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Systematic Review of Digital Activity Schedule Use in Individuals With Autism and Intellectual Disability

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Master of Science

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ABSTRACT

A Systematic Review of Digital Activity Schedule Use in
Individuals With Autism and Intellectual Disability

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The purpose of this systematic review of using digital activity schedules as an intervention in individuals with autism spectrum disorder and intellectual disabilities is to determine to what extent the current research shows it to be an effective intervention. For articles to be included in this review, they had to use a digitally presented activity schedule, the activity schedule could not be a task analysis of a single activity or a group visual schedule, and the intervention must have been carried out with individuals with autism or intellectual disabilities. Studies meeting the inclusion criteria totaled 17 studies with a total of 58 participants included. The studies focused on the effects of using digital activity schedules to teach leisure skills, independent living skills, and academic skills across various age groups. Settings of the intervention, ages of participants, varying participant characteristics, and What Works Clearinghouse quality indicator standards in each study are examined. Results show that interventions were heavily concentrated in early childhood age groups, teaching leisure activities, and were often combined with other concurrent interventions. Future research should focus on more interventions implemented with individuals in secondary education, independent living skills, and rigorous methodological standards as defined by the What Works Clearinghouse quality indicators.

Keywords: digital activity schedule, autism, intellectual disability, academic skills, independent living, leisure

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Finally, I want to show gratitude for my students. They inspire me to keep trying and give me the drive to research and expand my toolbox as a teacher that I may know how best to help them on their individual learning journeys. They humble and challenge me and give me daily reasons to continue my own learning with persistence and vulnerability.

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DESCRIPTION OF THESIS STRUCTURE AND CONTENT

This thesis, *A Systematic Review of Digital Activity Schedules,* is written in a format that combines the requirements of a master's thesis as well as incorporating elements needed for potential journal publication.

The first part of this thesis is written in alignment with the requirements necessary to submit this thesis to the McKay School of Education. It is written in the style of a journal article for submission to educational journals.

After the introduction and methodology, the results of the systematic review and a discussion of those results is included. Following the discussion of the results is a section listing the references of all the citations found in the systematic review. Following the references are the tables of study results as well as the PRISMA flowchart.

The formal review of the literature for this thesis can be found followed by the reference page for all citations listed in the literature review in Appendix A.

Introduction

Individuals with autism (ASD) often have difficulty with independent performance of tasks due to deficits in executive function and other skill sets that are characteristic of the disability as well as difficulty with generalization that often accompanies ASD (Hume et al., 2009). This difficulty with independent performance and executive function can have detrimental effects to their quality of life as they enter adulthood. While most adolescents experience an increase in independence and independent behaviors, individuals with ASD often experience a plateau if not a regression in independent behaviors as they navigate through puberty (Hume et al., 2014). Being too reliant on prompts and feedback can also be largely contributing factors in independent success delays for these students (Hume et al., 2009).

As with ASD, individuals with intellectual disabilities fall along a spectrum of functioning and severity (Snell et al., 2009). Individuals with intellectual disabilities may have an even harder time with skill acquisition and application because they are more easily distracted, have less ability to pay attention, read social cues, or control impulsive behaviors (Shree & Shukla, 2016).

A frequent co-occurring diagnosis of individuals with ASD is intellectual disability (Matson et al., 2009). One aspect of development that individuals of both groups show great deficit in, is that of independent living skills (Lord et al., 2018; Snell et al., 2009).

Supports that are thorough and tailored to the individual can help “bridge the gap between capabilities and demands” (Snell et al., 2009, p. 221). A critical support discussed to increase the achievement of individuals with disabilities is the use of visual supports (Cohen & Demchak, 2018).

Visual Schedules

Muchagata and Ferreira (2019) explain that "Children with autism often experience considerable challenges in understanding, structuring, and predicting their daily life activities" (p. 453). A schedule can be a cue to help students remember what is happening that day, and help them be ready for the activities and changes happening in the day which can help reduce anxiety that the students might feel (Cramer et al., 2011). In addition to helping students follow a routine, visual schedules have been shown to be an effective antecedent strategy in reducing problematic behaviors (Macdonald et al., 2018). When routines and procedures are established, students have higher rates of positive behavior.

Visual schedules can help students gain independence and answer contextual questions about their surroundings such as the process, duration, or what to do after completion of the assigned task (Connelly, 2017). Studies have found that it increases on-task behavior and decreases maladaptive behaviors, which decreases the amount of time that can be spent off-task (King, 2015). Visual schedules increase the autonomy of individuals because they help create predictability and increase the structure of their daily activities (Curtin & Long, 2021).

Activity Schedules

An activity schedule is defined as being a sequence of visuals or words that cue an individual to complete a set order of activities (McClannahan & Krantz, 1999). They are a visual cue that is consistently available to aid students in staying on task and engaged in a sequence of activities (Morrison et al., 2002). An activity schedule can be built to be individualized for each individual who uses it.

Activity schedules can be adapted and adjusted in size, presentation, order, and number of activities based on student ability level and needs. Studies show that activity schedules can be varied in their design as well as applied across a wide range of ages and settings while still increasing on-task and independent behaviors with some studies also showing social gains as well.

Activity schedules give individuals choice and control in their daily activities (Anderson et al., 1997). This flexibility in implementation and design makes them widely accessible for most individuals and situations. Activity schedules are cost effective and portable, allowing them to be generalized across settings and individuals (Morrison et al., 2002). Yet, the use of activity schedules can potentially be stigmatizing (Akers et al., 2018). If uncommon in the setting, an individual using a clipboard with hook and loop fasteners or a binder with dry erase check marks can be something that singles them out as being different than their peers. Thus, while giving them more independence in functioning, it can also label the individual as different and alienate them from their peers.

Digital Activity Schedules

With the benefits available from the use of activity schedules it becomes important to find an effective way to use and implement them in daily living situations in a format that is not stigmatizing. Perhaps the most important reason for using a high-tech activity schedule is that it may not be as stigmatizing as an individual carrying or using a book or paper-based activity schedule (Osos et al., 2021). Osos et al. (2021) discuss that students at all age levels are utilizing high-tech devices and thus using such a device can have an additional outcome of reducing social stigmatization and reducing the potential of being bullied. Despite the benefits of a paper-based activity schedule like cost, replaceability, and its ability to be customized, there are too many advantages of using technology for it to be dismissed (Uphold et al., 2016). Due to the quick advances in technology, laptops, tablets, and handheld or mobile devices should be put to use in classroom settings (Kurkcuoglu et al., 2015).

One of the benefits of technology now is that most pieces of technology are easily transportable. Having an intervention delivery that is conveniently portable gives greater opportunities for widespread generalization of skills being taught. As high-tech devices are portable enough to be taken to other settings with individuals, instruction in targeted skills can happen in any setting the device goes (Osos et al., 2021).

Statement of the Purpose

The research on the use of digital activity schedules is limited (Eliçin & Tunalı, 2016; Kurkcuoglu et al., 2015; Osos et al., 2021). There are a limited number of studies in each area of age and skill set (i.e., academic, leisure, independent living, etc.). Other researchers have called for more research to be done in the area of digital activity schedules (Carlile et al., 2013; Eliçin & Tunalı, 2016; Kurkcuoglu et al., 2015; Radi, 2017).

Research Question

This study was designed to answer the following research question: In the current corpus of research literature on digital activity schedules, what are the results and characteristics based on participants, components of the interventions (including dosage, frequency, fidelity, and social validity), research designs, quality, and outcomes?

Method

In conducting the systematic literature review a methodical set of steps was completed. First the inclusion and exclusion criteria were determined. Then the second step was determining the search terms and which databases were to be searched. Third, the results found from the databases were recorded in a Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Flowchart (https://www.prisma-statement.org). And fourth, those articles that met the inclusion criteria and were retrieved and coded. Finally, the fifth step in the review was that results were compared with a second coder to determine inter-rater agreement.

Inclusion and Exclusion Criteria

Articles for this review were chosen based on three criteria. The initial inclusion criteria that had to be met is that each study had to use an electronic or digital version of an activity schedule. This meant a list of close-ended activities presented in a digital format using an iPad, smartphone, laptop, computer, tablet, or other electronic device. To be sure that individuals were responding to the intervention and not just memorizing a sequence of steps to reach a terminal reinforcer, an additional inclusion criterion that needed to be met is that the activity schedule was not a task analysis of one activity broken down into simplified steps, or in other words, the activities in the schedule could be organized in varying orders without an effect on the terminal outcome. The final inclusion criteria that had to be met was that each study must have been performed with individuals who had a diagnosis of autism or intellectual disabilities.

Articles were excluded if the activities in the schedule were video modeled, were a daily visual routine presented digitally, or were a task analysis to complete an overall close-ended task.

For the purpose of this systematic review, a daily visual routine refers to a visual schedule like one that you would find posted in a classroom for the whole class to see. These routines are created for a whole group and are set in order. Having this presented digitally does not meet the criteria of a series of close-ended activities that can be completed independently as participants are reliant on class-wide completion of the activity or a specified duration of time between activities even if the participant is finished.

Video-modeled activity schedules and task analysis-based activity schedules were excluded as the purpose of this review is to determine the effects of the intervention on individuals and their ability to successfully complete a sequence of tasks or routines independently. Including video-modeled tasks was considered a teaching intervention to teach how to complete the steps in the schedule instead of evaluating the individual's ability to complete the tasks independently.

Search Procedure

A systematic search of ERIC, Education Full Text, APA PsycInfo, ProQuest Dissertations & Theses Global, and Medline electronic databases was conducted. The systematic search used the search terms "digital activity schedules" or "digital picture activity schedule" or "electronic activity schedule" or "electronic picture activity schedule" or "ePAS" and "disabilit*' or "disability" "autism" or "ASD" or "developmental disability" or "intellectual disability" entered into the database in pairs. One of the intervention name terms was systematically paired with each of the disability terms until each intervention term had been paired with each disability term and 30 systematic searches had been performed per data base. The systematic search also included the requirement that all search terms were found in the results for each search. In addition to this search of electronic databases, the reference lists of articles found on the subject was also searched to identify any other possible studies. The last search for these studies was completed February 1, 2024.

Covidence

The internet software Covidence (www.covidence.org) was used to load the results of each database search. Once each search was entered into Covidence they went through a series of two screening processes. The initial screening is a title and abstract screening, all the articles from the database searches are uploaded via RIS files and Covidence removes duplicates from all studies. After duplicates have been removed, each reviewer goes through the title and abstract of each article and marks if the article should move on to the next phase of screening or not. For all articles that are marked to move on to the next stage of screening, the full text of the article is analyzed by each reviewer and the screening includes marking whether the article is included in the study or excluded and if excluded, the reason for exclusion is selected. At each screening stage, when the second screener enters in their results the software gives a record of how many disagreements in screening. These disagreements had to be resolved before each stage of screening could be completed and reviewers could move on to the next stage of screening. At the end of each stage of screening, reviewers met together to go over disagreements and after discussion, consensus was decided for each article and it was given a final screening result. From these levels of screening a PRISMA Flowchart is automatically generated.

PRISMA Flowchart

As each search was conducted information was entered into Covidence and a PRISMA Flowchart was generated. For each database searched, the number of articles that came up in the initial search results was recorded. From there all articles that were duplicated across search engines were counted and their number was reported. The articles that were discovered in the initial search results were screened using their title and abstract to see if they were relevant or not relevant to the search terms. They were sorted and counted accordingly. Those articles that were sorted as being relevant to the search terms were then screened by reading through the article to determine if they met the inclusion criteria and if they didn't meet the inclusion criteria, the reason they were excluded from the review was documented. These categories were totaled and the final number of articles that met the inclusion criteria was retrieved for coding and included in the systematic review. The PRISMA Flowchart for these results can be found in Figure 1.

Procedures

Each study that met inclusion criteria was coded and information recorded in a table. Information was coded for (a) number of participants, (b) participant characteristics, (c) participant selection criteria, (d) setting, (e) materials, (f) intervention components, (g) experimental design, (h) procedures, and (i) a summary of the findings. The summary of the findings included data from baseline and intervention components, percent of non-overlapping data, and generalization/maintenance data where available. For studies that implemented a digital activity schedule across multiple settings, the overall results of all settings was also recorded.

Inter-Reviewer Agreement

The main author, a graduate student at Brigham Young University, conducted the initial search and sorted the articles into inclusion or exclusion categories, the main author also pulled all the information to create an initial summary of each of the included studies. A secondary author, who was also a graduate student at the same university, sorted each article at the title and abstract phase as well as the full text phase into inclusion and exclusion categories. The secondary author also coded all of the articles and extracted information was checked for agreements. After articles were sorted by both authors, the number of agreements was divided by the number of agreements plus the number of disagreements to find the percentage of reliability between the two authors for each stage.

In the title and abstract screening phase, there were 1,231 articles. After screening each of these, the main author and the secondary author had 36 conflicts. The inter-reviewer agreement at this stage was 97%. The next stage was full article screening. There were 115 articles that made it to this stage and of those the coders had six conflicts in whether articles should be included or excluded. With those six conflicts, the inter-rater agreement came out to 94.7%. At each stage of screening, both authors met to review and resolve conflicts to come to 100% agreement before moving on to the next stage of screening.

Results

Study Year and Setting

There were 17 studies that met the inclusion criteria. The studies were all published between 2010 and 2023. The highest percentage of studies were published between 2015 and 2019 ($k = 9$, 52.9%). Following this percentage were studies published from 2010 to 2014 ($k = 5$, 29.4%) and from 2020 to 2023 ($k = 3$, 17.6%). All studies reported the setting of the intervention with most occurring in a classroom or school setting ($k = 10$, 58.8%). Beyond the classroom or school interventions happened in a clinical setting ($k = 4$, 23.5%), out in the community ($k = 2$, 11.7%), and in the participant's home ($k = 1$, 5.9%).

Study Design

All 17 studies reported the study design used for the intervention. There were common themes of single participants or multiple baselines as well as alternating treatments. All studies that met the inclusion criteria used single-case study designs and k represents the number of studies. The following research designs were used: ABAB withdrawal ($k = 4$, 23.5%), multiple probe across participants ($k = 4$, 23.5%), multiple baseline across participants ($k = 4$, 23.5%), alternating treatment design ($k = 2$, 11.8%) as well as a non-concurrent baseline design ($k = 2$, 11.8%) were also used in some studies. The final study used an ABB with non-concurrent multiple probe across participants design ($k = 1$, 5.9%).

Participants

Across the studies that met inclusion criteria, a total of 58 participants were a part of the different interventions and participants are represented by the letter *n*. All studies gave an age range of participants. The participants of all studies were between the ages of 3 and 45 years old. The highest concentrations of participants were in preschool (n = 18, 31.0%) and elementary (n = 18, 31.0%) age ranges with equal numbers of participants. From there, high school age students made up the third largest group (n = 10, 17.2%) followed by college age (n = 6, 10.3%) and adult age participants (n = 6, 10.3%). No studies included participants in the middle school age range. Of the participants, 47 (81%) of them were male and 11 (18.9%) were female.

All participants included in the studies had a diagnosis of autism or intellectual disability per the inclusion criteria. A majority of participants included in the study were reported to have a diagnosis of autism (n = 41, 70.6%). Participants with intellectual disability were the next largest proportion of participants (n = 10, 17.2%). The remainder of participants were diagnosed with both autism and intellectual disability (n = 7, 12%).

Intervention Components

Area of Focus

In the studies that met inclusion criteria, there were three different areas that the digital activity schedule interventions focused on: academic skills, leisure skills, and independent living skills. Most studies implemented an intervention that focused on leisure skills (k = 9, 52.9%). Following leisure skills, a focus on academic skills had the next highest prevalence (k = 6, 35.2%) Only two studies had interventions focusing on independent living skills (k = 2, 11.7%).

Data Collected

All studies reported the areas of data collected. Most studies collected data on task completion (k = 8, 47%). Other data measures collected included mastery of target skills (k = 6, 35.2%) and intervals on task (k = 5, 29.4%). Equal numbers of studies reported data collection in transition, number of prompts, and number of correct responses (k = 3, 17.6% each). Few studies reported data collected on engagement (k = 2, 11.7%), duration (k = 1, 5.9%), task initiation (k = 1, 5.9%), independent play duration (k = 1, 5.9%), rates of behavior (k = 1, 5.9%), and role play behaviors (k = 1, 5.9%).

Delivery Dosage and Interventionist

Dosage

The number of intervention sessions was presented in a variety of ways reporting numbers for the overall study, reporting numbers for each individual participant, and pulling a number of sessions from graphs where the total number was clear. The number of sessions reported in studies spanned from 12 sessions to 84 with an average number of 25 sessions for each participant per intervention. There were nine studies (52.9%) that reported how many weekly sessions were held, all studies reported a number between two and five with four studies reporting a weekly range within that span. Along with weekly sessions, number of sessions per day were reported by seven studies (41%) with no more than three sessions a day being reported. As with the weekly session, these numbers were reported as a range of sessions (k = 5, 29.4%) from one to three sessions a day.

Of the 17 studies, 12 studies (70.5%) reported the duration of sessions. Most studies reported sessions lasting up to 15 minutes (k = 8, 47%). After that, the most frequent session length was 16 to 30 minutes (k = 2, 11.7%). The final studies reported sessions that last 31 to 45 minutes (*k* = 1, 5.9%) and 46 to 60 minutes (*k* = 1, 5.9%).

Interventionist

Each study reported who implemented the intervention. Most interventions were implemented by the researcher (*k* = 12, 70.5). After the researcher, teachers or classroom staff were the most frequent individuals used to implement the interventions (*k* = 5, 29.4%). In one study, the caregiver was selected to implement the intervention (5.9%).

Intervention Fidelity and Interobserver Agreement

Of the 17 studies, 14 studies (82.3%) reported fidelity in intervention implementation. The percentage of sessions in which fidelity data was collected reported statistics of from 23% to 100%, with fidelity data being collected on an overall average of 47.3% of sessions. Intervention fidelity was collected on the steps of the intervention completed (*k* = 10, 58.8%) and on if a task analysis or script for the intervention was followed (*k* = 5, 29.4%).

Only one of the studies included did not report on interobserver agreement (IOA). Of the remaining 16 studies (94.1%) IOA data was collected on anywhere from 11.5% to 100% of sessions. All the studies reporting IOA (*k* = 16, 94.1%) focused on percentage of agreement in the data being collected for the intervention.

Social Validity

Social validity was reported on a majority of studies (*k* = 14, 82.3%). Of the studies that collected social validity, only a few used a Likert scale as their method of collecting information (*k* = 5, 35.7%). Social validity was collected from a variety of sources: the person implementing the intervention or classroom educator (*k* = 7, 50%), the participant themselves (*k* = 5, 35.7%), or other individuals such as parents, peers, school staff, and college students (*k* = 6, 42.8%). Some of the more common themes investigated during social validity inquiries were practicality, community and peer acceptability, independence, and activity completion.

What Works Clearinghouse Quality Indicators

The author coded each article for the What Works Clearinghouse quality indicators found in *What Works Clearinghouse Standards Handbook* (2020; Version 4.1) to determine what percentage of articles (a) met the quality indicators, (b) met the quality indicators with reservations, or (c) did not meet the quality indicators. Of the included studies, only one met quality indicators (5.9%). Some of the studies met the quality indicators with reservations ($k = 6$, 35.3%) but most studies did not meet quality indicators ($k = 10$, 58.8%). All studies met the quality indicator of providing raw data in tables or graphs ($k = 17$, 100%). Not all studies met the criteria of providing sufficient IOA ($k = 13$, 76.5%), systematically manipulating the independent variable ($k = 15$, 88.2%), presence of residual treatment effects ($k = 15$, 88.2%), having no confounding factors ($k = 14$, 82.4%), and not having training phases happening to more than one participant at a time ($k = 11$, 64.7%). The area where most studies did not meet quality indicators was in the required phases to demonstrate effect and data points per phase, only a few studies met quality indicators ($k = 7$, 41.2%), most met the quality indicators with reservations ($k = 9$, 52.9%), and only one study expressly did not meet this quality indicator (5.9%).

Discussion

In a high school setting, especially a secondary or post-secondary classroom, students are regularly found working on their own IEP goals and skill sets. There is often a need for more independence in completing everyday tasks without constant supervision (Hume et al., 2009, 2014). After teaching independent skill sets and task completions teachers can introduce a digital activity schedule that varies the tasks included. Each of their students using a digital activity schedule then practices skill maintenance as well as independent completion of a list of tasks that could relate to vocational skills for one student, household tasks for another, or personal care tasks for yet another student.

Having the ability to move through a series of activities independently without the need for constant supervision or prompting is an essential component for having a high quality of life once they reach adulthood (Connelly, 2017). This skill is not generally something that comes naturally for individuals with disabilities and therefore needs to be explicitly taught. This systematic review found that most studies using digital activity schedules focused on individuals in early childhood and elementary education stages. It has also found that the majority of the use of digital activity schedules studies evaluated increasing leisure activities with some studies focusing on increasing academic skills and the least number of studies evaluated increasing independent living skills.

Importance in Terms of Independence and Independent Living

A schedule can be a cue to help students remember what is happening that day, it can also help them be ready for the activities and changes happening in the day which can help reduce anxiety that the students might feel (Cramer et al., 2011). Visual schedules can be helpful in removing the dependence students have on adults to give assurance and support during planned and unplanned changes in their daily schedule (Banda et al., 2009). Activity schedules can help students "develop a positive routine of looking for information and thus increase flexibility and the ability to cope with life's ups and downs in the future" (Davies, 2008, p.18). Tailoring visual activity schedules for individuals with disabilities has a positive effect on the individual's independence, and technology can allow these imperative adaptations to be more readily made (McDonald, 2021).

Harrower and Dunlap (2001) share that “one goal of education is to increase the independent academic functioning of students” (p. 767). If these practices and interventions are taught and implemented early and adapted to meet student growth levels, educators and other practitioners can help to set students on a path of higher independence as they reach adolescence and adulthood.

Visual activity schedules increase the autonomy of individuals because it creates predictability and increases the structure of their daily activities (Curtin & Long, 2021). One of the benefits of technology now is that most pieces of technology are easily transportable. Having an intervention delivery that is easily portable gives greater opportunities for widespread generalization of skills being taught. Having a digital version of an activity schedule has been shown to be effective and as discussed in social validity measures in multiple studies they were shown to be socially acceptable for all ages and were practical for those implementing the digital activity schedule.

Behavior

Visual schedules have been shown to be an effective antecedent strategy in reducing problematic behaviors (Macdonald et al., 2018). This is helpful in decreasing some problematic behaviors because the visual representation of what is coming and what is expected of them reduces the uncertainty that is the root of those behaviors. Visual schedules can increase on-task behavior and decrease maladaptive behaviors, which decreases the amount of time that can be spent off-task (King, 2015). The studies in this systematic review showed consistent increases in duration of on-task behaviors and task-completion which are incompatible with many problematic classroom behaviors.

Dosage and Concurrent Intervention Strategies

There was a wide range of intervention sessions as well as methods of how the intervention data was collected. The lowest number of reported sessions was 12 intervention sessions and the highest number of reported sessions was 84, with an average of 24.93 sessions and a standard deviation of 11.72. Four studies had participants with a number of sessions outside of a single standard deviation of the average number (Carlile et al., 2013; Giles & Markham, 2017; Reinert, 2016; Ulke-Kurkcuoglu et al., 2015). Reinert (2016) had a singular participant that only had 12 sessions with both of the remaining participants having a number of sessions that fell within one standard deviation, none of the participants had a generalization or maintenance session recorded. All participants included in the study by Carlile et al. (2013) had sessions that fell outside one standard deviation, 37–40 sessions, and each participant had extensive baseline data collected as well as three maintenance sessions. Ulke-Kurkcuoglu et al. (2015) also included a participant who had 44 sessions and the study had phases of full probe sessions between training phases for each participant where no data points were collected for any other participants. The final study that included the two participants that fell the farthest from one standard deviation had participants who had 44 and 84 sessions (Giles & Markham, 2017). The participant with 44 sessions had a baseline phase of 10 sessions, the participant with 84 sessions had a baseline phase of 14 sessions and 39 maintenance sessions; 30 of those sessions had a high variability and the last nine sessions leveled out and were at the level of mastery (Giles & Markham, 2017).

With data sessions being collected anywhere from once a week to three times a day there was a wide range of intervention effects that were recorded in the data. Effects of this intervention would be more comparable if the data were collected in a more standard pattern. In future research, if the intervention skills are being practiced daily then data should be collected daily as opposed to a once weekly data collection probe.

The intervention session time was also calculated in varying ways. Some of the studies recorded how long it took for participants to complete the close-ended tasks in the activity schedule, others timed activities and the digital activity schedule automatically prompted them to move on to the next activity, and still others had a predetermined session end time. While the session time distribution was generally a shorter duration in younger ages and a longer duration as participants were older this pattern also corresponds to the expected tasks completed. The younger participants were focused on short leisure activities that are completed in less time as that is appropriate to their attention span and developmental level, and older participants had activities that were focused on independent living skills and required more time that matched their attention span abilities and were appropriate to their developmental levels as well.

Many of the studies included in this review used concurrent intervention strategies as implementation tools with the most frequently occurring being a set prompting sequence. Whether that prompting pattern was most to least intrusive or least to most, multiple researchers used this during their intervention phases or during a training phase when introducing the digital activity schedule. Pre-teaching is a strategy that was mentioned by some studies in terms of something that happened before the intervention began. The pre-teaching was generally used to make sure students knew how to navigate the technology or could complete all the activities included in the digital activity schedule independently.

Limitations

One of the limitations to this review is that Tau-U nor the percentage of non-overlapping data (PND) were calculated for this review and therefore the effectiveness of the intervention on each age group, focus, and setting could not be mathematically quantified. A second limitation is that the risk of biases in each study was also not coded or addressed within this review. Additionally, search terms included variations of names for a digital activity schedule but it is possible that if interventions used vastly different terminology for an intervention that met inclusion criteria it could have been missing from this review.

Implications for Future Research

This review found that the majority of digital activity schedule studies focused on individuals elementary age and younger (62%), indicating that more research in this area needs to be completed on students in older grades and adulthood. Currently there is no research involving individuals in middle school using this intervention and less than half of the current research spans individuals from high school through middle age adulthood. Again, most of the studies found focused on using this intervention with a singular focus of increasing independence in leisure activities (52.9%), and only two studies used this intervention to focus on increasing independence in independent living skills. Both of those studies on independent living skills only focused on following a physical activity work-out regimen. Digital activity schedules could be useful in helping individuals to follow variable daily routines such as getting ready for school or getting ready for the day on the weekend as the different steps of getting ready may change but could still be completed independently. Future research should focus not only on implementing the intervention with populations middle school age and higher, and there needs to be more focus on what the effects are of using this intervention to teach academic and independent living skills to participants of all ages. These individuals spend a significant portion of time in an academic setting. After their school years end, individuals move in to independent living and functional living scenarios that take up a large portion of their time. Teaching individuals how to follow a digital activity schedule in academic and independent living scenarios is much more consequential and has a significant impact on long term outcomes.

Another recommendation is to shift the focus of this research to increasing academic skills in younger ages where learning how to be a student and have autonomy in certain aspects of their education can have long term effects. As individuals get older and more capable of completing independent living tasks on their own, the focus of research needs to adjust to where the most impactful application of a digital activity schedules lies. Building these academic and independent living skills earlier and making them more commonplace in classrooms leads to more opportunities for leisure activities as individuals get older. Digital activity schedules can be used to teach adult populations how to engage in and organize their leisure activities.

There is also a significant need to conduct high-quality studies using digital activity schedules. Studies using this intervention in the future need to structure their interventions carefully so that they meet the quality indicators set forth by What Works Clearinghouse. The majority of current studies are not high enough quality to show that using a digital activity schedule is a highly effective intervention. The studies consistently show positive outcomes and, in general, an increase in the target behavior, yet all but one lacked requirements necessary to meet high-quality standards. The primary shortcoming in meeting high-quality standards for articles was not providing enough data points or phases to fully demonstrate the effects of the intervention. Following this, studies with multiple baselines need to be sure that their interventions are structured as such that training is not happening with more than one participant at a time.

Conclusion

The studies included in this review have shown that using a digital activity schedule intervention has increased the independent task completion of individuals in early childhood, high school, and adulthood. Digital activity schedules have helped individuals learn to use different apps or toys during leisure time, follow a work-out program, or complete selected academic tasks. The studies found show that using a digital activity schedule had positive effects and increased target outcomes across all the age groups it was implemented with, was effective in all the settings it was used in, and increased independence in all three main focus areas.

Having a higher quality of life and greater autonomy in day-to-day living is a long-term outcome that requires learning and adaptations that build all throughout an individual's life. Introducing a digital activity schedule and implementing it with varying skills from different fields can have a lasting positive effect on these outcomes. If educators can implement and utilize this intervention early to teach the completion of academic tasks and build academic skills, they can also build in leisure activities and use it to teach the completion of various independent living skills. As students become fluent and reach mastery in following these digital activity schedules they can be implemented not only in the classroom with an educator, but as shown, they can successfully be implemented by caregivers in the individual's home (Aguilar et al., 2023). The technology used is simple, spanning from apps created specifically for the intervention to everyday websites such as Google Slides, and makes this intervention widely accessible to all caregivers and practitioners and across settings. A teacher could create a digital schedule of activities or skills a child knows how to complete and send it home to the parents where the schedule could be implemented and generalized across people and settings, reducing the gap of learning from school to home. This intervention is versatile, transportable, and adaptable to individuals at every stage and across a span of settings with differing focus. With further research applying the intervention in each setting and with each focus across age groups, especially expanding the skill sets utilized in an academic and independent living setting, this intervention could very well become a mainstream intervention that is seen in classrooms everywhere with a practical intervention for parents and caregivers that extends beyond the service drop off that happens when students age out of special education services.

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Tables

Table 1

Summary of Participant Characteristics and Settings

Study	Sample Size (*n*)	Age or (Grade)	Gender	Disability	Setting
Douglas & Uphold (2014)	*n* = 5	High School	3 female 2 male	ID	High school classroom and cafeteria
Aguilar et al. (2023)	*n* = 3	3-4	3 male	ASD	Play area in each child's home
Carlile et al. (2013)	*n* = 4	8-12	4 male	ASD	Designated area of self-contained classroom
Elicin & Tunali (2016)	*n* = 3	5-7	3 male	ASD	Classroom of educational institution in Turkey
Radi (2017)	*n* = 4	Freshman, 14		ASD	In classroom or during community-based instruction
Reinert (2016)	*n* = 3	Preschool, 3-5	3 male	ASD	Preschool classroom
Uphold et al. (2016)	*n* = 6	College	2 female 4 male	ASD & Mild-Mod ID	Recreational facility on college campus
Nepo et al. (2021)	*n* = 6	34-45	2 female 4 male	ASD & ID	Office area, work area, or cafeteria of vocational program
Brodhead et al. (2018)	*n* = 3	4, 6, 9	1 female 2 male	ASD	Small conference room
Ulke-Kurkcuoglu et al. (2015)	*n* = 4	4, 4, 6, 10	4 male	ASD	Individual study rooms at Unit for Children with Developmental Disabilities at Anadolu Univ.

Study	Sample Size (*n*)	Age or (Grade)	Gender	Disability	Setting
Giles & Markham (2017)	*n* = 3	Preschool	3 male	ASD	Partitioned off area of clinic
Jiminez et al. (2021)	*n* = 3	3,4,5	3 male	ASD	Classroom at a university-based clinic
Judge (2015)	*n* = 1	High School, 19	1 male	ASD	Fitness center of public high school in mid-west
Stephenson (2015)	*n* = 3	5-6	3 male	1 ASD, 1 ID, 1 ASD & ID	Segregated special education classroom
Gourwitz (2014)	*n = 3*	K-1	1 female 2 male	ASD	K-1- inclusive classroom
Hall et al. (2014)	*n* = 1	9	1 female	ASD	In classroom
Topcuoglu (2019)	*n* = 3	4-6	1 female 2 male	ASD	Private session room resembling a typical living room or classroom at university-based autism clinic

Note. ASD =Autism Spectrum Disorder, ID = Intellectual Disability

Table 2

Summary of Intervention Layout and Skill Area of Intervention Focus

Study	Focus	Experimental Design	Materials	Intervention Components
Douglas & Uphold (2014)	Academic	Withdrawal A-B-A-B design with generalization probes	iPad 2 with wifi, iPod touch 4th gen, First Then Visual Schedule app, task list of 3–5 tasks that varies per session	15 classroom tasks, 10 lunchroom tasks, pre-test generalization, baseline, teaching, baseline, intervention, post-test generalization.
Aguilar et al. (2023)	Leisure	Non-Concurrent Baseline	handheld digital device, a device for zoom, bluetooth wireless headphones, digital activity schedule with 4 close-ended activities, a terminal reinforcer,	1–2 sessions daily 2–3 times a week, caregiver training before sessions for 20 min via teleconference, baseline, teaching, generalization, and maintenance.
Carlile et al. (2013)	Leisure	Single Case Multi-Probe Design	iPod touch 4G, individualized picture activity schedules, pictures of leisure activities, timer application	Selection of Schedule Activities, Preference Assessment, Pre-Intervention Probes, Baseline, Intervention, Generalization, Post-Intervention Probes, Maintenance sessions
Elicin & Tunali (2016)	Leisure	Single Case Multi-Probe Design across Participants	7 in tablet, software program designed and developed for this research, pictures, audio clips, data sheets, video camera, desk-top computer	Baseline, teaching, maintenance, generalization phases.
Radi (2017)	Academic	Single Case Multiple Baseline across Participants	First Then Visual Schedule, guided access feature on iPad, iPad, math/language arts/science/technology/comm	Training to navigate app before sessions started, 5 baseline sessions, 15 intervention sessions: baseline 2

Study	Focus	Experimental Design	Materials	Intervention Components
			unity-based instruction tasks, data sheets	sessions longer and intervention 2 sessions shorter for next participants.
Reinert (2016)	Leisure	Multiple Baseline across Subjects	Student's paper-based activity schedule, tablet-based activity schedule, prototype application, iPad, ten close-ended activities	10 minute long sessions, Baseline, then intervention phases
Uphold et al. (2016)	Independent Living	A-B-A-B withdrawal design	iPod touch 4th generation, camera and phone applications, first then schedule app, 14 exercises identified for each individual, exercise equipment needed to complete exercises	4-6 exercises for each session pulled semi-randomly from bank, instructional phase, baseline, intervention, then generalization phases
Nepo et al. (2021)	Leisure	Multiple-probe design across participants	Preferred apps downloaded and installed on an iPad, additional apps, First Then Visual Schedule app	Baseline, intervention, and generalization Phases
Brodhead et al. (2018)	Leisure	Nonconcurrent multiple baseline across participants with an embedded reversal design	7 applications, Apple iPad, YouTube, Keynote app, 6 page activity schedule, timer application	1 session per day, pre-teaching, activity schedule present for baseline and schedule condition probes, novel application assessment
Ulke-Kurkcuoglu et al. (2015)	Academic	Multiple probe design across participants among single case design	Activity schedule, laptop, computer mouse, tools for testing skills required in roleplays, plastic containers for	Baseline probe session, daily probe session, full probe session, instruction, maintenance, and generalization.

Study	Focus	Experimental Design	Materials	Intervention Components
			materials, photographs of activities, video camera, tripod	
Giles & Markham (2017)	Leisure	Multiple baseline across participants and adapted alternating treatments design	Book-based activity schedule, colored table cloths, iPad Mini with a photo album, pictures of each activity, leisure activity materials in clear plastic containers, divided section of work area	Concurrent-Chains Preference Assessment, Baseline, Training, and Maintenance
Jiminez et al. (2021)	Leisure	Reveral Design ABCABC reversal for 2 and BACBAC reversal for 1	Octopus Watch, individual play schedules, smart phone, video camera, tripod, motivAider	3–5 sessions a week, 18 min long sessions, Preference assessment, correspondence icon to item in room checks, 3 consecutive play activities, clean up period, no prompt condition, vocal prompt condition, watch prompt condition
Judge (2015)	Independent Living	Single case A-B-A-B design	Flip ultra HD Video Camera, tripod, 7 fitness tasks, treadmill, 3 strength training machines, small floor mat, laptop with snipping tool, ink editing, photos of activity, PowerPoint, stopwatch	2-day training phase, Baseline, Training, Intervention Phases
Stephenson (2015)	Academic	Multiple baseline across participants with probes	iPad 2, protective case, guided access feature, First Then app, pictures of activities, icons for scheduled activities, materials to complete activities	5 baseline sessions with student 1, 3 baseline sessions with students 2 and 3, daily intervention sessions until mastery, then weekly data sessions.

Study	Focus	Experimental Design	Materials	Intervention Components
Gourwitz (2014)	Academic	Alternating treatment, single case design	Paper visual activity schedule, iPad visual activity schedule, reinforcers, Choiceworks visual support system, iPad 2, digital video recorder, hard drive, stopwatch, materials for literacy centers	5 observations per condition, baseline, treatment condition, teacher training, data collection training.
Hall et al. (2014)	Academic	Single case A-B-A-B reversal design	Routinely app, iPad	Baseline, treatment: teaching and implementing intervention, baseline, treatment: reintroducing and implementing intervention.
Topcuoglu (2019)	Leisure	A-B-B design with non-concurrent multiple probe across participants	Octopus watch, motivator, timer, clipboard, play materials, video camera	Preferance assessment, correspondence training of independent play, baseline, watch condition, generalization probes.

Table 3

Summary of Data Collected and Results

Study	Data Collected	Results
Douglas & Uphold (2014)	(a) Responding (b) Percentage of Non-Overlapping Data	(a) Baseline 1: low responding Intervention 1: level change Baseline 2: low responding Intervention 2: level change Post-test: 100% correct responding (b) 100% Non-Overlapping data for 4 of 5 participants
Aguilar et al. (2023)	(a) Independent step completion (b) Sessions to mastery criteria (c) Parent fidelity	(a) Baseline: less than 40% Generalization: 72% for 2 students, above master for 1 student (b) 10.3 sessions (c) Above 94% by final 3 sessions
Carlile et al. (2013)	(a) Correctly completed components (b) On Task Behavior	(a) Baseline: 0% Intervention: 94% after 11.75 sessions Maintenance: increased to 70% Generalization: 100% (b) Baseline: 14.9% Intervention: 92% Generalization: 100% Maintenance: 100% 2 participants 86.7% average for 2 participants
Elicin & Tunali (2016)	(a) Sessions to mastery (b) Accuracy	(a) Between 6 and 8 sessions for all participants (b) 0% to 100% for all participants
Radi (2017)	(a) Task Initiation (b) Task completion	(a) Baseline: 26.45% Intervention: 50.9% Intervention B for 1 participant: 80% (b) Baseline: 37.6% Intervention: 59.8% Intervention B for 1 participant:100%
Reinert (2016)	(a) Number of activities completed independently (b) Components completed independently (c) iPad activity schedule chosen	(a) Baseline: 2.78 activities Intervention: 8.67 activities (b) Baseline: 0% Intervention: 62.5% for 2 sessions for 1 student, all other sessions and students at or above 80% (c) iPad activity schedule chosen in 80%, 70%, and 20% of opportunities

Study	Data Collected	Results
Uphold et al. (2016)	(a) Percentage of exercises performed (b) Non-Overlapping Data (c) Sessions to program device	(a) Baseline 1: 8.5% Baseline 2: 50% ePAS phases: level change in both ePAS phases Generalization: 100% (b) 96% Non-Overlapping (c) 4.8 sessions, 96.8% accuracy in Generalization
Nepo et al. (2021)	(a) Independent step completion (b) Time spent on leisure activities	(a) Baseline: 0% Intervention: 83.6% Generalization: Maintained high levels (b) Baseline: 1.25 min Intervention: 6.47 min Generalization: Maintained high levels
Brodhead et al. (2018)	(a) Number of varied applications engaged in (b) Percentage of correct responses to activity schedule	(a) Baseline: 1 application Teaching: 4 applications No Schedule Probe: 1 application Activity Schedule Reintroduced: 4 applications (b) Teaching: increased to 80% Activity Schedule Reintroduced: 90% and above
Ulke-Kurkcuoglu et al. (2015)	(a) On-schedule skill acquisition (b) Role-play skills	(a) 29.7 sessions to criteria, from 0% to 100% correct, Maintenance: 100% correct (b) From 0% to 100% accuracy following instruction, Maintenance:100% correct responses Generalization: 100% correct responses
Giles & Markham (2017)	(a) Steps Completed Independently (b) Sessions to mastery (c) Concurrent-chains preference	(a) Baseline: few steps completed Training: gradual increase in percent of steps completed Maintenance: 1 participant fell below 80%, 19 training sessions to increase back to mastery (b) 13 sessions to tablet based mastery (c) 2 of 3 participants preferred tablet over paper-based activity schedule
Jiminez et al. (2021)	(a) Independent Play Rate	(a) No Prompt Condition: 20.6% Vocal Prompt Condition:70.6% Watch Condition: Gradual increase to 100% Return to no prompt: 46.5% with 1 participant unstated

Study	Data Collected	Results
Judge (2015)	(a) Independent Transitions per Session	(a) Baseline 1: 1-2 Intervention 1: 7 Baseline 2: 1-3 Intervention 2: 7
Stephenson (2015)	(a) Number of Steps Completed (b) Sessions to Mastery	(a) Baseline: .33 Intervention: 1 in first session, rapid improvement in following sessions (b) 13 for 2 participants, 1 participant never met mastery
Gourwitz (2014)	(a) On Task Behavior (b) Transition Time	(a) Baseline: 59.7% Intervention: 65.3% (b) Baseline: 63.3 sec Intervention: 62 sec
Hall et al. (2014)	(a) Latency (b) Prompting (c) On Schedule Behavior (d) Schedule Completion	(a) Decreased throughout study with reduced transition times Initial Intervention phase: steep deceleration (b) Stable downward trend, steep deceleration of more intrusive prompts (c) Acceleration to over 95% success and stable (d) Close to 100%
Topcuoglu (2019)	(a) On Schedule Responses (b) Bids for Attention (c) Intervals of On Task Behavior (d) Prompting (e) Problem behavior for 1 student	(a) Baseline: 25% Intervention 92.1% Generalization: 99% (b) Baseline: .096/min Intervention: .06/min Generalization: .015/min (c) Baseline: 92% Intervention: 97.3% Generalization: 99.5% (d) Baseline: .2/min Intervention: .07/min Generalization: .18/min (e) Baseline: .72/min Intervention: .03/min Generalization: 0/min

Note. ePAS= electronic Picture Activity Schedule

Table 4

Summary of Intervention Procedures

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
Douglas & Uphold (2014)	Taught to take photos of 3 tasks independently: After stable baseline, taught to make an ePAS with their device.	3 Sessions: Verbal directive of 3-5 tasks to be completed, No ePAS available	Sessions until students met criteria, then return to baseline ePAS reintroduced for second intervention phase	3 post-test sessions in lunchroom then 3 in classroom
Aguilar et al. (2023)	Training given to caregivers to learn to assist child in learning activity schedule completion and prompt hierarchy	Data taken with no prompts other than initial prompt	Before the session began, 3 edible reinforcers presented and 1 chosen as terminal reinforcer. Reinforcer added to activity schedule	Novel close-ended activities used, conducted 2 weeks after mastery criteria met
Carlile et al. (2013)		No prompts used, preferred snacks or prizes delivered independent of performance at end of each sessions, off-task/disruptive behavior redirected by prompting to engage in a mastered skills. Session terminated if no response for 5 min or repeated disruptive behavior.	Manual guidance for first 2 sessions, then prompt fading level specified for each session, only used if participant did not complete component in time specified. Prompt fading using progressive time-delay after 2 days of 100% correct completion at 0s, then 1 day at 100% for 2s and 4s delays. If error, behavior reversal trial with manual prompts to correct error and a return to 0s time delay manual guidance for next trial	Activities presented in variable order, multiple examples of an activity, using same time on iPod touch throughout all activity schedules, assessed using novel iPod touch activity schedules after about every 3rd session. Leisure activities were activities built into the device (music, games, videos, etc.) Identical

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
				set up to baseline sessions but no snacks/prizes given Conducted in general education classroom, 2 weeks, 1 month, and 3 months post intervention
Elicin & Tunali (2016)	Sessions 3 days a week	Data collected for 1 session, schedule presented and prompt "begin the activity" given.	Most to least prompts and teaching sessions end when students hit 100% accuracy independently	Data collected 7, 14. and 21 days after teaching ended
Radi (2017)		Students given prompt "Start your schedule" if no response in 30s session terminated	Electronic device programmed with currect activities for the student, beginning of task sequence, students given instructions and presented with associated pictures in electronic sequence-then they were asked to begin, gestural prompt delivered after 30 seconds if no response Intervention B for participant 4: additional reinforcer given upon completion of all tasks	
Reinert (2016)		Research assistant placed iPod on activity shelf and said "Go play" no binder-based activity schedules were present during baseline	Prompt of "go play" then physical prompts to engage with iPad-based activity schedule, immediate prompting if participant attempted to make an incorrect response, physical prompts only - no verbal or gestural prompts. prompts given if no response after 5	

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
			seconds, least intrusive prompt used to assist student in completing the task correctly if they respond incorrectly sessions would be terminated if students engaged in problem behavior for longer than 20 s or if they had an accident	
Uphold et al. (2016)		3 sessions in return to baseline phase	Sessions no more than 15 min, 2 days a week, no more than 2 sessions a day at least 30 min apart. during study exercises were semi-randomly selected from bank of 14 for each participant, 4-6 exercises chosen, verbal directives were given for each of the 4-6 exercises at the beginning of each session, once instructional criterion was met return to baseline IPod reintroduced after 3 baseline sessions	3 generalization sessions where students programmed exercises of their choice
Nepo et al. (2021)		iPad with preferred leisure apps and visual schedule app, no prompts given, if pushed away returned to arms reach after 10s. session ended after 15 min or challenging behaviors that could not be redirected after 5 min.	Most-to-least prompts used to teach participants to a check schedule app, b open activity on the schedule, close the app when alarm went off/activity ended, and d check the next activity (for 4 participants a paper schedule printed because of difficulty in discrimination of icon in schedule and icon on iPad home screen)	Same procedure as baseline in break area at vocational program, 2 addition generalization sessions held with 2 participants in natural environments

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
Brodhead et al. (2018)	Taught prerequisite skills before intervention started	Instruction to vary between applications, order always different but youtube always last. No prompts or activity schedule, 10 min	Manual guidance used to teach participant to engage in schedule-following sequence of behaviors, location of applications randomized on iPad home screen but Keynote and time were always in same location, activity schedule had 4 applications randomized in order with youtube always last, hand-over-hand guidance for all responses during first activity of first teaching session, then prompting/guidance if errors made in following responses, no vocal praise or tangible reinforcers given during teaching other than youtube as last activity	Same as intervention but 3 new applications replaced 3 applications used during intervention condition
Ulke-Kurkcuoglu et al. (2015)	Both on-schedule skill and role-play skills given, prompts provided by standing behind subject during instruction related to on-schedule skill without speaking to subject, graduated guidance with provision of computer-assisted activity schedules. Instruction continues until participant exhibits 100% correct	Probes held before instruction sessions until stable data obtained for at least 3 sessions in a row, full probe session used a single opportunity model used special attention drawing prompts, then prompt of "Let's follow the activity schedule" and 5 seconds to respond, incorrect responses were ignored and the session was ended	Sessions continued until stable data collected, same process as baseline and full probe sessions, followed Role-Play Skills. Subject completed the first stage by clicking mouse to display the photo of the first activity on the screen, selected box containing materials and brought to the table, most to least prompts to teach role play skills combined with visual prompts, both instruction prompts faded after 100% performance in a single session, goal was 3 sessions at 100% without visual prompts	Generalization sessions performed across settings and materials. Sessions conducted in playroom and activity schedule prepared as an activity folder instead of computer. Data taken on On-schedule and role-play skills. Generalization instruction given to participants with less than 80% performance.

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
	performance in 3 consecutive sessions On-Schedule Skill: trainer stood behind participant, when incorrect response, whole instruction session repeated with system of most to least prompts.			Prompts given with instant directions as necessary and often as required with gradual guidance. Maintenance sessions held in first, second, and fourth weeks of study
Giles & Markham (2017)		Participants given book or tablet schedule dependent on the condition, leisure activities present in clear plastic containers within arm's reach and tablecloth associated with schedule condition on table, prompt of "do your activity schedule" no other prompts given, session terminated with no response for 30 s or all steps completed.	First 2 sessions, all steps taught using hand-over-hand then different prompts used according to performance of participants, prompt level decreased if step completed correctly for 2 consecutive sessions, if an error occurred in 2 consecutive sessions on a step a more intrusive prompt used in next session, all steps in tasks analysis at 100% accuracy met mastery criteria. Additional sessions of both conditions run until mastery met of both conditions, additional training required for tablet condition for all participants	Initial discriminative stimulus provided then no other prompts given.
Jiminez et al. (2021)		No Prompt Condition: Prompt of "Time to play" then no other prompts or feedback, unless participant tried to leave	Participants told to follow instructions provided by the watch, no other vocal instructions or prompts provided. If participant tried to leave, initial prompt "follow the directions on your watch"	

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
		session setting area, then initial prompt repeated and elopement path blocked, participant's interactions and requests of the researcher ignored, descriptive praise for each play activity engaged in independently delivered at end of session only. Vocal Prompt Condition: Prompt of "Time to play with X", after 10s if no engagement with scheduled play item, prompt repeated every minute until participant engaged or time for that activity elapsed, when time for activity had elapsed, prompt for next activity delivered vocally "Time to play with X", no other interactions, requests ignored, descriptive praise delivered at end of session.	restated and elopement path blocked. no other interactions, requests ignored, descriptive praise delivered at end of session.	
Judge (2015)	Introduced participant to CBFS, reviewed necessary computer	Participant entered fitness center for 15 min without CBFS, observational data	First intervention phase participant instructed to use the CBFS to manage fitness program independently, same 7	

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
	skills, verbal prompts, feedback, praise given by APE teacher during 7 fitness tasks	collected on number of independent transitions through fitness activities of his choice	fitness tasks, data taken on number of independent transitions between tasks Return to Baseline Second intervention phase: participant told to use his CBFS, same 7 fitness tasks, number of independent transitions between tasks recorded	
Stephenson (2015)		Student brought to table with materials for tasks available, iPad presented with schedule displayed, cue of "time to do work" or "it's worktime" given, 30 second latency time or time until error was made then session was terminated.	Presentation of iPad with schedule and cues given the same as during baseline, after 5 seconds of no response, teacher engaged in a least to most prompting hierarchy, if an error, teacher delivered physical prompt after returning app to appropriate condition, once task was selected any assistance needed to complete task was given by the teacher until the task was put away. Procedure repeated for clicking the check mark for complete and moving to the next activity Reliability collected for procedure and observation with data collection	
Gourwitz (2014)		5 observational periods, students participated in literacy center activities without the independent variable, data collected for on-task behavior and duration of transition time	randomly assigned to one of 2 conditions for each observation, no more than 2 consecutive observations of same condition, a task analysis was used for implementing both visual activity schedules. at end of group instruction, students given paper or iPad visual activity schedule, student behaviors recorded	

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
Hall et al. (2014)		No activity schedule used, typical signal of transitions, latency to complete transitions and prompts were measured, on schedule behavior was not measured	Using graduated guidance to teach use of visual schedule and become independent. prompts given if student makes an error, is about to make an error, or more than 10 seconds passes. Started with full physical prompting, no verbal prompts given, minimum of 5 transitions with this level, moved to spatial fading and partial physical prompting, once complete moved to shadowing. If there was an error or if student was about to error, a prompt was given. Final transition to independence of on-schedule behaviors from activity to activity after student was on schedule for 80% of transitions. again, if she errored, was about to error, or more than 10 s delay after Sd given a greater level of prompt was given.	
Topcuoglu (2019)	Teaching correspondence of label, icon, and object of each play activity.	Octopus watch on but no tactual or visual prompts. Verbal prompt given at the beginning of 18 min play session “Go Play” etc. if participant moved 3 ft away from scheduled items without interaction another verbal prompt was delivered. At end of session, watch removed from wrist. conducted by	Sessions 3-5 days a week for approx. 30 minutes with interspersed breaks. Octopus watch on with created activity schedule of preferred play activities in a randomized order, watch gave tactual and visual prompts for each activity in 5 min time blocks of play skills and 3 times during ‘clean up time’, correspondence training conducted at the beginning of the session, prompt given by reading script directing to following watch schedule. When	Immediately after watch condition, conducted by caregiver and researcher in clinic and home simulated settings, same procedures as watch condition.

Study	Training	Baseline(s)	Intervention Phase(s)	Generalization/ Maintenance
		a researcher and a caregiver.	participant moved 3 feet away from scheduled activity without interacting a scripted prompt was given. At end of session watch removed and feedback was given by the instructor to the participant. Watch condition in place until mastery criteria reached for 3 consecutive sessions at 90% or higher of correct and independent completion of on-schedule steps.	

Note. ePAS= electronic Picture Activity Schedule CBFS= Computer Based Fitness Schedule

Table 5

What Works Clearinghouse Quality Indicators

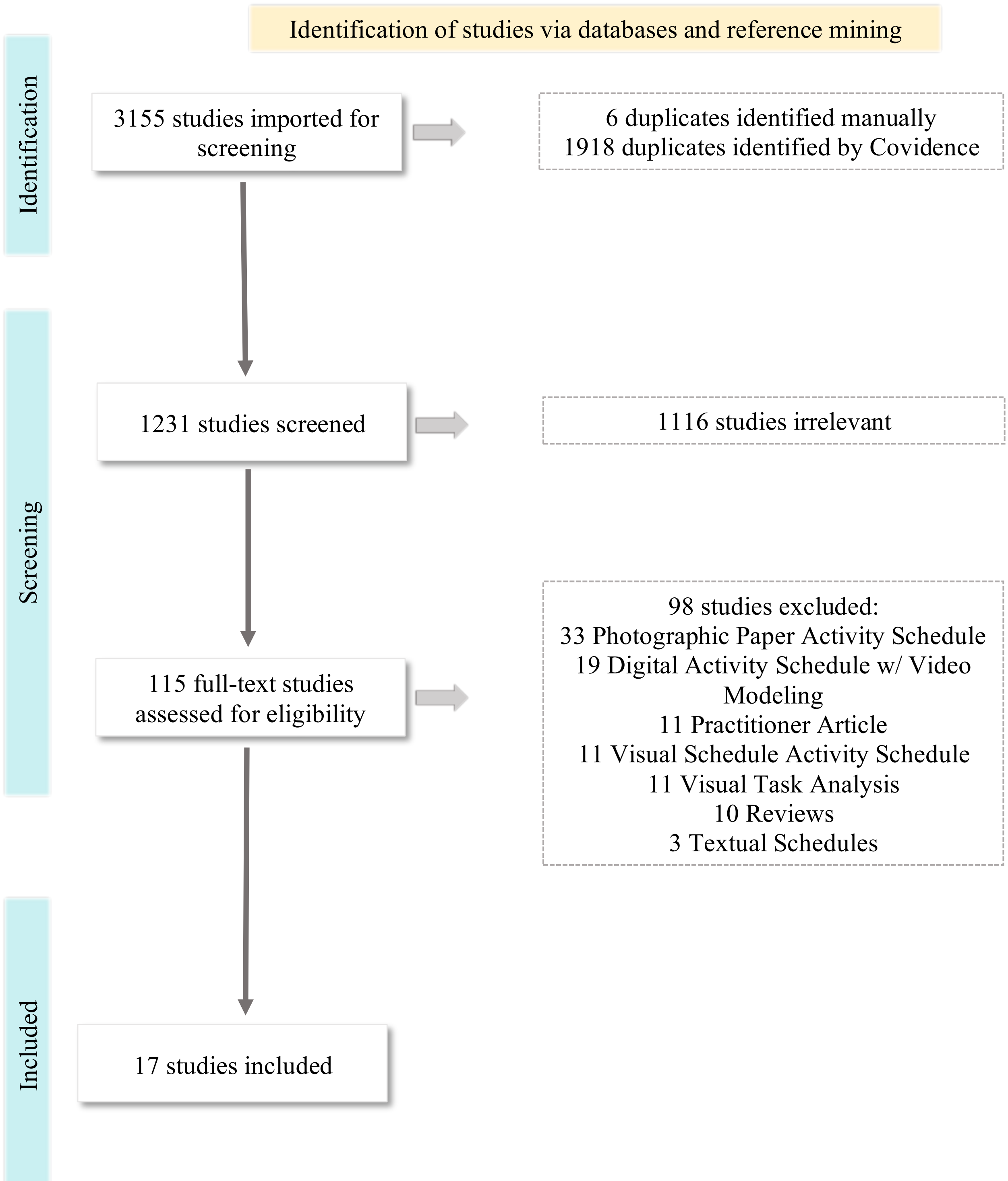
Study	Meets Quality Indicators	Data Availability	Independent Variable	IOA	Residual Treatment Effects	Confounding Factors	Concurrent Training Phases	Demonstrating Effect & Data Points
Douglas & Uphold (2014)	Met with Reservations	Met	Met	Met	n/a	None	n/a	With reservations
Aguilar et al. (2023)	Does Not Meet Expectations	Met	Met	Met	n/a	Not Met	Not Met	Met
Carlile et al. (2013)	Meets Expectation	Met	Met	Met	None	Met	Met	Met
Elicin & Tunali (2016)	Met with Reservations	Met	Met	Met	Ulikely to be Meaningful	Met	Met	With Reservations
Radi (2017)	Does Not Meet Expectations	Met	Met	Not Met	n/a	Met	Met	Met
Reinert (2016)	Does Not Meet Expectations	Met	Met	Met	n/a	Met	Not Met	Met
Uphold et al. (2016)	Met with Reservations	Met	Met	Met	Met	Met	n/a	With Reservations
Nepo et al. (2021)	Does Not Meet Expectations	Met	Not Met	Met	Met	Met	Not Met	With Reservations

Study	Meets Quality Indicators	Data Availability	Independent Variable	IOA	Residual Treatment Effects	Confounding Factors	Concurrent Training Phases	Demonstrating Effect & Data Points
Brodhead et al. (2018)	Does Not Meet Expectations	Met	Met	Met	n/a	Met	Not Met	Met
Ulke-Kurkcuoglu et al. (2015)	Met with Reservations	Met	Met	Met	Met	Met	Met	With Reservations
Giles & Markham (2017)	Does Not Meet Expectations	Met	Met	Met	Not Met	Met	Not Met	With Reservations
Jiminez et al. (2021)	Met with Reservations	Met	Met	Met	Met	Met	n/a	With Reservations
Judge (2015)	Met with Reservations	Met	Met	Not Met	n/a	Met	n/a	With Reservations
Stephenson (2015)	Does Not Meet Expectations	Met	Met	Not Met	Met	Met	Met	Met
Gourwitz (2014)	Does Not Meet Expectations	Met	Not Met	Met	Unlikely to be Meaningful	Met	n/a	Not Met
Hall et al. (2014)	Does Not Meet Expectations	Met	Met	Not Met	n/a	Met	n/a	Met
Topcuoglu (2019)	Does Not Meet Expectations	Met	Met	Met	Met	Met	Not Met	With Reservations

Figures

Figure 1

PRISMA Flowchart. Adapted from Page et al. (2020).



APPENDIX A

Review of the Literature

Autism

Autism spectrum disorder (ASD) is classified as a neurodevelopmental disorder, or a disorder resulting from the atypical development of the brain (World Health Organization, 2023). ASD is characterized by deficits in communication skills, repetitive motions, and restricted interests (Anagnostou & Taylor, 2011). Another characteristic of individuals with ASD is deficits in observational learning (Hume et al., 2009). The DSM-5 expanded the diagnosis of ASD to include Asperger syndrome, childhood disintegrative disorder, and pervasive developmental disorder, not otherwise specified (Lauritsen, 2013). Thus, ASD is experienced along a spectrum suggesting that some individuals exhibit more pronounced deficits in key areas than others, yet they are all still part of the autistic community.

According to the CDC (Maenner et al., 2023), as of 2020, 1 in 36 individuals in the United States is diagnosed with ASD. This is an increase from the prevalence of 1 in 44 individuals that was the previously reported prevalence in 2018 (Maenner et al., 2023). Many individuals who are diagnosed with ASD also have comorbid intellectual disability (Thurm et al., 2019).

Individuals with ASD have many challenges that often affect their daily lives. These individuals can have deficits in social skills that may include a lack of conversational give and take, irregular social interactions, and minimal connections involving interests and emotions as well as poor use and understanding of eye-contact, body language, and gestures (Lord et al., 2018). These deficits can lead to difficulty in finding success in learning environments. Marks et al. (2003) discuss roadblocks to individuals with ASD in making progress in a classroom. They discuss how these individuals struggle to filter through the given information to isolate what is the most significant, how they struggle to understand incidental learning, or that they can get really upset when what they produce is seen by them as substandard. As students with ASD can find slight changes, transitions, or adjustments to schedules highly upsetting, these students often benefit from visual representations of schedules, prompts, and learning materials (Ganz., 2007). Priming students for what will happen next in the classroom or how an activity will be completed or presented as well as using systematic prompting during activities can eliminate uncertainty about what will happen or how to do things which can cause maladaptive behaviors (Harrower & Dunlap, 2001). One way that these can be accomplished for larger tasks that have more than one part before completion, one way to help students succeed is to separate the task down into smaller concise parts that are easier for the student to access and manage (Marks et al., 2003). While these strategies can help students perform in a classroom setting, they often still struggle with independence skills.

Individuals with ASD often have difficulty with independent performance of tasks due to deficits in executive function and other skill sets that are characteristic of the disability as well as difficulty with generalization that often accompanies ASD (Hume et al., 2009). This difficulty with independent performance and executive function can have detrimental effects of their quality of life as they enter adulthood. While most adolescents experience an increase in independence and independent behaviors, individuals with ASD often experience a plateau if not a regression in independent behaviors as they navigate through puberty (Hume et al., 2014). The challenges individuals with ASD face can make conducting the essential activities of everyday life extremely difficult (Almazaydeh et al., 2022). Being too reliant on prompts and feedback can also be largely contributing factors in independent success delays for these students (Hume et al., 2009). "Functional independence and behavioral autonomy are key contributors to optimal post-secondary outcomes for all students, but play a critical role in the success of students with ASD" (Hume et al., 2014, p.104).

Intellectual Disabilities

As with ASD, individuals with intellectual disabilities fall along a spectrum of functioning or severity (Snell et al., 2009). Intellectual disability is also defined as having substantial deficits in academic performance and adaptive behavior (Schalock et al., 2021). These deficits for individuals with intellectual disability must become apparent before the age of 18 (Parmenter, 2011). The diagnosis of intellectual disability also requires that the manifestations of the disability have to have a significant social impact (Shree & Shukla, 2016). Thompson et al. (2009) explain that the operational criteria for diagnosing intellectual disability has remained mostly unchanged for the last 35 years.

Adding to the deficits in learning and retention abilities as well as adaptive skills, individuals with intellectual disabilities may have an even harder time with skill acquisition and application because they are more easily distracted, have less ability to pay attention, read social cues, or control impulsive behaviors (Shree & Shukla, 2016). Individuals with disabilities can be "passive, placid, and dependent, whereas others are industrious, cooperative, appropriately assertive, or even aggressive and impulsive" (Snell et al., 2009, p. 220). This shows just how different each of these individuals are and how their needs are just as individualized. An individual's support demands are related to their deficits in daily functioning because of their ability levels or simply the settings of the performance (Thompson et al., 2009).

One of the most beneficial practices for the learning of individuals with intellectual disabilities that had positive outcomes was simply having these individuals spend a larger portion of their day in a general education setting and less time in a special class setting separate from their general peers (Wehmeyer et al., 2020). When systematically taught, using visual supports brought increases in independence skills for these students with disabilities (Cohen & Demchak, 2018). It has also been shown that using a game-based learning approach shows an increase in skill acquisition for individuals with intellectual disabilities (Brown et al., 2011). Ford (2013) explains the positive effects of using direct instruction when teaching new skills to students with intellectual disabilities.

Individuals with intellectual disabilities often do not naturally use applicable learning strategies in new situations (Shree & Shukla, 2016). This combined with other characteristics of their disability can mean that the requirements of daily living can be crushing for individuals with intellectual and adaptive skill deficits (Snell et al., 2009).

Autism and Intellectual Disabilities Comorbidity

When a child is diagnosed with ASD, some of the first conditions that are looked at are often developmental delays or intellectual disability as well as language and/or motor deficits (Lord et al., 2018). The most frequent comorbid diagnosis of individuals with ASD is intellectual disability (Matson et al., 2009). As previously discussed, individuals who have ASD or intellectual disabilities both struggle with deficits in academic and adaptive skill acquisition. Individuals with ASD tend to struggle more with joint attention, sharing interests, social connection, and reading body language than individuals with other Intellectual Disabilities (Ventola et al., 2007). One aspect of development that individuals of both groups show great deficit in, is that of independent living skills (Lord et al., 2018; Snell et al., 2009).

As the characteristics of the two disabilities are similar, they impact independent performance of skills in similar ways. In order to achieve independent levels of performance these individuals need structured systems of supports. Individuals with ASD who do or do not also have an intellectual disability depend greatly on support from others to have success in career, living, and personal relationships (Hume et al., 2014). Harrower and Dunlap (2001) share that "one goal of education is to increase the independent academic functioning of students" (p. 767). Supports that are thorough and tailored to the individual can help "bridge the gap between capabilities and demands" (Snell et al., 2009, p. 221). Supports can be defined as resources and approaches that support an increase in daily living skills (Thompson et al., 2009). A critical support discussed to increase the achievement of individuals with disabilities is the use of visual supports (Cohen & Demchak, 2018).

Visual Schedules

The use of visual cues and other visual supports can help alleviate the effects of some of the common characteristics of ASD and intellectual disability (Cramer et al., 2011). A visual schedule is an arrangement of pictures or symbols that show the particular order that a sequence of tasks is performed (Banda et al., 2009; Fowkes, 2022). Many adults use a form of visual supports to assist them in their daily life yet this intervention is not widely used with younger individuals (Meadan et al., 2011). Muchagata and Ferreira (2019) explain that "children with autism often experience considerable challenges in understanding, structuring, and predicting their daily life activities" and they continue to explain that these children also need to have constant reinforcement of their daily behaviors (p. 453).

Visual schedules help to familiarize students with the classroom, they do this by showing an expected order of activities using written language, pictures, and/or symbols (Macdonald et al., 2018). There are between-activity schedules and within-activity schedules (Curtin & Long, 2021). Between activity schedules act as a visual sequence of events moving students from one task to another and helping with transitions, within-activity schedules act more as a visual task sequence of the steps required to complete a single task (Curtin & Long, 2021).

A schedule can be a cue to help students remember what is happening that day, help them be ready for the activities and changes happening in the day which can help reduce anxiety that the students might feel (Cramer et al., 2011). In addition to helping students follow a routine, visual schedules have been shown to be an effective antecedent strategy in reducing problematic behaviors (Macdonald et al., 2018).

Visual schedules can be helpful in removing the dependence students have on adults to give assurance and support during planned and unplanned changes in their daily schedule (Banda et al., 2009). Activity schedules can also help students "develop a positive routine of looking for information and thus increase flexibility and the ability to cope with life's ups and downs in the future" (Davies, 2008, p.18). While visual schedules fill the function of providing a pattern for the activities that are to be completed, they can also have multiple advantages such as relieving the stress of transitions, independent completion of tasks, following routines, and increasing executive function abilities (Fowkes, 2022). Using visual schedules can help decrease maladaptive or undesired behaviors during transition periods (Connelly, 2017). Visual schedules can also be used as an antecedent strategy in reducing problem behaviors (King, 2015).

When teaching a routine, students have more success if the steps of the routine are shown in a practical and applicable sequence with a distinctive beginning and end (Schneider & Goldstein, 2010). There are five main parts of a visual schedule, there is how long the schedule is, how students interact with the schedule, where the schedule is presented, how students begin the routine of following the schedule, and finally how the schedule is presented (Fowkes, 2022).

There are many formats for visual schedules as well as technologies used to present the schedule to the students. Using technology and other digital presentation formats has made organizing and using visual schedules easier for practitioners (Cramer et al., 2011).

Technology can allow visual schedules to be presented in varying levels of complexity, and with increased technology use, the way visual schedules are used has also been evolving (King, 2015). Because tailoring visual schedules for individuals with disabilities has a positive effect on the individual's independence, technology can allow these imperative adaptations to be more readily made (McDonald, 2021). Visual schedules can begin as simple as a "first–then" chart and then can become more complex as more steps and visuals are added (Fowkes, 2022). When visuals are added, individuals are able to understand and follow the schedule when the visuals in the schedule are relatable for them (Fowkes, 2022). Using visuals that are pictures of the individual completing the task or an icon that looks like the individual can be the most effective layout of a visual schedule.

Visual schedules can help students gain independence and answer contextual questions about their surroundings such as the process, duration, or what to do after completion of the assigned task (Connelly, 2017). As a visual schedule answers the previously stated questions, it increases on-task behavior and decreases maladaptive behaviors, which decreases the amount of time that can be spent off-task (King, 2015). Visual schedules increase the autonomy of individuals because it creates predictability and increases the structure of their daily activities (Curtin & Long, 2021). In addition to working independence, visual schedules can also help support independence in communication skills (Fowkes, 2022). Activity schedules can be created to facilitate independence in a variety of settings and behaviors.

Activity Schedules

An activity schedule is defined as being a sequence of visuals or words that cue an individual to complete a set order of activities (McClannahan & Krantz, 1999). Betz et al. (2008) state that an activity schedule is pairing a set order of activities with pictures, symbols, or words. They are a visual cue that is consistently available to aid students in staying on task and engaged in a sequence of activities (Morrison et al., 2002). An activity schedule can be presented in a format as simple as a 3-ring binder with somewhere from five to eight activities shown by presenting a single picture on each page with a final reinforcer presented on the last page of the activity schedule (Akers et al., 2016). Activity schedules can also be presented where pictures on a clipboard correspond to pictures attached to each activity available (Morrison et al., 2002). Activity schedules can also be presented in a 3-ring binder with choices and scripting on each page (Betz et al., 2008). Activity schedules can be adapted and adjusted in size, presentation, order, and number of activities based on student ability level and needs.

An activity schedule can be valuable when encouraging individuals who have autism or other disabilities to have more independence in their responses and their task engagement in various tasks and settings (Brodhead et al., 2014). "One of the primary benefits of using activity schedules as a teaching tool is that children learn to independently engage in [a] chain of activities without significant adult assistance" (Akers et al., 2018, p. 53). Activity schedules can help students learn to accomplish behavior chains with complex behaviors independently (Betz et al., 2008) Morrison et al. (2002) show how effective the use of a photographic activity schedule is in helping children with autism increase their independence when completing activities.

The use of activity schedules has been shown to be effective across a variety of participants and settings. The use of activity schedules can increase independent play and interaction amongst peers in groups of preschoolers with autism (Akers et al., 2018; Betz et al., 2008). They have been used to increase the on-task behavior of 7- and 8-year-olds with high functioning autism during their language arts instruction and subsequent work time (Bryan & Gast, 2000). In a slightly older age group of 9- to 14-year-olds with low functioning autism, activity schedules were used to increase leisure activity and homework completion with independence in a home setting (MacDuff et al., 1993). Anderson et al. (1997) used activity schedules to increase activity completion without staff prompting or reminders with three adults living in a group home. Watanabe and Sturmey (2003) used activity schedules with the ability to make choices of the activities with three adults in an adult program for individuals with disabilities and increased the amount of time on task during learning periods. These studies show us that activity schedules can be varied in their design as well as being applied across a wide range of ages and settings while still increasing on-task and independent behaviors with some studies also showing social gains as well.

While activity schedules can be tailored to the individual, the intervention can also be adjusted to the individual. Activity schedules can be used in conjunction with other intervention components. Morrison et al. (2002) used activity schedules in combination with correspondence training and Bryan and Gast (2000) used them along with graduated guidance and achieved positive outcomes. Activity schedules give individuals choice and control in their daily activities (Anderson et al., 1997). This flexibility in implementation and design makes them widely accessible for most individuals and situations. Activity schedules are cost effective and portable, allowing them to be generalized across settings and individuals (Morrison et al., 2002). Yet, Akers et al. (2018) pose that the use of activity schedules can potentially be stigmatizing.

Digital Activity Schedules

With the benefits available from the use of activity schedules it becomes important to find an effective way to use and implement them in daily living situations in a format that is not stigmatizing. Perhaps the most important reason for using a high-tech activity schedule is that it may not be as stigmatizing as an individual carrying or using a book or paper-based activity schedule (Osos et al., 2021). They discuss that students at all age levels are utilizing high-tech devices and thus using such a device can have an additional outcome of reducing social stigmatization and reducing the potential of being bullied (Osos et al., 2021). Despite the benefits of a paper-based activity schedule like cost, replaceability, and its ability to be customized, there are too many advantages of using technology for it to be dismissed (Uphold et al., 2016). Due to the quick advances in technology, laptops, tablets, and handheld or mobile devices should be put to use in classroom settings (Kurkcuoglu et al., 2015).

One of the benefits of technology now is that most pieces of technology are easily transportable. Having an intervention delivery that is easily portable gives greater opportunities for widespread generalization of skills being taught. As high-tech devices are portable enough to be taken to other settings with individuals, instruction in targeted skills can happen in any setting the device goes (Osos et al., 2021).

As with the paper activity schedules, one of the benefits of this intervention is its versatility in delivery. An iPod was used to help college-age individuals with autism learn how to engage in fitness activities independently (Uphold et al., 2016). Five high school students were taught how to program their own electronic activity schedule and taught them how to follow the steps to fulfill academic tasks (Douglas & Uphold, 2014). Preadolescent boys were taught to engage in leisure skills using an activity schedule on an iPod touch (Carlile et al., 2013). And an activity schedule on an iPad was implemented to teach effective leisure time usage to preschoolers (Reinert, 2016).

Digital activity schedules have also been used in conjunction with other research-based interventions. Video models have been embedded into digital activity schedules to effectively teach high school students with autism to follow a schedule within and between activities (Spriggs et al., 2014). Video enhanced visual schedules were used to help four preschoolers with autism practice and acquire social skills (Osos et al., 2021). In teaching activity schedules and digital activity schedules, it is suggested that the process is introduced with two or three activities that are familiar to the individual (Reinert et al., 2020).

The research on the use of digital activity schedules is limited (Eliçin, & Tunalı, 2016; Kurkcuoglu et al., 2015; Osos et al., 2021). There are a limited number of studies in each area of age and skill set (i.e., academic, leisure, independent living, etc.). Other researchers have called for more research to be done in the area of digital activity schedules (Carlile et al., 2013; Eliçin, & Tunalı, 2016; Kurkcuoglu et al., 2015; Radi, 2017). The research question focused on in this paper is asking to what extent the research support the use of digital activity schedules in increasing task completion of individuals with disabilities.

Systematic Reviews

Systematic reviews are “a method of making sense of large bodies of information, and a means of contributing to the answers to questions about what works and what does not” (Petticrew & Roberts, 2008, p. 2). Additionally, Pigott and Polanin (2020) state that “systematic reviews analyze and synthesize a body of literature in a logical, transparent, and analytical manner" (p. 24). In simpler terms, a systematic review takes multiple studies, finds the information present in each one, and synthesizes the information to answer the research questions asked, identify trends, and identify where research has occurred and where more research is warranted.

Systematic reviews are the most current method of gathering this information (O'Keeffe et al., 2012). There are some specifications that make a systematic review reliable. "Literature reviews guide research and practice most effectively when they feature transparent search procedures" and that transparency builds credibility with the readers of the review (King et al., 2020, p. 6).

"Conducting literature reviews systematically can enhance the quality, replicability, reliability, and validity of these reviews" (Xiao & Watson, 2019, p. 109). Much of the careful attention previously mentioned is centered around the search, inclusion, and exclusion criteria. This idea is further explained by the statement that, "establishing meaningful criteria for including or excluding articles in the literature synthesis is an epistemic concern that authors of systematic reviews face and one that must tie clearly back to the author's purpose in conducting the review" (Murphy et al., 2020, p. 4). Having a clear and concise search and inclusion criteria can remove the unsurety and question in what articles should be included in the systematic review.

"[Systematic reviews] are a method of mapping out areas of uncertainty, and identifying where little or no relevant research has been done, but where new studies are needed" (Petticrew & Roberts, 2008, p. 2). Specifically in the field of education and special education, Xiao and Watson (2019, p. 108) assert that "literature reviews establish the foundation for academic inquires." For researchers, journal editors, and practitioners, systematic reviews are a driving incentive for accessing research and new information to help individuals with disabilities make more progress; they are a way of finding answers, best practices, and getting research to those who benefit from the information the most while requiring less effort to find it.

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