

inclusive

Abstract This article presents **issues raised in designing an interactive multimedia software interface as a teaching aid for an inclusive preschool user group.** Issues such as: message variance caused by the disappearance of information when media access varies by user; finding commonalities across a broad user base out of which to build viable interface metaphors; among others, are presented within the description of the project team's approach to human computer interaction design. The software project is a cooperative project between East Carolina University School of Art's Environmental Design Program and School of Education's Remedial Education Activity Program, an inclusion preschool open to children with all levels of motor, sensory and cognitive ability, including typical children.

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Inclusive Interaction: Ability Enhancing Multimedia Design

This article presents a multimedia software interface currently in development between East Carolina University (ECU) School of Art's Environmental Design Program and the School of Education's Remedial Education Activity Program (REAP), an inclusion preschool open to children with all levels of motor, sensory and cognitive ability, including typical children. The interface project is presented as one example of designing interactive multimedia (IMM) software for children with special and typical needs, which raises issues such as: message variance caused by the disappearance of information when media access varies by user; finding commonalities across a broad user base out of which to build viable interface metaphors; and others presented in this article.

Kim Braddy, REAP Lead Teacher, articulated a need for software with which non-reading children could begin to learn the associations of words with actions. Vocabulary building interfaces existed to teach nouns and objects, and many more have been produced with young readers as the intended user group, but in her opinion there remained a gap regarding a clear and successful digital presentation of action-word concepts. Upon further investigation we both agreed that among action-word concept teaching software, a much larger void remained (in part due to issues explored later in this article), for digital interactive multimedia products whose intended user group was preschoolers including chil-

1 A survey of multimedia software products in this or any domain could never be thorough given that new multimedia products are constantly being created whose scale of geographic distribution and availability vary greatly. For the injustice done to artists, designers, developers and thinkers working in this area, of whose work I was unaware, I respectfully apologize.

dren with special needs.¹

We defined the generation of such an IMM teaching aid as our project goal adapting the abilities and needs of current and future REAP students and instructors as representative of our user group. Our project team would include: Kim to inform issues regarding teaching action-word concepts to preschoolers in

this inclusive user group; REAP Director Dr. James Taylor for Special Education expertise, product review, enthusiasm and encouragement; interested ECU Environmental Design students as multimedia artists and interaction designers; myself as interaction designer.

Our user group would not include all preschool age children. Digital multimedia software interfaces have certain prerequisite skills for navigation, even if motor skills capable of manipulating input devices could be assumed, which in our case they would not, there are other sensory and cognitive skills which could not be assumed representative of all chil-

education



dren, specifically among children with profound or perceptual disabilities. **We identified our user group as children with cognitive development levels representative of typical children from about two to four years old. Some characteristics of the early part of this stage include: a rapidly increasing receptive vocabulary, an understanding of two-word semantic relations and an understanding of action-word concepts.** Toward the latter part of this stage students exhibit skills such as: the basics of sentence grammar, syntax and moving from a semantic base to sentence grammar (Prizant and Bailey, 1992).

Children just entering this stage of development would not be expected to possess all of these skills and may be continuing to hone skills from what Piaget referred to as the sensorimotor stage of intellectual development. He defined the sensorimotor stage as progression through six successive stages of intelligence concepts pertaining to object permanence, means-end relationships, causality and spatial concepts. The tasks being attempted by children in their growth during this stage are (Robinson and Robinson, 1978):

- 1 visual fixation
- 2 visual tracking
- 3 sound localization
- 4 object grasp maintenance
- 5 visually directed reach and grasp
- 6 prerequisite object permanence skills
- 7 simple object permanence problems
- 8 complex object permanence problems
- 9 systematic repetition
- 10 development of attached tool use
- 11 use of separated object as a tool
- 12 development of operational causality
- 13 localization of objects in space
- 14 examining and relating to objects
- 15 container play

A user of instructive software interface products must possess several of these skills in order to provide for a rich, or even a functional, learning experience. Handling simple input devices such as: mouse, keyboard style devices and touch pads, require somewhat developed motor skills while manipulation of a device in order to direct predetermined input requires comprehension and competence with many of these tasks. Students not having attained skills in all of these areas could be assisted in navigation of the interface while it aids in their development of some of these sensorimotor skills.

Utilizing language building software to develop sensorimotor skills would not be supported by some researchers or theorists. One objection to utilizing our software in this manner might be found in Bricker and Dennison (1978): "... the development of a symbolic system, in general, and the comprehension and production of a formal language system, specifically, are predicated on the acquisition of an entire array of prerequisite behaviors which develop during the sensorimotor period." Given the reliability of this statement we would expect that children or instructors employing our software as a sensorimotor skills development tool would find success possibly with some delay. Instructors employing the software for exercises with children not possessing accomplishments in all tasks associated with the sensorimotor stage may achieve results only with difficulty. According to this theory the interface would be expected to be most effective when employed in the teaching of action-word concepts to children with developed sensorimotor skills.

Charles Brainerd (1978), however, objects strongly to the notion of structured stages as whole entities or what I

might call quantum stages. In Brainerd's view the notion that a child must complete all skills in one stage prior to advancement to the next stage is faulty. He believes that a child at any given instant exhibits behavior characteristics which represent combinations of Piaget's stages. Feldman states that empirical

interface



evidence found in their tests in map-drawing problems supports this theory. For example, when given an exercise in drawing a map representative of a model landscape, children frequently exhibited skills from multiple stages.

Corresponding to the display of skills from several stages, the presence of novel skills and reversion was noted. A *novelty* refers to a leap ahead or demonstration of an advanced skill not typically associated with the stage at which a person is otherwise performing. A *reversion* refers to backward movement between the stages. Feldman (1994) explains: "Suppose, for example, that our novel element is *perspective of buildings*. What happens to the other elements that deal with say, perspective of trees, or of roads? What seems to occur is that the novelty has a strong pulling effect on other elements dealing with the same map-drawing problem or feature (in this case the feature cluster of *buildings*)."

Feldman's idea of gradual transition of forward moving developmental organization versus quantum advancement through complete stages seems to support a larger user group for a teaching aid including one that is IMM software based. Students at individualized skill levels of several stages have the potential for benefit from the teaching device, exhibiting greater ease with familiar learned concepts and being challenged by new concepts. The individualized nature of the student's skill levels could provide further benefit through interaction of paired students representing different skill levels.

"Positive planning also includes pairing children whose dissimilar needs might serve as motivation or reinforcement for the others in the group. If, for instance, one child has a physical limitation and cannot hold or manipulate curriculum materials, a child who has those skills should be considered for inclusion in the group. **This pairing is likely to build constructive interpersonal relations, establishing empathy in the**

physically capable child, while helping the child with the limitations to accept help when it is needed. Conversely, the child receiving help must have an opportunity to give help in other contexts." (McKnight-Taylor, 1989)

An IMM software based teaching aid offers a unique opportunity for shared learning benefit through pairing. Students could take turns navigating or assisting each other with navigation and problem solving, providing an opportunity for the development of sharing skills. Navigation and task presentation could also be instructor prompted for the benefit of small groups if the monitor hardware, designed scale of graphics and the clarity and intensity of audio could support greater (than single-user to monitor) viewing distances.

As degrees of objectives attainment in teaching are often measured through testing and observation, the success of the design of any teaching aid must be similarly established. The teaching software, by definition, must be complete prior to use by any student, and as such cannot be informed by this testing. However, desired objectives must be set to aid in the generation of a coherent teaching tool and to aid instructors in the evaluation of its appropriateness in any student's instructional development plan. A unique feature of IMM teaching tools is the ease and speed with which they can be updated and revised following testing. It is imperative that multimedia designers allot time and resources to act on collected testing results by altering, improving and updating software as a final development stage. Only careful planning can make the testing and the software, worthwhile and effective.

The objectives of our IMM action-word concept teaching software are modeled after the four major objectives of a language training program developed by Bricker and Dennison:

- 1 On-task behavior
- 2 Imitation
- 3 Discriminative use of objects
- 4 Word recognition

A software environment provides an opportunity to control some environmental teaching conditions and consistency in repetitive tasks. On task behavior refers to a person's ability to develop focused attention relative to selected tasks. As the amount of time needed to accomplish a task is highly individual and expected to change with each student, we deter-

mined that task **specific time allotments would not be employed in the interface. In this way a child could utilize the time necessary for them to resolve the task.** It would be left to an attending instructor to observe excesses of time in task solving and administer further explanation as needed. Our interface would, however, employ a maximum timeout after which further digital prompting and explanation would be provided. During the delivery of this additional information, the task presented would be sustained in as original a manner as possible — the helping message would be an addition to, and not a replacement for, the assigned task.

Imitation refers to the child's ability to receive and reproduce the vocalizations and gestures of a model. A digital model offers the benefit of presenting a given example identically, each time it is summoned, or to offer the vocalizations and gestures in a variety of contexts for the purpose of building generalization skills. Digital models must be built sensitively to minimize the already present abstraction of anthropomorphizing screen images and computerized speech or object usage.

IMM software designers employ, among other techniques, two-dimensional images of objects as metaphors in task construction and presentation. This often requires the users of their products to utilize these metaphoric representations in a theatrically similar manner to utilizing the real objects. The profound exception is that the user may be employing comparatively different motor skills to manipulate an onscreen digital representation of an object as would be needed to manipulate the actual object. In such exercises the user must reference recollected experiences with real objects in order to make the onscreen representations meaningful. The discriminative use of objects objective, which is defined by: the child's ability to carry out specific activities with objects generally associated with the characteristics of the object (e.g., sitting on a chair), carries the most severe risk of confusion of all four objectives, due to possessing the greatest degree of abstraction.

Word recognition is defined by Bricker and Dennison (1978) as: an ability to associate meaningful auditory signals with appropriate events. While word recognition is the final objective, in the case of our IMM software, the associa-

tions of successful users need not be exclusively auditory and in the cases of some of our users, may alternately be sign-based signals. Our user group includes children who represent a

multimedia



variety of levels of speech production capability and communication modalities from verbal word generation to graphic symbol selection or identification.

We include a fifth objective as articulated by the REAP instructors motivated by observations in the classroom — the children could benefit from greater skill development in the area of choice-making. Further discussion however, created concern that while a multimedia interface could certainly be designed to build choice-making skills, this facet of the interface should be transparent to a child with developed abilities in this area. We decided that choice-making skill development be included in the software but be designed in such a way as to vary by user.

These general objectives needed to be presented in a manner which would engage and challenge the users without overwhelming them. Haskell and Barrett offer some general guidelines for teaching children with learning difficulties adapted from a combination of Piaget's developmental stages theory and Skinner's learning theory which has been tested with typical children. Only those directly applicable to IMM design for inclusive preschool groups are presented here, which

include: assessment; employment of incremental steps in task building; beginning with lower level skill tasks to ensure success; providing positive reinforcement; overlapping various sensory modalities in task presentation.² The employment of any instructional aid in the education of any individual student, must always and only be ascertained through careful and thorough assessment and program planning, on the student's behalf, by a careful and trained instructor. The assessment of each student's cognitive, physical, emotional and perhaps social strengths and weaknesses is essential to the development of a programmatic instruction plan upon which the decision to

2 The remaining guidelines more specifically inform techniques not achievable at this time by a software interface such as student performance observation, preliminary explanation to alleviate expected difficulties a specific student may encounter with a learning technique as supported by the observation of unsuccessful results using similar techniques, etc. Readers interested in these issues are referred to the original text from Haskell and Barrett, *The Education of Children with Physical and Neurological Disabilities*, 70. See also Hermelin and O'Connor, 1970.

employ a specific instructional aid should be based.

Providing encouragement and proper pacing through the interface should be careful considerations in the design of instructional software. Beginning with simpler tasks, with which members of the intended user group should be able to achieve success, can provide an encouraging springboard into more challenging task assignments. From these introductory tasks, intended to review and reinforce achievement more than teach new skills, the problems and tasks presented should advance incrementally in difficulty and complexity. The occasional inclusion of an earlier accomplished task concept presented in a new context, can be valuable to build generalization skills. Dunst discusses the benefit of presenting skills in a structured manner that is both horizontal and vertical, building generalization capacity and depth. Presenting skills horizontally refers to teaching a given behavior in a variety of situations, vertical refers to presenting a series of incrementally advancing skills (Dunst and Bartholomew, 1990).

In addition to presenting a task in a variety of contexts, tasks or modeled examples may be presented using a variety of overlapping sensory modalities. An expanded opportunity for clarity exists in the teaching of a new concept with IMM when the modeling of each concept stimulates multiple sensory modes: audio, static graphic illustrations or photographs, with diagrammatic or illustrative animation and captured video. While seemingly fundamental there are different consequences to presenting messages in multiple, overlapping, simultaneous media versus presenting messages, via distinct and exclusive media, simultaneously.

The question concerns which collection of events are occurring at a specific time, multiple messages each in an individual media or an individual message in many media. The latter method provides more opportunities for the user to both receive and understand the message, but with the risk of boring a user who comprehended the message at the outset. The former method provides a viewer, user or preferably interactor, an experience which builds in depth and complexity in what can be a symphonic manner. This is, however, provided that the interactor has sensory abilities with all of the media which are being employed by the IMM author. If not, then messages pass unreceived and the user is left either to guess at the gaps or confused. In this case, a sensory challenged user

becomes disabled because their access to the information is reduced or eliminated. As Mitchell (1977) explains: "**Handicap is the unsuccessful interaction between users and their environments.**"

Clearly the designers' goals for their product, in either case, do not include boring or disabling users, but these can be the consequences of early design decisions. A third solution is to design using the latter method but with transparency, that is allowing the user to disengage modalities which they find unnecessary. For example, an interface which communicates the same information via graphics, text and audio, presents the interface as an audio interface to users with low vision. Sighted users could be given the option of disengaging text or audio which they may utilize depending upon the difficulty of the material.

For our action-word teaching IMM interface, we choose a combination of the second and third methods — presenting each individual message in many media and occasionally employing disengagement options when appropriate

metaphoric



for a given task. The team felt that while full disengagement options were appropriate for older children and adults, given our age group, repetition would be useful and, if designed in an engaging and fun manner, the risks of boredom could be reduced.

"When we address the needs of preschool children, the use of chronological-age appropriate materials and of activities that do not infantilize or stigmatize the individual is not as critical an issue as it is when we address older individuals with severe disabilities." (Bailey and Wolery, 1992)

Bailey and Wolery identify that interventions should be designed to build upon childrens' current interests and activities. For this reason we choose to design around a first batch of action-word concepts in order to aid in the design of an interface metaphor appropriate for our user group. Later we could expand the metaphor to include other action-word concepts. The first batch would be *running, swinging, jumping, throwing, sitting, eating, drinking*. As we began to sketch we decided that they could be appropriately presented in a consistent manner within a digital playground environment. This

graphic and audio digital playground would include spaces for each activity with children already engaged in an action in each space. In this manner, the activity or the action would be an icon for itself as opposed to an abstracted generalized icon, for example shoes to represent running. In our interface running children would represent running both audibly and graphically.

Decidedly the greatest abstraction with which our users must grapple is that our playground is being represented on a computer, utilizing graphics and sound for presentation and navigation. For this reason we feel that the software should contribute to a learning plan designed to teach action-word concepts and not be employed as an exclusive measure in this area. The addition of metaphoric icons for this age level would add another level of abstraction. Designing the graphic and audio representations of activities to be representations for themselves removes this extra layer, leaving the skill of translating the action or activity into a word as the only other abstraction with which the user must grapple.

The digital playground offers familiar terrain for a preschool user group. A child enters a real playground and sees activities occurring there. Surveying available options, a decision is made and the child proceeds to engage in, or join in the case of an already occurring group activity, the activity. Upon approaching the chosen activity, it becomes for them a point of focus. All other activities are less apparent.

Our digital playground, would be designed to function in much the same manner. In our mockup the child would survey the available activities which would be presented visibly and audibly. They would hear and see all of the activities taking place on the screen. Clicking on an activity area with a mouse or other input device would engage this activity and access tasks associated with vocalizing the word, making finger signs and engaging audio and video of other living creatures engaging in the activity. A user with low or no vision would hear the activities taking place as a sort of collection of ambient sounds and could survey each of the activities in a linear fashion with the numeric keypad or the arrow keys, engaging the chosen activity by pressing the spacebar.

If a long delay occurred because a child was unclear on what sort of next step they may have available to them or they became distracted, then a digital playground friend would appear to advance toward them and with: actions, direc-

tional gestures focusing on various activities and audio, invite them to investigate one of the available activities. The playground friend would also provide interface navigation-aiding prompts if there was no response.

Utilizing these techniques we hope to create an interface which utilizes the extended sensory environment of multimedia to offer the user overlapping, simultaneous, multisensory messages to aid in the teaching of action-word concepts and present them with the tone, action, voice and prompting, fun environment of a playground. At this time our IMM software yet remains far from complete but as it progresses we depend upon previous, current and future testing to influence its design in hope of generating a competent product to assist instructors of preschool children in the teaching of word associations. As we proceed in this direction we are reminded of the gravity of our real challenge: The learning of action-word concepts by the students.

symphonic



“...we cannot say that they have learned it until they demonstrate that they can quickly try another viable solution (fluency), or until they continue to do it after we have stopped teaching it (maintenance), or until they have demonstrated the ability to discard unsuccessful solutions and select alternatives for many different types of problems and in different contexts (generalization).” (Bailey and Wolery, 525)

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