POSSIBILITY OF USING NEW TYPES OF MUSICAL ELECTRONIC INSTRUMENTS FOR ASSISTIVE TECHNOLOGY

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DOI: 10.2298/MICP2012325C

SUMMARY

People with cerebral palsy are incapable to perform certain variety of activities that are available to other people. One of the almost impracticable activities for people with CP is to play music instruments. Modern assistive technologies partly manage to help people with CP to live a quality life and to overcome everyday obstacles (common problems). The problem is availability of modern technology, its complexity and its price. This research would present a new idea for people with CP and their possibility to perform some elementary music activities. The advantage of this technological solution is its simplicity and its market price. One more advantage is the most direct contact between the user and the instruments possible. The instruments work by sensors and servo motors, which represent the hand of the musician. The sensors can be activated by many “triggers”, like: light, touch, movement... By activating sensors the signal is translating to the servo motor, which depend on the instrument: pulls string, hits the drums or does any activity to create sound. For pretty short time that we had for testing, the instruments showed really good. We tested how much musical knowledge the children got. We conformed that the children really improved. There is one more thing that we can't measure, but it means a lot. That is children’s smiles and the possibility for them to create music.

KEY WORDS: cerebral palsy, music, assistive technology
INTRODUCTION

Assistive technology

Assistive technology (AT) is an important part of special education services for students with disabilities in preschool, K-12, and postsecondary settings. However, the extent and usage of AT in education is not fully documented. Challenges in determining how teachers and students use AT include the very broad manner in which AT is defined, the lack of a nationwide (or even, in most states, a statewide) system of tracking educational accommodations, and the variety of AT delivery systems and personnel who provide AT services.

What is Assistive Technology?

"Any item, piece of equipment, or system, whether acquired commercially, modified, or customized, that is commonly used to increase, maintain, or improve functional capabilities of individuals with disabilities."

This above definition was initially established in the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (The Tech Act), amended in 1994. In 1998, that act was repealed and replaced with the Assistive Technology Act of 1998 (AT Act), but the definition has remained unchanged.

There is no fixed series of events that constitute the history of the development of assistive technology. The growth and development of this technology is dotted with events beginning in the 19th century. In 1808, Pellegrino built a typewriter to help his blind friend Countess Carolina Fivizzono write legibly. Since then, there have been sporadic attempts to strengthen the assistance provided for the disabled. The use of devices like wheelchairs, hearing aids, and various software applications like voice-assisted computers for the blind have boosted the creativity and ability of a largely dependent population. Perhaps, one of the greatest inspirations was provided by Louis Braille, who developed a language for the blind in the year 1821.

Assistive technology integrates a range of functions within the field which can be challenging and innovative. The invention of the telephone was one of the biggest contributions to the way humans communicated. It involved combining this device with a text telephone, known as telecommunications device for the deaf, enabling long distance communication for the deaf people. Televisions, remote controls, calculators come with additional equipment like speech recognition controls making the devices more user-friendly for the disabled. It should be a constant endeavor of the society to come up with such a
technology. In the modern age, a number of factors have made the use of assistive technology more important. These factors are frequent epidemics or war disabilities, requiring frequent assistance of technological innovations. Studies have also proved that the cognitive abilities and IQ levels of disabled people tend to be much higher than humans with no disabilities, since they make much more conscious use of their body and mind. This potential can be harnessed and channelized by constructive use of this technology. The disabled population, thought to be as the dependent people until recent times, can become independent and also a valuable human resource. The example of Stephen Hawking, who suffers from motor-neuron disease, is a great example of a genius mind in a disabled body. On being provided assistance through this customized technology, he has contributed enormously.

Generally speaking, the definition of assistive technology (AT) is very broad. The inclusiveness of the definition has advantage in that many different items and services can be provided under the AT umbrella. Adaptive pencil grips are considered AT, as are standing wheelchairs, and the most sophisticated scan-and-read software systems. When used in a customized or specified manner, so is spell-check in a word-processing program, a specific choice of a pen, or a change in the color of paper used for communication with a student. Educational uses of AT include both low-tech and high-tech, (for example, pencil grips vs. computers), remedial uses and accommodation (phonetic training software vs. augmentative communication devices), and even universal design and individually prescribed applications (classroom sound field systems or the IBM Liberated Learning system vs. a computer adaptation for one student). AT also includes solutions that can be installed everywhere and used by anyone (whether that be curb-cuts and building entry ramps or built-in text-to-speech in an internet browser), as well as solutions that must be specifically installed and must accompany the student from place to place (such as a Braille computer display).

Many forms of technology, both "high" and "low", can help individuals with learning disabilities capitalize on their strengths and bypass, or compensate for, their disabilities. This article surveys the current status of assistive technology for this population and reflects on future promises and potential problems. In addition, a model is presented for conceptualizing assistive technology in terms of the types of barriers it helps persons with disabilities to surmount. Several current technologies are described and the research supporting their effectiveness reviewed: word processing, computer-based instruction in reading and other academic areas, interactive videodisc interventions for math, and technologies for daily life. In conclusion, three themes related to the future success of assistive technology applications are
discussed: equity of access to technology; ease of technology use; and emergent technologies, such as virtual reality.

As technologies such as computers were increasing in number, the nature of these technologies was also changing in several ways. First, technology has become more powerful in the last decade and, at the same time, cheaper. For example, the memory capacities of computers sold today are measured in megabytes, not the kilobytes of a decade ago, and their costs (like those of other technologies, such as VCRs) have steadily decreased over time. Second, a variety of new technologies have become available, including fax machines, cellular phones, CD players, personal digital assistants, and voice-input devices for computers. Third, there has been a dramatic increase in the quality of technology, particularly in relationship to computer software. Today's software, with its realistic sound, dazzling visuals, and on-screen videos, bears little resemblance to the software of a decade ago, when green text in all capital letters was sometimes alleviated by blocky graphics (Lewis, 1998, 0022-2194).

Disabilities can impose barriers to full participation in school, at work, and in other important areas of life. Assistive technology offers ways to surmount those barriers. As the following sections explain, one way to think about the many technologies that are currently available is in relation to the type of barrier each addresses.

**Print Barriers**

Print materials are an obstacle to persons with vision impairments and to others who have difficulty reading. This includes preschool children, beginning readers, and individuals with learning disabilities who have not yet mastered the skill of reading. The most common way that assistive technology attempts to overcome the print barrier is to present information through a sense other than vision. Thus, individuals who are blind might use the sense of touch to read Braille, or might gain information by listening rather than reading. For individuals with learning disabilities (and others not yet competent in reading), an auditory display of information is often more accessible than a print display. Taped books, devices that read print books aloud, and "talking" computer programs are all options.

**Communication Barriers**

Individuals with speech and language disorders experience difficulty with oral communication. Beginning writers and many persons with learning disabilities experience a similar difficulty with written communication. Common written communication problems related to learning disabilities are poor handwriting, spelling, organizational skills, productivity, and quality of writing (Lerner, 1993; Newcomer,
Barenbaum, 1991). The most typical response to these problems is an instructional intervention. In addition, assistive technology can support individuals with learning disabilities in the writing process by providing strategies to bypass or compensate for specific problem areas. Most technological approaches to writing are computer based; examples are word processing programs, spelling and grammar aids for editing assistance, and programs to help writers organize their thoughts in the planning stage of the writing process.

**Learning Barriers**

Learning disabilities interfere with the learning process by inhibiting the acquisition of new skills and knowledge and the recall of previously learned material. As with communication barriers, the most typical response to problems in learning is instruction. Assistive technology plays a role by enhancing the range of instructional options available to teachers, or to adults with learning disabilities who are directing their own learning. Technology provides a wealth of alternatives to supplement or supplant traditional approaches, such as lectures and textbook readings. For example, learners can gain new information by listening to audiotapes, audio CDs, and radio; watching films, videos, and television; participating in instructional activities delivered by computer and videodisc; and interacting with electronic information sources, such as CD-ROM-based reference "books" and the data-bases found on the Internet. Computer-based instruction is one of the most popular technological alternatives; well-designed computer programs offer learners carefully sequenced, individualized activities and frequent, informative feedback on the quality of their responses. Such programs have the potential to increase the quantity, and in some cases, the quality of instruction.

**Other Types of Barriers**

Individuals with hearing impairments experience barriers to listening; people with physical impairments are faced with mobility barriers. Although such problems do not characterize individuals with learning disabilities, it is important to recognize that the technologies devised to circumvent one type of barrier may prove useful for another. For example, captioned films and videos designed for persons who are deaf bypass the need for intact hearing by adding text to the visual display. This text, along with its auditory counterpart, could also be used to enhance the reading skills of persons with adequate hearing (Layton, 1991). Also, there are a number of technologies that help persons with physical impairments bypass the motor demands of typing on a computer keyboard. For persons with learning disabilities, these technologies have potential for bypassing spelling demands. With voice-input devices, for example, the writer enters text in a word processor by
speaking words into a microphone, rather than by typing them letter by letter.

**Types of Assistive Technology Products**

Assistive technology products are designed to provide additional accessibility to individuals who have physical or cognitive difficulties, impairments, and disabilities. Alternative input devices allow individuals to control their computers through means other than a standard keyboard or pointing device. Examples include:

*Alternative keyboards* - featuring larger- or smaller-than-standard keys or keyboards, alternative key configurations, and keyboards for use with one hand.

*Electronic pointing devices* - used to control the cursor on the screen without use of hands. Devices used include ultrasound, infrared beams, eye movements, nerve signals, or brain waves.

*Sip-and-puff systems* - activated by inhaling or exhaling.

*Wands and sticks* - worn on the head, held in the mouth or strapped to the chin and used to press keys on the keyboard.

*Joysticks* - manipulated by hand, feet, chin, etc. and used to control the cursor on screen.

*Trackballs* - movable balls on top of a base that can be used to move the cursor on screen.

*Touch screens* - allow direct selection or activation of the computer by touching the screen, making it easier to select an option directly rather than through a mouse movement or keyboard. Touch screens are either built into the computer monitor or can be added onto a computer monitor.

*Braille embossers* transfer computer generated text into embossed Braille output. Braille translation programs convert text scanned-in or generated via standard word processing programs into Braille, which can be printed on the embosser.

*Keyboard filters* are typing aids such as word prediction utilities and add-on spelling checkers that reduce the required number of keystrokes. Keyboard filters enable users to quickly access the letters they need and to avoid inadvertently selecting keys they don’t want.

*Light signaler alerts* monitor computer sounds and alert the computer user with light signals. This is useful when a computer user cannot hear computer sounds or is not directly in front of the computer screen. As an example, a light can flash alerting the user when a new e-mail message has arrived or a computer command has completed.

*On-screen keyboards* provide an image of a standard or modified keyboard on the computer screen that allows the user to select keys
with a mouse, touch screen, trackball, joystick, switch, or electronic pointing device. On-screen keyboards often have a scanning option that highlights individual keys that can be selected by the user. On-screen keyboards are helpful for individuals who are not able to use a standard keyboard due to dexterity or mobility difficulties.

*Reading tools and learning disabilities programs* include software and hardware designed to make text-based materials more accessible for people who have difficulty with reading. Options can include scanning, reformatting, navigating, or speaking text out loud. These programs are helpful for those who have difficulty seeing or manipulating conventional print materials; people who are developing new literacy skills or who are learning English as a foreign language; and people who comprehend better when they hear and see text highlighted simultaneously.

*Refreshable Braille displays* provide tactile output of information represented on the computer screen. A Braille "cell" is composed of a series of dots. The pattern of the dots and various combinations of the cells are used in place of letters. Refreshable Braille displays mechanically lift small rounded plastic or metal pins as needed to form Braille characters. The user reads the Braille letters with his or her fingers, and then, after a line is read, can refresh the display to read the next line.

*Screen enlargers, or screen magnifiers*, work like a magnifying glass for the computer by enlarging a portion of the screen which can increase legibility and make it easier to see items on the computer. Some screen enlargers allow a person to zoom in and out on a particular area of the screen.

*Screen readers* are used to verbalize, or "speak", everything on the screen including text, graphics, control buttons, and menus into a computerized voice that is spoken aloud. In essence, a screen reader transforms a graphic user interface (GUI) into an audio interface. Screen readers are essential for computer users who are blind.

*Speech recognition or voice recognition programs*, allow people to give commands and enter data using their voices rather than a mouse or keyboard. Voice recognition systems use a microphone attached to the computer, which can be used to create text documents such as letters or e-mail messages, browse the Internet, and navigate among applications and menus by voice.

*Text-to-Speech (TTS) or speech synthesizers* receive information going to the screen in the form of letters, numbers, and punctuation marks, and then "speak" it out loud in a computerized voice. Using speech synthesizers allows computer users who are blind or who have learning
difficulties to hear what they are typing and also provide a spoken voice for individuals who can not communicate orally, but can communicate their thoughts through typing.

*Talking and large-print word processors* are software programs that use speech synthesizers to provide auditory feedback of what is typed. Large-print word processors allow the user to view everything in large text without added screen enlargement.

*TTY/TDD conversion modems* are connected between computers and telephones to allow an individual to type a message on a computer and send it to a TTY/TDD telephone or other Baudot equipped device (http://www.microsoft.com/enable/at/types.aspx, May 12, 2012).

**CEREBRAL PALSY**

**History of cerebral palsy**

But the medical profession did not begin to study cerebral palsy as a distinct medical condition until 1861. In that year, an English orthopedic surgeon, Dr. William John Little, published the first paper describing the neurological problems of children with spastic diplegia. Spastic diplegia is still sometimes called Little’s Disease. This was a disorder that struck children in the first years of life, characterized by stiff, spastic muscles in their arms and legs. These children had difficulty grasping objects, crawling, and walking. They did not show signs of improvement with age, nor did they become any worse. The term cerebral palsy came into use in the late 1800’s. Sir William Osler, a British medical doctor, is believed to have coined the term. Dr. Sigmund Freud, the Austrian neurologist better known for his work in psychiatry, published some of the earliest medical papers on cerebral palsy. In the early years, Dr. Little believed most cases of cerebral palsy were caused by obstetrical complications at birth. He suggested that children born with cerebral palsy were born following complicated deliveries, and that their condition was a result of lack of oxygen to the brain. He said this oxygen shortage damaged sensitive brain tissues controlling movement. But in the late 1800’s, Freud disagreed. Noting that children with cerebral palsy often had other problems such as mental retardation, visual disturbances, and seizures, Freud suggested that the disorder might be caused earlier in life, during the brain’s development in the womb.

Despite Freud’s research on cerebral palsy, the belief that birth complications accounted for most cases was widespread among doctors, families, and even medical researchers. In the 1980’s, scientists analyzed extensive data from a government study of more than 35000
births. While they found that birth trauma was the cause of thousands of cerebral palsy cases, no cause could be found in the majority of cases. This has influenced researchers to explore other causes, and look at medical theories about cerebral palsy more closely.

Mac Keith and Polani (1959) defined CP as a persisting but not unchanging disorder of movement and posture, appearing in the early years of life and due to a non-progressive disorder of the brain, the result of interference during its development. In 1964, Bax reported and annotated a definition of CP suggested by an international working group that has become a classic and is still used. It stated that CP is a disorder of movement and posture due to a defect or lesion of the immature brain. For practical purposes it is usual to exclude from cerebral palsy those disorders of posture and movement which are (1) of short duration, (2) due to progressive disease, or (3) due solely to mental deficiency. The group for which Bax was the reporter felt that this simple sentence could be readily translated into other languages and hoped that it might be universally accepted. At that time, it was felt that it was wiser not to define precisely what they meant by "immature brain", as any such definition might limit services to those in need. Like its predecessors, this formulation of the CP concept placed an exclusive focus on motor aspects, and also stressed the specific consequences of early as opposed to late-acquired brain damage. Not formally included in the concept were sensory, cognitive, behavioral and other associated impairments very prevalent in people with ‘disordered movement and posture due to a defect or lesion of the immature brain, and often significantly disabling.

**Definition of cerebral palsy**

For a variety of reasons, the definition and the classification of cerebral palsy need to be reconsidered. Modern brain imaging techniques have shed new light on the nature of the underlying brain injury and studies on the neurobiology of and pathology associated with brain development have further explored etiologic mechanisms. Previous definitions have not given sufficient prominence to the non-motor neurodevelopmental disabilities of performance and behaviour that commonly accompany cerebral palsy, nor to the progression of musculoskeletal difficulties that often occur with advancing age. In order to explore this information, pertinent material was reviewed.

Cerebral palsy is primarily a disorder of movement and posture. It is defined as an "umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of its development"(Mutch, Alberman, Hagberg, Kodama, Perat, 1992, 547-551). It may be stated as a static encephalopathy in which, even though the primary lesion, anomaly or injury is static, the clinical pattern of presentation
may change with time due to growth and developmental plasticity and maturation of the central nervous system.

**Classification of cerebral palsy**

The topographic classification of CP is monoplegia, hemiplegia, diplegia and quadriplegia; monoplegia and triplegia are relatively uncommon. There is a substantial overlap of the affected areas. In most studies, diplegia is the commonest form (30% – 40%), hemiplegiae is 20% – 30%, and quadriplegia accounting for 10% – 15%. In an analysis of 1000 cases of CP from India, it was found that spastic quadriplegia constituted 61% of cases followed by diplegia 22% (Singhi, Ray, Suri, 2002, 162-166).

**Types of Cerebral Palsy**

Cerebral palsy is a broad term which encompasses many different disorders of movement and posture. To describe particular types of movement disorders covered by the term, pediatricians, neurologists, and therapists use several classification systems and many labels. To understand different types of cerebral palsy more clearly, you must first understand what professionals mean by muscle tone.

All children with cerebral palsy have damage to the area of the brain that controls muscle tone. As a result, they may have increased muscle tone, reduced muscle tone, or a combination of the two (fluctuating tone). Which parts of their bodies are affected by the abnormal muscle tone depends upon where the brain damage occurs.

There are three main types of cerebral palsy:
* Spastic Cerebral Palsy (stiff and difficult movement)
* Athetoid Cerebral Palsy (involuntary and uncontrolled movement)
* Ataxic Cerebral Palsy (disturbed sense of balance and depth perception)
* Mixed Cerebral Palsy. There may be a combination of these types for any one person.

**BRIEF SUMMARY OF THE ASSISTIVE MUSICAL INSTRUMENS**

The present invention uses the power of music to provide both feedback and motivation to physical therapy patients to enable music expression, therapeutic engagement and compliance. The patient interacts with the apparatus through various contact and non-contact sensors such as optical, mechanical, or motion sensors as they perform their guided motions. The sensors send their output to a controller which actuates one or more transducers that play a musical instrument.
The sensors send their output to a controller that actuates one or more transducers to play a musical instrument combining entertainment and musical expression with physical therapy.

The system can be successfully adapted to work with patients who have different levels of neurological, physical, or developmental disabilities to enable therapeutic engagement and compliance. Compliance can be measured with additional time-based recording device, but the primary measure of success is in the performance, mastery, and improvement of technique.

In his book "Musicophilia: Tales of Music and the Brain" (Sacks, Vintage, 2008), Dr. Oliver Sacks, a neurologist, describes the integration of music in the deep structures of the brain. It is not uncommon to find people with profound neuro-developmental disabilities yet who retain the ability to understand, enjoy, and sometimes play music.

The present invention uses the power of music to provide both feedback and motivation to physical therapy patients. The apparatus comprises a sensor, a controller, and a music source.

The sensor can comprise a non-contact sensor such as an optical sensor, a motion sensor, or an audio or voice activated sensor. The optical sensor may comprise a sensor that is activated when a beam of light is directed at the sensor, or may be activated when a beam of light that is already directed at the sensor is obstructed, interrupted, or otherwise broken. In one embodiment of the present invention an optical sensor is triggered when the guided motion of a limb breaks the light-path of the prepositioned light source. In another embodiment, the light source is attached to an article of clothing which triggers the optical sensor when the guided motion results in the light source illuminating the optical sensor.

The sensor can also comprise a motion sensor. Visible light, infrared light, or laser technology may be used for optical motion detection. Motion detection devices, such as PIR motion detectors, have a sensor that detects a disturbance in the infrared spectrum, such as a person's limb. Once detected, an electronic signal can be generated. A simple algorithm for motion detection by a fixed camera compares the current image with a reference image and simply counts the number of different pixels. Since images will naturally differ due to factors such as varying lighting, camera flicker, and CCD dark currents, pre-processing is useful to reduce the number of false positive alarms. One embodiment of the present invention comprises an infrared motion detector that is triggered when the guided motion of a limb disturbs the background infrared spectrum. Another embodiment comprises a fixed camera that is triggered when the guided motion of a limb causes the camera's current image to differ from the camera's reference image.
The sensor can also comprise a contact sensor such as a button, a toggle switch, a paddle switch, a musical keyboard key, a slider, a joystick, a touch pad, or a dial. The contact sensors can be used singly or in an array with different sensors being used to trigger different sounds or musical instruments. Some types of contact sensors, such as a button or toggle switch, may be used to trigger a single sound or action. Other types of contact sensors, such as a slider, joystick, or touch pad, may be used to trigger sounds or actions of adjustable duration or changing pitch. The contact sensor can be positioned such that when the guided motion of the limb has reached its desired extent, the contact sensor is touched. In one embodiment of the present invention a button is positioned so that it is contacted at the full extent of the guided motion of a limb, triggering a sound that provides feedback to the patient. In another embodiment the guided motion of a limb runs along a touch pad that triggers a tone of increasing frequency.

The controller can comprise a mechanical, pneumatic, electrical, electronic, or computerized device. The output signal of the contact or non-contact sensor initiates the operation of the controller. The controller actuates the music source when it receives a signal from the sensor. The controller may initiate a servo-motor which plays a musical instrument, an audio sequence on a MIDI device, or a pre-recorded tone or musical passage.

In one embodiment, the controller receives the sensor signal and an input audio signal and modifies a property of the input audio signal dependent on the sensor signal to obtain an output audio signal. In another embodiment, a function may map the values of the sensor signal to control parameters for modifying the property (or the properties) of the input audio signal. This function may be any monotonic function including a piecewise function characterized by a threshold value. In an embodiment, the controller only supplies the output audio signal to the music source if the associated sense signal indicates that a property of the light is above a particular threshold.

The controller processes the input audio signal into an output audio signal in accordance with the sensed property or the sensed properties. In an embodiment, the input audio signal is supplied to the music source if a particular property of the light is detected to be present and no audio signal is supplied to the music source if this particular property is not present. For example, the audio signal is only supplied to the music source when the intensity of the sensed light is above a particular threshold value.
As an example, the controller may comprise a voltage comparator. A comparator is a device that compares two voltages or currents and switches its output to indicate which is larger. A dedicated voltage comparator chip such as LM339 is designed to interface with a digital logic interface (to a TTL or a CMOS). The output is a binary state often used to interface real world signals to digital circuitry (see analog to digital converter). If there is a fixed voltage source from, for example, a DC adjustable device in the signal path, a comparator is just the equivalent of a cascade of amplifiers. When the voltages are nearly equal, the output voltage will not fall into one of the logic levels, thus analog signals will enter the digital domain with unpredictable results. To make this range as small as possible, the amplifier cascade is high gain. The circuit consists of mainly Bipolar transistors except perhaps in the beginning stage which will likely be field effect transistors. For very high frequencies, the input impedance of the stages is low. This reduces the saturation of the slow, large P-N junction bipolar transistors that would otherwise lead to long recovery times. Fast small Schottky diodes, like those found in binary logic designs, improve the performance significantly though the performance still lags that of circuits with amplifiers using analog signals. Slew rate has no meaning for these devices. For applications in flash ADCs the distributed signal across 8 ports matches the voltage and current gain after each amplifier, and resistors then behave as level-shifters.
The music source may comprise a musical instrument, a MIDI device, or a pre-recorded tone or musical passage. The musical instrument may comprise a drum, cymbal, tambourine, maracas, or other percussion instrument. In the present invention percussion instruments are played by means of a solenoid, motor or servo-motor, which is actuated by the controller. The motor powers a drumstick or other contact means, which moves to tap the percussion instrument when activated by the controller. The musical instrument may further comprise a guitar, mandolin, ukulele, bass, violin, or other stringed instrument. In the present invention stringed instruments are played by means of a motor or servo-motor, which is actuated by the controller. The motor powers an arm holding a plectrum or other contact means, which moves to strum or bow the stringed instrument when activated by the controller. The musical instrument may further comprise a trumpet, bugle, trombone, or other brass instrument or a flute, clarinet, saxophone, or other woodwind instrument. In the present invention brass or woodwind instruments are played by means of a pneumatic power source, which is actuated by the controller. The pressurized air is directed into the brass or woodwind instrument when activated by the controller.
As an example, an actuator device may be used to hit a drum. The actuator device may comprise a post and arm powered by a solenoid. Once the solenoid’s electromagnet is energized by the controller, a plunger is forced upward coming in contact with a lever. The lever in turns moves in the opposite direction with a force equal to the force of the energized solenoid. The lever is constructed from a beam attached to ground by a hinge, or fulcrum.

The music device may comprise a MIDI device such as a synthesizer. In one embodiment of the present invention the controller may initiate a
sequence in the synthesizer to produce musical notes or a preprogrammed musical passage. In another embodiment the controller may initiate a sequence of beats to guide the timing of the physical therapy.

In a physical therapy session the guided motions are replicated in a series to strengthen the muscles and increase the range of functional movement. In another embodiment a musical passage is broken into segments and the segments are played in sequence with the reps of the guided motions, so that the entire musical passage is played through the series of motions that make up the physical therapy exercise.

SPECIAL SCHOOL FOR PRIMARY AND SECONDARY EDUCATION
"MILAN PETROVIC"

Special School "Milan Petrović" placed in city of Novi Sad (Serbia) and represents itself a Center in which 300 experts takes care about 900 children who are:
children with autism
children with mental retardation
children with multiple forms of disability
children with damaged eyesight
children with learning difficulties

Within our school we also have programs for children and students with different needs and abilities but also numerous nationalities and confessions. The Curricula is delivered in four different languages: Serbian, Slovak, Hungarian and Romany language. We provide education for all without any difference to the background. We also have regular classes of religion: Orthodox and Catholic Christian and Islam. Classes on Civil education are classes where children learn about Democracy as a part of the National Curriculum. We also teach foreign languages to children: English and French.

Our programs cover Early intervention, Preschool Education, Elementary School Education, Secondary education and job training, The Employment Centre as shelter employment, Health care and other services directed towards independent living and inclusion of our students in the life of the local community. Our latest activities are in the field of deinstitutionalization of persons with disabilities. The school recently provided an apartment for four people that were living in a Home institution for visually impaired to come and live independently in Novi Sad.
The school as a resource centre provides:

1. Specialists of different profiles: special education teachers, occupational therapists, speech therapists, music teachers, art teachers, crafts' educators, psychologists, social workers and doctors
2. Teaching tools, educational materials, computers and assistive equipment
3. Numerous facilities and equipment for therapeutic and sensory-motor activities (Sensory room, playroom, massage room, gym, sensory garden, craft workshops and ateliers)

Our teaching methodology and job training relies on best traditional methods and many contemporary approaches that support the development, learning and education. The school also provides services to families of children and adults with disabilities. Our specialists work closely with teachers from Mainstream schools. The school manages exhibitions, sport activities, performances and shows where our children mingle and interact with children from other schools. We also organize seminars and workshops for all specialists who need additional knowledge about persons who require intensive social support.

Great attention is placed on assistive technology and optimal use. Team of specialists evaluates each child and is assigned a specific assistive technology. After a certain period we evaluate students' progress and assessing whether or not the assistive technology has helped. Depending on the needs we use hi-tech and low-tech assistive technology. School has a workshop for the production of assistive technology. The workshop produced assistive technologies and adapt existing for individual students. Here are some of the technologies that we have:

- 2 computer lab with assistive hardware
- Multimedia center with teaching tools
- Internet portal for distance learning (www.milance.edu.rs)
- Eye tracking by Tobii Technology
- Assistive music lab

All activities are guided by our special education teachers and other professionals. Thanks to our initiative and experience in special education and support of the local government, the Municipality of Novi Sad and Serbian Ministry of Education and Ministry for Social care in the recent years we have become one of the most prestigious institutions in Serbia and the region. We also organize seminars and workshops for all specialists who need additional knowledge about persons who require intensive social support.
Children in School Milan Petrovic working on this type of assistive technology, just 3 months. In progress is many studies on the benefits and usefulness of this type of technology. In this paper we present preliminary research about the level of acquisition of musical knowledge. Measured by the acquisition of knowledge related to the natural rhythm.

**Methodology**

In this study we examined the level of acquisition of monitoring certain rhythm, using a drum that is activated by using a directed beam of light. The first measuring was performed at the beginning of exercise, when the second contact of students with drums. The second and final measuring was performed 24 hours after exercise during the three months.Measured by the percentage of mistake when performing two rhythmic exercises. The study included thirty-two students, ages nine to fifteen years, with cerebral palsy.

![percent of mistake](image)

*Figure 5. Results of research*

**CONCLUSION**

From the results it can be seen that the progress of pupils was significant. The control group was not because there are very few tools and the technology is still at the beginning. Currently ongoing research related to music therapy and improve the motor skills of students. We currently work on the development of methodological manuals for teachers.
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