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Abstract

A single-subject, alternating-treatments with no baseline design was used to study the effectiveness of work systems in three children with autism. Work systems build on the strengths of children with autism, taking advantage of their visuo-spatial strengths by building on the principles of visual cueing and organization. Individual work systems were developed for each child, and the effects of these systems on on-task behavior, dependence, productivity and organization were studied. Results indicate moderate significance for the effectiveness of work systems in increasing on-task behavior and decreasing dependence in children with autism. Results also revealed substantial evidence for the effectiveness of work systems in increasing organization in these children. Most important, this study illustrates that successful empirical research can be conducted on work systems and their effects on children with autism.

Effects of Structured Work Systems on Task Performance in Children with Autism

Autism is a developmental disorder affecting about 1 in every 1,000 children (Zagar, 1999). The disorder exists on a spectrum from mild to severe with a wide range of characteristics defining it. Although this range makes simplification of autism's defining features difficult, researchers have been able to identify some common characteristics (Zagar, 1999). The three main characteristics of autism listed in the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (APA, 1994) are impaired reciprocal social interaction, impaired communication skills, and restricted, repetitive, and stereotyped behavior. Associated features such as short attention span, resistance to change, and lack of motivation are also displayed in many children with autism (Schopler, Mesibov, & Hearsey, 1995). These impairments touch every aspect of the children's daily lives, making day to day social transactions difficult, communication attempts frustrating, and cognition and learning arduous and demanding.

Therefore, clinicians, researchers, and parents of children with autism have developed multiple instructional techniques to address these deficits. This study was designed to assess the effectiveness of one such instructional technique: work systems (Schopler, et al., 1995). Work systems are widely used in clinical settings, despite a lack of controlled empirical research establishing their effectiveness. Work systems rely heavily on visual tools to help children with autism work more independently, more systematically, and with less frustration (Schopler et al., 1995). One main goal of work systems is to compensate for the social, communication, and repetitive behavior deficits these children face. As a result, children with autism may learn and function more successfully.

Before explaining the present study in detail, I will first present an overview of the characteristics of autism that impact learning to provide a general background of the deficits

work systems strive to minimize. Second, I will present a brief description of work systems and the rationale for their use. Third, I will review the literature on the components of work systems. That is, although empirical data on work systems, themselves, is lacking, the components of work systems have been widely studied. Finally, I will discuss the present study in detail.

Characteristics of Autism that Impact Learning

The characteristics associated with autism--such as the social, communicative and behavioral impairments--make learning a difficult task for children with autism. First, children with autism have difficulties understanding their social world and processing social information. These students may seem disinterested or distracted in their social interactions, as evidenced through wandering attention, inability to hold joint attention, and routinely attempting to escape the learning environment (Quill, 1995). Further, impairments in the use of eye-to-eye gaze, facial expressions, and gestures that regulate social interactions inhibit successful learning (APA, 1994). For example, the misinterpretation of facial expressions and gestures may prevent the child from understanding directions or commands from their teacher. The child's educational experience may be jeopardized further if teachers and staff interpret these behaviors as disobedience, rather than the child's difficulty understanding traditional social cues and instructions. Quill (1995), like many autism experts, emphasizes that the social communication deficits in individuals with autism are not an unwillingness to share information but, rather, an impaired ability to extract relevant social information from social context (1995).

In addition, use of communication skills and pragmatic language are thought by many researchers and clinicians to be the fundamental deficits in autism (Bryson, 1996). Students with autism have difficulties abstracting pertinent information from their verbal environment. These students often fail to understand information effectively. For example, outcome studies

suggest that 50% of children with autism never develop functional speech (Schuler, 1995). Obviously, if a child cannot extract what is relevant from other's speech, then they will not receive the important information they need to perform tasks, initiate activities or regulate their behavior. Students with autism show many other communication impairments such as abnormal pitch, rhythm, intonation, stereotyped and repetitive use of language, and the inability to initiate or sustain conversations. These deficits confound traditional teaching methods. If a child cannot understand questions in class, engage in simple dialogue, or if the teacher cannot understand the child's stereotypical language, then a vital communicative relationship built on rules and commonalties cannot be established between the child and his or her teacher.

The third major characteristic of autism involves restricted behaviors and interests. Many individuals with autism become fixated on objects, inappropriately use teaching materials, or repeatedly perform the same action with an object (Cohen & Volkmar, 1997). These behaviors can be related to their preferences for stereotyped behavior, routines, and unchanging environments, but it is also important to recognize the detrimental effect these behaviors have on the acquisition of tasks. For example, when a child engages in self-stimulation with a teaching material, or uses it inappropriately, the learning task becomes overshadowed.

Clinical and empirical evidence now suggests that traditional teaching methods, which are highly dependent on social and communicative cues and interaction, are not sufficient for students with autism. The unique learning patterns and developmental course of children with autism require specialized instructional programming focused on each individual child's learning strengths. A work system is one instructional technique that recognizes the weaknesses and builds on the strengths of children with autism.

A Brief Description of Work Systems

Work systems combine a variety of visual tools to clarify the learning environment, and instill routine into the activities to be done. Work systems involve setting up the child's individual work area and work materials in a manner that visually communicates to the child: (1) the tasks that need to be completed, (2) the amount of work that needs to be done, (3) when the work will be finished, and (4) what happens after the work session (Mesibov, Schopler, & Hearsey, 1994). Work systems visually lay out all the information that is needed to successfully complete a task, allowing the child to predict his or her activities without frustration. The tasks included in work systems can range form self-care skills to vocational exercises, but the importance of the work system is the "system" itself. The goal is not to teach tasks per se, but to support independent work performance.

Work systems can be individualized for any student's functional level. At a basic level, a work system might consist of three plastic baskets placed at a child's left, each containing a work task. The child would take one basket at a time, complete the task, and then place it in a large "finished" basket at their right. This left-to right work system is illustrated in Figure 1. This systems shows: (1) what work to be done (work in baskets), (2) the amount of work to be completed (3 baskets), (3) when work is finished (all work baskets moved off shelf at child's left to a finished basket), and (4) what happens next (green choice board behind child). At a more complex level, additional visual directions can be utilized within the work system to communicate the tasks to be done. For example, in a picture-matching work system, the child would be presented with a series of picture cards (i.e., mini-schedules), that communicate the sequence of tasks to be completed. That is, the child takes the first card, matches the picture to a picture on a corresponding basket, and completes that task first. The remaining cards are used to guide subsequent tasks. See Figure 2 for a work system that incorporates a mini-schedule.

Rationale for Using Work Systems

Work systems build on the strengths of children with autism and overcome many of their deficits. First, work systems integrate routine and structure into the learning environment. Clinicians suggest that structure and routine help children with autism work more effectively (Mesibov et al., 1994). These authors argue that structure and routine take advantage of the autistic child's own drives to complete tasks independently. Further, because the child's desire for routine is utilized, less frustration and distress may be present. Second, work systems limit distractions and set visually clear boundaries for individual work areas, which enhance learning and engagement in activities (Kunce & Mesibov, 1998). Third, work systems circumvent verbal and social impairments of children with autism by decreasing the amount of social interaction and verbal communication required. Fourth, work systems keep children with autism on-task, on-schedule, and working in the correct sequence (Schopler et al., 1995). Fifth, once a child becomes familiar with the routine of the system, the structure can be generalized to a variety of tasks. In addition, work systems allow children with autism to work more independently, which will benefit these children in both the short and long-term (Hall et. al, 1995; Mesibov et. al, 1995; Kunce & Mesibov, 1998).

Finally, work systems take advantage of the visuo-spatial strengths characteristic of children with autism by building on the principles of visual cueing and organization. Through cognitive and neuropsychological testing, Hermlin and O' Connor (1970) first found that children with autism have a superior ability to process visuo-spatial information compared to audio-temporal information. Children with autism show strengths in visual-discrimination learning, puzzle assembly, matching, copying exact duplications, and sorting into categories (Quill, 1995; Zagar, 1999). All these tasks involve visual information that is present at all times. Students with autism have a much easier time focusing their attention on visual

materials than on a rapidly changing social and communicative environment (Twachtman, 1995). Work systems capitalize on these visual strengths of children with autism.

Research on Work System Components

Although, empirical research is lacking on work systems as a whole, researchers have studied the visual components of work systems. The two components of work systems with the most empirical evidence are visual organization of the learning environment and visual activity schedules. Both strategies utilize visual cues and organization, and are discussed in detail below.

Visual Organization of the Learning Environment

As mentioned above, many children with autism have a difficult time staying on task, maintaining attention to appropriate stimuli, and extracting relevant information from their environment. Organizing the child's physical learning environment has been proposed as a method for diminishing problems and maximizing each student's ability to attend to relevant information, block out distractions and promote successful learning (Kunce & Mesibov, 1998).

A number of visual organizational strategies can be implemented in a classroom. Mesibov and colleges (1994) suggest that the child's learning environment can be more effective if (1) visually clear areas and boundaries are established (i.e. play areas and work areas) and (2) distractors such as lights and bright colors are limited. These authors argue that the use of consistent areas for specific activities tells the students with autism that specific activities are expected in certain areas. Further, when these expectations are clear and constant, the students experience less frustration and anxiety about unpredictability and constant changes in routine.

One empirical study by Duker and Rasing (1989) supports this clinical evidence. These researchers studied the effects of redesigning the physical environment on decreasing inappropriate behaviors such as self-stimulation, and increasing task performance. Results of

the study show that by taking all the wall decorations off the walls and covering bookshelves and windows with sheets, an increase in on-task behavior and a decrease in self-stimulatory and inappropriate behaviors occurred. Therefore, evidence suggests that a clear, distraction-limited environment promotes learning by helping children with autism stay engaged in functional activities. Another tool to visually communicate information to children with autism is a visual activity schedule.

Visual Activity Schedules

Visual activity schedules have received substantial clinical recognition and empirical support as effective visual tools for communication and learning. These schedules visually explain to each student what activities are to be done for the day or for a specific task, and in what sequence the activities are to be performed. Visual activity schedules take many forms. For example, these schedules can be large poster boards displayed in front of a classroom, with all the activities of the day posted in words or pictures, or several pictures placed in individualized binders for each child, with separate activities on each page. After looking at picture prompts, the child is self-prompted to complete a step, or begin a task (Wacker & Berg, 1983). Schedules help students with autism minimize problems of verbal working memory, attention, time, and organization. In addition they foster independence and increase self-motivation (Schopler et al., 1995). Schedules also assist in the student's anticipation of activities and tasks, and decrease the student's dependence on adults.

Independence is an important issue for students with developmental disabilities because school and employment environments do not always have the resources to accommodate one-on-one attention. It is important for these students to be able to follow a schedule of activities, especially as they attempt to enter mainstream classrooms or work environments (Sowers, Rusch, Connis, & Cummings, 1980). Schedules promote independent

engagement in vocational tasks and transitions, and reduce the necessity for ongoing verbal prompts and gestures from teachers (MacDuff, Krantz & McClannahan, 1993).

Sequential photographic or object schedules have been used to help people with developmental disabilities acquire a wide variety of skills including, job training (Wacker & Berg, 1984), self-care (Thinesen & Bryan, 1981; Pierce & Schreibman, 1994; Hall, McClannahan & Krantz, 1995), cooking (Johnson & Cuvo, 1981), computer (Frank, Wacker, Berg & McMahon, 1985), and vocational skills (Sowers et al., 1980; Wacker & Berg, 1983; Wacker, Berg, Berrie & Swalter, 1985; Frank & Wacker, 1986; Hall, McClannahan & Krantz, 1995). For example, MacDuff et al. (1993) tested the effectiveness of photographic activity schedules on on-task and on-schedule behavior in four boys with autism. These researchers use photographic activity schedules displayed in a three-ring binder to communicate to the children the tasks to be performed and in what sequence. Results indicate that with he use of pictoral schedules, both on-task and on-schedule performance immediately increased in all subjects. When using photographic schedules, students displayed lengthier response chains and were more likely to independently change activities in the absence of immediate supervision and prompts from others.

Although there is substantial clinical evidence for the effectiveness of work systems and empirical evidence on the components of work systems, empirical data is lacking on work systems as a complete "system." Therefore, the present study implemented work systems with students enrolled in an educational program for children with autism. The present study constitutes one of the first attempts to assess the effects of work systems on the task performance of children with autism. There were four hypotheses tested in the present study. In contrast to a less structured work time, students using work systems were expected to (1) exhibit increased levels of on-task behavior, (2) require fewer teacher prompts, (3) be more productive, and (4) show increased levels of organization.

Method

Participants

Three out of ten children in an educational program for children with autism were selected to represent a range of developmental levels and both genders. Children who had severe behavior problems (i.e., aggression) or for whom school staff expressed concerns that participation in this study would be detrimental were excluded from the study. The three children who participated in the study were Susie, age 7, John, age 8, and Mike, age 10. All three children had received a DSM-IV (APA, 1994) diagnosis of autistic disorder as indicated in school records. Descriptive information for each child, received from school records and parental measures, is summarized in Table 1. Psychoeducational Profile Revised (PEP-R) scores indicate that all three children were functioning developmentally below chronological age expectations. None of the children had used work systems before the start of this study. Informed consent was obtained from each child's parent or legal guardian for participation in the study and the use of video equipment during work sessions.

Setting and Materials

This study was conducted in the children's regular classroom environment. In collaboration with school staff, two work areas were developed for the study in a corner of the classroom. Partitions and window coverings were used to limit distractions from outside the work area in both treatment conditions. In collaboration with school staff, intrusions into regular classroom routines and schedules were minimized. Steps were taken to differentiate the two experimental conditions. The work system sessions were conducted facing the southwest corner of the classroom. The children sat at a 3' by 2' desk. To the child's left were three work baskets which contained the child's tasks on top of a small thin bookcase. Independent "table time" was conducted facing the north and a different, slightly larger desk was used.

In both conditions, the "teaching adult" stood 2 feet behind the child. The coders sat 7 feet in front of the child. A video camera was positioned in between the two coders on a 3-foot tripod. Participants successfully habituated to the use of the video camera and coders in both conditions.

The same tasks were manipulated in each condition. After extensive consultation with school staff and review of school records, 12-15 tasks were developed for each child's level of functioning. Each child's list of tasks varied in difficulty within their ability range. A variety of skills such as sorting, visual matching, packaging, and fine motor skills were required for task completion. Refer back to Table 1 for a list of representative tasks used by each child and see Figure 3 for an illustration of four work tasks. Three work tasks were given to each child during each work session. The sequence of tasks that each child completed on any given day was randomly selected and counterbalanced across both treatments. That is, each student completed each sequence the same amount of times in both conditions.

Experimental Design and Procedures

A single-subject, alternating-treatments with no baseline design was used to assess the effects of the work system on the four outcome variables. This design is used to compare the effects of two independent variables (treatment conditions) on the same behaviors, when time does not permit the collection of baseline data (Richards, Taylor, Rasasamy, & Richards, 1999). Before experimental manipulation began, all tasks were pre-tested and work systems were taught.

Pre-testing and teaching. After developing work tasks for each child, all the tasks were pre-tested to ensure that the child could complete his or her set of tasks with 80% accuracy and being prompted no more than 1/3 of the time. For example, if a task had 12 component pieces, the child had to assemble 8 pieces without prompting. Each child was

directed to a table and given three tasks to complete. The number of pieces each child assembled and the number of prompts needed to complete each task were recorded.

Once 80% accuracy was reached for all the tasks, the teaching phase began. Since none of the children had been exposed to work systems, it was necessary to teach each child how to manipulate their individual work systems. The teaching adult used unrestricted manual, gestural and verbal prompts, given from behind the child, to demonstrate the correct manipulation of each child's work system. The teaching session ceased when each child could independently initiate 75% of the steps in their work system without teacher prompts for three consecutive sessions.

After all of the children seemed comfortable with their work systems, the independent table time was introduced. Each child was brought to a different table where they were prompted to do work. After the start prompt, unrestricted prompts, given from behind the child, were used to keep the child on task. Children were brought to independent table time on two separate occasions to become acquainted with the area and expectations.

<u>Experimental Manipulation and Data Collection.</u> Each child engaged in two work sessions per day. Sessions lasted for six and 2/3 minutes (i.e., for coding periods of ten 10-sec intervals) or until the child had completed all work and indicated that he or she had finished. The order of work system session and independent table time was alternated daily with each child participating in each condition an equal number of times. To help children transition from regular classroom activities to work time, the children were given an appropriate photo card and told "time to work" (i.e., photo of work area which matched photo at work table).

Using Schopler et al. (1995) and the clinical experience of the study's principle advisor (Linda Kunce), work systems appropriate for each child's functional level were developed. Mike used a simple left-to-right work system (illustrated in Figure 1). Three baskets, each containing a task, were placed at his left. He worked in a left to right pattern, manipulating the

farthest left basket first. When each task was completed it was placed back in the work basket and placed in the finished basket at his right. When Mike was finished, he was taught to choose a task from a picture activity board ("choice board") behind him. John and Susie also used a left-to-right system with three baskets, but a visual schedule was also integrated (illustrated in Figure 2). A picture schedule showing the correct sequence was placed on the left-hand corner of the desk. The child had to get the first card, match it to the correct basket, and then complete that task. As in Mike's system, when the task was completed, it was placed back in the work basket and put in the finished basket at the child's right. The same procedure for the next two cards followed. The last card on the schedule was a "choose" card that allowed the child to choose his or her next activity from the "choice board."

Independent table time was conducted at a different table. See Figure 4 for an illustration of Independent table time. Three tasks were placed on the table in an unstructured manner. During these sessions, the child placed their visual cue card, the child was verbally communicated the sequence of tasks required of him or her, and then the child began manipulation of the tasks. Children were expected to work until a timer signaled the end of the work session. If children finished all tasks and signaled that they were finished by either leaving the table or gesturing to the teaching adult, the session was terminated.

Outcome Variables.

Trained coders performed in-class data collection. Data was scored in ten-second intervals throughout each work session. Four outcome variables were measured over 12 days spread across 5 weeks.

On-task. On-task behavior was defined as the percentage of time in which the child was engaged in any functional interaction with the task material. On-task was recorded when participants were (a) visually attending to work materials, (b) manipulating task materials appropriately (i.e. as they were designed to be used) and (c) manipulating the work system

appropriately (i.e. matching cards, getting baskets, putting work baskets in finished basket). Off-task was recorded if they were (a) using materials in a manner other than that for which they were designed (i.e. throwing, chewing, self-stimulation), (b) not engaged with the task or work system (i.e. staring and walking away from table), (c) manipulating the work system inappropriately, or (d) undoing task pieces that had been correctly assembled. Both on-task and off-task behaviors were measured using a 10-second momentary time sampling procedure. See Appendix for coding criteria of on and off-task behavior and a sample coding sheet.

Dependence. Dependence was defined as the proportion of time intervals in which a teaching prompt was required. Prompts were measured using a 10-second partial interval recording procedure.

The following prompt rules were used in both conditions. See Appendix A for prompt rules. The teaching adult prompted if the child was scored off-task for 3 consecutive 10-second coding intervals. The prompt for all children consisted of tapping the table and stating "Do work." The child was also prompted if he or she left the work area (i.e. " Sit down and do work" while being accompanied back to the work area). In addition, a child would receive a prompt if he or she placed the first piece of a task incorrectly (i.e. "No, look" while modeling the correct manipulation of the task). Finally, a child would receive a prompt if he or she did not appropriately begin with the first task in the intended sequence (i.e., "No, first puzzles" while pointing to the correct task, basket, or picture schedule card). All of the above prompts were used in both conditions. Additional work system prompts were used when children made errors in the manipulation of the baskets or cards. If a child incorrectly manipulated a step in the work system, a hand-over-hand prompt was issued to show the correct manipulation. Prompts involving manipulation of the work system (i.e., work system prompts) were scored separately from other prompts (i.e., general prompts) involving task manipulation or redirection to the work area.

Productivity. Productivity was defined as the percentage of steps correctly completed for all work tasks (e.g., number of puzzle pieces placed correctly divided by the total number of puzzle pieces). Coders checked the completed materials after the work session and recorded the number of pieces correctly completed for each task. All three tasks were added together and one productivity score was recorded for each session. If a child did not complete all the task pieces within time limits, only the number of pieces that had been completed at the time limit were counted in the coding.

Organization. Organization was defined as manipulation of the work tasks in the intended sequence. This was measured after each work session by recording the sequence of tasks that the child completed and comparing it to the required sequence. Each child received one score for organization after each work session: correct or incorrect sequence. In the work system condition, sequence was communicated visually. Mike's correct sequence was communicated through the order of the baskets (i.e., left to right), while John and Susie's correct sequence was communicated through the visual schedule. In the independent table time the correct sequence was communicated verbally and gesturally. Each child was told the order of the tasks (i.e., “First pencils, then puzzle, then lotto card,” while pointing to each task).

Interobserver agreement. The two coders consisted of the principle advisor and an Illinois Wesleyan research assistant. Both coders were trained on coding procedures through the use of video tapes. An 80% agreement was required and reached for reliability during training. Two observers were present during 1/3 of the data collection period. Interobserver agreement of 96.2% was obtained for on-task behavior, 80.6% for off task behavior, and 94.1% for dependence.

Results

On-Task.

Figure 5 shows levels of on-task behavior for the three participants across all conditions. Each point on the graph represents the percentage of coding intervals during which the child was on-task. Visual analysis of the graphs suggests more consistently on-task behavior in the work system than in the independent table time for all three participants. Paired samples t-tests confirmed that all three children were significantly more on-task in the work system condition than in the independent table time, for Susie, t (36) = 3.36, $p < .01$, John, t (42) = 2.48, $p < .05$, and Mike, t (28) = 2.12, $p < .05$. See Table 2 for means and standard deviations.

Dependence

Figure 6 the shows the percentage of prompts needed for the three participants across the two conditions. In these graphs, task specific prompts (general prompts) in both sessions were compared. Visual analysis of the graphs shows that more prompts were required in the independent table time condition than in the work system condition. Paired samples t-tests confirmed that all the children needed more general prompts in the independent table time than in the work system. Mean percent of prompts was significantly lower in the work system session for Susie, t (36)= -.67, $p < .05$, John, t(34) = -3.10, $p < .01$, and Mike t (28) = -2.99, $p < .01$. See Table 2 for means and standard deviations.

Productivity

Table 3 illustrates each child's productivity, defined as the percentage of tasks completed, over the entire data collection period. Paired samples tests across situations found no significant difference in productivity across the two conditions for Susie, t (11) =.99, ns, John, t (11) =.00, ns, and Mike, t (10) = .60, ns. This data suggests the amount of work each child successfully completed was not significantly different between the two conditions.

Organization

Table 3 illustrates the number of sessions in which each child completed his or her tasks in the correct sequence. This data strongly suggests that the children were much more likely to complete the correct sequence in the work system condition (i.e., 100% correct for all three children) than in the independent table time (i.e., range of 9-33% of sessions completed in correct sequence).

Discussion

Children with autism face many difficulties in their learning environment and traditional teaching methods are not sufficient for these children's unique learning patterns. Empirical research is important to aid in the development of effective teaching methods for these children. Work systems build on the strengths and compensate for the weaknesses of children with autism, but empirical data and support is lacking for the effectiveness of work systems.

The present study provides statistical support for the effectiveness of work systems. Observer data also indicated that the three participant children with autism, none of whom had used work systems and who were seldom expected to work independently in their classroom, did effectively learn to use their work systems. Empirical results indicate that the structure of these work systems prompted more on-task behavior, independence and organization than in the control condition.

The first hypothesis of interest was that children using work systems would exhibit increased levels of on-task behavior. Visual and statistical analysis showed an increase in on-task behavior in the work system condition compared to the independent "table" time. Even though this difference was demonstrated across children, it was not as strong as expected. Children showed some off-task behavior in work systems and unexpectedly high instances of on-task behavior in the independent table time. I suspect a greater distinction between the two

conditions might lead to greater differences in on-task behavior. That is, it is possible that generalization between the two conditions occurred. Essentially, work sessions were constructed in a very similar manner in both conditions. Even though independent table time did not include baskets, a structured system of three tasks organized in a systematic manner was established. Also, even though steps were taken to discriminate the two areas from each other, the two sessions were conducted in the same general area and physically set-up in the same manner.

As discussed above, work systems communicate four things to the child (i.e. what work to do, how much work, when the work is finished, and what comes next). In retrospect, the manner in which independent table time was constructed also communicated three of the four aspects of work systems. Each child could easily see what work needed to be done because the tasks were the same in both conditions, they were familiar, and they were clearly, visually displayed. The child knew how much work there was to be done because there were always three tasks in both conditions and performing three tasks per work session became a learned routine. Finally, since the choice board was left up in the view of the children, they frequently used it to choose their next activities, even though that activity had not been taught to the children as part of independent table time. In summary, structured independent table time in much the same manner as the work system condition.

Consequently, it is possible that learning within the work system generalized to the independent table time. Observations support this hypothesis. That is, during data collection, it was observed that children often tried to structure their independent table time to incorporate the structure that their work system provided (i.e., stacking tasks when finished, looking for a finished basket, using the choice board in a nearby area).

In future research on work systems, actions need to be taken to increase differences between the two experimental conditions. In the present study, a single-subject, alternating

treatments design was used, which was considered advantageous (i.e., less intrusive to classroom functioning and limits child distress caused by unclear expectations). In an alternating-treatments design, it is very important that the subjects can discriminate between the two conditions (Richards et al., 1999). As discussed above, because of a limited amount of classroom space it was very difficult to discriminate the two areas. In future research, separate rooms should be used for each condition, and distinctly different visual cue cards should be utilized to bring each child to the work areas. In addition, as described above, the present study structured aspects of work systems into independent table time. The work needed to be done and how much work was to be completed were both visually communicated in independent table time. Less structured tasks, a different number of tasks, and no presentation of a "what's next" cue may assist in minimizing structure within the independent table time.

In addition, an alternative experimental design may be useful. Researchers have suggested that, time permitting, some sort of baseline should be attempted in all research designs (Richard, et al., 1999). When no baseline data is collected, each child's level of the target behaviors before the study is unknown. For future research, baseline data should be collected, perhaps using a single-subject, multiple baseline design. This design is more difficult because it requires each child to reach a steady baseline before implementation can begin, but stronger results may be established using this design.

The second hypothesis was that work systems, by providing visual instruction and capitalizing on child preference for routine, would decrease dependence on adults. Results suggested that more prompts were required in the independent table time than in the work system sessions. This data is encouraging because it suggests that work systems may decrease the need for teacher prompts. Many times children with autism are so dependent on teacher prompts that it guides their behavior. Work systems are one possible teaching method that can be used to minimize the need for teacher prompts and promote more independence in children

with autism. Increased independence is vital for these children as they develop and useful in schools and clinical programs that do not have the resources to provide constant one-on-one time for children with autism.

Results did not support the third hypothesis that children would be more productive in the work system condition compared to the independent table time. The present study found no significant difference in productivity between the work system condition and the independent "table" time condition. Again, one possible explanation for this is generalization. The same tasks were used in each condition. The tasks were also designed in a visually structured manner (i.e., tasks were organized so that each task piece fit into a clearly marked area), which allowed children to learn the structure of the task and use that structure in any manipulation of that task, regardless of the work condition they are engaged in. Further, during data collection, the teacher and coders observed difficulty with tasks due to the specific tasks and not the work condition, per se. Tasks that were confusing for children or less structured than others were difficult for children in both conditions. For future research, less structured tasks need to be developed for each child. Also, novel tasks can be included to counterbalance for an over-exposure effect. Overall, if investigators use highly structured, well-known tasks, the children are apt to complete those tasks at the same level no matter what work condition they are put into.

Results provided substantial support for the fourth hypothesis that work systems would these children complete work tasks in the correct sequence. All three children completed the correct sequence 100% of the time in the work system condition , but only one-third or less of the time in the independent table time. The work system visually communicates the sequence to the child, but the sequence information is verbally communicated to the child in the independent table time. As described in the introduction, it is much easier for children with autism to understand visual information compared to verbal

information. Also during data collection, it was observed that many times the children went back and forth between different tasks in the independent table time. In the work system session, the structure of the system prompts the child to complete one task before he or she moves on to the next. Work systems prompt children with autism to work in the correct sequence, which is a very important skill for them to learn as they develop. Organization is a vital skill they must possess for every day life, including daily living skills and employment settings. Many children with autism have a very difficult time working in the correct sequence (e.g., a child may put all of his clothes on before he takes a shower, or may put his underwear on after his pants). In a work setting, it is very important to work in the correct sequence (i.e., first water the plants, then take out the garbage, then check with supervisor for further directions). The structure of work systems may provide the organization skills that individuals with autism need.

The above results pose a very important question: Even though these results indicate statistical significance for the effectiveness of work systems, do these results have any clinical significance? Can these results have an impact of the everyday lives of children with autism? If work systems can keep a child on task 15% more of the time, more "teacher" time can be spent with other children or with that child when one-on-one help is crucial. Classrooms for children with autism are very demanding and teacher time is immensely valuable. If work systems are used with all of the children in a classroom, a significant difference in on-task behavior may be observed, and less teacher time is used trying to keep children on-task and more time can be used for productive teaching sessions.

Observational data also suggests that children using work systems suffered less frustration and transition problems than in the independent table time. In addition, because the end of the independent table time was so unclear, the children were much more likely to eat work tasks, or take apart work tasks after they had been completed. Work systems can also be

used in a wide variety of settings. As mentioned above, children with autism can use work systems in the bathroom to help organize self-care skills, or to help them learn to put their clothes on in the correct order. Any small difference in performance or organization in the classroom is a constructive difference and can be built on and strengthened.

In conclusion, this study provides empirical support for the effectiveness of work systems, although results were not as strong as expected. Most importantly, this study illustrates that successful empirical research can be conducted on work systems and their effects on children with autism. Further research needs to be done on work systems and methodological issues cleared up. Work systems open up a wide range of possibilities for children with autism, and further research can explore those options. For example, this study only examined the most basic forms of work systems (i.e. simple left-to-right and picture matching systems on a single condition). In the future, researchers might vary the level of difficulty of the work systems, incorporate more advanced sequence schedules, and increase the amount and difficulty of the work manipulated within the work system.

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Table 1.

Demographic Information and Representative Work Tasks

	Child		
	Susie	John	Mike
Age	7 yrs. 5 mo.	8 yrs. 4 mo.	10 yrs. 3mo.
PEP-R* Sub-scores			
Imitation	10mo.	-------	10 mo.
Perception	38 mo.	-------	38 mo.
Fine Motor	29 mo.	-------	33 mo.
Gross Motor	32 mo.	-------	37 mo.
Eye-Hand	32 mo.	-------	31 mo.
Cognitive	14 mo.	-------	17 mo.
Verbal	17 mo.	-------	17 mo.
Developmental Age	20 mo.	44 mo.	22 mo.
Representative Tasks	assembly 9 way lotto 3-way bead sort	functional match category sort color-to-word match	pencils in a can 4-card shape sort color matching

*Psychoeducational Profile Revised

Table 2.

Means and Standard Deviations for On-Task Behavior and Dependence for in Both Treatment Conditions

		On-Task* Mean(Standard Deviation)	Dependence* Mean (Standard Deviation)
Susie			
	Work System	93.2 (10.4)	.98 (3.0)
	Table Time	79.4 (23.8)	30.2 (27.0)
Mike			
	Work System	97.0 (7.2)	1.2 (3.3)
	Table Time	82.3 (26.5)	6.2 (8.9)
John			
	Work System	94.3 (17.4)	1.3 (4.5)
	Table Time	77.3 (31.9)	5.5 (8.2)

* Paired samples t-tests comparing work system and independent table time were significant at $p < .05$ for all three children

Table 3.

Percentage of Productivity(Amount of Tasks Completed) and Organization (Correct Sequence) in Both Treatment Conditions

		Productivity		Organization	
Child	n	Work System	Control	Work System	Control
Susie	12	92%	85%	100%	25%
John	12	79%	79%	100%	33%
Mike	11	91%	86%	100%	9%

Note: n is number of complete sessions for each condition

Figures Captions

Figure 1. One child engaged in a simple left-to-right work system.

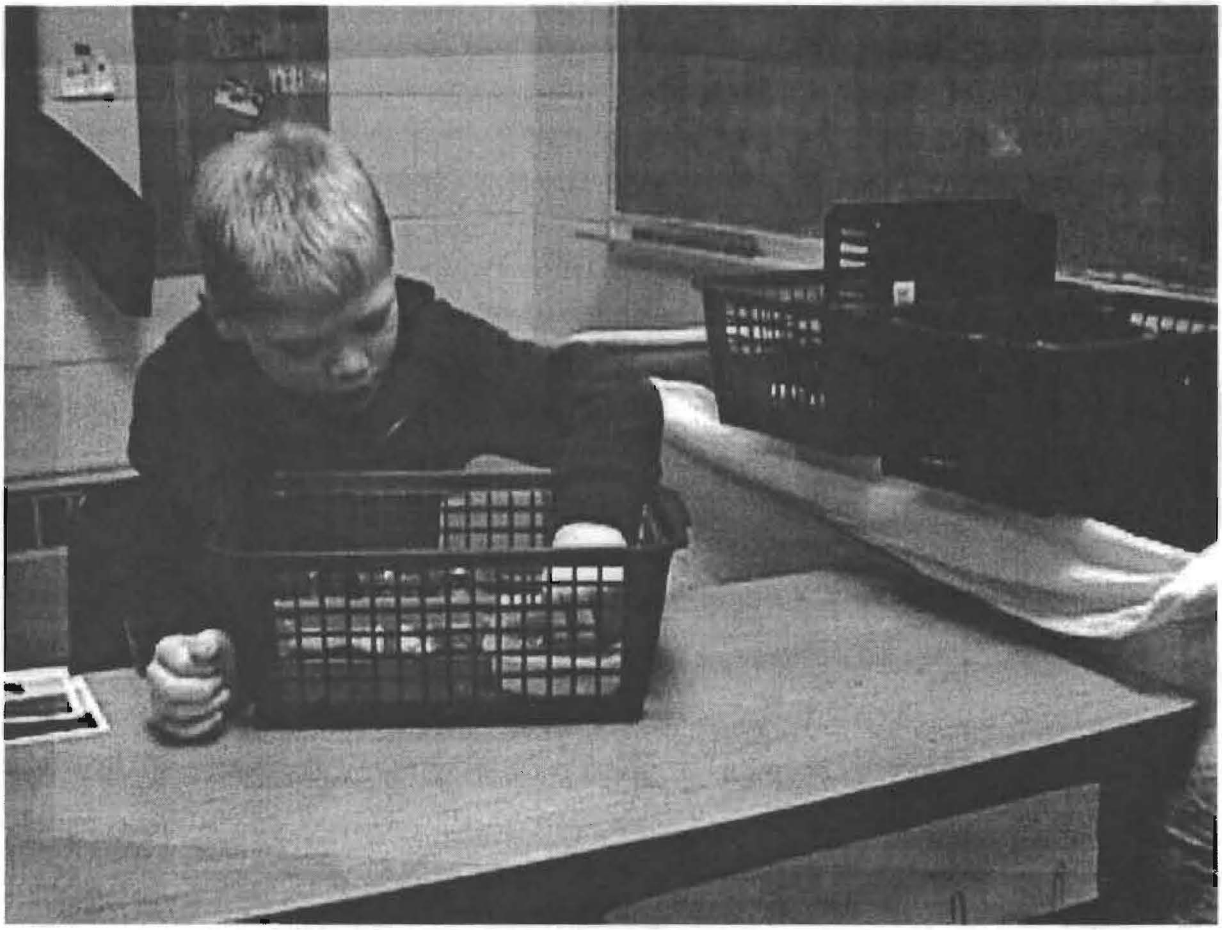
Figure 2. A left-to-right work system with a card-matching schedule.

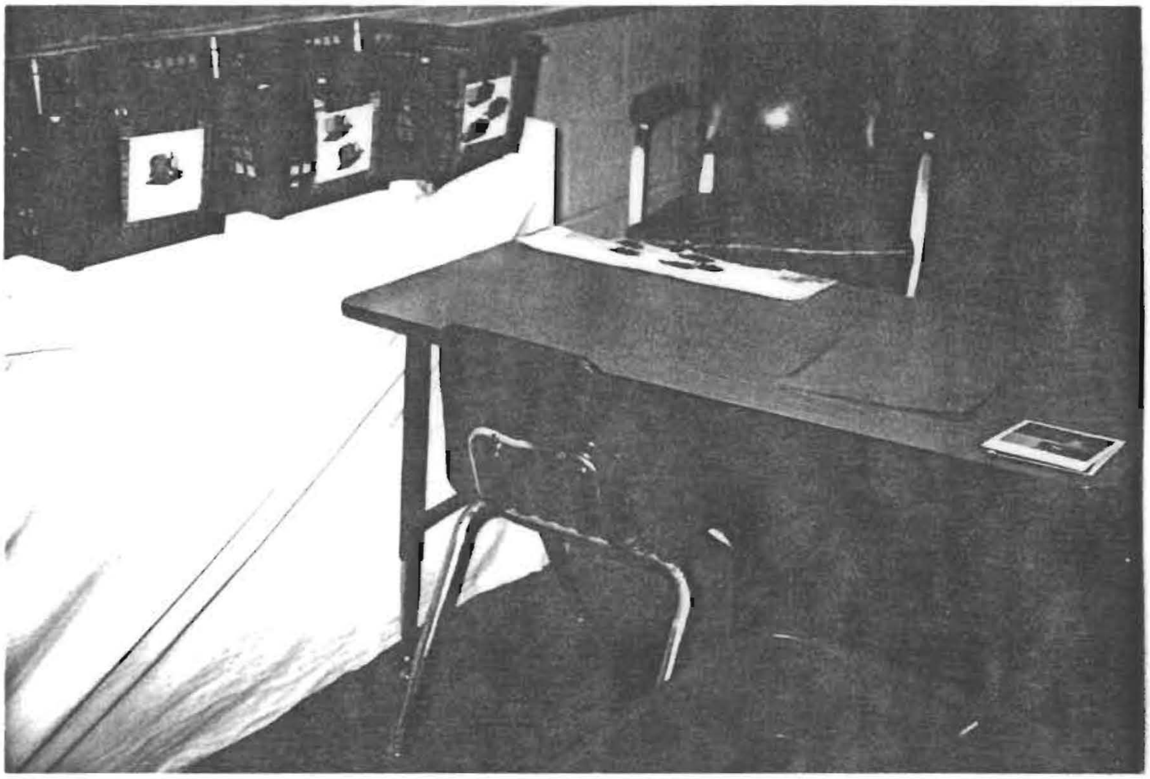
Figure 3. Three representative work tasks

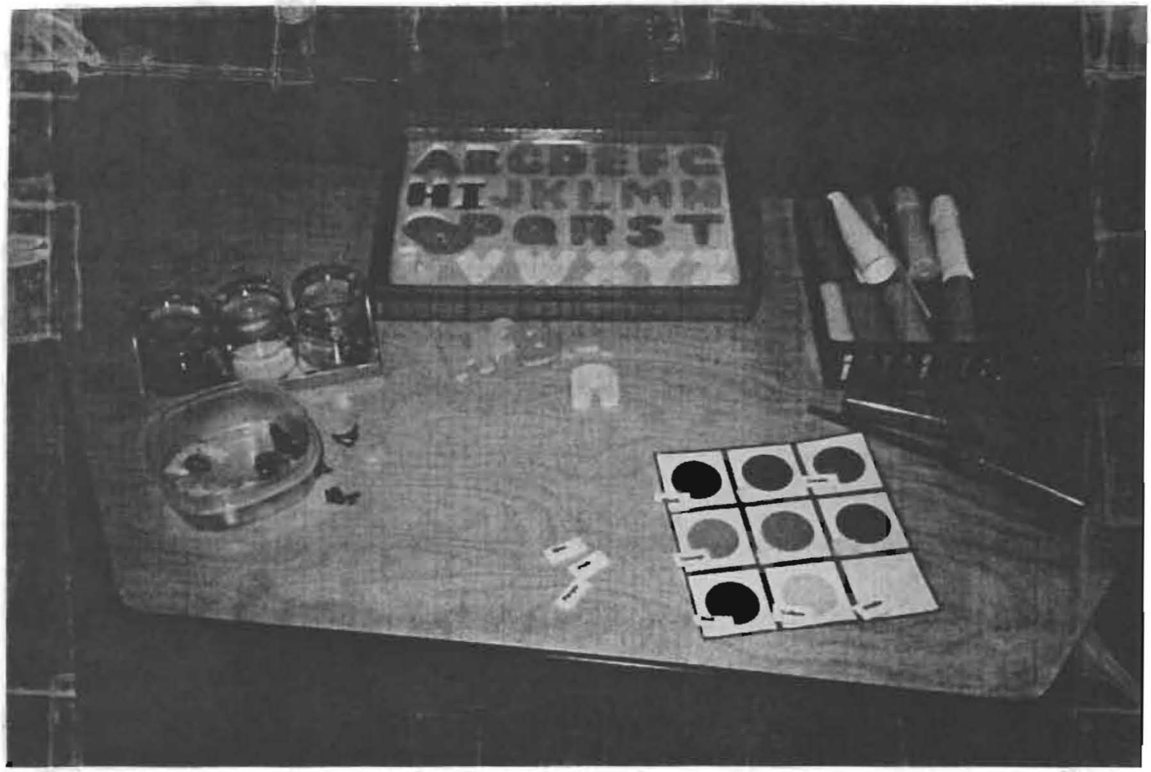
Figure 4. Independent table time

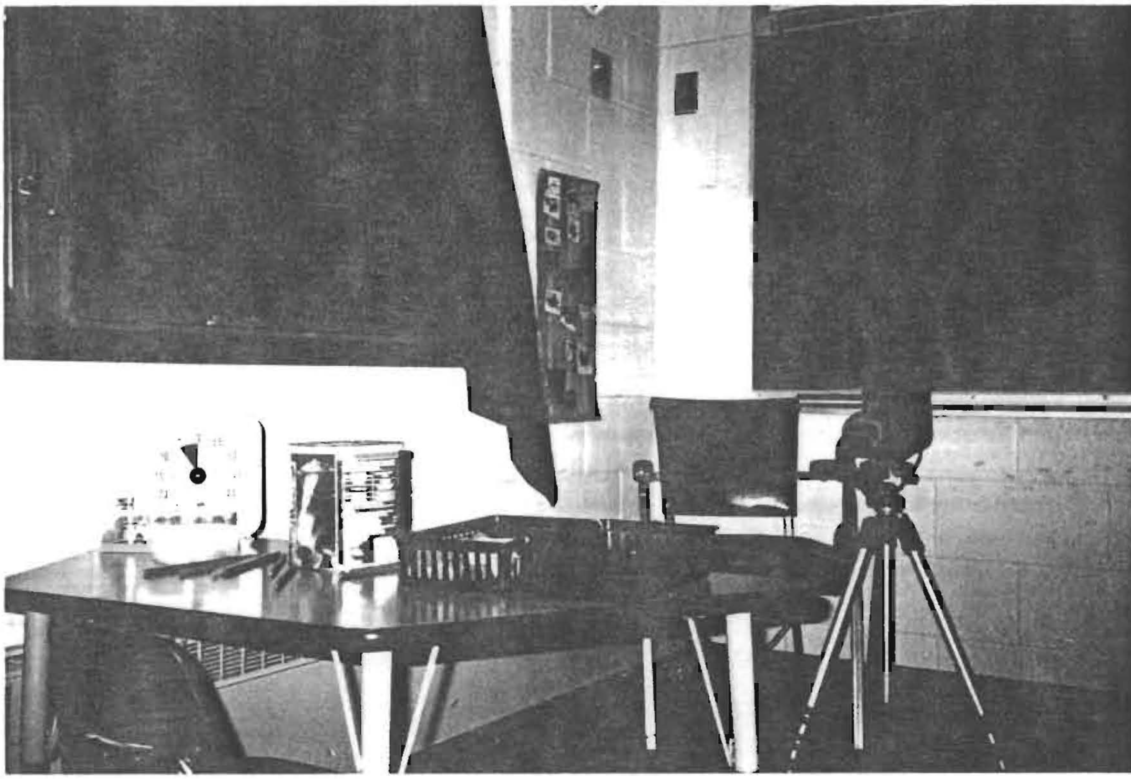
Figure 5. Percentage of on-task behavior within each data interval.

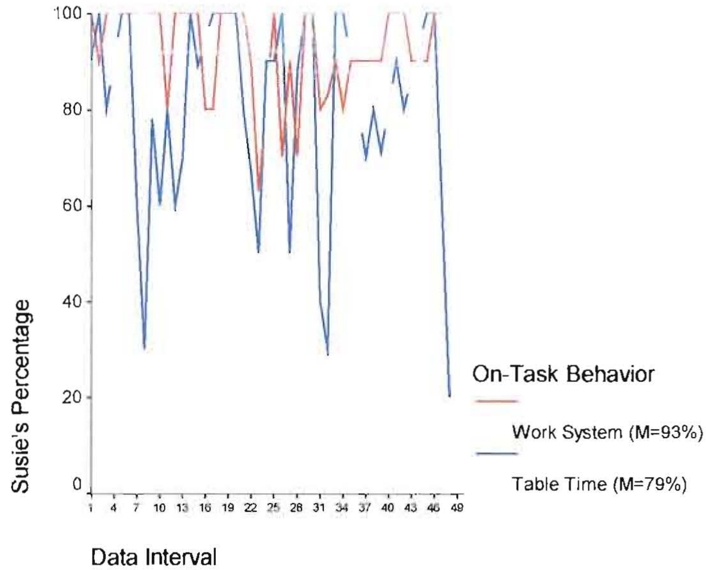
Figure 6. Percentage of prompts required within each data interval.



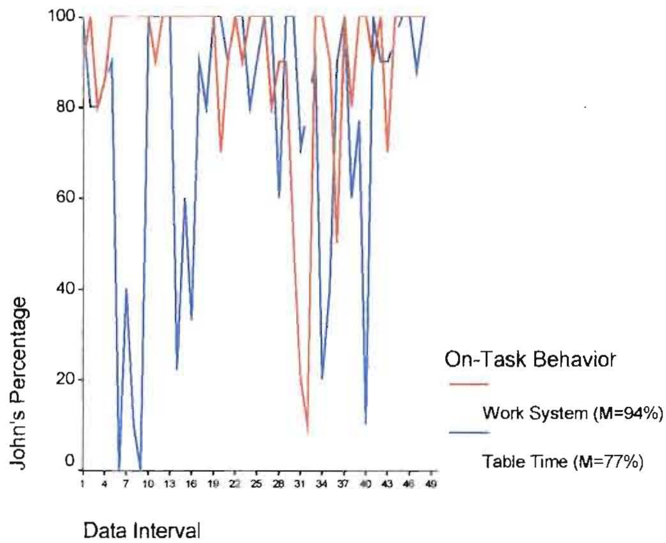




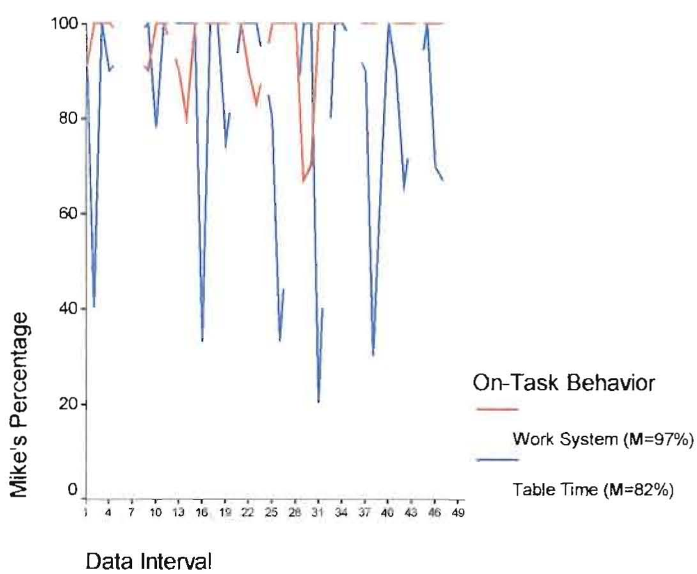




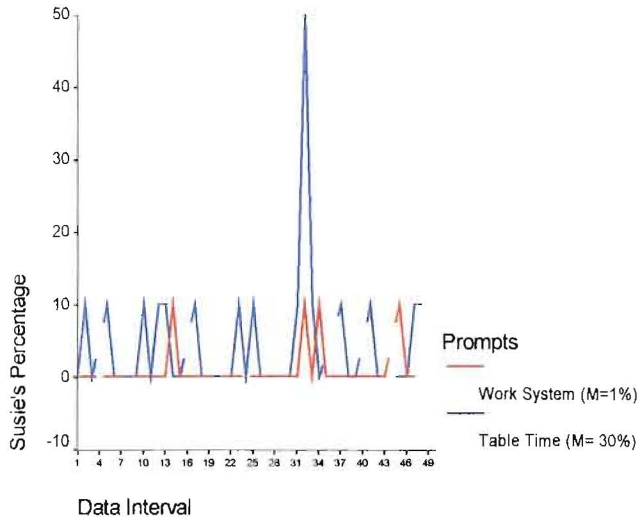
Susie's Percentage
100
80
60
40
20
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49
Data Interval
On-Task Behavior
Work System (M=93%)
Table Time (M=79%)

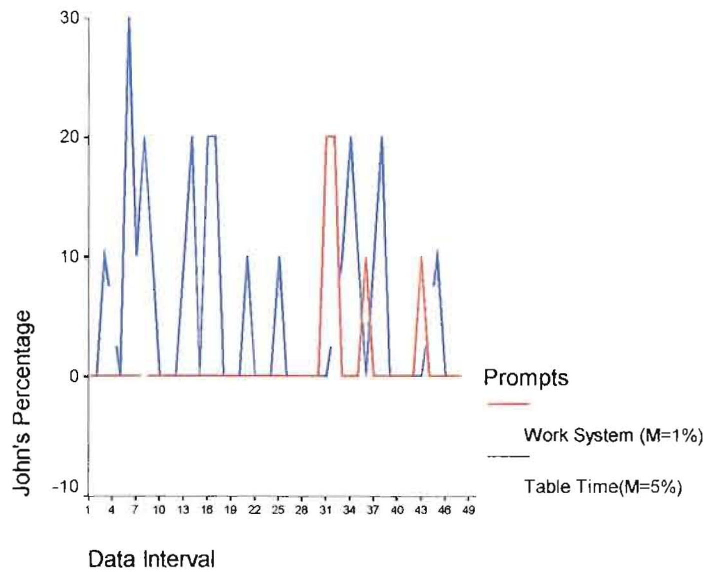


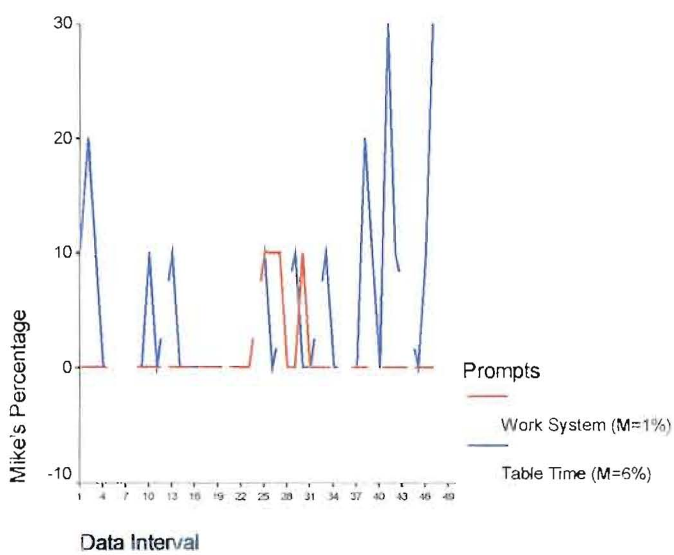
John's Percentage
100
80
60
40
20
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49
Data Interval
On-Task Behavior
Work System (M=94%)
Table Time (M=77%)



Mike's Percentage
100
80
60
40
20
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49
Data Interval
On-Task Behavior
Work System (M=97%)
Table Time (M=82%)


Susie's Percentage
Data Interval
Prompts
Work System (M=1%)
Table Time (M= 30%)


John's Percentage
Data Interval
Prompts
Work System (M=1%)
Table Time(M=5%)


Mike's Percentage
Data Interval
Prompts
Work System (M=1%)
Table Time (M=6%)