autism's inherent affinity to technology into career skill sets. *Specialisterne*, a Danish software testing company, has been employing individuals with autism around the world including in Poland, Norway Demark, Austria, Switzerland and Ireland. Specialisterne was named one of 26 winners of a global social entrepreneurship award at the World Economic Forum meeting, inspiring the world and information-technology companies thinking differently about how individuals with autism can contribute to their businesses. Specialisterne announced plans to open in the US believing that the increasing prevalence of autism as well as a large technology sector, suggests a good market for expansion.
It is estimated that every year 50,000+ students with an ASD turn 18. By investing in the solution to this problem now, we are taking the next step for improving transition outcomes for a very large and growing population. The observations aforementioned in conjunction with the enthusiastic and continued support from the autism, special education and disability communities

have served as compelling evidence to support the claim that Digitability is likely to contribute to solving this problem at scale.

Digitability is a web-based (cloud) technology improving transition outcomes for special education students by way of teaching digital life-skills through a curriculum of interactive simulations. The platform engages students through video modeling/video prompting, guided simulations and virtual rewards. The interface is simple and direct, limiting choices and directives to a single task. Specifically designed to accommodate students with expressive and receptive language difficulties, the pragmatics of the voice over audio uses simplified language, paced for extended auditory processing time. Using the principles of ABA therapy, we create a synthesized curriculum effective in teaching digital life-skills such as emailing, blogging and digital media design. Because students with autism often struggle with reciprocity in socialization and can generalize when dealing with online communication modes, the Digitability curriculum explicitly demystifies the nuances of digital and social media. The curriculum prioritizes and reinforces safety, teaching students to distinguish private information from public information and therefore, how to appropriately share on the internet; students learn to recognize and respond to internet threats such as spam, 'phishing' (when someone is trying to garner private information such as bank account information or email address) and cyber-bullying.

There are four (4) modules. Within each module comes a series of lessons grouped together by units. Modules require the user to develop increased levels of digital literacy. Units synthesize each task into their smallest, most manageable parts. Lessons are short; no more than 3 minutes in length including review content, new content delivery and review of the new content delivered. Below is a brief scope and sequence of the Digitability Curriculum (Figure 1).



(Figure 1).

Level 1 is designed to teacher students basic tech concepts,while simultaneously developing their social and communication skills. Systematically exploring tech and socialization helps prepare students to navigate the social nuance of sharing online as well as the hidden social norms of the

workplace. Level 2 trains student to use industry-standard workplace technologies such as word processing, email, presentation, spreadsheets. Through work-simulations, student manage budgets, plan travel, problem solve and learn how to give and receive feedback in a workplace, while navigating the most common workplace boundaries. Level 3 Students develop tech routines and collaborate in and out of the cloud, strengthening their executive functions. Student learn how to showcase their skills to develop a sense of empowerment. Level 4 is where student package their online resumes and work-ready portfolios to demonstrate marketable tech and social skills they developed through the Digitability program. Fully prepared for job-seeking process, students develop their self-advocacy plan for the workplace, equipped with the skills to obtain and sustain employment.

For the scope of this project, the users of Digitability were students grades 6-12, with a diagnosis or primary disability classification of autism as defined in Public Law 108-446, the Individuals with Disabilities Education Improvement Act of 2004 (IDEA). However, this project team is confident that Digitability is an appropriate intervention for students among both low-incidence and high-incidence categories including but not limited to, specific learning disability, speech or language impairments, multiple disabilities, orthopedic impairment and other health impairment. Intended users should have the gross motor skill to 1) Manipulate a mouse or 2) Use a touch screen device such as an iPad. Intended users must be able to execute a verbal prompt.

Critical components of this product include 1) a series of highly synthesized video animation *modules* providing modeled instruction. 2) Each *lesson* includes a simulated online environment for guided and independent practice of skill development. 3) Upon skill mastery, immediate feedback and virtual *rewards* reinforce student achievement. 4) *Software analytics* provide teachers with data to inform instruction and the development of transition goals. This data also lends to a personalized learning experience for students as they progress through the curriculum. Progress reports can be generated and shared with Individualized Educational Program team members such as parents and therapist. 5) *A resource portal* includes both supplemental instructional resources to support teacher facilitation of product and enhance learning experiences in the classroom, as well as on-demand professional development through video modeling and live-web streams.

The Digitability carefully structured curriculum utilizes Bloom's Taxonomy of Cognitive Domains as well as principles of ABA. It is composed of four (4) main stages or modules: 1) Internet Navigator, 2) Digital Citizen, 3) Tech Savvy Ambassador, and 4) Prime Professional. Each module is organized by standard-aligned objectives that measure skill mastery. Within each module of the Digitability curriculum, lessons are grouped into units by a specific topic and a measurable objective. For example: Module 1-The Internet Navigator, Unit 5 Sharing on the Internet includes 11 lessons that address the objective, "Student is able to distinguish appropriate online sharing behaviors with 80% success."
To achieve each objective, lessons provide a highly structured and consistent format beginning by accessing prior knowledge (reviewing content from a previous lesson), followed by delivery of new content and finally the review and reinforcement of the new content. New content for each lesson, delivers no more than two key concepts. Each lesson is represented as a "badge." These lessons and their accompanying activities need to be completed, or "unlocked," before

subsequent lessons can be started. A blue square flashes behind the next lesson badge in the sequence of the badge index. This designates the badge as the next lesson to start (Figure 2). Students click (or touch for iPad) the current lesson badge, loading the lesson video to begin. Video lessons animate pictogram imagery to communicate concepts (Figure 3) and follow a consistent scripted voice-over narrative. Voice over uses direct, simple language and is paced for learners who need extended auditory processing time. Important vocabulary is emphasized with supplemental text on screen. After student completes the video lesson, they are prompted to either replay the video or continue to the activity to unlock the badge. Clicking the "activity" button will automatically play a prompt video with key concepts that prompt the student to complete the activity. The activity or simulated environment is exhibited at the end of this video (Figure 4). If the student makes an attempt at the activity and selects an incorrect option, a "Try Again" video appears and provides additional video modeling to guide the student in completing the activity.

Figure 2

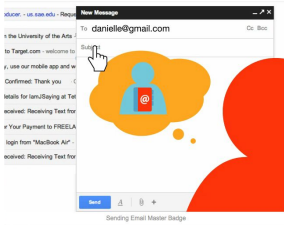


Figure 3

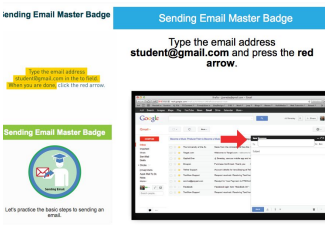


Figure 4

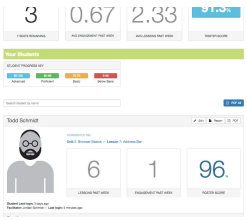


Figure 5

Upon successful completion of the activity, a "Congratulations!" video appears and reinforces their achievement and virtual achievement reward/badge. The imagery from each badge is designed to evoke the visual/verbal association to key concept and vocabulary. Students can view each badge they have earned in their badge library. Supplemental materials will be offered, including sticker books (representing the lesson badges) and charts, providing tactile and visual reinforcement of student achievement. Teachers can incorporate this system into their classroom management system or behavior modification program (facilitator forum will provide guidance on these strategies). As the student completes lessons and activities, a progress bar at the bottom of the lesson menu displays their progress through each unit.

Built-in lesson assessments monitor individual student progress and highlight skill proficiency and deficits. Teachers use this data to inform instruction and the development of transition goals. Student progress is tracked through an easy to use facilitator account (Figure 5). Software analytics evaluate student progress and assess mastery of each measurable objective by the number of attempts made to complete each of the activities. Teachers can generate reports for each student at any time. A facilitator messaging system sends automated emails 1) when a student is struggling in a specific lesson or requests help, 2) at important milestones surrounding student progress and report cards/ progress monitoring for the Student's Individualized Education Program (IEP), and 3) to provide supplemental resources such as unit quizzes, classroom activities or professional development on best practices for incorporating technology in instruction and classroom management/behavior modification programs. Our messaging system also allows teachers the option of emailing reports to other members of the student's

educational team (parents, therapist, counselors) to increase the support and engagement of the student's educational and therapeutic team in reinforcing skill development.

To support implementation of our product, teachers have access to a resource portal. A getting started document introduces the learning system and outline available resource. Resources include technical recommendations, (suggestions for managing technology in the classroom, technical troubleshooting, etc.) and printable and digital supplemental instructional materials (activities, comprehension questions, word wall vocabulary badges, posters, etc.). Additionally, the portal will host a community forum for facilitators to share resources. This community forum will also offer on-demand professional development on evidence-based practices through video modeling, updates in research validated teaching strategies, best practices to supporting students with an ASD as well as suggestions to implement appropriate measurable objectives for IEP Transition Planning.

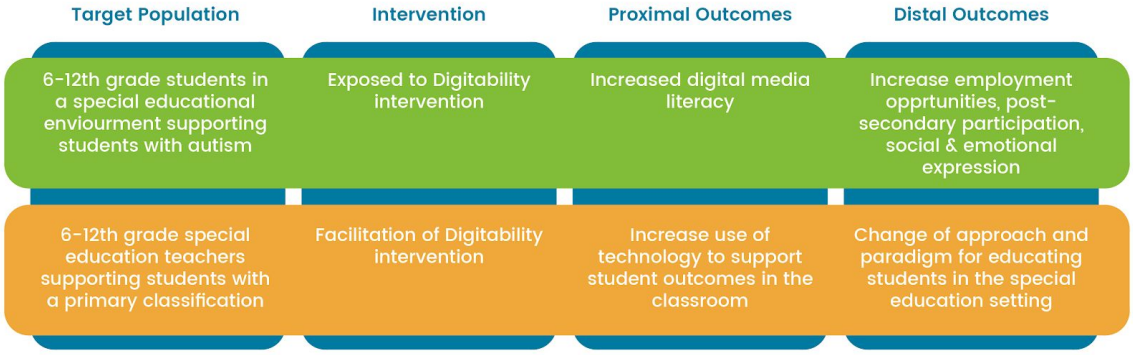
This product functions as an interactive curriculum used in special education environments, as defined in Section 1116(e) of the Elementary and Secondary Education Act of 1965, as amended by the No Child Left Behind Act of 2001, to improve transition outcomes. The cloud software will be accessible from any computer or personal device with a modern browser, supporting HTML5 (including the iPad) with Internet access. There is no software to download or install. Teachers are not responsible for creating lesson content within the learning portal. The first time a teacher logs in, the "getting started" video will provide a tour of how to manage their account. Teachers create student profiles and assigning a usernames and passwords for each student. Students can log in to their personal account using the teacher generated username and password to interact with the system independently or with teacher guidance. If a student struggles with content, the teacher will be sent an automatic email alert to intervene and address gaps in comprehension. Teachers have access to all lesson/activity content and can use the platform for direct instruction using a whiteboard or projector connected to a computer or device supporting HTML5 with internet access; alternatively teachers can use a computer to facilitate small group instruction. Teachers receive additional emails as students complete units of lessons to "earn their master badges." Teachers award badge stickers for each completed unit. Teachers print student progress reports evaluating mastery of each unit's measurable objective. Data informs instruction and development of transition goals. Implementation of curriculum is segmented to accommodate each school year. Teachers access approximately 20 units of content per school year. Teachers utilize the resource portal for supplemental materials to enhance and reinforce learning for each unit objective. Resources are aimed to integrate our program into the educational fibers, cross-curriculum to reflect what *Technology Review* calls a "paradigm shift that changes how we teach traditional material."

In 2012, The Wharton School of Business surveyed parents, school administrators and therapists regarding their perceived value of Digitability's services. The survey provided favorable results with 90% of respondents indicating that the digital literacy skills provided by Digitability are important. The key components of this product lead to increased digital literacy skills, a critical skill area needed for improved transition outcomes for students with disabilities to obtain further training and education (e.g., postsecondary education, vocational education programs). *Digitability is specifically designed to engage students in learning and practicing digital*

life-skills, simultaneously gaining access to unlimited resources to support behavioral, social and communicative development as well as functional, occupational and academic achievement. For example, the Digitability curriculum teaches students how to use free communication technologies, like Google Calendar, in time and task management, a life skill used for work and socialization. Teachers develop students' technological and vocational skills relevant to the digital age as well as a dynamic understanding of common digital age communication skills. The Digitability Curriculum teaches students how to create and maintain their own blog. Blogging incorporates a variety of didactic aid; inciting low interest in writing, developing communication and functional skills through visual-verbal connections using multimedia, engaging students through design to promote sequencing and serving teachers as an assessment tool. With new tools and new sets of data, teachers use data to inform instruction, develop personalized transition planning goals and create a learning environment that encourages positive social interaction, expressive communication and active engagement in learning and self-motivation.

As children with an ASD now grow up in an era of advocacy, early identification, and early and intensive interventions and therapies, many of today's youth with an ASD may find themselves better prepared for college (Hart et al. 2010). Our goal is to increase the overall productivity and ultimately the learning and earning potential for these individuals by allotting a portfolio of marketable digital media skills and the ability to showcase skills. "If the prediction for STEM interests among youth with autism is accurate and ASDs are on the rise, then the number of individuals with an ASD entering STEM fields in the future appears likely to increase." Key components of this product will lend to preparing students for STEM fields and related employment opportunities at technology-based employment opportunities like those provided by *Specialisterne*, and companies to come thereafter. The ultimate outcomes results in a greater sense of empowerment and autonomy as well as increased earning and learning potential for students as they pursue post-secondary educational goals.

The key components of this product lead to improved digital media literacy skills for students with autism.



Research discusses the importance of continuing studies in the area of ASD and STEM to bridge the gap between education research and practice by high school teachers and administrators. Findings suggest that, "students with an ASD had the highest STEM participation rates although their college enrollment rate was the third lowest among 11 disability categories and students in the general population" (Wei, Yu, Shattuck, Mccracken, & Blackorby, 2012). "For students with

autism, computerized instruction has been effective in teaching sentence structure, social problem solving, vocabulary, and increasing communication initiations and relevant speech in naturalistic interactions" (ASHA, 2006).

The characteristics of autism make it difficult for students to learn vocabulary and other information in traditional settings. However, many children with an ASD have a natural affinity and comfort level with computers (Cole, et. al, 2003). A preference for visual stimuli particularly those delivered via electronic screen media (ESM) has been noted by numerous researchers (Mineo, 2008). Digitability uses visual stimuli delivered via electronic screen media. Multi-step skills are taught through video prompting, breaking task to their smallest most manageable parts and then using additional video prompts to have student completed each step. Research shows that video prompting is more effective than video modeling of an entire task (Cannella-Malone et al., 2006). Using principles of ABA including task-analysis, prompting and maintenance provide a predictable learning environment that is highly structured. Each lesson is consistently structured to repeat and pace auditory information to address user-processing delays. Students with autism often have auditory processing impairments and therefore a need for auditory information to be repeated or paired with text. Throughout the four modules, instructional scaffolding, strategically built on the hierarchy of Bloom's Taxonomy of Cognitive Domains, organizes lesson content into their smallest, most manageable parts in order to build upon each previously mastered skill, expanding on skill development incrementally. Using a standard prompting sequence of, Show-Tell-Assist, lessons includes methods for continuing the demand following noncompliance, delivering a brief praise for compliance, and continue demand following other behavior (Carr, Auburn and Fox, 2009). Teaching these skills in a simulated environment removes social expectations and provides consistent routine in a predictable environment (Cole, et. al 2003). In this way, we leverage the inherent affinity and the motivation to engage with digital media to teach skills in that same domain (Mazurek, Shattuck, Wagner, & Cooper 2012). Recognized technical merit will serve as a baseline for planning next stages of skill development and potential post-secondary goals.

Research continues to demonstrate these evidence-based practices effective for changing and/or maintaining student behavior (Gilberts, Agran, Hughes, & Wehmeyer, 2001; Polirstok & Greer, 1977). **"**ABA is based on the idea that people are more likely to repeat behaviors that are rewarded than behaviors that are not recognized or are ignored. Since the 1960s, researchers have recognized that ABA can help children with autism. ABA does this by helping them develop a number of skill sets at the same time as it reduces the likelihood of their engaging in problematic behaviors. The technique is endorsed as a treatment for autism by the American Medical Association, American Academy of Pediatrics, and the U.S. Surgeon General. Rewards/Reinforcers used in Digitability are a combination of sensory, social and tactile modes. Social reinforcers have proven effective for teachers in changing and maintaining student behavior (Gilberts, Agran, Hughes, & Wehmeyer, 2001; Polirstok & Greer, 1977). Upon completion of each lesson activity, the student is delivered a video that includes the verbal feedback, "Congratulations!" followed by a statement of their accomplishment accompanied by music and video animation of the "badge" they have earned. Such sensory reinforces (visual and auditory) have been used successfully among students with developmental disabilities (Cicero & Pfadt, 2002; Summers, Rincover, & Feldman, 1993). When a student completes a unit of

lessons, they may redeem a Master Badge Sticker from their teacher to place on their achievement chart. This tactile, token reinforcement is only earned at the completion of a unit of content and is rewarded as a milestone motivating the student to work towards his next badge.

Beyond the evidence based practices embedded in the Digitability Technology, the program training on Digitability's Classroom Economy, a behavior modification system using boundaries and reinforcers in the design of the best ABA practices for promoting productive and healthy behaviors and working toward extinguishing behaviors that are problematic in the social, academic and vocational setting. The Digitability Classroom Economy combines behavior modification as a token economy and financial literacy training to move students from extrinsic motivation to intrinsic motivation. The are four stages to the Digitability Classroom Economy, where social and emotional capacity is build incrementally (Figure 6).

(Figure 6)

Digitability includes software analytics and an evidence-based practices resource portal. Teachers can identify new areas of strengths and use data to inform instruction and to develop personalized IEP transition goals and objectives, therefore improving Transition Outcomes and Post-secondary Goals. Software analytics evaluate student mastery of each unit's measurable objective and are used for quarterly IEP Progress Monitoring reports. Additionally, software analytics provide fidelity data to teachers and administrators. This data is used to measure and support teacher implementation fidelity of evidence-based practices. *Teachers can identify new areas of strengths and use data to inform instruction and to develop personalized transition goals and objectives.*

The Resource Portal and professional development builds teacher capacity for implementing these practices. The portal includes modeling, explanations and applied resources. It also ensures that teachers have the best education on using technology to support work-readiness and the changing paradigm for educating students with disabilities. The Apple Classroom of Tomorrow (ACOT) conducted a longitudinal study focused on the process of technology integration at the classroom level. Key findings from the study found that technology, "encourages fundamentally different forms of interactions among students and between students and teachers, engages students systematically in high-order cognitive task and prompts teachers to question old assumptions about instruction and learning (Dwyer, 1994, p8). Empowered by digital media literacy, teachers integrate modeled practices into their instructional practices to support an environment that fosters communication and socialization (Barron, et al., 2003 p.489).

The PI and Co-PI have been conducting action research on the lessons included in Digitability. The original lessons that are now in the program have been developed and used while teaching an autistic support classroom. In 2012, through a Wells Fargo and Corzo Center for the Creative

Economy $10,000 grant funding, a beta of Digitability was developed and pilot tested in the School District of Philadelphia, The Pediatric Wellness Network of New Jersey, and The D.C. Public Library. Digitability was piloted with 14 students with autism for approximately 20 school days. Students in the pilot completed an average of 18.4 lessons with a range of 6 lessons completed to 46 lessons completed.

A teacher who is facilitating a autistic support classroom, will not find a suitable product teaching digital media skills to improve transition outcomes for students with disabilities. There are products that either teach digital literacy or use technology to teach skills to students with autism, but none will do both.

Common Sense Digital Life and Citizen Curriculum is a paper and pencil curriculum teaching digital media literacy for students. The content lives in the domain of digital citizenry, but is not designed to accommodate the diversified, multi-sensory needs of student with autism. Further, if the teacher does not have a strong digital media literacy they will be not comfortable or effective in teaching these skills and students will miss out on learning the essential skills for today's society. Digitability is the **only** standardized and scalable curriculum solution, using a multisensory approach to make digital media literacy accessible to students with autism.

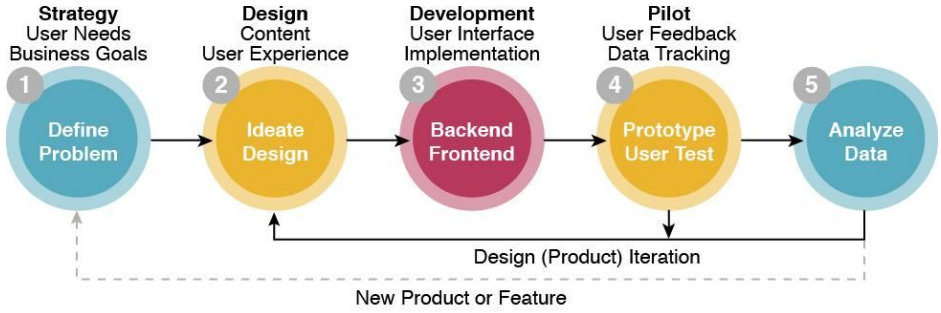
Vizzle is an authoring software helping teachers to create visual supports for existing curriculum. It does not offer a systematic curriculum to teach skills that are used in the vocational, social and function fabrics of our society. Vizzle's platform requires extensive time to learn how to navigate a cumbersome interface, create educational content or search through premade content and identify the appropriate resources. Digitability has a clean and intuitive interface and doe not require teachers to create content.

BrainPop! is a website teaching science and technology. Like other displaced alternatives, BrainPop is not accessible for students with cognitive disabilities. While BrainPop's website is interactive, using colorful animation, the imagery is abstract and does not depict concepts in an explicit manner. The pragmatics of the voice-over are complex and difficult for learners who have impairments in expressive and receptive language. The pacing of the language does not support auditory processing delays. Digitability uses universal iconography and simplified language, paced for extended auditory processing time. BrainPop is not a synthesized curriculum organized in the sequence of steps to develop skills.

Skawg is a socialization platform designed specifically for tweens with ASD. While Swag lives in the area of socialization, it does not explicitly teach skills in that domain. Opportunities for socialization occur in self-contained "chatting" environments and do not prepare students for socialization within the content of real world digital media platforms. Digitability teaches specific *skills* to safely and responsibly engage in digital media.

The impact of this research resulted in a complete and comprehensive learning platform that engages students with disabilities such as autism, speech and language impairments and more, to acquire marketable digital age skill sets to be used in the pursuit of their post-secondary transition, while gaining insight to methods for cognitive and social development.

The processes of user-centered design, usability testing and agile development are built on the consideration of the needs, wants, and limitations of end users (figure 7). Extensive attention to these variables within a process allows insights to be discovered and product requirements to be defined. User-centered design is an iterative problem solving process that requires designers to observe and analyze how users are interacting with a product and test the validity of their assumptions with regards to user behavior in real world tests with actual users.

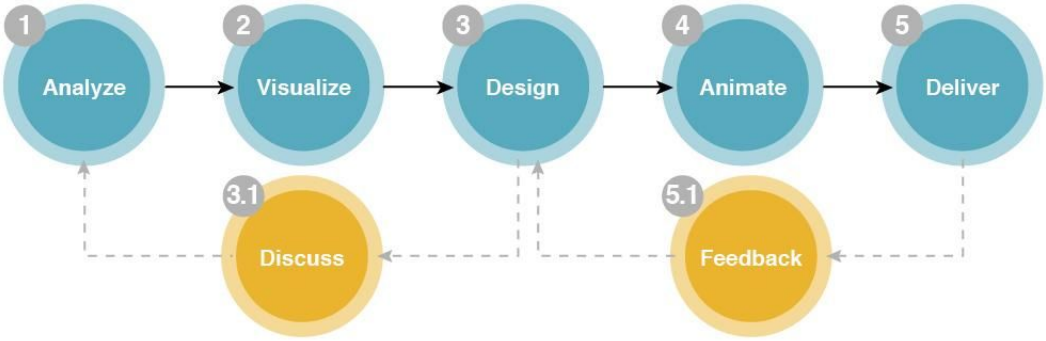


1) Define Problem (Strategy): Digitability designed a successful prototype in teaching digital media skills through simulated environments. Digitability's platform has been constructed and subjected to testing on both desktops and iPads by students with and without disabilities. An extensive library of lesson content has been produced. The platform is hosted on a secure and scalable cloud architecture, hosted on Amazon AWS Services. The platform and multimedia content was created through the processes of user-centered design, usability testing and agile development. With these processes in place and knowledge gained from our beta, Digitability's provides an easy to navigate and highly structured environment, delivering the core functionality of our product.

2) Ideate Design (Content/User Experience)

1. Analyze. Reviewed lesson scripts for a single unit of content and distinguished the main concepts to be delivered through each lesson. Any issues of unclear comprehension is reevaluated and either applied or dismissed.
2. Visualize. Graphics to represent and communicate core concepts are conceptualized into a clean and simple visual format.
3. Design. Graphics are mocked-up as badges and imagery for lesson storyboards. All files are organized in preparation for animation. While designing the lesson graphics in Adobe Illustrator each lesson is broken down into specific layers and labeled for recognition. When importing into Adobe After Effects the Illustrator file is read as a composition distinguishing each layer separately for animation. Any minor changes can be made directly within After Effects while major changes can be addressed in Illustrator. When a change has been made outside of After Effects we simply choose to update (reload) the file inside the After Effects project. Voice over is recorded. ***3.1 Discuss***. All design assets are reviewed and approved by team. Feedback on storyboards ensures content aligns with script.
4. Animate. Audio is engineered to ensure pacing is appropriate (providing extended auditory processing time). Designed content is imported and animated to synch voice over. The total

amount of time for all video content per lesson ranges from 3-5 minutes. However, because each lesson uses repetition of previous content and review of the new content, only 1-2 minutes of new content is generated per lesson.
5. Deliver. Videos are rendered out and delivered for final review and feedback. ***5.1 Feedback***. Videos are reviewed and approved by curriculum team. Necessary changes are made and issues resolved. While designing the lesson graphics in Adobe Illustrator each lesson is broken down into specific layers and labeled for recognition. When importing into Adobe After Effects the Illustrator file is read as a composition distinguishing each layer separately for animation. Any minor changes can be made directly within After Effects while major changes can be addressed in Illustrator. When a change has been made outside of After Effects we simply choose to update (reload) the file inside the After Effects project.



3) Development: The application is written in HTML5 and CSS. Server-side logic is scripted in PHP using the Laravel framework. Client-side logic is scripted in JavaScript and jQuery. The Amazon Web Services hosts the application source code and data is securely stored in the Amazon Web Services mySQL Relational Database Service. We use an online git repository to control the code. Video and graphic assets are hosted by the Amazon Web Services S3 cloud service. Amazon Web Services provides automatic, seamless, native scaling that accommodates exponential increases in site usage.

Research questions: 1. Does the implementation of the Digitability intervention improve digital media literacy skills of students with autism in grades 6 – 12 in a special education environment? 2. What are teacher's ideas for how and whether to teach digital media literacy skills? 3. Does the implementation of the Digitability intervention by special education teachers lead to their increased knowledge of ways to teach and foster the development of digital media literacy skills of their students?

Our partner schools identified 10 special education teachers in autistic support classroom settings with students in grade 6 – 12 to participate in this study. Students from each classroom who met the minimum gross motor skill requirements and could follow a single step, verbal prompt were asked to participate. The total sample of students was 96. All student and teacher records were coded as participant numbers.

A variety of quantitative and qualitative measures were used to answer our research questions. Student progress was determined by how many lessons and units each student completed during the study. Software analytics collected scoring data for each of the measurable technology objectives. Both written reflections and Student Think-Alouds were used to gain user feedback. Teachers' ideas were collected via impact statements and reflective essays. Topics focused on teachers' ideas about the importance of teaching digital media skills and specific teaching practices they use in their classrooms.

Digital media literacy is a multi-dimensional skill. When considering literacy in any medium, it combines skills of reading, comprehending, and writing in that medium. There was no pre-existing, single assessment tool that was developed to assess all aspects of digital media literacy prior to this project. Digitability developed a number of tools to measure the proximal outcomes of the project. The combination of these tools and software analytics in the program led to an understanding of a student's overall digital media literacy. The first tool includes a digital vocabulary pre-assessment. This assessment measures the students understanding of vocabulary needed to use digital media prior to engaging with the Digitability system. The second set of tools is built into the software analytics in the program. Since the program is gated and does not allow a student to progress, it can be assumed that the student's digital media literacy skills in the Digitability environment is commensurate with the lesson they complete successfully. Additionally, success is gauged in each culminating activity of the lesson in a simulated environment. The software logged the number of attempts by the student in each activity, after two unsuccessful attempts the facilitator is notified by email. This process is logged automatically in the system for each user and presented in the student data dashboard via reporting features.

The fidelity will be measured through a series of indirect and direct assessments. The project staff will verify the number of lessons successfully completed by each student each week. Direct observations will measure engagement of the students using the program. In order to understand the teacher approaches and paradigm for educating students in the special education setting using technology tools, teachers were asked to outline their beliefs for Digitability's potential for improving student's digital literacy.

Partner school leadership was asked to identify potential classrooms and teachers for the study and to facilitate a meeting of teachers with project staff. At the meeting, the project staff provided an overview of the program, shared the planned pilot study details, answered teacher questions, and requested teacher participation.

The pilot study lasted approximately 30 weeks. Teachers were instructed to introduce Digitability to their students and to have students begin at lesson one. Students used the program for at least 1 hour each week during the school day. Data was collected through the student engagement analytics built into the program. Additionally, project staff conducted student observations in classrooms.

Summing the total units and lessons each student completed, demonstrated the rate of student progress. Averaging the unit objectives for each group of students in a classroom presente levels

of increased digital literacy skill mastery. Student and teacher written feedback was collected. Student interviews were recorded.

Digital media literacy is increasingly being recognized as an important skill for employment and independence. With ~80% of people with cognitive disabilities experiencing unemployment, there is a great need for specialized training for students with special education needs. The Department of Labor and Statistics reports that 75% of all jobs require some degree of technological literacy. Digitability's pre-employment/transition program is a comprehensive workplace readiness training program that includes solutions for academic, social/emotional and vocational skill development and is based entirely on evidence-based practices including, but not limited to Applied Behavioral Analysis (an FDA approved form of treatment for behavioral health), Bloom's Taxonomy of Cognitive Development.

The impact of this research resulted in insights to the engagement of students with autism to acquire digital life skill sets to be used in the pursuit of their post-secondary transition. This project showed that implementation of the Digitability intervention improves digital media literacy skills of students with autism in grades 6 – 12 in a special education environment. The combination of digital literacy assessment tools and software analytics in the program led to an understanding of student overall increase in digital media literacy.

The project team developed a digital literacy vocabulary pre-assessment that measured the students' understanding of vocabulary. This pre-assessment was given to students prior to engaging with the Digitability system. This digital literacy pre-assessment tool was used to establish baseline literacy levels for students. The average cumulative score among all students in this sample was 55%.

Post-intervention progress data showed that students were able to master digital literacy skills through Digitability's platform. The cumulative average of all objectives completed was calculated for each student. Scores were grouped in four performance categories. These were Advanced (90-100), Proficient (80-89), Basic (70-79) and Below Basic (<69). The cumulative average of all objectives completed was calculated for each student. At the end of the 30 week implementation period of Digitability across ten classrooms, 92% of students achieved mastery (≥80%) in completed digital literacy objectives (Table 1 & 2). Among the 10 classrooms, the average number of units completed by students was 9 (Table 3).

STUDENT PERFORMANCE KEY	**Student Progress Scores**
Advanced (90-100)	46%
Proficient (80-89)	46%
Basic (70-79)	8%
Below Basic (<69)	0%

(Table 1)

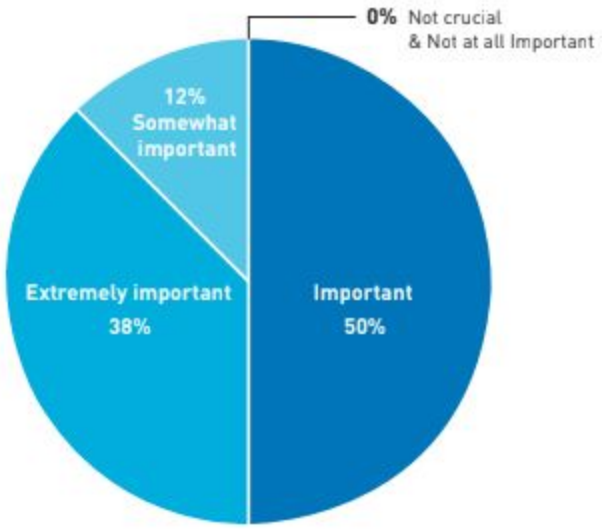
Average Student Activity Score by Classroom Group	Average Score by Group	Placement
Group 001	93	Advanced
Group 002	90	Advanced
Group 003	89	Proficient
Group 004	83	Proficient
Group 005	91	Advanced
Group 006	74	Basic
Group 007	90	Advanced
Group 008	84	Proficient
Group 009	89	Proficient
Group 010	95	Advanced

(Table 2)

Average Student Activity Score by Classroom Group	Average number of completed units	Average Score
Group 001	8	93%
Group 002	11	90%
Group 003	5	89%
Group 004	4	83%
Group 005	3	91%
Group 006	20	74%
Group 007	7	90%
Group 008	10	84%
Group 009	12	89%
Group 010	9	95%
Sample Averages	9	88%

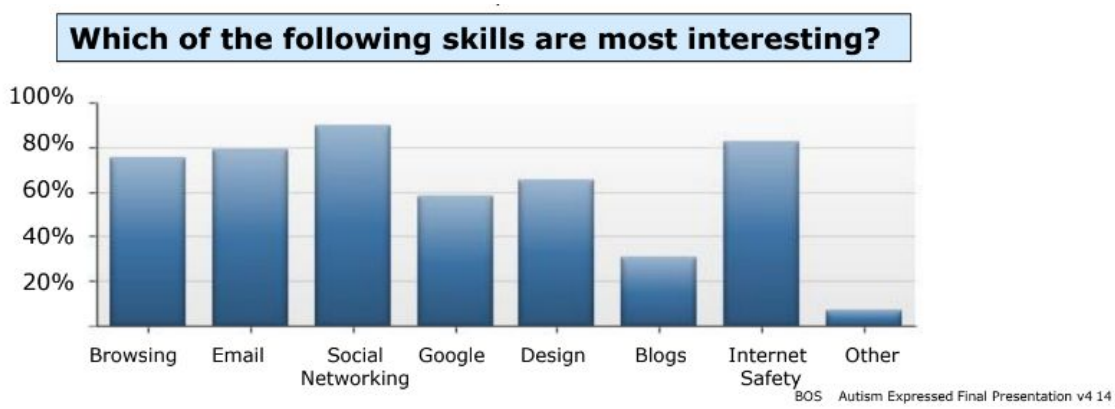
(Table 3)

Through this research, teachers' ideas for how and whether to teach digital media literacy skills were assessed through both quantitative and qualitative measures. The Wharton School's direct research with Digitability on perceptions of digital literacy in special education demonstrated that among parents, teachers and administrators surveyed, there was a perceived importance of digital literacy services for a student's transition to independence. The research found that 88% of people surveyed found digital literacy to be either important or extremely important to special education students in their transition phase (Figure 7).



(Figure 7)

As part of Wharton's research, respondents were asked to identify digital literacy skills that were most interesting. Among the non-parent category, which included teachers, school administrators and therapist, more than 80% of respondents identified internet safety, social networking, and using email as the most interesting digital literacy skills (Figure 8).



(Figure 8)

In addition to the quantitative data to demonstrate teacher perceptions, participants also provided qualitative feedback on perceptions of digital literacy levels for their students and the importance of digital literacy for Transition Planning. Teacher participants recognized that the implementation of the Digitability intervention in their classroom led to their increased knowledge of ways to teach and foster the development of digital media literacy skills of their students. There was a strong recognition that students in special education classrooms did not have the skills to use the internet safely, and student needs around impairments in socialization and concepts of reciprocity made this difficult for teachers to teach without a specially designed curriculum.

Teachers described the impact on their instruction and how Digitability changed the language they used for technology in the classroom. “I began to use the vocabulary from Digitability in the classroom like web app, icon, hyperlink.” Teachers noted the impact of both the explicit language and the repetition used in the videos to reinforce concepts for students with speech and language issues. “Students with disabilities need to be taught explicitly with repeated repetition. I found the use of the program to expand to all parts of the school day and not just during the lesson.”

Digitability helped teachers understand general strategies that can be used to support executive functions. As an example, when students struggle with working memory, they are not fully managing to hold on to all of those elements of a story, and therefore may score low in reading comprehension. One strategy for developing working memory is chunking information. Digitability’s online learning program chunks information through the process of task analysis. For example, the lesson on using a Google Calendar web app breaks down each step to creating a calendar event using chunking. Within that same module, teachers developed strategies for sustaining attention and self-regulation. Digitability feels like a game to students. When requesting feedback on the student experience with Digitability 79% of students mentioned the badge reward system. The badges made learning feel like playing games during the school day and increased motivation, which promotes sustained attention.

Teachers expressed the lack of a relevant curriculum available to support the transition needs of their students. While there are a high number of tools such for skill inventory and job exploration, there are only a few tools that are designed to develop skills and can be easily implemented into the classroom. The Digitability curriculum addresses widespread need to formally teach skill sets that research indicates are an “essential component of job readiness, citizenry, and life skills” (Baker & O’Neil, 2003).

Project Team – Biographical Summary of Each Key Project Personnel

Principle Investigator. Michele C. McKeone, M. Ed, (PI) Founder and CEO of Digitability. In 2005, McKeone earned her Bachelors of Science in Digital Media from the University of the Arts, College of Media and Communication, where she studied and deployed such concepts as streaming media and social networking before the launch of YouTube and prior to Facebook becoming a household name. Gaining insight to digital media trends, McKeone anticipated the need for digital media literacy in education. McKeone was awarded Philadelphia Teaching Fellowship, where she went to work in a Title I high school, teaching students with autism. McKeone completed both The 21st Century Teaching Learning Series as well as Highly Qualified Special Education Certification. McKeone pursued a research focus in using digital media to circumvent the learning variations that students with autism present while earning a Master’s of Education, with a concentration in Special Education from Chestnut Hill College.

In 2010, McKeone led her own students, (profiles ranging from mild to severe and verbal to non-verbal) to place 3rd in the Multimedia Category at Philadelphia’s Regional Computer Fair. Her methods earned the nomination of the Christian and Mary Lindback Award for Distinguished Teaching and The Mona Cohen Excellence in autism Education Award. With a

highly-specialized background in the area of digital media literacy and autism Education, McKeone became a consultant and teacher trainer for the School District of Philadelphia's Office of Specialized Services, designing workshops that motivate both young and veteran teachers to implement technology in the classroom to support students with autism and other learning variations. McKeone continued to train and evaluate new teachers under The New Teacher Project. In 2011, McKeone was awarded a $10,000 Wells Fargo grant through The Corzo Center for the Creative Economy Business Plan Competition to support her innovation. McKeone was thereafter invited to participate in the Good Company Ventures Social Venture Incubator and awarded a Fellowship in The Alliance of Women Entrepreneurs, where she learned to develop her business model and acumen while planning the design and development of the Digitability beta platform. In 2013, The University of Pennsylvania Graduate School of Education awarded McKeone a $20,000 to develop and scale her innovation. As a self-advocate, continues to present, consult and facilitate training to advocate for individuals with disabilities, reinforcing the notion that people with neurodiverse needs can achieve more with the right supports.

Co-Principal Investigator. (Co-PI): The late Dr. Michel L. Miller, an Assistant Professor in the School of Education (SoE), served as the Co-Principal Investigator for the Digitability Project. Dr. Miller joined the faculty of Drexel University in July of 2007. Dr. Miller developed a special education teacher certification program at the undergraduate and graduate level within the SoE. Within the master's program, Dr. Miller developed a concentration in autism Spectrum Disorders. Dr. Miller was a Supervisor of Pupil Services with direct supervisory responsibilities over all of the district's special education programs, which included programs for students with ASD prior to coming to Drexel. She also had teaching experience working with students with learning, social, and behavioral disorders in inclusive and self-contained settings. She helds a Ph. D. in Special Education from the University of Miami and has completed extensive course work in educational administration at Widener and Temple Universities. Her research interests focused on autism, technology for special education, special education leadership, and program evaluation. Dr. Miller was also a Co-PI on two iPad application development projects funded by outside agencies. The first is a project to develop an iPad app for the Academy of Natural Sciences of Drexel University that will provide families with children with ASD an interactive platform to prepare for their visit and to use during their time at the academy. The second, entitled Physics at the Art Museum is to develop an iPad app that will facilitate learning of physics concepts through the use of art museum exhibits and uses the concepts of universal design to ensure accessibility for all learners.

Curriculum and Assessment: Catherine Chase, MS, LDTC. Catherine Rae Chase, M.A., LDTC, is a Psycho-Educational Diagnostician and Learning Consultant/Reading Specialist, providing interventions in attention, learning, and behavior. She has over 30 years of experience in the field of education and psycho-educational diagnostics. Chase is the *first educator to receive a Fellowship in Developmental and Behavioral Pediatrics at Harvard Medical School.* Catherine holds a M.A. in Curriculum and Instruction from the Catholic University of America, in Washington, D.C. She has completed advanced diagnostic assessment training at Tufts University, in Medford, Massachusetts. Chase served as a Psycho-Educational Diagnostician at the Richard Wood Research Center of the Children's Hospital of Philadelphia: Developmental

Behavioral Pediatrics and she was a faculty member of the School Function Center, where she provided community lectures and educational intervention. Chase has served as the Director of Special Services in the Egg Harbor City School District, NJ and as a teacher of the multiple handicapped populations at the Atlantic County Special Services School District. Chase continues to present and trainer for school districts throughout the state of New Jersey.

Chief Technologist**.** Tristan Hoffmann, MS SM, has spent his entire career working on education technology solutions for schools. As an Upper School Technology Coordinator at Sanford School, he trained faculty to incorporating technology to increase engagement and measure progress. Hoffman was selected to give four separate poster presentations at the International Society for Technology in Education's annual National Education Computing Conferences. After Sanford, Tristan spent 5 years at Gravic, Inc., where as a Product Manager Analyst and a Solutions Developer he defined their vision and commercially applied their technology to the education industry. His focus was on the Remark Office OMR and Remark Web Survey software, used by over 50,000 schools and institutions worldwide to do testing, data-collection, and data-analysis. Hoffman worked hands-on as a developer, adding advanced technology features to the software like dynamic data collection and display in Remark Web Survey. Tristan recently graduated top of his class from Carnegie Mellon's Silicon Valley campus with their Master's of Software Management program, which focuses on using contextual design to interview and elicit customer needs to strategically design the "idea" and build it into a sustainable technology business. Classes included Software Product Definition, Requirements Analysis, Project and Process Management, Software Product Strategy, and the Business of Software. He received the only A+ awarded to the summer practicum projects for his work with Digitability.

Joshua James Sereday is an award-winning multimedia designer and architect. Using an User-Centered Design (UCD) Approach. During his education and work experience among world-class designers and award-winning media and technology firms, Sereday developed an innate insight to the science of user-computer interaction and user centered design. He has applied this expertise in all technology-based endeavors. An expert user-experience designer with advanced proficiency in a variety of multimedia production software and front-end development programming languages, Sereday uses his expertise to produce dynamic, multi-sensory technology and digital media driven products including interactive mobile platforms and concept designs for a wide variety of interactive mobile apps.

David Mandell is an Associate Professor at the University of Pennsylvania with over 83 peer-reviewed publications. Dr. Mandell served as a research consultant on the project, as it relates to feasibility of use in public school settings, and supporting the evaluation design. For the past 15 years, he has conducted research on strategies to improve quality of care for individuals with autism in community settings. He has studied issues related to financing of interventions, their implementation in schools, and family issues that may affect their success. Most germane to project, he was principle investigator of a recently-completed randomized controlled trial of two classroom-based interventions for students with autism. Following the completion of this study, he entered into a contract with the School District of Philadelphia to provide training and ongoing in-classroom support to staff in 140 autism support classrooms.

Through these experiences, he have developed expertise in issues related to intervention implementation and evaluation in community settings.

Resources.

Drexel University & School of Education (SoE).

Drexel is a top-ranked, comprehensive university recognized for its focus on experiential learning through co-operative education. Drexel is a leader in creating technological solutions to societal problems of the 21st century. For the fifth consecutive year, Drexel University has achieved the "most promising and innovative changes in academics, faculty, students, campus or facilities," according to *U.S. News and World Report* for the 2013 edition of "America's Best Colleges." Recognized as one of America's Best Graduate Schools by *U.S. News and World Report*, the SoE's mission is to produce education leaders. Benefiting from Drexel University's position as one of the premier technology universities, SoE provides technologically based curriculum with a strong orientation in science, technology, and math. As faculty members in the SoE, the Co-PI had ample resources available to her to carry out the research activities of this project. The Co-PI had a private office with up-to-date technology including a desktop computer, and laptop computer.

The Digitability Project team technical resources.

Design. Adobe Illustrator CS6, Adobe After Effects CS6, Miro Video Converter, Transmit FTP, iMac 27", 2.93 Ghz Intel Core i7,16GB,ATI Radeon HD 5750, 1024 MB, 8TB Raid Rack Pro, Pro Tools. Development. A desktop workstation and laptop with access to Apple OSX, Linux and Windows 7 operating systems and a high-speed data connection and access to all modern web browsers, Pitvotal Pracker, BitHub, Amazon Web Services Elastic Beanstalk Services, Amazon Web Services S3 cloud service. PI & Curriculum. Desktop and laptop workstations and two ipads with high-speed data connection and access too all-modern web browsers, Industrial printer, ESPON Stylus R280 printer, Microsoft Office, and Adobe Photoshop.

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