

PLAIME: Multimedia Platform for the Integration of Handicapped Children in Music Education

Maria-Dolores Cano, Antonio Martinez-Rojo, Ramon Sanchez-Iborra, Andrés Cabrera-Lozoya, Fernando Cerdan
Department of Information Technologies and Communications
Universidad Politécnica de Cartagena
Cartagena, Spain
{mdolores.cano, antoniom.martinezrojo, ramon.sancheziborra, andres.cabrera, fernando.cerdan}@upct.es

Abstract—This paper focuses on the use of multimedia technology to augment instruction for a special population. In Spain, the main musical instrument used in music classes is the recorder. However, the integration of children with disabilities in music classes that strictly follow a traditional learning system can be very difficult or even intractable, resulting in a negative effect on students. Information technologies represent a valuable means to overcome this potentially negative situation. In this work, we present the PLatform for the Integration of handicapped children in Music Education (PLAIME), a multimedia tool to assist children in learning music, disregarding having some disability that inhibits handling the recorder. This tool is not intended to replace the teacher but to serve as a complementary learning mechanism, integrating e-learning with traditional learning. PLAIME includes theoretical lessons, customized activities, and collaborative games using peer-to-peer technology. Initial results show a positive acceptance by children.

Keywords—media in education; computer-assisted instruction; handicapped children; interactive learning environments; music learning tool.

I. INTRODUCTION

The Information Age is imposing new challenges in current education systems. In Spain, one of the compulsory areas for primary education is Artistic Education that includes Music and Plastic. The curricula for primary education include two significant goals. The first goal is to use Information and Communication Technologies (ICT). ICT functions as a facilitator of active learning and higher-order thinking and also serves as a tool for curriculum differentiation, adapting the learning content and tasks to the needs and capabilities of each individual pupil [1]. Moreover, the significance of cooperation and interaction in the classroom environment in order to promote the acquisition of learning skills and social relations has been demonstrated in previous works [2], and [3] has shown the positive impact of software games on pupils' logical and strategic reasoning skills. The second goal is to be able to communicate through oral, corporal, visual, and musical means, developing the capacity of enjoying artistic expressions. The combination of these two goals results in an interesting music learning approach, e.g., Chan *et al.* [4] identified that ICT enabled pupils to approach music-based

activities with greater confidence, a deeper level of understanding, and appreciation. Moreover, music has gained recognition through the years, and is playing a key role in the field of learning disabilities, providing a better quality of life to this group [5].

Although the current offer of software tools for music learning is varied, there is still a gap on the use of ICT in music teaching. With our proposal, we propose to address a current problem in Spanish primary schools: how to approach to a handicapped student during music classes? Through the collaboration between music teachers and university researchers in the telecommunications field, we present PLAIME (PLatform for the Integration of handicapped children in Music Education), a useful multimedia tool for both teachers and pupils in primary music education. With PLAIME, a handicapped student can learn at the same pace as other pupils using the software tool instead of playing the recorder. Thus, PLAIME assists children to learn the primary education music curriculum whatever their physical condition is, creates a common ground for music learning promoting social inclusion, and fills the gap between ICT and music teaching.

The rest of the paper is organized as follows. Section II reviews other similar tools for music education with children. In Section 3, we identify the goals of our platform and describe its functionalities. A first insight on children's attitude towards the platform is included in Section IV. The paper ends summarizing the most important facts.

II. RELATED WORK

Networked DrumSteps is a free tool for meaningful, collaborative, interaction in a constructionist music composition environment. It allows multiple users in different locations to collaborate in the process of music composition, but without the use of standard notation. Students that were tested confirmed that music composition in groups was much more fun and different than working alone, hence proving the advantages of collaborative software for music learning. Gall *et al.* [7] evaluated the impact of eJay in the development of composition skills in children aged 10–11 using Dance eJay. This music software provides the user with a variety of short musical samples that students can organize to create their own piece of music. After their study, authors argued that the use of eJay in the classroom led to a collaborative work among students that

increased their music creativity. In a similar way, the commercial software Teach me Piano Deluxe (TPD) teaches basic practical keyboard skills in music, focusing on rhythm, staff notation, and fingering. After being studied, authors concluded that TPD had clear effects on high school students, enhancing their rhythm, note-reading, and pitch.

The i-Maestro project [8] is intended to develop interactive multimedia environments for technology enhanced music education. The main technical objectives of the project include: basic research and development on new solutions and enabling technologies to support traditional pedagogical paradigms for music training, novel pedagogical paradigms, and a framework for technology-enhanced music educational models and tools to support the creation of flexible and customized e-learning courses to improve accessibility to the musical knowledge. Compared with our proposal, i-Maestro is a more ambitious project tackling much deeper music knowledge, excellent for arts schools, but maybe less indicated as a supportive application for a primary school curriculum. As a minor observation, it has been thought for string instruments, whereas in this proposal we work with a wind instrument due to its popularity in Spanish primary education. Finally, Lenmus [9] is a free open source program to practice music reading skills, to improve aural recognition abilities, and to acquire theoretical music knowledge. It also includes a score editor. Above all, it focuses on recognition of intervals, chords, scales, and tonality. It is based on the use of music books written in XML that teachers have to create using the DocBook XML format. In our opinion, Lenmus is not children-oriented, and would be recommended for music knowledge much deeper than the requirements of a primary education music curriculum. Moreover, the use of XML syntax is not straightforward, requiring an extra effort from the teacher's point of view. Table I summarizes PLAIME's features compared to these tools from the related literature. The comparison has been completed based on the corresponding works mentioned above. Observe that, up to the knowledge of the authors, none of these works makes any reference to disabled pupils.

III. PLAIME

PLAIME is a complementary method for music learning in primary education, promoting social inclusion of

handicapped children in a music learning environment. With the proposed multimedia platform, children with disabilities will be able to emulate music practice at the same pace of other pupils. Although they will not play the instrument physically, they will become more knowledgeable in music basics and will be part of the same educational environment. Designed for children, PLAIME includes basic concepts about the recorder and assists in acquiring competences such as basic scores and notes identification. Following guidelines from the teachers and from the primary education Spanish curriculum, PLAIME provides a gradual acquisition of music knowledge.

Bearing this in mind, the specific challenges of the platform can be described as follows. This tool has to be useful in order to help in the understanding of music in primary education, thus being necessary to attend the music teacher demands to achieve a real useful tool, and to avoid teachers' negative beliefs about the benefits of ICT on primary education [10]. The platform has to be interactive and versatile through the combination of theory, exercises, and games. Outstanding over other platforms, activities and games in PLAIME address student differentiation issues. Particularly, games and exercises of our platform can be used not only in the classroom but also in extracurricular activities or at home. The graphical interface has to be simple, attractive, and intuitive for teachers, parents, and children, carefully taking into account design requirements for handicapped children. Previous works [11] have verified the relationship among button size and number of buttons in a touch screen and the effectiveness of the assistive communication device interface. We follow these recommendations. Observe that a normal screen could be also employed. Last, Java is the selected high-level object-oriented programming language. With platform independence, PLAIME can be run in any software or hardware platform. We have followed the Factory and Singleton programming patterns, which allow an easier error recovery and memory saving, particularly interesting when using a graphical interface. In addition, the system has been designed to take advantage of polymorphism to reduce processing load.

The platform starts with a launch screen, a user selection screen, a character screen, and a main menu screen (see Fig. 1). Regarding the pedagogical agents (character), we decided

TABLE I. COMPARING PLAIME WITH OTHER AVAILABLE MUSIC LEARNING TOOLS (L=LOW;M=MEDIUM;H=HIGH)

	i-Maestro	Networked DrumSteps	eJay	TPD	Lenmus	PLAIME
Audience	All ages	All ages	All ages	All ages	All ages	All ages
Instruments	String	Drums	Several	Piano	Several	Recorder
Music knowledge	H	L	M	H	M	L
Lessons	Yes	No	No	Yes	Yes	Yes
Practice	Yes	No	No	Yes	Yes	Yes
Games	Yes	Yes	No	No	No	Yes
Composition	No	Yes	Yes	Yes	Yes	No
Collaborative	Yes	Yes	Yes	No	No	Yes
Contents' flexibility	H	L	L	L	M	H
Teacher's required ICT knowledge	M	L	L	L	H	L
Children-oriented graphical interface	No	Yes	Yes	Yes	No	Yes
Adaptability to primary schools' curriculum	L	M	M	M	L	H

to incorporate an unrealistic character integrated with the whole application design as an onscreen trainer, which makes students to learn better [12]. The character is active only for the explanations (lectures), not participating in games or in activities. This is the best approach to not distract the learners attention, i.e., to not interfere negatively on the learning process, but at the same time fostering learning [13]. The characters included in PLAIME are simple, 2D, as preferred by children [14]. On the other hand, for the designs used to show the positions of fingers over the recorder, we use a more realistic approach, since they try to “reflect” the student’s hands.

Lectures have been developed following an example of Spanish music curriculum for primary education. Accordingly, PLAIME comprises seven theoretical lessons. The structure of a lesson includes an explanation (whose content can be read by the character), examples, and practice (see Fig. 2). Contents include: recorder history, recorder structure, basic techniques regarding tongue and finger position and breathing, practicing how to play the recorder, and reading and writing scores. In a traditional classroom environment, the teacher explains and then the pupils play (physically) the recorder. From the disabled pupil’s perspective, the practice section of each lecture provided in PLAIME allows him to perform virtually with the advantage of being in the classroom with the other students. Being with their peers has social benefits for children with disabilities. Moreover, children with peer interaction skills are more likely to be accepted by their peers, and are less likely to experience the negative effects of social rejection [15].

With PLAIME, students can load activities created by their teacher or even by their parents using a built-in activities content manager. Students can complete these activities at the school or a home, benefiting from parental participation in their education. An activity can include as many exercises as necessary, and exercises belong to eight different types: test, questions, score to note, note to score, recorder to note, note to recorder, score to recorder, and recorder to score. Tests and questions are the traditional exercises to evaluate theoretical knowledge. The work with notes is divided into six different exercises that increase in complexity, from the simplest “score to note” to the toughest “score to recorder” (see Fig. 2). The platform is designed so that solved exercises can be saved in the computer, printed, or sent by email to the teacher. Handing in the answers in any of the available methods (e.g., email) is the way to get personal feedback from the teacher, and to obtain an explanation on why the exercise is right or wrong. Observe that feedback is often the weakest link in educational software, often offering nothing more than an indication of whether an answer is right or wrong [16]. The activities content manager is an additional built-in program that allows the teacher or the parents to create a new activity or to open an existing activity for edition.

Games have been included in PLAIME because they can be effective teaching and learning tools and the incorporation of multimedia stimuli and games is a motivational factor for children, enticing them to use the software [16]. Moreover, by using these games, pupils (handicapped or not) play with



Figure 1. Character screen.

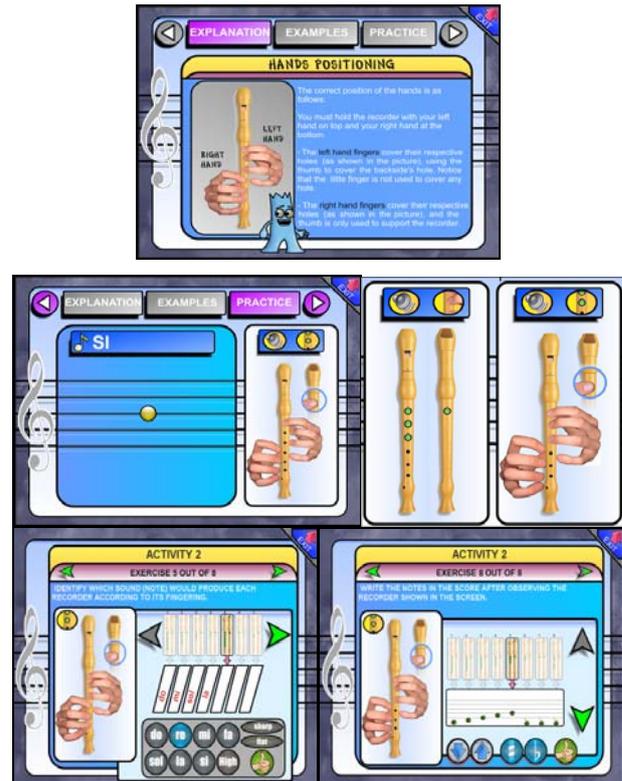


Figure 2. Example of explanation and practice.

their peers in the classroom (or at home) favoring the creation of an inclusion environment, which will have a positive effect on their social and educational behavior [15]. PLAIME contains six games, each one designed to develop a specific music skill, such as writing and reading scores or performing a score with the recorder (see Fig. 3). It is also possible to play with two players in the same local area network using Peer-to-Peer (P2P) technology. All games provide feedback on the learner’s performance, thus he progresses at his own pace.

IV. INITIAL EVALUATION APPROACH

A first experience on children acceptance of this tool was carried out in the Information Society fair for citizens, which takes place annually in the Autonomous Community of Murcia (Spain). During two days, we presented our platform in one of the stands and let children use it. More than 20 children between 6 and 11 years old accompanied by their

parents showed spontaneous interest in PLAIME and decided to use it (see Table II). More than 90% of these children found it fun and useful, spending in average 14 minutes using it. Their parents also found the platform as very useful. Nevertheless, only 75% rated it as easy to use mainly because of the use of the activities content manager. This is only an initial observation, and a deeper study is needed to collect teachers' experience and measuring the effect on children's music and social attitudes.

V. CONCLUSION

PLAIME is a multimedia platform designed to promote the integration of children with special educational needs in music classes. With this software tool, we create a common ground for music learning that allows differentiation requirements, but at the same time is compatible with a traditional music curriculum approach. The platform is highly flexible, allowing the teachers to customize contents and exercises, so that all students can learn at their own pace. PLAIME provides several games to be played by one or two players becoming a collaborative environment that benefits social inclusion. Special needs of handicapped children within music classes are not covered by other known applications because they are not designed as supporting tools for the primary education curriculum. From the initial evaluation, PLAIME is a competitive multimedia platform whose content's flexibility and design make it a potent tool to integrate traditional learning with innovative learning.



Figure 3. Example of games.

TABLE II. RESULTS OBTAINED IN A PRELIMINARY SURVEY (X=MEAN; S=STANDARD DEVIATION; (1)=CHILDREN; (2)=PARENTS)

	Children		Parents	
	mean	std_dev	mean	std_dev
Age (years) (1)	8,25	1,79	--	--
Spent time using PLAIME (min.) (1)	13,9	4,72	--	--
Useful (yes/no) (1) (2)	90%	--	100%	--
Fun (yes/no) (1)	95%	--	--	--
Easy to use (yes/no) (1) (2)	90%	--	75%	--

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REFERENCES

- [1] E., Smeets and T. Mooij, "Pupil-centred learning, ICT, and teacher behaviour: observations in educational practice", *British Journal of Educational Technology*, 32(4), pp. 403-418, 2001.
- [2] E. B. Susman, "Co-operative learning: a review of factors that increase the effectiveness of computer-based instruction", *Journal of Educational Computing Research*, 18(4), pp. 303-322, 1998.
- [3] R. M., Bottino, L. Ferlino, M. Ott, and M. Tavella, "Developing strategic and reasoning abilities with computer games at primary school level", *Computers & Education* 49 (4), pp. 1272-1286, 2007.
- [4] L. M. Y. Chan, A. C. Jones, E. Scanlon, and R. Joiner, "The use of ICT to support the development of practical music skills through acquiring keyboard skills: a classroom based study", *Computers & Education* 46, pp. 391-406, 2006.
- [5] D. Savarimuthu and T. Bunnell, "The effects of music on clients with learning disabilities: a literature review", *Complementary Therapies in Nursing & Midwifery* 8, pp. 160-165, 2002.
- [6] C. McCarthy, J. Bligh, K. Jennings, and B. Tangney, "Virtual collaborative learning environments for music: Networked DrumSteps", *Computers&Education* 44, pp. 173-195, 2005.
- [7] M. Gall and N. Breeze, "Music and eJay: An opportunity for creative collaborations in the classroom", *International Journal of Educational Research* 47, pp. 27-40, 2008.
- [8] B. Ong, N. Mitolo, and P. Nesi, "i-Maestro: Interactive Multimedia Environments for Music Education", *LNCS*, vol. 5105, pp. 770-776, Springer, Heidelberg, 2008.
- [9] Lenmus, <http://www.lenmus.org>. Last accessed November 14th, 2011.
- [10] R. Hermans, J. Tondeur, J. Van Braak, and M. Valcke, "The impact of primary school teachers' educational beliefs on the classroom use of computers", *Computers & Education* 51, pp. 1499-1509, 2008.
- [11] T. D. Sanger and J. Henderson, "Optimizing Assisted Communication Devices for Children With Motor Impairments Using a Model of Information Rate and Channel Capacity", *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 15 (3), pp. 458-468, 2007.
- [12] R.C. Clark and R. E. Mayer, "E-learning and the science of instruction proven guidelines for consumers and designers of multimedia learning", John Wiley & Sons, 2003.
- [13] R. K. Atkinson, "Optimizing learning from examples using animated pedagogical agents", *Journal of Educational Psychology*, 94 (2), pp. 416-427, 2002.
- [14] S. Girard and H. Johnson, "What Do Children Favor as Embodied Pedagogical Agents?", *LNCS*, Vol 6094, pp. 307-316, 2010.
- [15] M. B. Bronson, P. Hauser-Cram, and M. E. Warfield, "Classrooms Matter: Relations between the Classroom Environment and the Social and Mastery Behavior of Five-Year-Old Children with Disabilities", *Journal of Applied Developmental Psychology* 18, pp. 331- 348, 1997.
- [16] G. Sim, S. MacFarlane, and J. Read, "All work and no play: Measuring fun, usability, and learning in software for children", *Computers&Education*, 46, pp. 235-248, 2006.