DOCUMENT RESUME

ED 298 032 SO 019 227

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TITLE A Special Needs Music Community: Color and the Computer.
SPONS AGENCY Ontario Dept. of Education, Toronto.
PUB DATE 8 Apr 88
NOTE 16p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 5-9, 1988).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Software; *Computer Uses in Education; Elementary Education; Elementary School Students; *Exceptional Child Research; Foreign Countries; *Music; Musical Composition; *Severe Disabilities
IDENTIFIERS *IPAINT; *Ontario; Student Cooperation

ABSTRACT

The daily use of music in a Kingston, Ontario, Canada, special needs classroom motivates severely neurologically and mentally handicapped students and encourages their communication skills. In a special project, handicapped students use tape recorders with special switches to indicate to nonhandicapped elementary students what music appeals to them. With IPAINT, a computer program, the nonhandicapped students then create a visual pattern of colors to illustrate the music composed by the handicapped students. IPAINT notations increase student ability to understand music and deviate from standard musical notations in the following ways: (1) the music's texture is depicted by color; (2) the visual forms correlated with sound allow the music to be more easily "heard"; (3) interpretation of the notations can vary to create new compositions; and (4) IPAINT musical notations are accessible to all students. In the future, special touch sensitive switches will be attached to the computer and adapted music software provided so that handicapped students can create their own compositions. (LJC)

A Special Needs Music Community: Color and the Computer

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This research was funded under contract by the Ministry of Education of Ontario. It reflects the views of the author and not necessarily those of the Ministry.

Presented at the 1988 Annual Meeting of the American Educational Research Association, New Orleans, April 4 - 8, 1988.

A Special Needs Music Community: Color and the Computer

It has long been argued that creating one's own music is the most effective means for children and teachers to learn about music in a way that gives them personal ownership over the music they perform and produce (c.f., Slind, 1971; Schafer, 1973; Upitis, 1986, 1987). The present research was undertaken with this premise in mind, but in an unusual classroom and school setting.

The research reported here was carried out in an urban elementary school in Kingston, Ontario. It began in the fall of the 1986 school year. The school was equipped with 35 computers for the 206 students in the school. The special needs classroom had a population of five students, ranging in age from 12 to 20 years. (In the second year of the study, 1987-1988, two of the five original students remained in the school. Three new students enrolled at the school, and one student from another school became involved.) All of the special needs students were severely neurologically and mentally handicapped. Most of the students were unable to propel themselves, with the exception of one child who could operate a wheelchair manually. All of the children communicated solely through gesture, eye contact, or by operating touch sensitive switches. Two children, through gesture or eye movement, could make choices of activities, such as sitting in a rocking chair or listening to music, by indicating the appropriate picture for the activity. The children's vocalization abilities were limited to chortles, grunts, laughter, and other similar sounds.

The school was selected by a team of researchers for a long term study (a minimum of three years, and a maximum of six) focussing on the mutual adaptation of technology and teaching and learning (see Hawes, Egnatoff, Higginson, Miller, Olson, & Upitis, 1987 for a more complete description of the project site). The research follows earlier work with microcomputers in Ontario elementary schools, where creative uses of microcomputers were explored and documented in a number of different schools. The schools described in the earlier studies made extensive use of the programming language Logo, word processors, and music composition programs (Carmichael, Higginson, Burnett, Moore, & Pollard, 1985; Upitis, 1986). Following the earlier studies, creative software including Logo, word processors, graphic programs, and music composition programs are now used at the school. These programs are all used on the ICON, an educational microcomputer developed by the Ontario Ministry of

Education. A great deal of educational software has been developed for the ICON, including the kinds of programs named above, as well as simulations, tutorials, games, and drill and practice programs. One of the programs, IPAINT, is of particular importance to the research reported here. IPAINT is a graphics program which can be used to create highly complex and colorful still and animated images. Its potential uses in elementary school settings are wide and varied. IPAINT has been used by children to learn about mathematics, to illustrate their stories, to create animated sequences, and, as described below, as an integral part of computer-based music making.

The music research in the special needs setting is one of a number of research/teaching projects in the school. It builds on the earlier computer and music research in two ways. Similar creative computer uses to those used by non-handicapped children in music have been developed, but both the input method and the type of software used were modified for the special needs setting. This made it possible to examine the contention that the kinds of music experiences most conducive to making music one's own, namely the creative acts of improvisation, composition, and performance, would be of the same fundamental nature for all people, regardless of age, training, or ability. Second, the current research examines the role of the classroom teacher and other students in the school in building a creative music community.

One way of characterizing the special needs music setting is to call it a "music playground." In a music playground, children and adults use a variety of tools to generate personally meaningful music expressions. Students and teachers together learn about music through playful explorations on traditional instruments like the piano and bells, by building instruments using readily available materials, and by using the computer as a means of further creating and modifying musical structures. This type of learning environment provides a highly motivating setting for communication on a deep level, beyond the music expressions themselves. In the music playground, much like the playground in the park, teachers, researchers, and students become active members of a music community, a community which grows despite the all too real boundaries created by classroom walls, by expected roles of teachers, researchers, children, and by expected abilities of handicapped and non-handicapped people, and experienced and inexperienced musicians.

In keeping with the playground atmosphere, my research assistant and I spent many hours in the classroom simply to be with the children, and not for the purposes of conducting research as such. The development of new interface devices also evolved as the researchers, teacher, and children

came to know one another. Thus, the changes were mutually adaptive rather than imposed by a research team. Similarly, the data that were collected reflected this cooperative approach. Data consisted of field notes (four hours a week), videotapes, and interviews with the Grade 2/3 students, the special needs teacher, and the physiotherapist. The various sources of data together serve to illustrate that by using the ocmputer and specially designed input devices, even severely handicapped students can engage in creative musical explorations.

The Special Needs Teacher and Classroom Environment

The special needs teacher believes that any real learning has to have intrinsic meaning for the student. This is reflected in her desire to help her special students find ways to communicate using whatever physical and intellectual resources are available to them. Thus, one student may use a rubbing gesture while another may use a tap to initiate, carry on, and end a communication. For some of the students, there is the possibility of early vocalization or the use of picture communication symbols.

As part of her belief in the importance of meaningful communication, the teacher leads activities involving other children in the school community with the special needs students. One reason for doing this is to provide a context for young non-handicapped children to develop positive attitudes toward disabled people. Thus, students in Grades 2 and 3 spend class time with the special needs children, communicating and learning together. This scheduled class time is often spent playing interactive music games. Children from other classes also have the opportunity to spend the recess periods with the special needs children. Individual children, on their own initiative, indicate their interest in spending recess with a particular special needs child by signing their name to a sheet displayed next to the classroom door.

The special needs teacher also believes that the materials in the learning environment should be highly appealing and potentially meaningful for the students. The room is filled with colorful art work, made by the special needs students and other students in the school. There are many cushions, a hammock, and chairs to curl up in, and plants near most of the windows. Instruments and toys fill the shelves.

For all of the students, music materials of one type or another tend to be, as she puts it, highly motivating. Music is the basis for the many interactive games in her classroom, such as movement activities with music, where the student can signal to continue, discontinue, or switch to something else.

As with all of the music activities in the special needs classroom, the music serves a deeper purpose beyond the music experience itself. Music motivates children to respond in specific ways, whether physical or cognitive, and these specific responses can then be further shaped by the teacher so that the child's possibilities for communication are enhanced. This is true whether a student is choosing to listen to music as a leisure activity (e.g., by operating a switch to start and stop recorded music), playing an instrument, or using the computer to control music outputs.

The special needs teacher sees the computer as having the greatest potential influence for her students in the areas of communication and in leisure activities, in both language and music related endeavors. She also views the computer as a vehicle for making links between the special needs students and other students in the school. She argues that by having her students use the same machine as non-handicapped students, although not necessarily in the same ways, the non-handicapped students may come to see similarities between what they and the special needs students find interesting and motivating.

Music Activities in the Special Needs Setting

The special needs teacher uses music in her classroom on a daily basis. When the research began in November of the 1986 school year, it was already evident that listening practices were in place, that children were already playing instruments, and movement had been linked with music as a means of making meaning and communicating. Each of these three areas were developed further during the course of the year as the teacher, researcher (myself), and research assistant together discussed and developed new ways for the special needs students to have richer music experiences. The teacher and researchers planned to provide a greater variety of listening music for the students, both live and taped, based in part on a closer examination of the students' individual music tastes. Also, a better selection of instruments for the children to play would be provided where non-handicapped students would play a part in designing and building such instruments. We also expected to develop more movement-music activities, in keeping with the activities/therapy already established in the special needs classroom.

The most obvious missing element from the special needs music program was that the children had no systematic way of creating their own music. It was the area of music creation that efforts in using the computer were concentrated.

The music creation programs available for students on the ICON were Musicland and Melody Manipulations. Both programs have several features in common. They allow the user to enter a musical idea or motif by using the ICON trackball, an input device something like a cross between a joystick and a mouse. Then the idea can be manipulated using musical transformations such as transposition, augmentation and inversion. Larger musical structures can be built from the basic motifs, and the pieces can be performed on the computer through a synthesizer. However, both programs were much too sophisticated for use by the special needs children at the school, both in terms of musical content and physical manipulation of the trackball. However, it was felt that the basic features of Musicland could be incorporated into a special version where switches could take the place of the trackball, so that the special needs children might also experience and manipulate their own musical ideas using computer tools.

The idea for adapting the ICON for the special needs students was based on one of the most simple yet versatile instruments commonly used for early improvisations, called Orff bells. A unique feature of Orff bells is that individual bells or notes can be added or removed from the set, so that the player can choose his or her notes (or scale), and then physically arrange the notes as he or she chooses. An input device for the special needs students was designed to capture this feature of the Orff bells, with the additional capacity of enabling the teacher or another student to program the note or sequence of notes for each "bell". Thus, the student has three or four "bells" (actually touch sensitive switches), which can be physically arranged in any spatial arrangement desired by the student, and then played by pushing on the switch. Since the notes of the switches or "bells" are programmable, the notes can be changed according to the various parameters offered by the music capabilities of the ICON, including pitch, duration, and timbre, within a number of musical structures (such as single notes, chords, single pitched rhythm patterns, or sequences of notes of varying pitches). This type of input device allows the special needs students to make musical communications with non-handicapped students, and in turn, non-handicapped students can enhance the music experiences of the special needs students by programming different sequences on the computer, or by using the same devices to make their own music structures.

During the inevitable delays encountered in producing the switches and interface for the ICON, the computer was used in a number of related ways with the special needs students and students from the Grade 2/3 classroom. The use of the computer described later in the following section not only complimented the ways in which the special needs teacher

was already using music in her classroom, but also served to prepare both the special needs students and the non-handicapped Grade 2/3 students for the special switches once they arrived.

Research Findings

The findings are described in two sections, each giving a different point of view on the activities and change in the special needs setting. First, two students are described in detail, in terms of the physical and intellectual abilities, music preferences, and interaction with the music technology. Second, a few of the specific music activities engaged in by the special needs children and the Grade 2/3 children are discussed.

Profiles for Two Students: John and Janet

John and Janet are two of the five special needs students at the project school (both in the 1986-1987 and 1987-1988 academic years). While all of the children participated in the research, only Janet and John are described in detail in the present report. This is because they are very different in terms of the nature of their abilities and responses, as well as having distinctly different personalities as evidenced not only in the music activities, but in other settings as well.

Both John and Janet are blind, and both are also neurologically impaired. They can communicate through simple vocalization, but neither can speak. Janet has limited use of her hands and feet. John is considerably more impaired in that he often loses control of automatic reflex motions in his arms and legs. Neither of the two children can walk nor otherwise propel themselves along the floor. Both can sit in rocking chairs, and Janet can rock the chair herself. Janet frequently plays with musical instruments in an extender, while John is most often in a wheelchair with a tray table. Both take delight in music. While John is less capable than Janet in manipulating musical instruments, he has a very definite and strong response to music. John invariably chortles with glee every time he hears music played.

John

John responds to just about any type of music that he hears. His reactions range from screams of joy and excitment, to very pensive, almost distressed expressions, which usually cadence into a smile once a song is finished.

In addition to simply listening to songs, John thrives on just about

any interactive game that involves music, including ones with tapping on his arms or legs, or moving his hands around. He also likes games in which he can use a hand signal to request more songs or pieces played on the synthesizer. For example, while listening to a recording of Bob Schneider's *I Don't Wanna (Have an Iguana)*, the research assistant once tapped different rhythms on John's knees, arms, and hands, to which John produced lots of cooing and smiles. Songs with a very strong pulse and rhythms, such as Sandy Offenheim's *Comin' Down the Chimney* and the even faster *Junior Rag* produce not only smiles but screams of delight, and movement involving his entire body rather than just the simple hand waving as a means of indicating that John is liking what he is hearing.

The synthesizer was introduced into the music interactive games played by John and a member of the research team. The pieces were mostly variations on simple I-IV-V-I progressions in different major and minor keys, exploring various tempi and rhythms. The operating rule in these games was that John make the appropriate hand signal before another song was played. Another type of game involved the same sort of improvisations, with tantalizing delays between phrases or just before cadences. During these pauses, John would smile and even cry out in delighted anticipation of the next notes.

John's sensitivity to his music environment extended outside of the individual one-on-one activities with a teacher, myself or my research assistant. In the music setting with the Grade 2/3 and special needs students combined, John took great pleasure in group singing, instrument playing, and music games. When involved in a non-musical individual activity, such as rocking in a hammock or doing physiotherapy exercises, John would often respond to music activities occuring in other parts of the classroom by smiling or vocalizing.

Janet

More than any piece of music that has been played for Janet, her favorite sounds seem to be the ones produced by a remote control toy that lives in her classroom. This is a plastic toy police car, complete with siren, clanging bells and flashing light, which roars away at Janet's command via a remote control switch attached either to a table or at the side of her wheel chair. A similar type of toy is a drumming monkey, which Janet also enjoys, though not as much as the police car.

Janet was uncharacteristically excited when she was able to operate three different switches at a time, thereby producing sound from three different sources. Her right hand operated a tape deck with some flute

music, her left hand switch ran the drumming monkey, and she was assisted by a member of the research team in running the police car with her left foot. Janet produced many smiles and giggles as she operated all three items at the same time. When it came to zeroing in on one of the items, Janet chose to operate the foot switch and run the car. She varied between hitting the switch repeatedly and holding it down for a minute or longer.

These general observations of Janet are in keeping with the classroom teacher's comments concerning Janet's music preferences; Janet likes anything loud, clanging and noisy: anything that leans towards the terrific.

In sharp contrast, and therefore somewhat surprisingly, it was also found that Janet was very sensitive to music with a light, floating quality. During a listening session with Carl, also a special needs student, Janet heard the song *Never Surrender* by Corey Hart being played at the other end of the classroom. This piece has an opening instrumental section which uses synthesizers set to produce notes with a bell-like quality. Janet was seated in her wheel chair with her head forward, chin against her chest. As the music began, Janet lifted her head, eyes open wide at first, then closed, and rolled her head from side to side in a figure eight pattern. Janet showed the same reaction in later listening sessions when I or my research assistant improvised songs on a synthesizer using a voice with a light or bell-like quality, such as flute or "fairytale".

Janet and I also enjoyed engaging in tapping games. The games involved taking turns tapping on a table, in even pulses or simple rhythms, sometimes with a tambourine placed on the table to add a different color to the sound. Janet became quite familiar with the concepts of turn taking, and seemed to delight in any new rhythms that she heard.

A new activity for Janet included playing a rhythm instrument designed by Nicholas, one my young private music students. Having heard my descriptions of Janet, Nicholas put together a creation made up of two plastic yogurt containers containing a few dried seeds, and joined at the lids with a pipe cleaner. The instrument was suspended from the classroom ceiling so that Janet, when strapped into a standing frame, would have to lift her left arm up above her head in order to produce a sound. When the teacher suspended another instrument, the tambourine, above Janet's right arm, she learned to extend both arms at once. This was perhaps the first time that Janet had shown sufficient interest and motivation to perform this bilateral extension of both arms simultaneously.

The Integration of Special Needs Students in the School Community Through Music

Each Tuesday and Thursday morning, groups of eight or nine students from the Grade 2/3 class visited the special needs room for a half hour of music activities. These sessions played a major role in the integration of the special needs students into the school community, creating a greater awareness amoung students and staff concerning the events and people in the special needs room. The sessions also became the focal point for using the synthesizer, ICON, and for making plans for developing switches to interface with the ICON.

As both myself and my research assistant became involved in the music sessions, the synthesizer became a regular and much enjoyed feature of the group music activities in a number of ways. Some students learned simple accompaniments for songs. In word games where clapping or rhythm instruments had been used to play name rhythms, the synthesizer was used instead. A color game was created to explore the synthesizer's different internal voices. "We know what the color green looks like, but what do you think it might sound like if you could play it on the synthesizer?" Students would take turns interpreting different colors on the synthesizer, and were encouraged to explore lots of colors in their own time with their classroom synthesizer.

As the ICON switches were being developed, we meanwhile began using the switches that the children could already control to operate tape recorders, each of which would act like a "bell", playing music when the switch was held down, and stopping when the switch was released.

The equipment consisted of four tape recorders, each to play a different piece of music of approximately 60 seconds duration. Each tape recorder was operated by one of the large low pressure sensitive switches. The music on each of the 60-second looped tapes was recorded on the synthesizer. The pieces were improvised using different internal voices, tempi, rhythms and textures. Each piece was an musical representation of a color; pink (sometimes the same music was used for yellow) used the "fairytale" voice of the synthesizer to produce a bright flowing melody; the red anthem was also bright, but much bolder and stronger than pink; blue was dark and melancholy, played in a minor key; black was even darker, sounding evil, even morbid at times.

These tapes and switches were used for several different activities. When the tapes were first used, the activity would begin with a discussion

or review of the pieces, the colors that the students associated with these pieces, and why the pieces might bring certain colors to mind. Initial discussions included questions such as "Janet can't see, but if you wanted to show her what the color pink was like, how do you think pink would sound?" Such questions were designed not only to assist the Grade 2/3 students' understanding of the nature of the activities, but to help them focus in on the needs of their special needs team mates in these games.

The first game involved five Grade 2/3 students, each matched with one of the five special needs students. Four of the pairs would run the four color tapes, with the fifth pair creating and conducting a color "score" at the computer (see Figure 1). The score would be created using IPAINT, producing a collage of four colors corresponding to the four color tapes. The cursor was moved horizontally, vertically or at random across the screen to indicate which color was to play. Grade 2/3 students would assist their special needs partners to press their switch when their color came up.

Smaller group activities involved a special needs student running one of the color tapes while two of the Grade 2/3 students drew what was being played on the computer using IPAINT. A shape, such as a square, would be dragged across the screen while the music was played, stopped and moved when there was silence, ready for another phrase.

During the group activities, the Grade 2/3 students appeared very much absorbed in the colors, at times to the point of excluding the special needs students. A second color activity was set up just for the Grade 2/3's, to familiarize them with the color activity, allowing them to concentrate more on their special needs partners when the larger group activities resumed. This activity involved groups of five students, four musicians playing the color tapes, and one conductor. The conductor held a stack of coloured cards corresponding to each of the tapes, plus a number of white cards, for which each conductor would make up their own meaning. White was most often chosen to indicate silence. The cards were dealt out onto two or three piles of cards. As a musician's color of card appeared at the top of a stack, their tape recorder would go on and stay on until their color was no longer showing. Pieces were usually ended by placing a white card at the top of each stack. The students would also conduct their own mini compositions by selecting seven or eight cards and finding different ways of indicating to the orchestra which colors were to play.

The looping tapes, switches and tape recorder set-up described above served many of the functions that the new switches for the computer later

Figure 1. ICON Score for a Colour Composition (4 colours)

served. The switches were used by the Grade 2/3 children and the special needs children to start and stop the tape recorded music, in the same way that they can start and stop music stored in the memory of the computer. Also, the children, teacher, myself and my research assistant could change the music associated with each of the switches by recording a new note or melody directly from the synthesizer to the tape recorder. The tape recorder switches could be moved from one location to another, also a feature of the computer switches. However, there were several important operations which could not be carried out using the tape recorder apparatus, but which are possible with the computer. First, students and teachers can able to manipulate the music played by each switch according to the musical manipulations described earlier: transposition (moving the sequence up or down a set tonal distance), diminuition (playing all of the notes faster according to a set proportion), augmentation (playing all of the notes slower according to a set proportion), retrograde (playing the sequence backwards), and inversion (playing the sequence upside-down). Second, the computer can be used to generate a graphic representation of music as it is played by the student, linking sound to notation in a dynamic way.

IPAINT provides a rich setting for exploring the functions of music notation, both standard and non-traditional or invented notations. IPAINT notations are similar to standard notation in that they provide a record of the music, they indicate something of the voicing or orchestration of the piece, they are usually written and read by the children in a systematic way (e.g., left to right, or from the bottom of the screen to the top of the screen), and serve as a score for players and conductors. However, in some ways IPAINT music notations are significantly different, and in fact, richer than standard notation. First, since they are in color, more information about the music texture of the composition is depicted by the IPAINT notations than by standard notations alone. Second, IPAINT notations are more intuitive for children to read and "hear inside [their] heads" than standard notation, probably because of the color and because the visual forms are easily identified, and then correlated with sound. Third, IPAINT compositions lend themselves to being played in more than one way. Children do not feel bound to reading from left to right when playing an IPAINT piece. Thus, not only can one notation depict a number of different pieces, but different pieces can be created simply by interpreting the notation according to a different set of rules. Finally, IPAINT music notations, unlike standard notations, are accessible to all of students, both handicapped and non-handicapped. Instead of spending several years learning to read and write standard notation, children can immediately create and record music using the IPAINT notation. This is of particular significance in terms of the special needs students involved in the present

study, who would have no hope of ever understanding something so complex as standard music notation. However, using the IPAINT system these children were able to dictate compositions to Grade 2/3 students using IPAINT, create visual patterns which could then be interpreted as sound patterns, and participate, with help, in the performance of IPAINT compositions. Perhaps even more important, this activity afforded the opportunity for the Grade 2/3 students to see the special needs students as active members of a musical enterprise.

New Directions for the Second Year of the Study

A new use for the switches in the 1987-1988 school year has been to operate the Logo program on the ICON through the switches. This is particularly useful for one of the special needs children who has considerable language ability through graphic representations. She is now able to operate and manipulate Logo procedures using the same switches that she previously learned how to use through music and the computer. Although this use of the switches was not anticipated when they were originally designed, it is a welcome development to find that the hardware can be readily adapted to new software, thereby increasing the potential power of the switches, and therefore, the computer, for these special needs children.

It is clear that much of the future work in the special needs setting, both in music and other subject areas, will depend on the growing versatility of use of the switches and interface and on the degree to which heterogeneous learning settings, with respect to age and ability, can continue to be fostered. In this way, the music community revolving around the special needs children will continue to develop, not only for the special need students, but for other children and adults whose lives they touch.

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