


A new way to play music together: The Continuator in the classroom

International Journal of
Music Education
2014, Vol. 32(2) 171–184
© The Author(s) 2013
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/0255761413504706
ijm.sagepub.com


Laura Ferrari and Anna Rita Addressi

University of Bologna, Italy

Abstract

This article describes a didactic experience concerning the interaction between young children and the Continuator, an Interactive Reflexive Musical System (IRMS) elaborated at SONY- Computer Science Laboratory in Paris. The general aim was to analyse whether and how the Continuator can be used in the kindergartner during the daily school activities and the role of the teacher in the context of free play and in guided activities with the system. The experience took place in Bologna (Italy) and involved 18 children aged 3–5 years. The children learned to dialogue musically with the system and to manage various kinds of collaborative play. These factors gave rise to some particularly attentive and prolonged bouts of listening, stimulating the children to think in terms of sound and developing a genuine desire to “play” with music. This experience shows how the Continuator could represent a versatile device capable of enhancing musical creativity and exploration in a classroom setting.

Keywords

classroom setting, collaborative learning, Continuator, music creativity, new technologies

In the landscape of research on music education and new technologies, several authors have investigated the role of the new technologies and of computer devices in particular aspects of the music education, as for example the composition processes (Brown, 2007; Savage, 2006; Seddon, 2006). Brown identified three broad groups: a) computer as musical tool, b) computer as musical instruments and finally, c) computer as musical medium. Other authors, such as Williams and Webster (2006), studied, in a more general way, the impact of the new technologies on the musical learning. According to these authors, technology in music education offers new tools for reaching the non-traditional music students. Williams and Webster underlined the possibility offered by the music software to open new doors to the musical creativity and the expression for very young children who do not read notation. The traditional pedagogical tools for music education follow the traditional

Corresponding author:

Laura Ferrari, Via I° Maggio, 22, 40066 Pieve di Cento, Bologna, Italy.
Email: laura.ferrari10@unibo.it



Figure 1. A simple melody is continued by the Continuator in the same style.

way to pass on information: from teacher to pupil in a univocal way of learning, and the software tends to become a virtual teacher that gives information and tasks to children. Instead, the new types of software are characterized by interactivity and real time feedback that allow the children to play and make music according to their own competences and choosing the difficulty of the task. The technology offers the opportunity to pass from an education based on the “information age” to that based on “the creative age” (Williams & Webster, 2006). In the same way, Brown (2007) spoke of the role of technologies to assist teacher to “design technological environments that help the students develop musical intelligence and the fostering of a culture of creativity” (p. 3).

In this article,¹ it will be introduced the didactic experience carried out with young children and the Continuator. Previous experiments have shown the strong potential of this kind of system in the field of music education (Addessi & Pachet, 2005, 2006). The general aim of the experience here described was to analyse if and how the Continuator can be used in the daily school activities and the role of the teacher in free play and in guided activities with the system.

The continuator and the children

This didactic experience was part of a wider project founded on the collaboration between the University of Bologna and the CSL-SONY of Paris, started in 2003 and devoted to the psychological and pedagogical experimentation of an interactive music system called the Continuator. The Continuator is a system able to produce music in the same style as a human playing the keyboard (Pachet, 2003, 2006). The phrases generated by the system are similar but different to those played by the users. The basic playing mode of the Continuator is turn-taking: the user plays the keyboard, when he/she raises his/her hands away from it, the system answers by repeating and changing the input. If the user decides to play a phrase while the Continuator is still playing, the system will stop and return to the listening mode. The Continuator is a particular kind of IRMS able to learn constantly from the input given (see Figure 1). The Interactive Reflective Music Systems (IRMS) are systems in which the user, whatever his/her level of competence, is confronted with a kind of developing mirror of him/herself.

The experiments carried out with 3–5-year-old children and the Continuator suggested that this system is able to develop interesting child/machine interaction and creative music processes in young children, creating a state of well-being very similar to that described in the Theory of Flow by Csikszentmihalyi (1996; see also Addessi & Pachet, 2005, 2006). The innovative function of the Continuator is the creation of a dialogue with the child while he/she is playing the keyboard. This dialogue is grounded on turn-taking rules, and on the mechanism of repetition and variation very

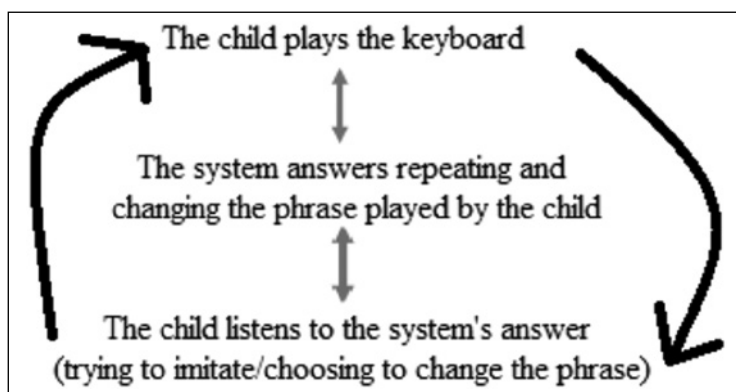


Figure 2. The circular interaction between the child and the Continuator.

similar to that observed in the infant/mother interaction by Stern (1995) and Imberty (2002). A circular interaction is set up between the Continuator and the child (Figure 2), in which the child's musical style influences the system, which answers repeating and changing the child's musical fragment, in a continuous improvisation process.

In the pilot protocol, children were asked to play the keyboard alone and/or in pairs with/without the system over three sessions. Some general aspects emerged concerning: the interaction between children and the system, the relationship between pairs of children and the Continuator, different listening conducts, aesthetical experience, the variety of ways of playing and exploring the keyboard, and the musical improvisation. The results of the detailed analysis of two case studies show the presence of a *life cycle of interaction* characterized by particular emotive states and behaviour, such as surprise and the "Aha" effect, excitement and concentration and analytical behaviour, repetition/variation in the dialogue with the system, dead moments and "attunement" between child and machine. The Continuator seems to activate interaction micro-systems similar to those observed in infant/adult communication but with a more mechanical and computational approach. Furthermore, a particular grid of observation based on that of Csikszentmihalyi's (1996)² emotional states was created. The analysis of the video through this grid describes the dynamic profile of the presence of the Flow state in children playing with or without the Continuator. According to Pachet (2010), "flow theory turned out to be particularly helpful to assess the impact of Continuator, as it is the only psychological attempt to describe these particular mental states where people engage entirely in their activity, regardless of anything around them" (p. 145). More precisely, the results show that when a child plays alone with the Continuator the child reaches a constant level of Flow (Addressi, Ferrari, Carlotti, & Pachet, 2006).

Taking into account the results of the pilot protocol, we decided to propose some activities with the Continuator in a classroom setting. From a pedagogical point of view, the aim was to study if and how the Continuator can be used in daily school activities with children of 3–5 years. For this purpose, we arranged for the didactic experience with the Continuator to be included within the annual music project of the class. In the pilot protocol, the adult did not play with children and her role was to prepare the software and to change the set-up of the Continuator. In the didactic experience described here, the teacher had the role of preparing the setting, and "using" the Continuator as a "device" (Frapat, 1994) to foster the children's creativity and musical improvisation. Thus, we were interested in the observation of the role of the teacher and of the groups of children in two different situations: during free play and in guided activities.

Method

The didactic experience was carried out in 2005 at the Kindergarten “Aurora Battaglia” in San Giorgio di Piano (Bologna, Italy). Taking into account both the age of the children (3–5 years) and the aim of the research, we decided to maintain the school laboratory style of working with children: a small group of children went out of the class with one of their teachers and went to the “laboratories” (rooms previously prepared by the teacher). The experience took place within the musical education class project “Simon the Sound-catcher” (original title: “Simone l’acchiappasuoni”). Simon is the fantasy protagonist of an Italian short tale written by Gianni Rodari and illustrated by Francesco Tullio Altan in 1995. Simon catches sounds from everywhere using a strange type of net. Before carrying out the activities with the system, we played a game with the children aimed at recognizing the different sounds surrounding us in everyday life. Keeping in mind that the Continuator allows a central role to be given to musical production through listening, the teacher organized some games with the children, ranging from exploration of the system to musical invention.

Participants

The class teacher (first author) proposed the experience to the whole class (22 children), but the complete protocol was carried out only with eight children: five children aged 4 years (two boys and three girls); three children aged 3 years (all girls). The other children took part in one or two sessions, or in a free-play sessions, which were also recorded on video. The children were divided into small groups of three to four elements.

Setting

The experience took place in the school library and a table, five small chairs, a large mirror in front of the table and six small mattresses were present.

Equipment

The Continuator (the software), a Roland ED PC-180A keyboard as interface, a Roland expander, a pair of amplified loudspeakers, a computer, a video camera, a digital camera. During the third session, we used some instruments like triangles, maracas, tambourines and jingle-sticks.

Data registration

All the sessions with all the participants were video-recorded. After each session, the teacher compiled a daily diary with some observations and comments. Photographs were also taken.

Procedure

First session: Exploration

In the first session, Simon the Sound Catcher (the fantasy character) invited the children to go out of the class to listen to music and to try to find the source of the music (the Continuator repeated a simple melody in a loop). After discovering the keyboard, the children explored it.

Second session: Two games

In this session, the teacher proposed two games:

1. “The little boxes:” in this game children pretended to be animals closed inside a box; we invited each child to play the call of the animal they had thought of. The children then listened to the answer of the Continuator, dancing and imitating the movement of the animals. Sometimes the Continuator answered with an echo, repeating the input of child exactly, at other times it changed the answer. At the end, some stories were invented involving these strange animals.
2. “The little chairs:” four children and three chairs were present. One child played on the keyboard, and when he/she raised his/her hands the other children danced to the answer of the system. They had to pay careful attention to the Continuator’s answer, as they had to sit down when it stopped. The teacher encouraged the children to dance whilst taking into account the musical characteristics of the system’s answers.

Third session: Tell a story

In the final session, the teacher told the children’s tale by Jakob and Wilhelm Grimm; “The Wolf and the Seven Kids.” The children, together with the teacher, decided to “retell” the story using instruments: the jingle-sticks played the kids’ voice, the maracas the mother’s voice and the wolf’s voice was played by the reply of the system. The wolf’s voice is very important in this story as the wolf changes it in order to trick the seven kids and then to eat them.

All the sessions involved elements of free play, alone, in pairs, or in groups.

Discussion

All the data collected describe and analyse what the children did in the three sessions. We are above all interested in the behaviour of the single child with respect to the group. In this article, therefore, we present some general aspects of the experience which are linked to some interesting conducts (Delalande, 2001) observed during activities with the system. We then discuss the role of the system and of the teacher in the activities.

Table 1 represents a summary of the most frequent musical conducts observed in the children during the activities with the Continuator.

Using the Continuator in daily school activities with children

Exploration of the Continuator and of the keyboard

The exploration of the system and of the keyboard is the first and main action of the children. We observe the exploration and the discovery of the rules of the system, the exploration of the different sounds for example: the high/low notes, black/white keys, strong/weak sounds, notes played single or in clusters, etc. We observe also the sensory-motor exploration of the keyboard: some children play with one finger, others with open hands or also with other parts of the body (head, nose and elbow). We notice that while the children are playing gently with one finger, they generally pay attention to the pitch and the melody and they often play short scales. When they play with an open hand, they concentrate more on the differences in volume and intensity of the sound. It is

Table 1. Summary of the most frequent musical conducts observed in children.

Explore and learn	Gesture – ways of playing the keyboard with:	One hand, two hands Fingers Elbow, head
	Sound – how the keyboard is played	Strong/ gently Cluster Single keys On the right/left side of keyboard (high/low notes)
Imitate	Partner's actions on the keyboard – Gesture	
Listen to	System's answers – Sound	
	Partners' productions	
	System's answers	
Verbalize	Teacher's suggestions and comments	
	Discoveries concerning the rules of the system	
	Different ways of playing	
	Different ways (turns, rules) of managing interaction with the system in a group	
	Symbolic associations, for example the answer of the system is linked to the Wolf's voice	
	Comments and hypothesis about how the system works	

interesting to observe that the choice to play in one way rather than in another often depends on the Continuator's answer: when the system answers the children sometimes use single notes followed by a chord; they listen to the Continuator's answer and try to imitate it by playing a cluster with an open hand, which is their way of re-playing a chord.

After the sensory-motor exploration, the symbolic exploration takes place during which the children look for the best way of representing an animal (especially in the third session during "The Wolf and the Seven Kids" story-telling), or a state of mind. One of the most interesting results of the exploration is the discovery and use of the system's basic rules:

- Children learn to raise their hands away from the keyboard for the system to start to play. This allows them to decide when to interact and/or listen to the system; this is a great discovery and most of the children teach it to their partner (see Figure 3).
- Children also easily learn that they can stop the system by simply touching one key.
- Some children discovered that the Continuator's answer was similar to their own. This is the beginning of turn-taking. Usually the children said, "The keyboard answers!" when the output was very similar to the input, whereas when the answer was very different from the input, the child said, "The keyboard plays."

Musical invention

We observed musical conducts on the part of the children playing the system. These were most of all characterized by listening, imitation and improvisation. In this process, it is possible to observe:

1. The child listens carefully to his/her productions, those of his/her partner, and those of the Continuator.
2. a) The child imitates his/her partner's ways of playing (for example strongly or gently); b) The child also imitates the style of the Continuator.



Figure 3. The girl on the right teaches her partner to launch the Continuator's answer by raising her hands.

3. The child then tries to repeat the very short musical phrase that he/she has just listened to, and he/she adds new elements: a note, a cluster, the same phrase played with a different rhythm.

In this process of music exploration and creation, the presence and movement of the body is very important. Some children play with different parts of the body: hands, nose, elbows, etc. Some of the children, who play the keyboard, wait for the answer of the Continuator and then they dance to it, and as Young (2003) assumes "from the child's perspective, the sounding result is inseparable from bodily involvement" (p. 56).

Each session included some elements of free play. These were planned as moments of relaxation and readjustment between one activity and the next. These elements were very interesting to observe because during these moments children showed *self-regulation* (Bandura, 1997) of the group and managed the use of the space, the keyboard and the instruments without the presence of the teacher. For example, while one child was playing the keyboard alone, one child read a book, another wrote a letter to Simon the Sound Catcher, and another followed his/her partner near to the keyboard. All the children respected the established simple and implicit rule: the keyboard is for all the children, and one child can play it alone, or two or three children, a little at a time at any moment. When other children occupied the keyboard, the child waited his/her turn, doing something else or joining the other one near the keyboard. It is interesting to note that these rules were the same for all three groups that took part in the sessions. The system had quickly become a virtual partner and the children spoke about it as if it were real. They thought that if the system could hear what they played on it, it could also hear what they were saying or doing. So the Continuator was not only a magic toy (some children called it "Simon the magic keyboard"), but also a partner that is able to answer, to listen and to play.

Concentrated listening and excited pleasure

The experience with the system was especially characterized by two different emotive states. Generally, when the children played the keyboard alone, exploring it and trying to dialogue with



Figure 4. Federica and Lucia listen carefully to the Continuator's answer.

the system, they were very concentrated. They focused their attention both on their production and on the system's answer. They lost the perception of time and they were no longer interested in what the other children were doing. However, when the children played together with the keyboard, or when they played a game together, they became very excited. It was possible to observe a powerful and explosive reaction in the state of being of the children: they laughed, their tone of voice became higher, they called the teacher and partners, and they played the keyboard with considerable energy. Sometimes, during the free play, there were also some "dead moments" in which the child preferred to read a book, dance, listen, or talk to the teacher.

The children were attentive in listening both to the reply of the Continuator and to their own input (see Figure 4). We observed a difference between the situation when the child played the keyboard alone or when he/she played with one or more partners. In the second case, the children laughed and they had great fun playing together because they tried to invent games and/or amusing ways to play the Continuator, but they generally focused their attention only on the interaction between one another. When the child played alone, the Continuator became his/her partner and the child focused his/her attention on it: typically, he/she looked at the keyboard, put his/her ear near the loudspeaker, waited for the end of the Continuator's answer and showed considerable concentration.

The role of the teacher and of the group in two different situations

It is interesting to observe the role of the teacher within the organization of the group. In particular, we noticed some functions such as:

- Preparation of the space and of some devices (Frapat, 1994) to make exploration easy for the children. By "devices," we include concrete ones like the keyboard, the mirror, the



Figure 5. The multiple role of the mirror.

instruments and also “abstract” devices like the games and the whole pedagogic organization of the activity as for example the number of children, the number and order of the sessions, etc.

- Participating observer. Without using any words, the teacher could reinforce the exploration and production of the children by watching them attentively and without evaluating/judging.
- Re-launching the child’s musical invention to the whole group, proposing new games in order to “further explorative behaviour.”
- Teacher as a partner in the games. The teacher refrained from playing the keyboard or from saying how it worked right from the first session. From this point of view, the teacher is on the same level as the children: she does not have anything to teach them and can instead act as a partner in the games.

Me and myself: The multiple role of the mirror

The original function of the large mirror in front of the table was as an observational tool for the teacher: with it, the teacher could control her movements, presence or intrusiveness within the group.

From the first session, however, the mirror became a real device for the children who used it to:

- observe their partner and the teacher during the free play;
- be “tuned into” the group in “the little boxes” game and during the telling of “The Wolf and the Seven Kids.” Alex looked at himself in the mirror while waiting for his turn to play the Wolf’s voice on the keyboard; by looking at the mirror, Alex could see the teacher and the other children behind him. After playing the keyboard, Alex listened to the reply of the Continuator: from his facial expression, we can say that he was the “real Wolf”;



Figure 6. Example of collaborative playing: two girls arrange a session with the keyboard, a tambourine and with the Continuator.

- observe their own facial expressions or body movements during exploration of the system and while listening to the system's answer;
- observe the partner when two children played together (Figure 5).

The mirror therefore represents a support for the children, allowing them to develop a high level of control over the situation (Csikzscentmihalyi, 1996) without constantly asking the teacher to confirm or support the activity.

Collaborative playing

The activities proposed by the teacher, from exploration to the creation of a story using imaginary animals, were all based around the group. The observations reveal the presence of typical conducts of collaborative learning, especially during free play with the system:

- Tutoring: the children tried to explain the rules of the system to their friends; often the function of tutoring among children is based on reciprocal imitation and on "modelling." We observed many cases where children taught their friends to launch the answer of the system by raising their hands. An example: Lorenzo (5 years old) is near Davide (5 years old), they are playing the keyboard together; after a while Lorenzo raises his hands and, looking at Davide, says "you must do like this, if you want it (the Continuator) to answer to us;" in other situations the children showed that the system imitates them, and that it is possible for the system to play a joke on them. The function of tutoring is very important for the adult, because it represents one of the few moments in which children spontaneously speak about how the system works (implicit knowledge) to their partner;
- Invention of rules to play the keyboard with two or three children working together: they established how to play the keyboard (using all the keys or only a part of the keyboard,

playing with just fingers or with hands, playing only the black or the white keys) and in which order (they established the turns);

- Invention of sound games between the system and some instruments. The reply of the Continuator became a basis on which other children improvised with instruments (see Figure 6). Since the children learned turn-taking with the system, they could also decide the precise moment to launch or to stop the answer of the Continuator. While one child was playing the keyboard, the other child listened carefully and when the child raised her hands (to give the sign), they began to improvise with instruments on and with the system's answer. It is interesting to note how one girl, who had played the keyboard, then listened to and commented on the performance of the other child during the improvisation saying "it's better if you do like this" and she showed her friend the rhythm by shaking her hands. It is also interesting to observe how children looked for the best instrument to play to the Continuator's answer: usually when the answer was faster, they preferred to play the maracas and the jingle-sticks. When it was slower, they tended to play the tambourine.

Conclusions

In this article, we have described a didactic experience carried out in a kindergarten concerning children playing with an interactive reflexive music system: the Continuator. The results show an interesting interaction between the children and the system. We can underline how the Continuator promotes a state of well-being within the group, characterized by a high level of intrinsic motivation, control of the situation and excitement, very similar to the state described in the Theory of Flow by Csikszentmihalyi (1996).

The double role of the system as partner and tutor enhances musical creativity and offers a practical pedagogical experience based on discovery and invention: the children discover and invent new solutions, for example, to link the music to dance, or to imitate the call of an animal. These musical inventions are associated with a strong listening participation towards the child's own productions and those of the other children. The careful listening and the focused attention observed in the children playing with the Continuator show how the system encourages children to structure their attention around listening, as previous research has already illustrated. Whereas other new technologies and multimedia instruments developed for musical education hold the attention of the children above all using visual stimuli, the Continuator provides only sound outputs without any visual dimension. This allows children to focus all their attention on the sound and on how to create it. In this way, children play with a virtual musician and in so doing can combine the experience of listening with the creation of a "sounding-language." We also notice that the system promotes an interesting development from behaviour to musical conduct when the children played with the system over the three different sessions: the action may always be the same (only touching the white keys, for example), but, from the first session to the third, the behaviour develops into conduct because motivation and expectations become increasingly present.

McPherson (2005) asserts that among the mental strategies observed in children, "monitoring" and "controlling" learning gradually, play a basic role in coping with the difficulties of learning to play an instrument. The Continuator can be used to stimulate an increase in these mental strategies, mirroring the development of children's skills: through its answer, the system offers the child a continuous feedback of his/her production and the control of the situation. In this way, the child can develop a self-regulated way of approaching the instrument and musical improvisation.

From a pedagogical point of view, working in a group fosters *collaborative playing* through: mutual and circular imitation, tutoring and explicit communication between children concerning

their own intentions (for example, one girl said to her partner: “now I’ll play the white keys while you are playing the black ones, but then we’ll raise our hands together”). Crook (1994) asserts that it is essential for children playing together with a computer to communicate their own intentions in order to create a common field of discoveries and skills. In our case, the exploration of the system, carried out with the whole group, allowed the children to share the discovery of rules inherent to the Continuator, which also reduced the exploration time.

The system also assumed an important role in terms of essential *self-regulation* and *autonomy* of the group of children: while on the one hand, playing music together reduced the time available for individual exploration, on the other, it required a strict regulation of the group in order for the children not to be overwhelmed by the sounds. The balance between challenges and skills created by the mirroring reflection enables the system to enhance self-regulation, self-initiated activities and the learner-centred approach. Although she does not speak directly of collaborative learning, Burnard (2006) also affirms the essential role of the social dimension and of the context in the development of musical creativity: if we observe the role of a teacher in the activities with pre-school children, we can note how children often play on their own and then the teacher shares the “sound making” with the others. When working with the Continuator, the role of the teacher is not to teach, but to observe and to encourage children to imagine situations that allow music to be played, as Delalande (2001) has asserted in defining how the role of the teacher could function in a creative musical situation. The teacher does not observe in order to evaluate the performance of the children, but rather to understand and share. With the Continuator, the teacher, “supports artistic autonomy by making challenging musical materials available” as it is already affirmed by Custodero (in her study on the role of teacher in the classroom musical activities; 2005, p. 209).

The use of the Continuator in daily activities underlines how new technologies should be considered important not only as tools or devices which are useful for teaching, but also as a means of creating new didactic strategies and methodologies able to qualify and determine the learning process. The time spent on the activities with the Continuator, during the present experience, has led us to conclude that music-making and interaction with this system are highly engaging for children. This is very important because the ability “of a computer music system to enhance creative engagement with music is a key measure of its likely impact on learning” (Brown, 2007, p. 25). The first author of this article has suggested that the Continuator and other Interactive Reflexive Music Systems could be considered as being within the “fanta-cognitive pedagogic perspective” theorized by Guerra (2002). According to this pedagogic perspective, the didactic situation is based on the subject and on the valorization of his/her previous experiences through the application and use of new technologies. Guerra asserts that various computer applications (such as the perceptive prosthesis and the software to create or manipulate music and images or virtual reality) are characterized by some essential elements for learning such as innovation, appeal, flexibility, autonomy/socialization and, in particular, interactivity. Thus, the Interactive Reflexive Music Systems can support children by creating a framework within which children can mix, in an original way, new music experiences with the older ones and new skills with the others that have already been acquired. We can consider the IRMS to constitute a new didactic approach to music, above all because they exploit subjectivity. The possibility offered to the child to improvise, to listen and to repeat, and also to evaluate his/her own errors as well as those of the Continuator, makes the Continuator an instrument which “widens the aesthetic dimension of the subject” (Guerra, 2002, p. 23).

The promising results of the experiments and didactic experiences have led to the creation of the *MIRROR Project*, an EU-ICT Project aiming to develop an innovative system for music learning and teaching in early childhood music education (for description and early results please see: Addressi & Volpe, 2011; www.mirrorproject.eu).

Acknowledgements

We would like to thank the children, parents and the staff of the kindergarten “Aurora Battaglia” in San Giorgio di Piano (Bologna, Italy). We would like to thank the teachers Wilma Montanari and Claudia Alvoni for their help and collaboration, and Dr. Giuliana Minarelli, Director of the education sector.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Notes

1. This article is a revised and extended version of Laura Ferrari, Anna Rita Addressi and François Pachet’s paper “New technologies for new music education: The Continuator in classroom setting” published in the *Proceedings of the 9th International Conference on Music Perception and Cognition and the 6th Triennial Conference of the European Society for the Cognitive Sciences of Music*, edited by M. Baroni et al. (2006) Bologna: Bononia University Press. Copyright 2006 by ICMPC and ESCOM. Adapted with permission. The paper was awarded with the ESCOM Young Researchers Award.
2. In the theory of Flow, the subject can reach the state of Flow (defined also as optimal experience) when the challenges and the skills are balanced. For more details, see Csikszentmihalyi (1996).

References

- Addressi, A. R., & Pachet, F. (2005). Experiments with a musical machine: Music style replication in 3/5 year old children. *British Journal of Music Education*, 22(1), 21–46.
- Addressi, A. R., & Pachet, F. (2006). Young children confronting the Continuator, an interactive reflective musical system. *Musicae Scientiae, Special Issue 2005–2006*, 13–39.
- Addressi, A. R., Ferrari, L., Carlotti, S., & Pachet, F. (2006, August). Young children’s musical experiences with a flow machine. In M. Baroni, A. R. Addressi, R. Caterina, & M. Costa (Eds.), *Proceedings of the 9th International Conference on Music Perception and Cognition (ICMPC9)* (pp. 1658–1664). Bologna, Italy: Bononia University Press.
- Addressi, A. R., & Volpe, G. (2011, September). The MIROR Project. In C. Delgados Kloos, D. Gillet, R. M. Crespo Garcia, F. Wild, & M. Wolpers. (Eds.), *Towards ubiquitous learning. Proceedings of the Sixth European Conference on Technology Enhanced Learning (EC-TEL 2011)* (pp. 15–28). Berlin, Germany: Springer Verlag.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.
- Brown, A. R. (2007). *Computers in music education. Amplifying musicality*. New York, NY: Routledge, Taylor & Francis Group.
- Burnard, P. (2006). The individual and social worlds of children’s musical creativity. In G. McPherson (Ed.), *The child as musician: a handbook of musical development* (pp. 353–372). Oxford, UK: Oxford University Press.
- Crook, C. (1994). *Computers and the collaborative experience of learning*. London, UK: Routledge.
- Csikszentmihalyi, M. (1996). *Creativity*. New York, NY: Harper Collins.
- Custodero, L. A. (2005). Observable indicators of flow experience: A developmental perspectives on musical engagement in young children from infancy to school age. *Music Education Research*, 7(2), 185–209.
- Delalande, F. (2001). *La musica è un gioco da bambini* [The music is a child’s play]. Milan, Italy: Franco Angeli Editori.
- Frapat, M. (1994). *L’invenzione musicale nella scuola dell’infanzia* [The musical invention in the kindergarten]. Bergamo, Italy: Junior Edizioni.
- Guerra L. (Ed.). (2002). *Educazione e tecnologie. I nuovi strumenti della mediazione didattica* [Education and technology. New tools of teaching mediation]. Bergamo, Italy: Junior Edizioni.

- Imberty, M. (2002). Il bambino e la musica [The child and the music]. In J. J. Nattiez (Ed.), *Enciclopedia della Musica* [Encyclopedia of Music] (Vol. II, pp. 477–495). Turin, Italy: Einaudi.
- McPherson, G. (2005). From child to musician: Skill development during the beginning stages of learning an instrument. *Psychology of Music*, 33(1), 5–35.
- Pachet, F. (2003). The Continuator: Musical interaction with style. *Journal of New Music Research*, 32(3), 333–341.
- Pachet, F. (2006). Enhancing individual creativity with Interactive Musical Reflective Systems. In I. Deliège & G. H. Wiggins (Eds.), *Musical creativity: Multidisciplinary research in theory and practice* (pp. 359–375). Hove, UK: Psychology Press.
- Pachet, F. (2010). The future of content is in ourselves. In M. Tokoro (Ed.), *Open systems science. From understanding principles to solving problems* (pp. 133–157). Amsterdam, The Netherlands: IOS Press.
- Savage, J. (2006). Working toward a theory for music technologies in the classroom: How pupils engage with and organize sounds with new technologies. *British Journal of Music Education*, 22(2), 167–180.
- Seddon, F. A. (2006). Collaborative computer-mediated music composition in cyberspace. *British Journal of Music Education*, 23(3), 273–283.
- Stern, D. (1995). *The motherhood constellation*. New York, NY: Basic Books.
- Williams, D. B., & Webster, P. R. (2006). *Experiencing music technology* (3rd ed.). Belmont, CA: Thomson Higher Education, Wadsworth.
- Young, S. (2003). Time-space structuring in spontaneous play on educational percussion instruments among three and four-year-olds. *British Journal of Music Education*, 20(1), 45–59.

Author biographies

Laura Ferrari holds a 4-year degree in Education from the University of Bologna (2002) and is currently attending the PhD course in Education at the University of Bologna. From 2006–2008 she attended the Research School in Music Education, coordinated by Prof. Mario Baroni. She has a background as preschool teacher and nursery practitioner. Since 2003, she has collaborated at the research project “DiaMuse: Interactive Reflexive Musical Systems for the Music Education,” and since 2010 she has been research fellow at the EU project MIROR - Musical Interaction Relying on Reflexion, coordinated by Anna Rita Addessi, University of Bologna. Since 2006 she has been a member of the research-action group on “the musical dimension of daily routines with under-four children” coordinated by Anna Rita Addessi. She is interested especially in the pedagogical and didactic aspects of music education for early childhood as collaborative learning, the child/new technologies interaction and the role of the teacher.

Anna Rita Addessi holds a PhD in systematic musicology and is a Permanent Researcher in Systematic Musicology at the University of Bologna, Italy, where she teaches Music Education. Her main research topics are music learning and artificial intelligence, music knowledge as social representations, training music teachers, infant musicality, auditive music analysis of post-tonal music, musical style and intertextuality, Claude Debussy and Manuel de Falla. She is the coordinator of the EU project MIROR - Musical Interaction Relying on Reflexion. She is past Vice-President of ESCOM, and a member of the ESCOM-Executive Committee, ICMPC-Advisory Committee and MERYC Board. She was co-organiser of the 9th ICMPC and 6th Conference of ESCOM (2006), and of the 4th Conference of MERYC (2009). She has published Italian books and many academic articles on topics which reflect her wide range of interests across systematic, empirical musicology and music education. She is a member of the editorial board of *Musicae Scientiae*, *International Journal of Music Education*, *Cognição & Artes Musicais*, *Música em Perspectiva*, and *Infanzia*. She plays mandolin.