A COMPUTER-ASSISTED INSTRUCTION MODULE ON ENHANCING NUMERACY SKILLS OF PRESCHOOLERS WITH ATTENTION-DEFICIT HYPERACTIVITY DISORDER

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Abstract: Children with Attention-Deficit/Hyperactivity Disorder (ADHD) experience significant academic problems attributed to their symptoms of inattention, impulsivity and hyperactivity (National Institute of Mental Health, 2005). In the field of mathematics where focus and accuracy are essential, this problem is further complicated. Mathematics in nature is sequential as it builds on previously acquired knowledge – the most basic being numeracy which is honed during childhood. The use of Computer Assisted Instruction (CAI) for numeracy instruction benefits children due its presentation and interactivity features (Clements, 2002). There exists alignment in the motivational factors of CAI and the symptoms of children with ADHD (Lerner, 2000). This research aimed to develop a proposed CAI Module in Numeracy for Preschoolers with ADHD following the ADDIE Model of Instructional Design by McArdle (1991) and the ARCS Model of Motivational Design by Keller and Keller (1994). Design considerations under the Motivational Motivating Interactivity in Multimedia (MIM) Checklist by Keller and Keller were deemed important by eleven (11) teachers of preschoolers with ADHD and were further rated as appropriately handled in the CAI Module by three (3) Special Education (SPED) experts. Pilot testing of the CAI Module to three (3) preschoolers with ADHD has proven its impact. It is recommended that integration of the CAI Module in the curriculum be examined. Evaluation and development are on-going processes that should also be taken into consideration.

Keywords: Computer Assisted Instruction, Instructional System Design, Attention-Deficit/Hyperactivity Disorder, Preschool Numeracy

INTRODUCTION

A familiar subject area many students find difficulty in is mathematics. It can be noted that mathematics builds upon previous knowledge and skills acquired by students, the most basic of which is numeracy. Thus, numeracy is one of the fundamental human skills each individual should develop (National Council of Teachers of Mathematics, 2008). It is considered one of the skills needed in order to be called literate – writing and reading being the other two. Its applications, not only in education, are evident and eminent. It is therefore of utmost importance that this skill is taught in the best possible manner.

Numeracy instruction is affected by a lot of factors, including the kind of instructional instrument used (NCTM, 2008). The instrument engages the student, and to some extent, influences whether or not a love for numbers is developed. These instruments are mostly dependent on the existing and available technology. Therefore, rapid changes in technology demand needed changes in the practices of educational institutions including their preparation of instructional materials. And at the present, the technological trend is the use of computers.

Computers, for their much greater speed, accuracy and efficiency are becoming more and more integrated into the curriculum (Cotton, 1991). Administrators, parents, teachers and students themselves recognize the benefits brought about by the use of computers. From simply replacing the basic chalk and board technology, the overhead projectors and other print materials, computers are now replacing even the instructors and themselves becoming the source of the
knowledge. When designed and implemented appropriately, instruction becomes more fast-paced, interesting and appealing. This in turn results to an increase in subject contents retention and therefore in classroom achievement (Miller, 2002).

One field of education that shows great potentiality in adapting the use of computers in instruction is special education (Hitchcock & Noonan, 2000). With the premise that regular students benefit from computers, one may ask how much more would special children? For a child who has special needs, computer does even more (Lerner, 2000). In particular, the in-attentive behaviors demonstrated by students with Attention-Deficit Hyperactivity Disorder (ADHD) prove to be consistent with the benefits of Computer Assisted Instruction (CAI).

Although a lot of CAIs have been made, most of these are intended for the use of regular students and focused on other subject areas. Only few have been designed to address the specific learning needs of special individuals, especially preschool children with ADHD in relation to their acquisition and development of numeracy skills. This strongly implies that new ways of teaching special children should also be designed in consideration of their right to quality education and full access to educational opportunities.

Attention-Deficit Hyperactivity Disorder (ADHD) and Student Performance

Attention-Deficit/Hyperactivity Disorder (ADHD) is a developmental disability characterized by serious and persistent difficulties of inattentiveness, impulsivity and hyperactivity (ERIC Clearinghouse on Disabilities and Gifted Education, 1998). According to Banaag (as cited by Manongdo, 2005), ADHD is a neurobiological condition characterized by developmentally inappropriate levels of inattention and concentration, distractibility, and hyperactivity-impulsivity that can occur in combination across school, home and social settings. The Attention Deficit Disorder Association (Jaksa, 1998) identifies three (3) characteristics of children with ADHD – inattention/distractibility (poor sustained attention to tasks), impulsivity (impaired impulse control and delay of gratification), and hyperactivity (excessive activity and physical restlessness).

Most students with learning disabilities hold a lower self-concept, regarding their academic skills, and lower perceived academic competence than their peers without disabilities (Tabassam & Grainger, 2002). One major problem of children with learning disabilities and ADHD is motivation. It is important to note that motivational orientations, attributes, and characteristics are highly predictive of subsequent student engagement and behavior in academic and nonacademic tasks (Sideridis & Scanlon, 2006).

Children with ADHD are described as having performance deficits, not skill deficits. They have the capabilities to function in a higher level but fail to use them because they often get frustrated and quit working on academic tasks (Barron, Evans, Baranik, Serpell & Buvinger, 2006). ADHD children, due to their inattention and impulsive activities, experience frequent failure.

ADHD and Mathematics Difficulty

The Australian Association of Mathematics Teachers (1997) defined numeracy as the effective use of mathematics to meet the general demands of life at home, in paid work, and for participation in community and civic life. Numeracy in the preschool set-up varies. According to NCTM (2008), the preschool numeracy curriculum can be as focus on the development of number skills (naming, counting and sequencing) or as wide as the including spatial (reproducing and identifying geometric shapes) and measurement skills (visual addition and subtraction).

The mathematical achievement of youth with learning disabilities, attention deficit disorders, and attention-deficit hyperactive disorders is lower than that of their peers. The failure of youth with attention disorders to over learn the execution of problems and computational skills is attributed to their difficulty in sustaining attention to repetitive tasks and stimuli as well as their disorganization (Zentall & Ferkis, 1993). They often struggle mastering even the basic facts.

As compared to the other subtypes of ADHD, namely the Hyperactive-Impulsive Type and the Combined Type, the Inattentive Type showed to have more significant lower level of math achievement (Marshall, Hynd, Handweck, & Hall, 1997). In particular, subtraction problems prove to be more
difficult (Benedetto-Nasho&Tannnock, 1999). There is no exact cause for this experienced difficulty in math for the Inattentive subtype of ADHD. One reason can be the delayed intervention for these students, which is 4.4 years from first detection (Rabiner, 1998). This is the case since the Inattentive subtype is the most behave compared to the other subtypes, and thus often overlooked in the early years and primary grades (Marshall, Hynd, Handweck, & Hall, 1997). This in turn has drastic effects in their acquisition of basic arithmetic skills. Another explanation for the math difficulty of the Inattentive subtype has to do with failure in automatization (or the ability to mentally perform basic math calculations); problems with working memory; and troubles automatically recalling math facts (Benedetto-Nasho&Tannnock, 1999).

ADHD and Computer Assisted Instruction (CAI)

Computer-assisted instruction is the use of computers with the purpose of improving students’ skills, knowledge or academic performance (Miller, 2002). CAI refers to drill-and-practice, tutorial, or simulation activities through the use of computers offered either by themselves or as supplement to traditional, teacher-directed instruction (Cotton, 2001). It is any program or application that teaches or simulates the learning environment that includes motivation, feedback, interactivity and challenge (Vogel, 2006). It is an electronic tool that may be use in the classroom to improve traditional methodology.

Although minimal research has been done on the effectiveness of technology for students with ADHD, technology is seen as one potential tool that offers promising results for these students. Technology enables the teacher to plan learning activities for students with short attention spans, allowing them to be actively involved in learning, and in turn even increase the student’s motivation and confidence (Fitzgerald as cited in Xu, Reid & Steckelberg, 2002). CAI can also provide an instructional environment that is highly stimulating, where students receive frequent and immediate performance feedback, instant reinforcement, and continuous opportunities to respond to academic stimuli. All of these attributes have been shown to improve the performance of children with ADHD (Barkley, 1998). CAI can make more individual attention and feedbacking possible which is beneficial for students with ADHD (Belson, 2003). Computerized math instruction in game format increased active engagement and academic performance, but decreased off-task behaviors for 3 students in 4th through 6th grade with ADHD (Clarfield & Stoner, 2005). Playing video games for more than one hour each day increase the inattention symptoms of children with ADHD (Schmidt & Vandewater, 2008). Video games offer immediate feedback, which is highly motivating for children with ADHD.

With regards to CAI interface, pupils with ADHD preferred to reading short texts, watching short videos (Garagouni-areou, Solomonidou, & Zafiropoulou, 2004). Video games increase activation and arousal, which may improve task performance (Schmidt & Vandewater, 2008). Fewer words should be used when explaining, visual aids should be used to illustrate and support verbal information, and rate of presentation should be slow (Lerner, Lerner, & Lowenthal, 1994). Low lights are suggested rather than bright lights for ADHD to concentrate on tasks (Brand et. al, 2002). Listening to short narration items is preferred more by students when they work on the computer (Garagouni-areou, Solomonidou, & Zafiropoulou, 2004). According to Bender and Bender (1996) step-by-step elaboration of tasks, models of task completion, concrete examples, and shorter assignments are some proven instructional modifications beneficial to students with ADHD that CAI can handle. Hasselbring and Botte (2000) pointed out specific conditions for CAI that can result to positive gains for children with ADHD such as the terminal skill as acquired before the practice begins, the activity emphasizing rapid responding, and inclusion of a management system that monitors student progress.

The ARCS Model of Motivational Design

One model for developing CAI is the ARCS Model by Keller & Keller. It is a model that provides educators not only a heuristic approach to generally increase the motivational appeal of instruction but also a model for stimulating and sustaining curiosity in particular (Arnone & Small, 1995). It is anchored on the expectancy-value motivation theory identifying “effort” as the major measurable motivational outcome. The necessary things for effort to occur are (1) the person must value the task and (2) the person must believe he/she can succeed in the task. This means that the learning task needs to be presented in a way that is engaging and meaningful to the student, and in a way
that promotes positive expectations for the successful achievement of the objectives (Small, 1997). The ARCS Model focuses on four (4) essential strategy components for motivating students, namely attention, relevance, confidence, and satisfaction.

Attention strategies refer to strategies for arousing and sustaining curiosity and interest. This includes Perceptual arousal, or providing novelty, surprise, and uncertainty; Inquiry arousal, or stimulating curiosity by posting problems to solve; and Variability, or incorporating a range of methods and media to meet student’s varying needs. Implications under attention strategies include careful selection of visuals – the use of cartoons, animation, and video clips to get attention (ChanLin, 1994).

Relevance strategies refer to strategies that link to learners’ needs, interests, and motives. This include Goal Orientation, or presenting the objectives and useful purpose of the instruction specific methods for successful achievement; Motive Matching, or matching objectives to student needs and motives; and Familiarity, or presenting content in ways that are understandable and that are related to the learners’ experience and values. Clear, specific goals are related to improved performance. When a learner sets clear goals, he can evaluate whether he has met them. When his performance does not attain his goal, the learner is motivated to close the gap between goal and performance, thus leading to increase in motivation, greater effort and improved performance (Schmidt &Vandewater, 2008).

Confidence strategies refer to strategies that help students develop a positive expectation for successful achievement. This includes Learning Requirements, or informing students about learning and performance requirements and assessment criteria; Success Opportunities, or providing challenging and meaningful opportunities for successful learning; and Personal Responsibility, or linking success to students’ personal effort and ability. Implications under the confidence strategies include making the directions straightforward and easy to follow, and providing sufficient opportunities to practice (ChanLin, 1994). Video games also offer players the opportunity to control elements of the experience. Giving learners control increases motivation and learning. Challenge is another feature of engaging video games. The game should have levels of increasing difficulty, so it can keep pace with players’ growing skill levels. The optimal game provides a set goal structure but leaves players uncertain about whether they can achieve it (Schmidt &Vandewater, 2008).

Satisfaction strategies refer to strategies that provide extrinsic and intrinsic reinforcement for effort. This includes Intrinsic Reinforcement, or encouraging and supporting intrinsic enjoyment of the learning experience; Extrinsic Rewards, or providing positive reinforcement and motivational feedback; and Equity, or maintaining consistent standards and consequences for success. Implications under the satisfaction strategies include frequent questioning and making sure the contents are interrelated (ChanLin, 1994). Games provide an inquiry-based learning experience, whereby learners approach new material through trial and error, in a safe space. Games offer learners the opportunity to try again and again, receiving feedback, all while experimenting with different strategies (Schmidt &Vandewater, 2008).

**ADDIE Model of Instructional Design**

This study was primarily based on the premise that CAI can help improve the behaviors of preschoolers with ADHD and consequently their numeracy achievement. It aimed to develop a CAI Module on enhancing numeracy skills of preschoolers with ADHD. To maximize the benefits of technology use, program development has to be considered. For this purpose, the ADDIE Model of Instructional Systems Design (ISD) by McArdle (1991) was utilized in the study. The ADDIE Model is a sequential process that includes Analysis, Design, Development, Implementation and Evaluation (See Figure 1).

The analysis stage was the process of defining what is to be learned. For the study, the content of the CAI focused on developing numeracy skills under The Learning Framework in Number (LFIN) by Martland, Stafford & Wright (2006). This was utilized since the Learning Framework in Number focuses on early numeracy topics that serve as basis for more advanced math topics.

The design stage was the process of specifying how learning will occur. This included determining design considerations for the CAI Module. For the study, the Motivating Interactivity in Multimedia
(MIM) Checklist by Keller & Keller was used to serve as guide for the design of the CAI Module. Interactivity can be categorized as Management Interactivity and Motivation Interactivity (Keller & Keller, 1994). The management interactivity of the MIM checklist handled the impulsive and hyperactive symptoms of preschoolers with ADHD. The motivation interactivity of the MIM checklist handled the inattentive symptom of preschoolers with ADHD. Management Interactivity refers to CAI features that apply to learner control over managing the instructional program (Bender & Bender, 1996). This includes Pacing, or the rate of introduction of new problems; Override, or the possible interruption options of flow of the program; and Selection, or the sequence of the program a student may make and when material is reviewed (Keller & Keller, 1994). Motivation Interactivity refers to CAI features that affect the degree of motivation in the instructional interactivity (Bender & Bender, 1996). This includes Stimulus Characteristics, or the program interface (audio and video). This refers to the materials presented and how they are presented; Learner Responses, or the output required by the program from the learner. This refers to the emotional responses as well as the mechanical responses such as solving problems and note taking; and Consequences, or the feedback and actions the program takes as a result of student responses (Keller & Keller, 1994).

The development stage was the process of authoring/producing the CAI Module. This also entailed the production of the teacher’s manual. For the study, the CAI Module was developed through a Macromedia corporation authoring program called Flash MX. Another software used in the study was Audacity.

The implementation stage was the process of installing the instruction in the real world or school environment. For the study, this included the initial implementation phase that entailed pilot testing of the CAI Module to preschoolers with ADHD. Pilot testing results were then incorporated in re-development to come up with the final form of the CAI Module. The production of the Final CAI Module Package was the end result of the implementation stage.

OBJECTIVES

This study sought to provide answers to the following questions, which have been grouped according to the following stages of the ADDIE Model:

1. Analysis
   1.1 What is the difficulty level of topics under the Learning Framework in Number?
   1.2 Based on the difficulty level, which topics under LFIN should be included in the CAI Module?

2. Design
   2.1 Based on the participant teachers, what design practices should be incorporated in the CAI Module in terms of:
      2.1.1 Management Interactivity (Pacing, Override, Selection)
      2.1.2 Motivation Interactivity (Stimulus Characteristics, Learner Responses, Consequences)
   2.2 What other design practices should be incorporated in the CAI Module?

3. Development
   3.1 How do the SPED experts find the appropriateness of the CAI Module design?
   3.2 Based on the results of evaluation by SPED experts, what revisions are needed for the CAI Module?

4. Implementation
   4.1 During pilot testing, what are the reactions that preschoolers with ADHD exhibit while using the CAI Module?
   4.2 Based on the results of pilot testing, what revisions are needed for the CAI Module?
   4.3 What is the Final CAI Module Package?
METHODOLOGY

The study was a developmental research whose primary goal was to develop a CAI Module on enhancing the numeracy skills of preschoolers with ADHD based on the ARCS Model of Motivational Design by Keller & Keller following the ADDIE Model of Instructional System Design by McArdle.

Purposive sampling was used in the study. Interviews and survey questionnaires were employed in the needs assessment to gather data for the development of the CAI Module in the study. The study made use of a survey questionnaire to gather data for the needs assessment of the study. The survey questionnaire was validated by three (3) SPED experts. It is composed of two sections.

The first section was to identify the content for the CAI Module. It was based on the Learning Framework in Number by Martland, Stafford, and Wright (2006). Numeracy topics were rated as Easy, Moderate, Hard, and/or No Response. Frequencies were then computed and used to analyze the difficulty level of the numeracy topics. Contents identified as “Hard” by majority of the respondents were determined as the coverage of the CAI Module. This identified as well the general approach to be used for the CAI Module.

The second section was to identify the design considerations for the CAI. It was based on Keller & Keller’s (1994) Motivating Interactivity in Multimedia (The MIM Checklist) derived from the ARCS Model of Motivational Design. This was further divided in terms of Management Interactivity (Pacing, Override, and Selection) and Motivation Interactivity (Stimulus Characteristics, Learner Responses, and Consequences). The criteria were rated as 5 - Strongly Agree, 4 - Agree, 3 - Neutral, 2 - Disagree, and 1 - Strongly Disagree based on appropriateness as a feature for the CAI Module for preschoolers with ADHD. The weighted average was then computed.

Afterwards, eleven (11) teachers from selected preschools participated in the study for the analysis stage. These teachers came from five (5) preschools in Metro Manila. The schools were selected based on the presence of preschoolers with ADHD in their student population and the existence of a computer program for their students. Interviews with the participant teachers
were also conducted to cross validate the needs assessment questionnaire.

For the initial evaluation stage, three (3) SPED experts were selected to evaluate the CAI Module in terms of its appropriateness in addressing the design considerations previously mentioned by the participant teachers. The study made use again of Keller & Keller’s (1994) Motivating Interactivity in Multimedia (The MIM Checklist). It is important to note that the MIM Checklist is intended to serve as a tool for both the development and evaluation of Instructional Software Design for children with exceptionalities. The weighted average was also computed to evaluate the responses. In addition to the MIM Checklist, interview with the SPED experts were also conducted to cross validate the evaluation.

For the pilot testing, three (3) preschoolers with ADHD were selected to use the CAI Module. Their age range is 5-6 years old. All of the preschoolers belonged to the Inattentive-Impulsive ADHD subtype. The preschoolers were tasked to try out the CAI Module for twenty (20) minutes. The reactions of preschoolers with ADHD in using the CAI Module were examined by the researcher using an observation tool. The observation tool was composed of specific desirable behaviors for preschoolers with ADHD. These were derived from the list of inattentive and hyperactive-impulsive behaviors of children with ADHD as mentioned by the National Institute of Mental Health. Indicators were established for each of the behaviors such as number of computer prompts to determine ease of navigation, following instructions, and focusing on tasks. These indicators were then tallied. For the duration of the pilot testing, the computer screens of the preschoolers were recorded using the software BB Flashback 2. This was used so as to keep track of the preschoolers’ navigation and actions throughout the pilot testing. Additional observations were also taken note of for the said behaviors. The reactions of the preschoolers served as important feedback for the redevelopment process.

RESULTS AND DISCUSSION

The main goal of the analysis stage was to determine the coverage of the CAI Module. Only the Early Arithmetical Strategies were rated as Easy by forty-five percent (45%) of the participant teachers. Topics on Base-Ten Arithmetical Strategies (70%), Numeral Identification (55%), Spatial Patterns and Subitizing (73%), and Temporal Sequences (50%) were rated as Moderate. What the participant teachers considered as Hard topics are the Forward Number Sequences (44%) and Backward Number Sequences (56%). According to the National Council of Teachers of Mathematics (2008), one major expectation in pre-kindergarten through grade 2 is for students to develop understanding of the relative position and magnitude of whole numbers and of ordinal and cardinal numbers and their connections. This is involves a working knowledge of number sequences. Number sequencing is one of the skills necessary for a child to develop stable order counting, or knowing the right order of the number in a consistent sequence (Wespi, n.d.). For the purpose of the study, the coverage was further divided into Number Sequences up to five (5) and Number Sequences up to ten (10). Based on the developmental standards set by NCTM (2008), children by age three should develop a strong sense of stable order counting from numbers one to five and later on develop stable order counting from numbers one to ten.

All participant teachers expressed the benefit of computers for numeracy instruction. Most of them saw computers for complementary instruction rather than direct instruction, mentioning that they use computer assisted instruction as “an option for students during free play” and primarily for “practice and reinforcement.” This implies that the type of CAI Module should not be for purposes of initial instruction but rather a tool for mastery practice. This is supported by Bender & Bender (1996) that CAI should be integrated with and complements other forms of instruction.

Practice and repetition are two essential components to develop numeracy as expressed by majority the participant teachers. Repetition of exercises leads to retention (Deubel, 2005) and increases the likelihood of transfer of learning (Schmidt & Vandewater, 2008). The main benefit that all the participant teachers saw from computer instruction is its “visual nature that brings about excitement.” According to Reiber & McLaughlin, (2004), use of colorful and visually appealing materials draw students’ attention to critical aspects of the tasks.

For the CAI Management Interactivity under pacing, the participant teachers agree that the CAI Module should enable students to have control over
when and how fast to move through the program (3.64) and when to move to new problems (3.91). They strongly agree that practice problems should be adequately provided (3.91). These results suggest that the appropriate CAI Module according to the participant teachers should be open-ended (non-linear), that is, there are options that the students can select regarding where to go next. As mentioned by Schmidt & Vandewater (2008), giving learners control increases motivation and learning. This also conforms to the principle that the greater control students have over their learning, the more encouraged they are in taking risks (Belson, 2003). Moreover, the CAI Module should not have a fixed set of practice problems but present varied problems every time the students select a task.

For the CAI Management Interactivity under override, the participant teachers agree that access to system help should be available at all times (4.00), as well as access to main menu (4.00). On whether the students may exit the program when they wish to, the participant teachers are neutral to this (2.82). They find it also neutral for students to be able to skip or exit instructional presentations and practice exercises when they wish (2.82). It was emphasized by the participant teachers that students must “finish first the activity before they can exit as part of their training.” These results suggest that the CAI Module should have a help or tutorial button accessible all throughout the software. Also, going back to the selection menu must be an available option for the students. But once they enter an activity, they should not be allowed to exit but rather must finish the activity first before they can go back to the selection menu. Skipping from one uncompleted activity to another is one of the inattentive behaviors of children with ADHD according to the National Institute of Mental Health (2005).

For the CAI Management Interactivity under selection, all design considerations under this were agreed upon by the participant teachers. They strongly agree that Navigating through the program should be easy (4.82), with the provision of a tutorial for navigation (4.45). A teacher respondent stated that the CAI Module should be “simple to promote independence from the student.” A pre-determined sequence (4.00) is agreed upon by the participant teachers with “little progression in the sequence.” Other instructional resources such glossary, encyclopedia, videos, etc. should also be available (3.91). The participant teachers agree with the need for students to be able to review presentations and practice as often as they wish (4.00), mentioning that even the “past lessons should be available for review.” They strongly agree that diagnostic checkpoints should be provided for major portions, with students performing satisfactorily as a criterion for moving ahead of the program (4.36). A participant teacher even mentioned that “only students getting a perfect score should be able to move on with the program.” These results suggest that the CAI Module should contain navigation instructions before the student do an activity. These directions should be straightforward and easy to follow (ChanLin, 1994). Although the CAI Module is open-ended, there must be a recommended flow of how to go about the software. The CAI Module should be divided into major portions and should enable the student to go back to portions he already mastered. Mastery of a portion pertains to students performing satisfactorily on the assessment found at the end of each portion. Rewards in the form of instructional resources should be provided upon completion of the portions. Intrinsic rewards through positive recognition in the form of praise are essential for ADHD instruction (Cooper & Ideus, 1996). Rewards such as novel instructional activities can also facilitate over learning and automatization (Zentall & Ferkis, 1993).

The participant teachers also brought up the need for the CAI Module to be “teacher- and parent-friendly” and make sure that “they can easily go through it and manage it better.” This suggest that an implementation manual be provided for teachers containing the software flow and navigation tutorial.

For the CAI Motivation Interactivity under stimulus characteristics, all design considerations under this was agreed upon by the participant teachers. They strongly agree that appealing and clear graphics should be used to communicate information to the students (4.73). It would be best to use “visually that are not so colorful such as in ‘Blue’s Clues’ “ as expressed by a teacher respondent so as not to “over-stimulate the students.” For the CAI animation, it would be best not to have “too much movement.” Similar consideration for the background sound should also be implemented by using soft music (4.73). The participant teachers expressed agreement for introductions or overviews before each presentation (4.09), containing clear and simple directions with verbal instruction (4.00) that uses language terminologies appropriate to learners (4.91). Participant teachers mentioned that “students should know the objectives of what they are doing.”

Regarding
the instructional presentations, they should be varied in length and speed (3.82), with students playing different roles (4.45) in realistic role-plays, games, and simulations (4.00). The participant teachers suggested “gender considerations” such as “different roles for boys and girls.” The presentation of examples and practice exercises should be posed as questions (3.91) and sequenced from easy to difficult (4.82). Finally, summaries of the instructional presentations must be provided at the end (4.18). Overall, stimulus characteristics considerations were strongly agreed upon by the participant teachers (4.33). These results suggest that the CAI Module should not be distracting in its presentation of both visual and audio content. Brand et al. (2002) suggests low lights as appropriate for ADHD to concentrate on tasks. A common background should be used all throughout the software, with consistent font type and size. This is so since being easily distracted by irrelevant sights and sounds is one of the inattentive behaviors of children with ADHD (NIMH, 2005). Real life contexts and scenarios (at home, school and community) should also be incorporated, with students being able to play and interact in these scenarios. Deubel (2005) mentioned the need for knowledge to be anchored in realistic contexts and settings. In other words, the type of CAI Module should not only be a tool for mastery practice, but also a tool for simulations and problem solving. Summaries in the form of transitions between these scenarios must also be present to make the flow consistent. Lerner, Lerner, & Lowenthal (1994) suggest that fewer words should be used when explaining and instead visual aids should be used to illustrate and support verbal information. A program flow was developed to ensure the considerations mentioned by the participant teachers for the area of CAI Management Interactivity were appropriately handled.

For the CAI Motivation Interactivity learner responses, the participant teachers agree to all the design considerations under this. Adequate time for the students’ response (4.45), with provision of prompts after a designated interval (4.36) was seen as very appropriate. Time-limit should be imposed as to avoid “students play on the computer for a long period of time,” as mentioned by a participant teacher. These requests for both varied physical responses (3.82) such as clicking, dragging, and typing-in and cognitive responses (4.45) such as selecting, identifying, and matching should be spread within the instructional presentations (4.36). A participant teacher mentioned making the CAI Module “manipulative-like” and suggests the possibility of “voice input” from the learner. Finally, the participant teachers strongly agree (4.36) that a number of chances to respond to practice exercises should be given to students, with provision of clues after wrong responses (4.00). These results suggest that the CAI Module should be an electronic manipulative, presenting varied activities and tasks to the students. These activities should be timed with user prompts after a while when the student is not responding. It is advisable to prompt students to repeat instructions after listening to them, and alert students by using key phrases such as “This is important!” (Lerner, Lerner, & Lowenthal, 1994). For practice exercises, students should be given a certain number of tries, giving hints after an incorrect try.

For the CAI Motivation Interactivity consequences, all the design considerations under this were agreed upon by the teacher respondents. The participant teachers strongly agree that a variety of feedback style should be required from the students (4.82) such as text and voice prompts, and be given as soon as possible after practice (4.45). For wrong student responses, corrective feedback should focus on tasks and content, not on personal traits of learners (4.09). For correct responses, confirming feedback should be used to reinforce them (4.00), using statements giving recognition and credit to learners (4.09). In drill and practice activities, they find it very appropriate for students to have knowledge of results (4.45) plus knowledge of the correct answers (3.73). These results suggest that the CAI Module should be interactive both in the feedback it requires from the student and the feedback it gives. Feedback should be positive reinforcements and not be derogatory of the students. Solutions should also be given when mistakes are made. According to Deubel (2005) feedback should provide occasional motivational messages, as well as information about the correctness and/or appropriateness of a response. Finally, a summary page should also be shown at the end of each activity showing the student’s score.

The main goal of initial evaluation was to determine whether the design considerations mentioned by the participant teachers were appropriately handled. Overall, the SPED experts agree that pacing considerations (4.00) were appropriately; override (4.42) and selection considerations (4.33) were very appropriately handled by the CAI Module for the
Management Interactivity. Additional suggestions for pacing include having “pauses” after each problem, with students deciding first before the next problem is presented. For override, it was suggested to remove the “skip intro” button in the presentation of instructions so that students have to view the complete instructions before proceeding to a task. For selection, the inclusion of navigation tutorial in the manual for teachers focusing on the purpose of the navigation buttons. Since the teacher will serve as the facilitator of the CAI Module if ever it will be used in the field, they should be very familiar with the how to go about the CAI Module. It was also suggested to state in the manual that basic mouse skills is a prerequisite skill that preschoolers should have before using the CAI Module.

Overall, the SPED experts agree that stimulus characteristics (4.18) and learner responses (4.19) considerations were appropriately; and consequences considerations (4.33) were very appropriately handled by the CAI Module for the Motivation Interactivity. Additional suggestions for stimulus characteristics include the modifications of drawings in the characters to make it more attractive for the student. The characters were seen as lacking facial expressions at times. It was recommended to avoid using sad facial expressions when the child commits an error, and use smiling faces in conversations between characters. The need to modify color schemes was also mentioned in some parts of the CAI Module, such as the skin tone of the main character and the teacher which was seen as “too dark.” Graphics were also recommended to be more realistic such as adding doors in the house and school, and making the road marks narrower in the going to the school activity. Important aspects of the task should also be emphasized by making the font size larger and font color different, such as the list of tasks in the room activity. Language terminologies were also suggested to be modified such as “mother and father” instead of “mom and dad,” and improvement of some grammar such as “How many pieces of bread are missing?” instead of “How many bread are missing?” to improve the questions. Finally, some of the objects were recommended to be removed such as the chairs in the teacher activity so as to remove additional distractions for the children. For learner responses, it was suggested to add in the prompts the physical and cognitive response type required from the user, such as “type-in your answer” and “choose what to do” prompts. For consequences, the removal of the total number of items in the knowledge of results was suggested. Use of exclamation marks in confirming feedbacks to recognize the student, such as “Good job!” was also encouraged.

The main goal of the implementation stage was the finalization of the CAI Module for dissemination by pilot testing the module to three children.

Child A is a 6 year old boy in the Kinder level with ADHD inattentive subtype. He was able to use the CAI Module for 22:22. For navigation-related tasks, Child A was prompted 1 out of 49 instances by the computer and 5 out of 38 instances for problem-related tasks (Table 1). Moreover, only 1 computer prompt was shown for all 19 instances of instruction-related-tasks. The navigation-related prompt happened at the main title screen where Child A did not know where to start (took him 27 seconds). He was verifying with the researcher whether to click “here?” Three of the problem-related prompts happened in the test activity where the child was prompted once for question 1 (took him 33 seconds) and twice for question 2 (42 seconds). It is important to note that for the succeeding 8 problem-related tasks, Child A was no longer prompted indicating familiarization with the navigation buttons. This was also the case for the other problem-related prompt that was given in question 1 of the teacher activity (took him 37 seconds) since Child A was observed as clicking on the numbers instead of the swap button. For the succeeding four questions, Child A was not given any more prompt. The last problem-related prompts happened in the classmate activity (took him 22 seconds) where Child A was observed to begin getting restless and kept expressing desire to try another program he’s playing at home. Finally, the instruction-related prompt happened in the room activity where it took Child A 18 seconds to proceed. It is important to note that this was the first instruction-related task that Child A encountered in the program.
Table 1. Observed behaviors for Child A

<table>
<thead>
<tr>
<th>The child is seen…</th>
<th>Indicators</th>
<th>Frequency (Total Instances)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiating tasks in the program.</td>
<td>Number of tasks done</td>
<td>6 (8)</td>
</tr>
<tr>
<td>Navigating with ease through the program sequence.</td>
<td>Number of computer Prompts in navigation-related tasks</td>
<td>1 (49)</td>
</tr>
<tr>
<td>Following the instructions of the program with ease.</td>
<td>Number of computer Prompts in instruction-related tasks</td>
<td>1 (19)</td>
</tr>
<tr>
<td>Focusing on tasks in the program.</td>
<td>Number of computer Prompts in problem-related tasks</td>
<td>5 (38)</td>
</tr>
<tr>
<td>• Remembering things needed for a task.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pays attention to details of the task.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Child A was able to accomplish 6 out of 8 tasks. He even committed no mistake for the diagnostic checkpoint or the going to school activity. Although Child A initially found difficulty with the swap button in the teacher activity which resulted to a prompt, he was still able to get a perfect score. These indicate that he’s analyzing the tasks and not simply completing them. Moreover, the time it took for him to answer the succeeding items is on the average 13 seconds, indicating that he got used to the swap button. One task he had difficulty was the test activity where he scored 1 out of 10. It is important to note that in this activity Child A was also prompted 3 times and was observed to be puzzled with the task and/or simply clicking the choices. The 2 tasks he was not able to accomplish were due to a navigation error and to the end of time. The navigation error happened in the classmate activity when the child started to display restless behavior. He constantly mentioned the desire to change task during that time. These suggest that overall, Child A found navigating through the program, instruction and problems of the CAI Module with ease.

Table 2. Observed behaviors for Child B

<table>
<thead>
<tr>
<th>The child is seen…</th>
<th>Indicators</th>
<th>Frequency (Total Instances)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiating tasks in the program.</td>
<td>Number of tasks done</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Navigating with ease through the program sequence.</td>
<td>Number of computer Prompts in navigation-related tasks</td>
<td>2 (35)</td>
</tr>
<tr>
<td>Following the instructions of the program with ease.</td>
<td>Number of computer Prompts in instruction-related tasks</td>
<td>5 (12)</td>
</tr>
<tr>
<td>Focusing on tasks in the program.</td>
<td>Number of computer Prompts in problem-related tasks</td>
<td>18 (18)</td>
</tr>
<tr>
<td>• Remembering things needed for a task.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pays attention to details of the task.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Child B was able to finish 3 out of 4 tasks she initiated. The task she was not able to finish was the 4th and final task, or the going to school activity, where she tried twice. Moreover, in the two times Child B tried the activity, it took her 20 seconds and 27 seconds to
proceed to the task proper resulting to two instruction-related prompts. In this activity, Child B was observed as simply clicking and kept saying “where’s the school?” It is important to note that this is one of the diagnostic checkpoints and require perfect completion to be able to move on to the next portion of the CAI Module. The other three instruction-related prompts happened in the room activity where Child B was seen as clicking in the text rather than the proceed button. In this activity, she was also observed as saying “(should I press) here?” For navigation-related tasks, she was only prompted twice out of 35 instances. These were exhibited at the start of the CAI Module in the main screen and in responding to the wake up question. It is important to note that these are the first two navigation-related tasks in the CAI Module. These suggest that overall, Child B found navigating through the program and instructions of the CAI Module with ease while problem-related tasks as needing familiarization.

Child C is a 5 year old boy in the Kinder level with ADHD inattentive subtype. He was able to use the CAI Module for 19:47. In the problem-related tasks, he was prompted 7 out of 30 instances (Table 3). All seven prompts occurred in the mother activity where Child C was observed as waiting for the animation to finish before answering. For question 1 he was prompted twice (took him 40 seconds), once for questions 2 (31 seconds) and 3 (31 seconds), twice again for question 4 (46 seconds) and once for question 5 (28 seconds). For the navigation-related tasks, Child C was prompted 5 out of 37 instances. Two prompts was given in the mother activity where it took Child C 47 seconds to respond whether to help mother or not. When she decided to help in the mother activity, Child B was prompted twice in the later part of the activity by taking 20 seconds and 17 seconds to proceed. The last prompt was given at the room activity where Child C forgot what to with the task and decided to go back to the list that took him 17 seconds. The two prompts in instruction-related tasks are due to confusion with the skip intro button that happened in the going to school activity (took him 23 seconds) and in the mother activity (33 seconds).

Table 3. Observed behaviors for Child C

<table>
<thead>
<tr>
<th>The child is seen…</th>
<th>Indicators</th>
<th>Frequency (Total Instances)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiating tasks in the program.</td>
<td>Number of tasks done</td>
<td>5 (6)</td>
</tr>
<tr>
<td>Navigating with ease through the program sequence.</td>
<td>Number of computer Prompts in navigation-related tasks</td>
<td>5 (37)</td>
</tr>
<tr>
<td>Following the instructions of the program with ease.</td>
<td>Number of computer Prompts in instruction-related tasks</td>
<td>2 (14)</td>
</tr>
<tr>
<td>Focusing on tasks in the program.</td>
<td>Number of computer Prompts in problem-related tasks</td>
<td>7 (30)</td>
</tr>
<tr>
<td>• Remembering things needed for a task.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pays attention to details of the task.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Child C was able to finish 5 out of 6 tasks. The one instance where he did not finish a task was when he responded not to help with the mother activity. He was observed as not knowing what to do in the request prompt to whether or not help mother. It is important to note that Child C chose the mother activity again from the home menu selection and decided to help in the mother activity. At the end of the room activity, Child C was observed as undecided with the navigation buttons to proceed or repeat. He finally decided to repeat the room activity and on the second try did not encounter any navigation problem based on observation. In one of his other task, the going to school checkpoint, Child C was able to perfect the task on the first try. Another vital observation was Child C’s performance in the final test activity where he scored 6 out of 10. All six of his correct items are from questions that ask for either the immediate next or immediate previous missing number. Additionally, three of her mistakes are on items that do not ask for the immediate missing number. This shows that Child C is not yet capable of extending the concept of number sequencing. These suggest that overall, Child C found navigating through the program, instructions, and problem-related tasks of the CAI Module with ease.

Based on the results of the needs assessment, the revisions anchored on the results of evaluation by SPED experts, and further revisions anchored on the
results of the pilot testing, the final form of the CAI Module was achieved. The Final CAI Module package contained the following:

1. The CAI Module containing
   a. Number sequencing for preschoolers with ADHD
   b. Number sequencing for preschool teachers
2. The teacher’s manual containing
   a. Background description of the CAI Module
   b. Navigation instructions
   c. Implementation guidelines

The CAI Module developed was designed for preschoolers with ADHD preferable the Inattentive subtype. Prerequisite skills necessary included basic computer skills for navigating through the CAI Module and knowledge of stable-order counting. The minimum computer specifications suggested to run the CAI Module were Windows XP or Vista operating system, 2.00 GHz processor or higher, 2.00 GB RAM or higher, 500 MB free space or bigger, and Flash player 6.0 or higher.

The CAI Module was composed of two sections. The first section was focused on number sequencing from 1-5 while the second section was focused on number sequencing from 1-10. Under each section, six activities are found – four of which are part of the initial choices while the other two are bonus activities. Each activity starts by presenting a scenario and then giving options to either accept or decline the activity. Accepting would lead to the demonstration of instructions for that activity while declining will lead to returning to the activity selection screen. Bonus activities are unlocked upon perfect completion of activity two and three under each section. The fourth activity serves as the checkpoint for each section. Only perfect completion in these activities would allow the user to proceed to the section of the CAI Module.

Familiarization with the navigation and tasks involved in the CAI Module by teachers were crucial to properly facilitate the CAI Module. This included trying out both CAI Modules for Students and Teachers. Planning the integration of the CAI Module in the curriculum was also suggested to be undertaken before implementation to preschoolers.

Suggested implementation guidelines for the CAI Module are as follows:
1. Allow each student to work with the Module for 20 minutes per session.
2. Ask each student to select and perform the task in the CAI Module.
3. Observe and record the physical and verbal reactions of each student.
4. Facilitate the CAI Module by helping with navigation problems and directing the students on the tasks.
5. Tally the computer prompts and scores for activities.

CONCLUSIONS

It can be concluded from the study that the promising benefits of technology are aligned with the inattention, impulsivity, and hyperactivity symptoms of students with ADHD. This relation is further enhanced when one follow the ADDIE Model of Instructional Systems Design, and integrates principles under the ARCS Model of Motivational Design and considerations expressed by teachers of those students in developing the CAI Module.

Since software development is a continuous process, further improvements can still be incorporated to the proposed CAI Module. It is recommended that evaluation of the effectiveness of the CAI Module to a bigger sample and long term study of the effects of the use of the CAI Module can determine possible improvements for the CAI Module. An experimental study can be done to establish that using the CAI Module has a significant effect on reducing students’ ADHD symptoms in learning compared to students without the CAI Module intervention.

Future researchers can develop CAI modules for ADHD for other topics in numeracy as well as CAI modules for other subjects as well as for other related exceptionalities following the Motivating Interactivity in Multimedia (MIM) Checklist and the ARCS Model of Motivational Design.

REFERENCES


