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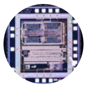
12 authors, including:

Antonio Valente
Universidade de Trás-os-Montes e Alto Douro



R. Morais
Universidade de Trás-os-Montes e Alto Douro

Joaquim Escola
Universidade de Trás-os-Montes e Alto Douro

Manuel Reis
Universidade de Trás-os-Montes e Alto Douro

USING INFORMATION TECHNOLOGY BASED EXERCISES IN PRIMARY MATHEMATICS TEACHING OF CHILDREN WITH CEREBRAL PALSY AND MENTAL RETARDATION: A CASE STUDY

M. G. A. D. REIS[a], L. CABRAL[b], E. PERES[c], M. BESSA[d], A. VALENTE[e], R. MORAİS[c], S. SOARES[e], J. BAPTİSTA[c], A. AİRES[g], J. J. ESCOLA[a], J. A. BULAS-CRUZ[c], & M. J. C. S. REIS[e]

[a]Dept. Educação e Psicologia, UTAD, Universidade de Trás-os-Montes e Alto Douro (UTAD), 5001-801 Vila Real, Portugal.
[b]Transdisciplinary Research Centre Culture, Space, Memory CITCEM, UTAD
[c]ECT-Dept. Engenharias/CITAB, UTAD
[d]Instituto de Engenharia de Sistemas e Computadores do Porto - INESC Porto, ECT-Dept. Engenharias, UTAD
[e]ECT-Dept. Engenharias/IEETA, UTAD
[f]ECT-Dept. Engenharias, UTAD
[g]Dept. Matemática/CM, UTAD
manuelcabral.reis@gmail.com

ABSTRACT
Technology has profoundly changed the way we learn and live. Indeed, such relationship appears to be quite complex, within IT contexts, and especially in socially and technologically rich learning environments, where related skills and learning are progressively required and fostered. Thus, if a satisfactory level of intellectual performance and social competence of a primary school pupil is indeed highly dependent on the type of participation that parents offer their children, IT, in general, and Internet, in particular, may well provide a new paradigm, setting forth that education and communication approach is truly more complex than ever before. It is on the basis of such paradigm that we therefore present a case study where a set of multimedia exercises were used in order to possibly improve the mathematical skills of pupils, one with mental retardation and another with cerebral palsy. Being part of a Web-based system to support students' learning, the referred set of multimedia exercises proved to be the children's favorite, rather than exercises in paper form, which also led the children to show a fair more positive attitude towards learning. Also, we observed that through the mentioned multimedia exercises, the children became far more autonomous, interested, persistent, happy, and able to easily absorb the material as well as more willingly to continue on working.

Key words: Teaching/learning strategies, improving teaching, primary education, cerebral palsy, mental retardation

INTRODUCTION
Technology has profoundly changed the way we learn and live. In fact, according to some authors it seems that we are moving to a "digital learning" (Rogers, 1995; Weller, 2002; Roberts, 2005; Warschauer, 2007; Bull and Hammond, 2008; Willoughby and Wood, 2008). Such is the case of Weller (2002), to whom there are five factors that favor de use of the Internet in education: (i) its social acceptance, (ii) the fact that it does provide a sense of control and therefore ownership for educators, far more than previous technologies due to its many facilities, (iii) the development of the web browser as a generic interface, (iv) it is both an interactive, it works on the information rather than just being a passive recipient, and personal medium, all learners are not the same, (v) it is a sustaining (e.g., a retailer that uses it to supplement its physical shops, for example by means of home delivery from supermarkets) and disruptive technology (e.g., it does not intend Web-based shopping to displace its standard retail outlets, but it hopes instead that both will complement each other, and thus altering the organization in which it is implemented).

Consequently and unsurprisingly, Internet can be used to successfully supplement face-to-face teaching. At present, for example, many are the campus based universities using the Internet, not to replace their traditional face-to-face mode of delivery, but rather as a means of supplementing it (e.g., web pages can be used to provide additional information, and e-mail may be used as a means of contacting tutors of large courses). Surely, there are topics that better suit its use, such is the case of a course on "Introduction to Information Technology", and a teacher especially designed course thought of to address the teachers willing to learn about computer conferencing. Both cases are examples of courses that were using effectively the technology forms as an integral part of the academic content of the course, without forgetting pedagogic suitability. For example, the resource based learning, where students can be presented with a wide range of resources, often external to the university, and may acquire their own learning experience from these resources within the overall framework of the course. On the other hand, Internet's practice brings advantages to Institutions as they may obviously gain from the use of Internet in education, both on campus and while potentially reaching new audiences. Meanwhile, it may also obtain advantageous opportunities from the fact that it can be seen as a Computer Assisted Learning delivery mechanism, as proven by a fair number of courses that are now using the Internet to deliver simulations, visualization aids and interactive tools.

Additionally, mathematics is a fundamental human activity, namely a way of making sense of the world which turns out to be the object of children's natural curiosity and interest, which, at the same time, come to school with a particular understanding of mathematical concepts and problem-solving strategies as discovered through their explorations of the environment surrounding them. According to Johnson (2004) and the Expert Panel on Mathematics report (2004), primary education is an important time of transitional growth in students' mathematical thinking. In order to become more accurate in their work, both in reading problems and in working out solutions, primary students need more practice to reinforce what they are learning, a process which traditionally takes place on paper. In general, after students have completed practical set of exercises (or homework), they often have to wait for their teacher to check it and provide a correspondent feedback. However, interruptions such as these may well reduce the pupils' interest in learning, besides preventing them from learning efficiently.

The researching works of the Expert Panel on Mathematics (2004) show that mathematically literate students think flexibly about how to best solve a problem. Even so, most approaches that even mathematically literate students adopt are provided from general textbooks or tutoring books. Unfortunately, these materials are usually designed for average learners, and it is often difficult to find the best-fitting content for pupils with differing abilities. For example, in Portuguese (primary) classes there is only one textbook designed for all pupils, even though literate students still may need a higher-level tutoring, while illiterate may need a lower-level tutoring. Therefore, the depth and flexibility of ability as obtained from these textbooks are undeniably restricted. Even if some programs based on e-learning technology may provide personalized contents for learners by collecting the learning process, primary school students may still become restless and unfocused when staying in front of computers to work on mathematics during long periods of time. Usually, such is the regrettable case of children with mental retardation, in which case both teachers and parents do have an important word to say. In fact, as Warschauer (2007) points out, "the teacher must be centrally involved, actively instructing and mentoring students, especially at the initial stages of work on a project. Unfocused instruction can leave students rudderless, and this is particularly harmful to at-risk students, such as those with learning disabilities, limited literacy, and language skills, or insufficient background knowledge".

Together with these referred principles and thoughts, here we present a case study of two children: one with mental retardation and one with cerebral palsy. The clinical statuses of these children were previously established by a team of experts, according to the Portuguese legislation. The Ministry of Education asked our team to intervene at the educational level to ensure the learning of these children. To this end we have followed the methodology proposed by Yin (1984). Using such methodology, the researcher is allowed to conduct the research in its working context. We have used a set of eleven multimedia exercises and their corresponding paper format, i.e., in total we observed, recorded and analyzed the children's behavior in twenty-two cases (eleven on paper and eleven on the computer), as it will be reported in section 4. These multimedia exercises are a subset of the ones available in a Web-based system to support students' learning, explained in section 2.2. The prompt feedback about the exercises accuracy, added to the training with different exercises sets about the same subject, besides the utilization of video, color, sound, etc., that positively reinforce children's senses, are elected as the main advantages of these exercises.

The remaining of the paper is organized as follows: The next section presents the more recent programmes that the Portuguese government have launched to help IT settlement, as well as our team's efforts in the dissemination and use of IT resources, namely the ones related with Internet's usage, and with the Web-based e-Exercise-book system. Furthermore, in section 3 we present a review of how children can learn through the use of exercises and games and section 4 is dedicated to the presentation of the collected data and some of our main retrieved achievements. Finally, in section 5 we present this work's major and significant conclusions.

Portuguese reality

Governmental programmes

The Portuguese computational park is very diverse, ranging from scholar and personal desktops to laptop computers, or from low-processing capabilities (e.g., computers running under a Pentium I processor and lower) and low-memory, both main RAM memory and secondary hard-drive memory, to high-processing capabilities and high-memory. Additionally, whereas in some rural areas the Internet connections are limited to 128Kbps (Kilobits per second), in urban areas Internet may reach from 256Kbps up to 16Mbps (Megabits per second) with ADSL (Asymmetric Digital Subscriber Line) connections. This is a consequence of the several different programmes being implemented during the last decades (Santos, 2001; Reis, 2002; Reis 2003; and also de governmental sites http://www.umic.pt/ and http://www.fccn.pt/).

Besides these difficulties, it was also elsewhere recognized the necessity to call on specific training for teachers, based on Internet contents (Pratt, 2008; Reis et al., 2008); in the Portuguese specific case, for instance, the teachers also reported the lack of time to meet the program as recommended by the Portuguese Ministry of Education.

The Programme "Internet in the Schools", launched by the Portuguese Ministry of Science and Technology (MST) in 1997, aimed at the development of Information Technology in the Portuguese schools. Each school (basic teaching, 2nd cycle — 5th and 6th grade, and secondary — 7th to 12th) was provided with at least one multimedia computer with Internet access. For more information and further details about the organization of the educational system in Portugal and other countries, please visit the following site: http://www.eurydice.org.

In the year of 2006, the "ESchool" Programme (e.escola—http://www.eescola.net/indexA.aspx) enabled both teachers and students, from the 5th up to 10th grades, to purchase a low 150 euro cost laptops. More recently, some protocols have also been set by the national government with Intel, the leading telecommunications operators (Optimus, TMN, Vodafone, and Zon, all Portuguese Telecom operators), Microsoft, "Magic Box" (Caixa Mágica), and the local members, allowing primary schools students accessing portable computers with Internet access, known as "Magalean" (Magalhães), for a maximum cost of 50 euro (http://www.eescolinha.gov.pt/portal/server.pt/community/e-escolinha/200/apresentacao). Additionally, a huge effort is being lately made in equipping all the classrooms with interactive multimedia boards.

The existence of computers at schools, as this Portuguese example shows, is obviously necessary to integrate IT effectively in the learning process, but it is by no means sufficient. Setting-up infrastructures is a relatively simple process when compared to its actual handling, since both the necessary training and the change of habits of the entire school community, that lead to an everyday practice, are the result of a slow and gradual process, which entails a number of technical and cultural difficulties, Reis et al. (2008); Brown et al. (2008); Pratt (2008); Gil and de Vasconcelos (2007); Wishart (2004); Watson et al. (1998). Moreover, several researchers claim that it is what teachers think and believe that ultimately shapes the activities in the classroom, Hargeaves (1993); Lampert and Ball (1998); Pijlc and Meijer (1997).

Web-based E-Exercise-book System overview

The lack of tools supporting the authoring and automatic checking of exercises sustaining specific topics in primary education (e.g., ordering and numbering in mathematics), drastically reduces the advantages in the use of e-learning environments on a larger scale.

For a complete description of the system presented in this subsection please refer to Peres et al. (2010). The Web-based "Collaborative E-Exercise-book" system is a Web application divided in a back-end, and a front-end. In short, the back-end works as the administration component of the system, and the front-end is the system's work area. The user must be registered, and in order to get full system's features and advantages s/he must pass through the authentication (login and password) process. A non-registered user may do random exercises but s/he has no access to its completed work (set of solved exercises), neither to statistics nor to new exercises areas. On the other hand, a registered student has indeed access to its own personal area, where s/he can see (and do) the work as recommend by his/her teacher.

Meanwhile, the registered teacher may post new exercises, recommend students' home-work, and access statistics. The statistics module grabs all the information of every student. The information that may be queried by the teacher concerning a student (individually), a group of students or even the entire class, includes grades, time spent per exercise, number of tries, who has done its set of exercises (complete homework or the exercises individually), among others.

Furthermore, the mentioned system also has a forum/discussion area intended to promote the interaction amongst teachers, parents and students. We believe that this area, in particular, may be used not only to increment the use of IT by teachers and students, but also to promote teacher-student-parent communication, especially if all parts, namely teachers, students, and parents, are expected to share their thoughts, worries, activities, strategies, etc., thus allowing a truly collaborative work through this system.

Consequently, teachers, pupils and parents are given the chance to post and e-mail questions/opinions to other participants in the discussion/forum area, including text message, photos, audio and video, in order to foster rich contexts for discussion.

This process of discussion is divided into three steps, as follows: the first step consists in preparing the question/opinion (e.g., write the question/opinion on a paper and then take a picture of it or record the question in sound or video); the second step sends the multimedia message by e-mail (individual e-mail accounts are set for each participant); and the third, and final, step focus on the system which analyzes the message and then publishes it in the discussion community (the e-mail's subject line becomes the topic title of the discussion and the e-mail's body is the body of the discussion).

We want that in the near future this system may be used in English-speaking countries, and so the system is already prepared to support different languages (Multilanguage support). The user must choose the desired language and then translate (and upload) the exercises' contents into the system database. From the exercises point of view, they do not need adjustments, because it all depends on the templates (the templates must be designed in English, as well as everything they contain, such as video, images, text, speech, music, etc.).

Figures 1 and 2 show the screenshots of two examples of multimedia exercises used in this study; Indeed, in figure 1, the student is asked to drag and drop the animals into the circle, and in figure 2, the student is asked to sort the numbers in ascending order. As can be seen, the character in this template "says" "*Olá! Ana"* (*Hello! Ana*; this information was retrieved from the user login name). Also, all the exercises provide automatic feedback to the student about its respective accuracy, by simply clicking the "*Verificar"* (*verify*) button.

Fig. 1. Sample exercises: drag and drop the animals into the circle.

It shall be remarked that this set of exercises represents a promising didactic strategy concerned with promoting the rich teaching practice that brings together both "inductive" and "deductive" methods, obviously depending on the particular dynamic of the teaching/learning process. Also, and according to Zabalza (1994), the affective and motivating attitude of the teacher, along with the more "technical-objective" one shall be object of major concern, as the child is frequently put at the center of all our decisions. This means that it is the pupil who has to be able to withstand all the technical and emotional situations which s/he is exposed to, therefore justifying the study of the attitudes and cognitive strategies and actions from which that is brought out, Zabalza (1994).

Furthermore, the set of exercises used in this study were built specifically to deal with the special needs of the children under consideration, using a model based on the constructivist approach, particularly inspired in the work of Papert (1980, 1993, 1996), also agreeing with the guidelines and educational programs offered by the Portuguese Ministry of Education. For example, with the exercise presented in figure 1 we aim to contribute to an improvement of the following skills: to form sets of two, three, four, five or more objects / elements, to form sets by classes, establishing relationships between sets. With the exercise presented in figure 2 we aim to contribute to an improvement of the following skills: to read and to write numbers to 10; to perform counts in increasing and decreasing order to 10, to sort in a logical order numbers, figures and patterns.

Fig. 2. Sample exercises: sort the numbers in ascending order.

Learning through exercises and games, and children with special needs

The most effective educational practices should be built upon all the ways in which humans are especially gifted at picking out certain kinds of information and causal patterns. All too often, educational approaches have adopted deficit model in which it is assumed that children enter the schools with bundles of misconceptions that need to be overridden and corrected. A primary goal of education should be to generate explanatory ideas that are just at the right level of detail, that is, the right grain size. However, this is not an easy challenge to be faced with. It requires several things, such as: knowing what students are already and more acquainted with, knowing what they could potentially know after a reasonable period of instruction, and knowing what kinds of new knowledge would do them the most good when it comes to expanding their understanding of the world and enabling them to make more informed decisions and more effective actions in relevant contexts.

As stated by Keil (2008), "children acquire most of what they know secondhand, through others", and most of the knowledge "occurs in many nonschool settings such as through television, museums, toys and other artifacts, the Internet, or even in various games and activities such as chess, cooking, or running a lemonade stand".

Modern teaching and researching communities agree that it is through the strategic didactic approach based on the use of exercises and games, that learning becomes potentially effective, regardless of the educational model or philosophy used. For example, proponents of socio-cultural theory claim that learning is primarily a social process mediated through interactions using tools Vygotsky (1978); Wertsch (1992). Accordingly, Vygotsky (1978) does consider that mediation occurs through the use of 'semiotic' and 'material' tools. The semiotic tools include symbols, signs, and spoken languages. Material tools include such items as pens, spoons, and particularly networked (Internet) computers. Most importantly, not only do these tools simply facilitate the set of activity that might take place in the educational process and setting, but also they fundamentally shape and define the type of activities that might be developed, Wertsch (1992).

Furthermore, Seymour Papert (1980) proposed the use of tools, particularly the computer, considered as "a mighty education tool", in serving the process of building knowledge, from which the "constructionist" theory would emerge, adapting the very beginnings of the cognitive constructivism of Jean Piaget in order to make a better use of technology.

Becoming competent in mathematics, for example, one can be conceived of as acquiring a mathematical disposition (see, for example, Corte and Verschaffel, 2006; Council 2001). Traditionally, the dominant form of learning in schools has been the known teacher directed learning or guided learning, that is, "a trainer or teacher takes all the relevant decisions and the learner can and should follow him or her. Within such learning model, it is the teacher who decides about the goals of learning, the learning strategies, the way how to measure outcomes and takes care of feedback, judgments, and rewards", Simons et al. (2000). However, besides guided learning, there are two additional types of learning experiences as identified by Simons, Linden and Duffy, Simons et al. (2000), namely the: experiential and action learning. Also, there has been a strong and widespread awareness regarding the advantages of novel classroom practices and cultures thought of to facilitate and support learners through the gradual and progressive acquisition of adaptive mathematical competence. Indeed, such practices and cultures are therefore expected to create the necessary conditions for a substantial shift from a poorer guided learning experience towards a richer experiential one, as well as action learning, regarded as a successful learning strategy from the didactics standpoint, Fontoura (1971), resulting in a balanced and integrated use of the three ways of learning: constructive, self regulated, and contextual or situated, Corte (2007).

The constructivist view of learning has become common ground among educational psychologists (see, for example, Phillips, 2000; Simons et al., 2000; Steffe and Gale, 1995). Actually, constructivism implies that constructive learning is self-regulated. According to Zimmerman (1994), self-regulation "refers to the degree that individuals are metacognitively, motivationally, and behaviorally active participants in their own learning process". Moreover, De Corte (2007) emphasizes that "constructive and self-regulated learning processes should be preferably chosen and studied in context", and because learning is collaborative, the learning efforts are distributed over the individual student, his/her partners in the learning environment, and the (technological) resources and tools that are available, Salomon (1993).

What's more, De Corte (2004) stresses that "starting as much as possible from tasks and problems that are meaningful and challenging for students, learning environments should initiate socially supported constructive learning processes that enhance students' cognitive and volitional self-regulatory skills". It is expected that students will be able to use their acquired knowledge and skills to solve a given mathematics-related situation and further corresponding problems in everyday life, something that Bransford and Schwartz (1999), and Bransford et al. (2006), call "preparation for future learning".

When it comes to children with special education needs, according to Jeffs et al.(2003) "Technology as a teaching tool immediately, profoundly, and positively impacted the education of individuals with mental retardation (…). The introduction of the computer as a teaching tool (…) can be viewed as the greatest agent of change (…) for individuals with mental retardation". In particular, and as stated by Zentel, Opfermann, and Krewinkel, (2006) "A Computer can be used as an effective learning tool to support the acquisition of basic learning skills". In addition, and according to Wehmeyer (1998), the work with this medium supports the increase of self-determination, of independence, and integration skills, and allows for "positive changes in inter- and intrapersonal relationships, sensory abilities and cognitive capabilities, communication skills, motor performance, self-maintenance, leisure, and productively", Parette (1997).

The ways that computers can support writing by students with learning disabilities was studied by MacArthur (1996), with an emphasis on applications that go beyond word processing. Williams (2005) used ICT in a special educational needs environment to develop a multimedia learning environment. He examined the benefits and barriers of ICT usage, and attitudes and experiences of special educational needs teachers were also explored. The special educational needs working environment was found to have changed greatly in recent years. There was now a more formal and structured curriculum, and many attempts at activities designed to foster inclusion. Difficulties faced by teachers included a lack of and poorly functioning equipment, a paucity of appropriate learning materials, and unusual challenges posed by the differing needs of learners. The needs of teachers included ways of facilitating evidence of progress, lesson plans classified according to cognitive and accessibility levels, and administrative information. Advantages of using ICT ranged from enhancing the learning experience by offering a more personalized environment, to "liberating pupils" from problems such as physical cutting and pasting. Also, in Portugal the work of Esteves et al. (2008), for example, introduces software directed to young children less than 13 years old with special needs at vision and sound levels, addressing the usability.

METHOD

As previously mentioned, we have conducted a case study of two children, one with mental retardation and one with cerebral palsy. The clinical statuses of these children were previously established by a team of experts, according to the Portuguese legislation. The Ministry of Education asked our team to intervene at the educational level to ensure the learning of these children. These children belong to the same group of schools, namely the "Agrupamento de Escolas de Santa Marta de Penaguião" (Portugal), where one of the co-authors worked during the 2008/09 academic year. They were the only children with these kinds of disabilities. More than quantitative we wanted that our work to be qualitative, and so we have used the case study methodology proposed by Yin

(1984). By using this methodology the researcher can conduct its "participant observation" research in its working context.

We have used a set of eleven multimedia exercises together with its corresponding equivalent paper format. As explained in subsection 2.2, these exercises were built specifically to deal with these special needs, using a model of constructivist inspiration. Two examples of these exercises are presented in figures 1 and 2. This means that, in total, we have used several data sheets to observe, record and analyze the pupils' behavior in twenty-two cases (namely, eleven on paper and eleven on the computer). Obviously, this set of exercises agrees with the objectives proposed by the Portuguese Ministry of Education, and trying to contribute to develop the desired skills. The pupils were presented with the referred exercises between the months of April through June of the 2008/09 academic year.

Table 1 presents the obtained results concerning the child with cerebral palsy. As we can observe from the results regarding the paper exercises, on average, there was 28.0 (362.1 – 334.1) seconds less total time, the run time of the exercise itself was higher, precisely 13.6 (267.7 – 254.1) seconds. The "total time" includes de "execution time" plus the time the child is focused in the teacher's explanation of how to solve the exercise (i.e., what the child is asked to do). Hence, the "difference" row represents the extra time the child was more attentive to the teacher and the exercise itself. This also implies that although the child took less time to solve the paper format exercises, namely exercises number 1 (5 seconds), 9 and 10 (20 seconds) she was, overall, more attentive (on average, she was more 41.6 (108 – 66.4) seconds attentive per exercise).

Also, the mode (most frequent case) is the same for the indicators "anxiety", "attention", "withdrawal" and "difficulty solving the exercise" and in both types of multimedia and paper exercises. We may also conclude that there were always more manifestations of interest, persistence, less anxiety and greater willingness to continue on solving multimedia exercises rather than in paper format. It is also clear that, on average, hear less help, more joy, less anxiety, less apathy, more attention, less disinterested, less withdrawal, fewer difficulties in solving the exercise, easier to perform/run the exercise and less indifference.

These facts are also reinforced by the child's comments noted in our "diary-board" when she said "It's fun playing this! And now teacher...? Teacher, and now, what will I do?" or "Let's make another?", referring to the multimedia exercises, or "I no longer work more!", "This is boring!", "When we work on the computer?" or "I'm sick of work! It's just work, work, work, ...!", when commenting on the paper exercises.

When it comes to the child with mental retardation, as we can see from the results in table 2 dealing with the paper exercises, on average there was 6.7 (179.7 – 173.0) seconds less total time of concentration, the run time of the exercise itself was higher, 34.4 (144.4 –110.0) seconds. This fact is also reinforced by the data in row "difference", meaning that the child was more attentive to the teacher's explanation, on average, she was more 41.1 (69.7 – 28.6) seconds attentive per exercise.

Having the multimedia exercises for reference, on average, we can also conclude that the child needed less assistance, had more joy, less anxiety, less apathy, more attention, less disinterest, less withdrawal, less resolution difficulties, found it easier in run, less indifference, more absorption, more persistence, less sadness, and showed more will to continue on doing the exercises. We have not registered any changes in the manual dexterity/fine motor. Also, the mode (most frequent case) is the same for all indicators except for "disinterest", being bigger for the paper exercises.

The child's comments *"When may I go to the playground?"* when working with paper format exercises, and *"the computer is more fun", "When done, I go to my computer?"*, or *"may I work on the computer?"*, when working with the computer, both recorded in our "diary-board", have clearly and undoubtedly shown that the child elected the multimedia exercises as the favorite ones.

As can be further observed, the child with mental retardation began to experience the most difficulties in solving the multimedia exercises, which warranted some extra help, but after this situation was overcome, the child not only revealed less indifference, but also showed more interest and willingness to continue on solving the multimedia exercises. Such behavior may be due to the fact that the student was not familiar with the use of computers to solve exercises, however, throughout the school year we perfectly noticed the progressive development of a positive "familiarity" attitude towards the computer.

These facts seem to be partially untrue in 7 (4%) of the 187 values. More precisely, and having for reference the multimedia exercises, in exercise number 1 we have observed more anxiety, in exercise number 2 more resolution difficulties and less easy in run, in exercise number 3 more help, in exercise number 4 more indifference, in exercise number 6 less joy, and in exercise number 11 less attention.

CONCLUSIONS

Students with disabilities have a set of unique characteristics that hinder their integration in school and consequently their learning. With this work we, somehow, have contributed to promote the indispensable and necessary inclusion, significantly improve teaching practices (in both personal and professional dimensions) and positively promote the educational success of children with disabilities.

However, we must remember that nothing is worth this teacher effort if the student does not have an active participation in the process, being fundamental to "strengthen the capacity of the subject itself to manage its projects, its processes, its strategies" Perrenoud (1999).

Only through the knowledge of the medical history and the development process of a disabled child, the most common causes and recognized characteristics of disabilities and their educational possibilities can we, in fact, develop in consciousness, an individual educative program and consequently an educational program that caters the child's needs and contribute to an effective learning and development of skills and capabilities.

Finally, we may conclude that the studied children prefer multimedia exercises (using the computer) rather than exercises in paper format (using more traditional materials) and exhibit a more positive attitude towards the former. Holistically, and based on the multimedia exercises, we can state that the total time that the children were focused was higher, the total run time was lower, the help was lower, the joy was greater, the anxiety was lower, the apathy was lower, the attention was greater, the disinterest was lower, the withdrawal was lower, the difficulty in solving the exercises was lower, the ease in running the exercises was greater, the indifference was lower, the interest was greater, the persistence was greater, the sadness was lower and the will to continue on solving exercises was greater.

Indicator	Multimedia format														Paper format													
	Exercise number											Avg	Std	Mod	Exercise number											Avg	Std	Mod
	1	2	3	4	5	6	7	8	9	10	11				1	2	3	4	5	6	7	8	9	10	11			
Time focused	60	80	82	155	96	210	600	540	600	900	660	362.1			50	70	80	140	80	180	550	545	580	800	600	334.1		
Execution time	50	45	30	60	60	90	420	360	540	600	540	254.1			45	50	40	70	60	120	470	405	520	580	585	267.7		
Difference (time)	10	35	52	95	36	120	180	180	60	300	120	108			5	20	40	70	20	60	80	140	60	220	15	66.4		
Help	1	2	2	2	2	2	3	3	3	3	3	2.4	0.7	2	2	2	2	2	2	3	3	3	3	3	3	2.5	0.5	3
Joy	3	3	3	3	3	3	3	3	1	3	3	2.8	0.6	3	2	2	2	2	2	2	1	1	1	2	1	1.6	0.5	2
Anxiety	1	1	1	1	2	2	2	2	2	1	2	1.5	0.5	2	1	1	1	2	2	2	2	2	2	2	2	1.7	0.5	2
Apathy	1	1	1	1	1	1	2	2	2	1	1	1.3	0.5	1	1	2	1	2	1	1	2	2	2	1	2	1.5	0.5	2
Attention	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	2	2	3	2	3	3	3	2	3	3	2	2.5	0.5	3
Disinterest	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	1	1	1	1	2	2	1	2	2	2	1	2	1.5	0.5	2
Withdrawal	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	1	1	1	1	1	1	2	1	2	2	2	2	1.5	0.5	1
Manual dexterity/f.motor	3	3	3	3	3	3	3	3	2	2	2	2.7	0.5	3	3	3	3	3	3	2	2	2	2	2	2	2.5	0.5	2
Resolution difficulties	1	2	1	2	2	3	3	3	3	3	3	2.4	0.8	3	1	1	2	3	3	3	3	3	3	3	3	2.5	0.8	3
Easy in run	3	2	3	2	3	1	1	1	1	2	2	1.9	0.8	2	3	3	2	2	1	1	1	1	1	1	1	1.5	0.8	1
Indifference	1	1	1	1	1	1	2	1	1	1	1	1.1	0.3	1	1	2	1	2	2	2	2	3	2	3	3	2.1	0.7	2
Absorption	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	2	2	2	2	2	2	2	2	2	2	2	2.0	0.0	2
Persistence	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	2	2	2	2	2	2	2	2	2	2	2	2.0	0.0	2
Sadness	1	1	1	1	1	1	1	1	1	1	2	1.1	0.3	1	2	2	2	2	2	2	3	3	3	2	3	2.4	0.5	2
Will to continue	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	2	2	2	2	2	2	2	2	2	2	2	2.0	0.0	2

Table 1 – Recorded indicators of involvement and success for the child with cerebral palsy (1—None, 2—Low, 3—High): Avg—average, Std—standard deviation, Mod—mode.

Indicator	Multimedia format														Paper format													
	Exercise number											Avg	Std	Mod	Exercise number											Avg	Std	Mod
	1	2	3	4	5	6	7	8	9	10	11				1	2	3	4	5	6	7	8	9	10	11			
Time focused	20	25	20	30	40	50	60	90	371	540	731	179.7			18	25	20	30	35	45	55	85	350	540	700	173.0		
Execution time	10	17	18	25	30	40	50	60	180	420	360	110.0			12	20	18	26	30	40	52	70	250	490	580	144.4		
Difference (time)	10	8	2	5	10	10	10	30	191	120	371	69.7			6	5	2	4	5	5	3	15	100	50	120	28.6		
Help	1	1	2	2	2	2	2	2	2	2	2	1.8	0.4	2	1	1	1	2	2	2	2	2	2	3	3	1.9	0.7	2
Joy	3	3	3	3	3	2	3	3	3	3	2	2.8	0.4	3	3	3	2	3	3	3	3	2	2	3	2	2.6	0.5	3
Anxiety	2	1	1	1	1	2	1	2	1	1	2	1.4	0.5	1	1	1	1	1	1	2	2	2	1	2	2	1.5	0.5	1
Apathy	2	1	2	2	2	2	1	2	1	1	2	1.6	0.5	2	2	2	2	2	2	2	1	2	2	1	2	1.8	0.4	2
Attention	3	3	3	2	3	3	3	3	3	3	2	2.8	0.4	3	2	3	3	2	2	2	3	3	3	3	3	2.6	0.5	3
Disinterest	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	1	1	1	1	2	2	2	2	2	1	1	2	1.5	0.5	2
Withdrawal	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	1	1	1	1	1	1	1	1	1	1	1	2	1.1	0.3	1
Manual dexterity/f.motor	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3
Resolution difficulties	1	2	2	2	2	2	2	2	2	2	2	1.9	0.3	2	1	1	2	2	2	2	2	2	2	3	3	2.0	0.6	2
Easy in run	3	2	2	2	2	2	3	3	2	2	2	2.3	0.5	2	3	3	2	2	2	2	2	2	2	2	2	2.2	0.4	2
Indifference	1	1	1	2	1	1	1	1	1	1	1	1.1	0.3	1	1	1	1	1	1	1	2	2	2	2	2	1.5	0.5	1
Absorption	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	3	3	3	2	3	2	2	3	3	3	3	2.7	0.5	3
Persistence	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	3	3	3	2	3	3	3	3	2	2	2	2.6	0.5	3
Sadness	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0	1	1	1	1	1	2	2	1	1	1	1	2	1.3	0.5	1
Will to continue	3	3	3	3	3	3	3	3	3	3	3	3.0	0.0	3	3	3	3	3	3	3	2	2	3	3	2	2.7	0.5	3

Table 2 – Recorded indicators of involvement and success for the child with mental retardation (1—None, 2—Low, 3—High): Avg—average, Std—standard deviation, Mod—mode.

We would also like to stress out that the use of computers has enabled the development of both tactile and motor coordination by touching / pressing buttons (using the keyboard) and mouse, and this fact was more evident in the case of child with cerebral palsy.

These conclusions agree with the views of the different researchers presented in section 3. In particular, the exercises helped children to acquire basic leaning skills, increased self-determination, independence, and integration skills, and also allowed for positive changes in inter- and intrapersonal relationships, sensory abilities and cognitive capabilities, communication skills, motor performance, self-maintenance, leisure, and productively.

We believe that the prompt feedback about the exercises correctness, added to the training with different exercises sets about the same subject, besides the utilization of video, color, sound, etc., that positively reinforce the different child's senses, definitely contributed to capture and motivate the child.

In fact, according to Warschauer (2007), "New technologies do not replace the need for strong human mentorship, but, indeed, amplify the role of such mentorship". Obviously, it is already remarkably recognized that the students must become into contact with the new teaching/studding tools progressively, in order to take part in the learning environment as smoothly as possible.

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