

Employing technology in creative music making: Case studies of classroom applications

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Abstract This paper focuses on young children's composing activities using new music technologies (the MIROR composition software). It presents findings from classroom case studies that explore the ways in which these music technologies can be implemented into existing curricula and debates the challenges that arise when teachers and students experiment with these. Two qualitative case studies explore 8-year-old pupils' creative music making in the context of a Greek and British music classroom. Classroom observations and discussions with young children document the learning that takes place and pupils' expressions of agency and voice. Key issues that arose across these largely different educational contexts were that: a) The use of multimodality allowed pupils to explore structure and form during composing activities, their movements shifting when listening to chunks of melodies or whole melodic forms. Children also learned to distinguish melodic detail in the composed melodies and sharpen their listening abilities through a breakdown of tasks; b) Technology assisted the teacher in developing children's verbal ability in voicing the complex processes involved, and making informed and engaged artistic decisions. Teachers gradually built a common language using musical and extra-musical references to frame subsequent discussion, encouraging also pupils' mindful engagement with the technology. The visualisation of pupils' creative process allowed for anticipating what will be heard but also planning what will be played, hence enhancing the user's sense of purpose when engaging with the technology; c) Technology provided pupils with an inclusive social space in which to experiment and discuss. It performed simple executive functions such as repeating or comparing different options, thus allowing pupils to make more complex musical decisions, even those with little prior musical training. In sum, the case studies, employing the musical software MIROR, allowed us to question current music education curricula, review the meaning of creativity, reassess the role of the teacher and imagine a more inclusive pathway for the 21st century young music learner.

Keywords composing; agency; technology; inclusion

Introduction

Historically, Western music education practices have supported the acquisition of a specific set of musical skills, with a focus on measurable assessment and musical outcomes and outputs at the expense of creative and critical thinking processes (McPherson, 2002). As a result, creative forms of musical engagement, such as pupils' composing activity, are seldom viewed as a distinct field of interest, worthy of study in their own right. Such creative forms of musical engagement are studied in this paper with an emphasis on musical processes rather than musical production. Concurrently, digital music technologies provide teachers and learners with the means to record, research and celebrate such musical creations, as well as offering participants opportunities for review of and reflection on prior work, interaction,

participation and the active demonstration of imagination, originality and value (Kim, 2013; Ruthmann, 2013).

In stark contrast with other forms of artistic engagement, music education focuses mostly on reproduction rather than on the production of musical products. And when the original creation of composed work is the centre of attention, the educational framework seems to concern secondary rather than primary-age children. Hence, there has been scarce study on technologically informed compositional processes at the primary level of education. Composing is accessible to young children. The technological tools employed in the case studies allowed for the creation of a playful and inclusive environment, in which children, including those with no former instrumental training, were allowed to explore and experiment with increasingly complex musical ideas.

Such inclusive views hold that formal teaching and learning needs to be approached as more of a partnership between teacher and child, thereby facilitating and enhancing a greater degree of agency in young children. Indeed, recent research in children's musical learning has assumed an agentic turn (Wiggins, 2015) perhaps due to the increasingly-held belief that by supporting individual children's learning and agency we are better able to scaffold more authentic and deeper forms of learning and increase levels of motivation when learning music. This paper focuses on young children's composing activities using new music technologies (and specifically the MIROR composition software) and presents findings from classroom case studies that explore the ways in which these music technologies can be implemented into existing curricula.

1. Music technology and composing processes

While technology and music technology is a key initiator of music learning in many secondary and tertiary music courses, its use by primary or pre-school teachers is much less frequent. Yet, technology can be considered not only as a useful 'enabler' for young people as they create music, it can also be a helpful tool for researchers in music education that are seeking to access and document the processes children adopt while creating music. A less linear, diffuse kind of learning is now evidenced through children's engagement with ICT, whereby their attention moves swiftly, almost simultaneously amongst a number of different sources, for example by opening tabs and clicking on hyperlinks (Lankshear and Knobel, 2003). This form of learning, most likely to figure prominently in informal learning environments, for example at home, may be less structured compared with the predominantly linear and focused approach of traditional school education, yet still creates knowledge and develops skills of a certain kind that educators can build upon and value in formal learning environments. Furthermore, as Gall and Breeze (2007) point out, listening to music figures largely in young people's lives outside of school ... "inevitably impacting upon their musical tastes and informing their musical preferences. Since much of the music that young people listen to involves or is created using ICT, technology might be viewed as providing the bridge between 'school' music and young people's 'lived' music" (p.42).

A broad range of different music technologies are now available with differing purposes and functions. It is beyond the scope of this paper to review them all but some are intended as live performance tools or instruments (such as Soundbeam and DubDubDub), others encourage the development of musical skills, such as playing in time or allow users to layer, sequence and loop musical materials (such as Cubase and Garage Band). Other programs, such as Sibelius or Finale, provide traditional notation transcriptions of sounds that can be

arranged, played back and rescored. The usefulness of these programs for music education lies in facilitating musical creation in ways that would not be possible with more traditional modes of music-making. Besides enhancing children's motivation, such programs encourage the development of careful listening, planning, decision-making, structuring and so on (Young, 2009).

The MIROR technology our research employed when working with young children - developed during the MIROR Project (www.mirrorproject.eu) - provided an interactive musical experience in which the software responded to the player's ideas. Specifically, the MIROR Improvisation software engages the user in musical dialogues during which the machine plays "what the user could have played" (Pachet, 2016). The system builds a database of these improvisations and stores them for later use. Subsequently, the MIROR Composition software offers the opportunity to build compositions out of musical material originally improvised by the child-user and the system during their musical interactions. So with MIROR Compo, the emphasis is not on improvising various phrases and engaging in dialogs, but on thinking about *structure* by building a fully-fledged musical *piece*. The entry point to COMPO is the main IMPRO interface, which allows the user to select a corpus or set of previously recorded sessions with IMPRO, and to launch COMPO from that selected corpus. Composition is performed by selecting in sequence a series of buttons, each corresponding to a specific response type: "statement", "question", "answer", "conclusion", "repetition" and "rest. COMPO is designed explicitly to engage the user in a reflective act of composition, by which he or she has to focus on a limited set of operations (the response types), with an intentionally limited capacity to edit the outputs (unlike a traditional time-line based music editor). Thanks to these limitations, however, a musical piece can be built in a few seconds, and the user is able to focus on higher-order thinking, while MIROR COMPO carries out the basic tasks of offering optional phrase choices, playing back, notating and recording the work (Pachet, 2016).

In primary education, the lack of dedicated composition activity often reveals ingrained perceptions that relate to developmental stages in young children (e.g. Kratus, 1989). A study by Barrett (1996) investigated 137 compositions by children aged 6-12 and suggests that various structural strategies are employed, such as repetition, sequences, inversion and achievement of closure, even at an early age. On the other hand, many young children will find such basic compositional elements quite taxing, particularly those with little prior musical training. In these cases, music technology may provide a tool for facilitating such strategies; yet, while classroom applications using technology to compose or, less so, to improvise, at the secondary level of education (approximately 11-16) or the final Grades of Primary school (approximately 10-12) are well-documented in the literature (Major, 2007; Gall and Breeze, 2008), when it comes to creative music making with younger ages (e.g. 7-8 year olds) similar classroom activities are much less common.

The current paper contributes towards a growing music education literature in using technology in creative music-making, by describing in detail two classroom situations whereby one form of music technology was used and the ways in which it was used to assist in young children's composing activity.

2. Children's music-making

Key questions, such as those Glover (2000) puts forward in her writings, open up new debate on the nature of children's music, e.g.: "what does children's music sound like? And what can

be expected when children compose?” (p.5). While children’s artistic or creative writing activity is often displayed and celebrated, there is still very little understanding of what their music is like. However with the easy availability of technology that records and stores music, this should no longer pose the problem it once did. Technology provides the tool for recording and showcasing in a variety of ways children’s composed work and music making processes. Furthermore, it remains a point of interest that children’s own musical creations are seldom viewed as a distinct field of interest, worthy of study in their own right. As Knudsen (2008) points out, children’s spontaneous musical expression is not “a musical *gradus ad Parnassum* directed towards adult culture” as “it is not so much about becoming an adult, as it is about being a child” (p.290).

As adults we need to listen to children’s music from their perspective, and not from our sophisticated expectation or re-interpretation of it. It is important, too, to avoid a ‘deficit’ view of children’s music, to be prepared to encounter the music in terms of how the children approached it and not to envisage it as an immature or defective version of ‘adult’ music. To an extent, exploring children’s ‘intentions’ during composing activities may be the way forward. For example verbal interactions with peers or adults (teachers) during classroom music making activities may help reveal the rationale behind decisions made and actions taken. ‘Talking through’ an experience in order to give form and structure to personal thoughts, actions and knowledge, may be facilitated through the role of technology by assisting children to recall important choices and decisions, thereby providing a sort of ‘map’ of the music-making process. Such mapping of children’s learning processes is not uncommon outside music education (Williams et al, 2014), yet within the domain of music teaching and learning there seems to be a scarcity of studies that aim to make visible the complexity of young children’s music-making within specific classroom contexts and educational cultures.

3. Agency and creative play in music-making

Similar to other art forms, composing allows children to give life to their abstract ideas as well as express a growing awareness of themselves and the world in which they live. Trevarthen and Malloch (2012) call for caution as educators struggle to sustain children’s spontaneous musicality and creative curiosity while simultaneously imparting subject knowledge within set curricula; while Trehub (2006) calls for music practitioners to “foster and sustain the joy of music and musical creativity that are so cleverly evident in early years” (p.44). In a study of 760 children composing using a computer-based software application, Hewitt (2009) found that younger children (8-9 year olds) tended to engage in more exploratory composing behavior than older children (10-11 year olds). Similarly to a previous study by the authors of this article (Rowe, Triantafyllaki, and Anagnostopoulou, 2015) Hewitt’s research also seems to show that prior instrumental music training does not necessarily provide children with the confidence to engage in the kind of exploratory and creative play that is key to composition activity in the early years of schooling. One possible explanation for Hewitt’s finding may be that their ‘default setting’ is to follow a teacher-given musical score, rather than to explore freely, as a naïve player might do.

Wiggins and Espeland (2012) point out that learning requires risk-taking, something that is “only possible when learners feel able to have some degree of control, are willing to engage and when they believe that their contributions will be valued” (p. 346). The concept of agency is closely related to theories about personal and social identity. Alexandra Lamont (2001) talks about two sides of forming an identity as ‘self-understanding’ and ‘self-other understanding’; children aged 6-13 develop particular ideas about themselves ‘being good’ at

something or 'not-as-good'. They also start to compare themselves with their peers, as "social, psychological and activity-related characteristics become more important" (p. 42). In literature exploring children's collaborative composition processes (Muhonen, 2016; Rimmer, 2017) similar to those discussed in the current article, concepts such as agency and social identity are key to strengthening motivation and aspiration towards compositional (and other musical) goals.

The notion of children's agency is closely linked to that of 'intent' (Ruthmann, 2008). One example of musical intent would be working towards a particular goal (such as composing a piece and then devising a choreography for it or having a tune in one's head and trying to reproduce it) and negotiating its process (such as when discussing musical decisions when composing in groups or whole-class situations) or outcome (such as when justifying decisions of composing). Especially, however, when engaging with younger ages, it could be argued that children's intentions are not always evident; indeed, more often than not children do not start out with intentions other than just to play around with the musical (and technological) equipment. It is here that the 'artful scaffolding' of an adult –teacher is of particular importance in building upon students' prior knowledge, acknowledging individual agency whilst encouraging 'risk-taking' and higher levels of musical understanding in the classroom (Wiggins & Espeland, 2012). In attempting to highlight some of the complexities of the interaction between music, technology and the context of music classrooms in diverse settings, this article now considers two case studies of composing activities employing new music technologies at the primary level of education.

4. Research Process

The interpretive research reported here employed two qualitative case studies in order to explore 8-year-old pupils' creative music making in the context of a Greek and British music classroom. Classroom observations documented the learning that took place and pupils' physical and verbal expressions of agency and musical creativity. Case 1 implemented the technology across eight weeks in a Greek primary music classroom, with the aim to encourage the development of a composition vocabulary and increase pupils' verbal skills in discussing composition processes and outputs. A secondary aim was to increase pupils' knowledge of musical structure. In Case 2, conducted in a British primary school, pupils were given the task of composing music specifically for movement. Using their own musical material, assisted by MIROR composing software, the group produced their own composition, which they then choreographed and performed. Both classroom teachers used their expertise to facilitate children's explorations and encourage artistic decisions.

Research data were collected through participant observation techniques and individual interviews and teachers and focus group interviews with children, following similar studies in the field of music education (Howell, 2011). Audio-recording of classroom talk and field-notes of classroom behavior and interactions formed the main corpus of the findings presented below. Transcripts from both fieldnotes and interviews were read carefully and analysed using some guiding questions, such as how the teacher initiated the tasks, what kinds of questions were asked, how the children and teacher organized themselves with respect to the tasks. The findings, though presented as two case studies situated in very different educational contexts, highlight a number of common themes that are subsequently taken up in the discussion section.

5. Case Study 1

A large Greek primary school in Athens is the setting of this small-scale case study. The rather traditional rows of desks in Grade 3 (8-9 year olds) face an interactive whiteboard where the teacher's desk is located, with a laptop linked to a keyboard. During the activities we purposely chose to work with a single computer terminal and keyboard; this set-up, though traditional, would have been relevant to most teaching and learning situations in the majority of Greek state primary schools. The data presented below were collected are part of a series of eight 'lessons' in improvising and composing, initiated by the 1st author of this paper and the host school, with the aim of increasing children's understanding about *musical structure* by building their *musical vocabulary*. Studies which investigate children's 'musical talk' during creative music making in the primary classroom are scarce in the literature and more research is required on children's reasoning and thinking processes as powerful entry points to music composition.

The classroom teacher had no prior experience of teaching composing but had a solid history of initiating other technology-assisted musical activities with younger children. The 25 children in the class had acquired through the previous sessions some familiarity with the MIROR software program and experimented with both its functions, IMPRO and COMPO in whole-class and small-group activities. The aim of this particular session was to compose a 'class tune' out of a known melody they had already learnt to play on the recorder. This allowed the teacher to build on children's prior knowledge and it also allowed children to engage in 'problem solving' by composing an 'alternative' melody to one they already knew. During the course of the session, the teacher initiated the form of ABC by finding a proper start to our composition (A), continuing the melody (B) using interesting features such as contrast, repetition, etc., and concluding the melody (C), so that the audience knows that it's 'finished'. The teacher tells us of the task:

Teacher (T): The use of a known melody saves us time and gives us a common starting point. It also makes the final reflection more concrete.

By building on children's prior, shared knowledge she attempts something new, using the 'support net' of the known melody. This she says is unconventional for the 'reality' of this particular classroom; in the start of the session this is evidenced also in pupils' difficulty of composing an alternative melody. The discussion that follows allows children to discuss the various options that MIROR COMPO provided them in composing the class melody from the known melody. The teacher gradually introduces musical concepts to children by provided musical lexicon whenever needed, such as 'loud and soft' (instead of 'loud and low') or a 'pause' (instead of 'gap'), encouraging also the pupils in musical talk that is characterize by recalling bits and pieces of knowledge accumulated during Stages 1 and 2 of the study.

Teacher (T): Do you think this bit here gives the feeling that the beginning ends, or should we add something here?

Child 1 (C1): Add something.

T: Who has an idea then what should be added?

C2: a pause.

T: but each time we add another brick, what do we decide, what should we decide each time we create a small bit of our melody?

C3: the new piece, if we like it.

The teacher had previously emphasized the relation between the added block of music and the previously composed piece.

T: So shall we hear both blocks together? When we make a musical piece, we hear it again from start to

finish. We might be making it out of little blocks but in the same way we make a house from lego, when its completed we don't see each and every block, we see the whole of it. Perhaps now it doesn't sound so bad?

C1: It seems more notes now, not so loud, seems better than on its own.

C2: On its own it sounded different, now the two melodies seem to match.

As Glover and Young (1998) suggest, "learning to talk about music must be seen as a key part of the teaching agenda with early years children" (p.25). Encouraging verbal communication can strengthen children's musical intent, as it develops appraising skills or critical thinking in music, encourages the exploration of ideas and feelings about music and, in essence, creates greater awareness of and meaningful engagement in music making processes, such as improvising and composing (Major, 2007).

Later, the teacher attempts to increase children's 'intent' by slowing down their decision-making process by asking a series of questions with regards their choice to add a 'pause' to their melody in order to complete their composition.

C1: we could put first the pause and then the last brick.

C 3: she's right! 'Cause it doesn't make sense to put something and then it cannot be heard.

C 4: but, perhaps 'cause we end everything, the beginning, middle in a pause we should put there also a pause.

T: so that there's symmetry there you mean.

C 5: I think there should be a pause between those two bricks as the first is faster than the second.

T: Ok so let's hear it again (plays back the recorded tune). What do you think? (no response)

T: so let me help by asking, what does the pause help the last brick to do?

C 2: as its quite fast in tempo it helps it gives a different feeling to that bit.

C 6: I actually don't like it as it seems like a new piece is starting.

C 7: I think we should take away the pause and between the last two put another brick that will connect them.

The feature of 'pause' is here used as an organizing element of promoting understanding of structure in the classroom. In the above excerpt, the teacher introduces the notion of 'symmetry' in continuing to emphasise the relationship of each part of the melody (or building block) to another. The children's language, as revealed in the kind of classroom dialogues that were recorded during the study, show an increase in the kind of reflective musical vocabulary that we aimed to introduce during the implementation of the MIROR technology during their classroom sessions. Essentially, the breakdown of tasks by the teacher (familiarization with the software, familiarization with composing, drawing on prior knowledge, setting the task, moving consecutively through each part of the melody – beginning-middle-end) allowed children to *mindfully* engage with the technology, enhancing their sense of *purpose* and *imagining* what will come next in the composition process. Children were 'allowed' to experiment with the composition and the technology provided a 'safe' point where risk-taking and individual agency were encouraged.

6. Case Study 2

The setting is a small English primary school. A space has been cleared at one end of the room and there is an interactive whiteboard on the wall that displays the MIROR-Compo screen, running from a laptop via a Korg keyboard. The class of 20 eight-year-olds have encountered the software program MIROR-IMPRO and -COMPO a few times before. The lesson is taught by their class teacher, Bernie ('T1'), who is also the school's music specialist and Sarah ('T2') a composer/performer who is responsible for the software and also for recording the session. The aim of the lesson is to get the children to create music suitable for movement, while developing listening and movement skills and becoming familiar with musical terminology.

Bernie begins by asking the children to listen to a short rising glissando and then try with a partner to find one or two words to describe what they heard. They suggest: *someone going up steps, or a roller coaster*. A new fragment is played on a loop, for the children to invent their own individual movements to fit. Bernie points out some good interpretations and some that are less successful. She encourages really good listening, asking the children to draw the music's shape in the air and trying to match it in movement. They experiment with several other fragments, discovering what works well and what does not – a long sound can't be interpreted as a jump, because that doesn't stay still and nor does a giant step. One of the class suggests a 'freeze', as if they are playing the game 'musical statues'. They practise leading their movements towards this: everyone needs to know how many notes there are before the 'freeze' so that they are ready for it.

Now that the children have experienced combining movement with pre-recorded music it is time to generate some new musical ideas, specifically for movement. Bernie asks the children to play some ideas in Impro, making each idea different from the one before. She describes each input and talks about how easy or difficult it might be to move to. A new musical term is introduced: *tempo*. When there are plenty of ideas stored in Impro, they move on to Compo and Sarah helps the children to start building a piece. As they discuss their choices, they begin to exercise musical judgement, frequently playing back the growing composition to check its progress:

C1: *I think the ending is too fast.*

After a new idea is added:

C2: *Now you've heard it, it sounds good. It sounds like it's joined together.*

C3 adds a rest and then suggests: *After the rest we should have something fast.*

Bernie invites various children to contribute by listening to what has been done and then choosing the next chunk, comments on the various chunks and highlights also how the piece is structured:

T1: *We've got a first section which has got some short spiky little bits and you can see there aren't any long notes, and then [in] the second section we've got a long held bit and then the third is more silence and then back to some long held sections.*

The session continues with more children choosing chunks to add to the Compo screen and one boy comes up with a good ending, which they store for later. Bernie encourages listening and frequent playbacks and continues to describe the character of the musical sections. Once the piece is completed to everyone's satisfaction, a small group now work together with Sarah on developing their own movements to the finished piece. They have had plenty of input from Bernie, so at this point Sarah leaves them free to explore their ideas. After some time for experimenting, they come back together to discuss their work and solve problems. Sometimes they need to simplify a movement in order to get it to fit in time, and there is a tricky rhythmic pattern which Sarah claps and rehearses with them until they are confident with it.

The rest of the class return and Bernie reminds them of the aim of the session, to create a piece of music for movement and to invent movements for it. The class watch the small group perform and there are several positive comments from the audience, suggesting that the group achieved their objective.

C1: *It expresses that the fast bits were fast.*

C2: *The dots [on the score] were good for the running. I would have thought that too.*

C3: *At the ending they all did the same movement but in a different way.*

After a repeat performance the children point out more features and Bernie comments on the expressive hand movements and the children's use of different levels in their dance.

As described above, it sounds as if Bernie was quite directive with the children, but it should be borne in mind that this was a new concept for them and that talking about music and movement required some novel vocabulary. The need for good listening was also very important if the children were to achieve their objective. In later classes, once the children had acquired more fluency, they were able to discuss their ideas clearly and make decisions with each other as they negotiated further compositions.

Sarah, the composer/performer who looked after the software reflected on the session:

*T2: I remember being interested in why they liked certain sounds, what it was they did and then what that inspired – how quick that was. They would hear it in their heads suddenly, and that's what you do as a composer....
The movement really focuses the children's listening. It develops their ability to recall the music in their head, when they practise the movements without the recording. It encourages them to vocalise the phrases. And because they 'own' the music, having made it themselves, the dancing helps them to experience listening and learning music more deeply than would happen when dancing to a 'ready-made' piece of music.*

Sarah's comment about the deep learning that takes place because the children 'own' the music that they have choreographed, clearly illustrates this concept of agency. The composition is built from the children's own musical inputs, the assembly of the piece is negotiated amongst the class and the movements are the children's own inventions, mediated by the temporal aspects of their music. The seriousness with which they approach the task – great concentration on finding the best possible moves and rehearsing them, absolutely no 'off task behaviour' but instead good co-operation and listening to each other and to their music throughout – shows how they respond to this challenge and are motivated to achieve a successful performance in front of the class. This they manage, not once but twice. Bearing in mind that the children are only eight years old, average in co-ordination and with little musical or movement experience, this is a successful outcome. This is 'their' creation in every way.

In the above case study, the use of multimodality allowed children to actively engage with the music and assisted in focusing their attention to a common sense of purpose, which was the choreography of their 'own' dance. The visualization feature of MIROR Compo also enhanced their ability to plan what would come next, encouraging mindful and meaningful forms of musical participation.

7. Discussion and Conclusion

As evidenced in the case studies featured in this paper, composing with a common goal (creating a 'class melody' or 'dance sequence'), sensitive teacher scaffolding and using the medium of music technology, offered students valuable experience of contributing their own views and ideas in an inclusive social space. In a connected study, Wallerstedt (2013) concludes that a major part of being able to participate in a musical composition task is the ability to find words that mediate musical meaning and facilitate communication between participants. In such situations, a teacher or more knowledgeable peer can offer scaffolding to support the learning process.

Muhonen (2016) recommends the inclusion of a wider spectrum of opportunities for students

in the music class to create their own music collaboratively, with the teacher's roles including 'sensitive facilitation', 'scaffolding' and 'co-creating' as appropriate (p. 265). At different times in Case 2, Bernie and Sarah adopted each of these roles, thereby assisting the children to develop their capacity for action, decision making and social negotiation, all very much connected with seeing themselves as agents. They also provide useful musical language for the children to assimilate, and this is made meaningful to them because it is being used in connection with the sounds they are hearing at that moment, and need to talk about. So 'dots' become 'notes', the 'roller coaster' is a 'glissando' and 'speed' becomes 'tempo'. A movement term, 'spikey' becomes linked to a musical one: 'staccato'. The new vocabulary is reinforced aurally by the sounds they are hearing and kinaesthetically by the movements they are using. Alternatively, in Case 1, the class teacher guides the children through a complex process of decision-making whereby particular musical concepts, e.g. 'rest' become organising elements of promoting their understanding of structure in the classroom. The breakdown of the task of composing the class melody into smaller chunks of activity and the establishment of a 'safe' space in which children took risks, enabled the children to gradually and systematically build their musical vocabulary during the creation of their composition.

In both case studies, innovative technology was combined with a collaborative and inclusive approach in order to encourage creative and rewarding experimentation amongst novice musicians.

Acknowledgements

The research data used in this paper were collected as part of a larger project funded by the FP7 ICT Strand of the European Commission. We are grateful for our collaboration with research partners: Francois Pachet, Anna Rita Addessi, Christina Anagnostopoulou, Susan Young and Bengt Olsson, and their research teams in the conduct of the pedagogical studies, which this paper refers to. We are especially grateful to the participating teachers and pupils' mentioned in this paper for offering their time and wisdom to our studies.

References

- Barrett, M. (1996). Children's aesthetic decision-making: an analysis of children's musical discourse as composers, *International Journal of Music Education*, 28, 37-62.
- Gall, M. & Breeze, N., (2007). The sub-culture of music and ICT in the classroom, *Technology, Pedagogy and Education*, 16(1), 41-56, DOI:10.1080/14759390601168015
- Gall, M. & Breeze, N. (2008). Music and eJay: An opportunity for creative collaborations in the classroom. *International Journal of Educational Research* 47(1), 27-40.
- Glover, J. (2000). *Children composing 4-14*. Oxon: Routledge.
- Glover, J. & Young, S. (1998). *Music in the early years*. London: Falmer Press.
- Hewitt, A. (2009). Some features of children's composing in a computer-based environment: The influence of age, task familiarity and formal instrumental music instruction. *Journal of Music, Technology and Education*, 2(1), 57-67.
- Howell, G. (2011). 'Do they know they're composing?': Music making and understanding among newly arrived immigrant and refugee children', *International Journal of Community Music*, 4(1), 47-58, doi: 10.1386/ijcm.4.1.47_1.

- Kim, E. (2013). Music technology-mediated teaching and learning approach for music education: A case study from an elementary school in South Korea. *International Journal of Music Education*, 31(4), 413-27.
- Knudsen, J.S. (2008). Children's improvised vocalizations: Learning, communication and technology of the self. *Contemporary Issues in Early Childhood*, 9(4), 287-96.
- Kratus, J. (1989). A time analysis of the compositional processes used by children ages 7 to 11. *Journal of Research in Music Education*, 37, 5-20.
- Lamont, A. (2001). Musical identities and the school environment. In R. MacDonald, D. Hargreaves & D. Miell (Eds.) *Musical identities*. New York: Oxford University Press, Inc.
- Lankshear, C. & Knobel, M. (2006). *New literacies: Everyday practices and classroom learning*. Maidenhead: Oxford University Press.
- Major, A. (2007). Talking about composing in secondary school music lessons. *British Journal of Music Education*, 24, 165-178. doi:10.1017/S0265051707007437.
- McPherson, G. (2002). From sound to sign. In R. Parncutt & G. McPherson (Eds.), *The science and psychology of music performance* (pp. 99–115). New York: Oxford University Press.
- Muhonen, S. (2016). Students' experiences of collaborative creation through songcrafting in primary school: Supporting creative agency in 'school music' programmes. *British Journal of Music Education*, 33(3), 263-281.
- Pachet, F. (2016). Interacting with style. The MIROR software and its learning theories. In Rowe, V., Triantafyllaki, A. & Pachet, F. *Children's Creative Music-making with Reflexive Interactive Technology*. Oxon: Routledge
- Rimmer, M. (2017). Music, middle childhood and agency: The value of an *interactional-relational* approach. *Childhood* 00(0), 1 – 15. DOI: 10.1177/0907568217711741
- Rowe, V., Triantafyllaki, A., & Anagnostopoulou, C. (2015). Young pianists exploring improvisation using interactive music technology, 33(1), 113-30. Article first published online: June 24, 2014; Issue published: February 1, 2015
<https://doi.org/10.1177/0255761414540137>
- Ruthmann, A. (2008). Whose agency matters? Negotiating pedagogical and creative intent during composing experiences. *Research Studies in Music Education*. 30(1), 43-58.
- Ruthmann, A. (2013). Exploring new media musically and creatively. In P. Burnard & R. Murphy (Eds.) *Teaching music creatively*. Learning to Teach in the Primary School Series. London: Routledge.
- Trehub, S. (2006). Infants as musical connoisseurs. In G. McPherson (Ed.) *The child as musician: A handbook of musical development* (pp. 32-49). New York: Oxford University Press.
- Trevarthen, C. & Malloch, S. (2012). Musicality and musical culture: Sharing narratives of sound from early childhood. In McPherson, G. & Welch, G. (Eds.) *Oxford handbook of music education, Volume 1*, (pp.248-60). New York: Oxford University Press.
- Wallerstedt, C. (2013). "Here comes the sausage": An empirical study of children's communication during a collaborative music-making activity. *Music Education Research*, 15(4), 421-434.
- Wiggins, I. & Espeland, M. (2012). Creating music in learning contexts. In G. McPherson & G. Welch (Eds.), *The Oxford handbook of music education, Volume 1*. (pp. 342-360). New York: Oxford University Press.
- Wiggins, J. (2015). Musical agency. In G. E. McPherson (Ed.), *The child as musician: A handbook of musical development* (pp. 102–121). New York: Oxford University Press

Williams, P. Sheridan, S. & Sandberg, A. (2014). Preschool – an arena for children’s learning of social and cognitive knowledge, *Early Years*, 34(3), 226-240, DOI:10.1080/09575146.2013.872605

Young, S. (2009). Interactive music technologies in early childhood music education. In M.Baroni, A. R. Addessi, R. Caterina & M.Costa (Eds.) *Proceedings of the 9th International Conference on Music Perception and Cognition (ICMPC9)*, August 22-26, Bologna, Italy.