Connecting music and mathematics: Exploring the professional development of primary school teachers in the English context

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Building upon previous research, a small-scale qualitative study was established to work with generalist class teachers in primary schools in London, UK. The research explored how music and mathematics may be co-taught so as to support ongoing professional development. Early findings suggest that the co-teaching of music and mathematics supported: i) a meaningful context for exploration and mastery within both subject domains; ii) extended dialogues within both subject domains; iii) collaborative dialogues between teachers focused on problem solving and learning in preference to previous foci around content and repetition; and iv) a need for the further examination of the impact of teacher identity on issues including planning, craft and professional knowledge and the notion of an 'expert'.

Keywords: Music; co-teaching; primary; teacher identity

Introduction

Previous international collaboration across European higher education institutions working in initial teacher education highlighted the benefits of interdisciplinary approaches in the learning of music and mathematics within the primary school context (Viladot, et al., 2018). Establishing these approaches is becoming more important in the light of current concerns around teaching and learning in primary education and the need for an increasingly broad and balanced curriculum (Ofsted, 2019).

Researchers from UCL, Institute of Education specialising in music and mathematics, met regularly with the participating teachers from two schools to support facilitated discussions around the potential learning opportunities and issues that arose. Each meeting took place in the case school so that the teachers could develop activities in relation to the available resources, expertise across the staff and to maximise opportunities for participation. A range of activities were modelled by the researchers so as to provide starting points that enabled teachers to individualise approaches according to the needs of their students. Each class teacher brought to the discussion their medium-term plans for mathematical learning, which was further supported by input from the school-based music and mathematics specialists, as well as the researchers' expertise.

Review of the literature

Previous international collaboration across European higher education institutions working in initial teacher education highlighted the benefits of interdisciplinary approaches in the learning of music and mathematics within the primary school context (Viladot, et al., 2018).

Several studies have explored the positive effects of music on children's achievement in mathematics (e.g. Edelson & Johnson, 2003). Research evidence indicates a positive relationship between children's visuo-spatial skills and their mathematical attainment (Tosto et al., 2014) and playing music has been reported to help develop visuo-motor coordination (Brown et al., 1981). In addition, the visual representation of music (when presented as sequences of varying luminance) has been found to develop children's sensory integration and memory (Aizenman et al., 2018). Together, these research findings support the argument that engaging with music can positively contribute to the development of children's knowledge and understanding in mathematics.

Research has further explored the link between music and mathematics by considering definitions of 'mathematical thinking' (Hofstadter, 1979). If mathematical thinking relies on pattern recognition, iteration and repetition (Burton, 1984), it would seem to indicate that these processes are also found in musical thinking. From a neuroscientific perspective, it has been suggested that the human brain experiences beauty in music in the same way beauty in mathematics (Zeki et al., 2014).

Why integrate the teaching of music and mathematics?

Cumming (1994) observed that one of the problems with the traditional subject-specific teaching of mathematics in school was lack of interest due to the absence of any connections with topics students found interesting. An et al. (2013, p.1) have argued that because "learning is a situated, socially-constructed, and culturally-intervening procedure", integrated approaches to teaching and learning are likely to be more motivating and more effective. Consequently, providing more natural and engaging opportunities for children to engage in mathematical activities, is likely to achieve better outcomes.

Santos-Luiz, (2007, p.136) has proposed a comprehensive list, identifying relationships between fundamental elements of both music and mathematics:

> … mathematical concepts are presented in melody and rhythm; musical notation includes concepts of time (length of notes, bar lines, and time signatures), rhythm (beat and the grouping of notes in tempos), pitch (clefs, staff, and frequency of the sound), and dynamics (signs of graduation of intensity), all in the circle of musical space (geometry of music)…..mathematical patterns, "friezes", and motifs (types of symmetries) have been employed in musical compositions by a number of composers within geometrical ideas.

This serves to provide a starting point from which to devise activities that support an integrated approach to the teaching of music and mathematics.

Different approaches to integrated teaching

In the consideration of approaches to integrating music and mathematics, different models of integration should be explored so as to maintain the integrity of both disciplines and ensure that learning is taking place. Barnes (2015) identified six common and contrasting ways of using more than one subject to respond to a problem, theme or issue. These styles of cross-curricular teaching and learning have different aims, depend upon a range of planning strategies and result in different learning opportunities and include tokenistic, hierarchical, multidisciplinary, interdisciplinary, double focus and opportunistic approaches.

A common form of integrated teaching applied to music and mathematics is tokenistic. In such cases, music is most often used as a vehicle to support the teaching

of mathematics (e.g. using songs to help with the learning of times tables). A challenge in developing integrated approaches is to avoid adopting a hierarchical approach (where one subject becomes more important than the other) and rather to adopt an interdisciplinary approach where both subjects are embedded in the teaching approaches and activities. In addition, previous research (Brown & McNamara, 2011; Biasutti et al., 2015) has suggested that teachers require ongoing and personalised support during their early careers, so as to support the development of teacher identity in both the musical and mathematical domains.

Methodology

Following a European Comenius project (European Music Portfolio (EMP) – Maths: 'Sounding Ways into Mathematics', 2013-16) in which the co-teaching and co-learning of music and mathematics were explored through a detailed literature review, the development of a range of resources and classroom observations. This exploratory qualitative research aimed to develop this work further by giving class teachers more autonomy in the development of the activities. The research sought to understand how class teachers in a small sample of primary schools in London, planned and delivered such activities to support their students' learning.

Data were collected from focus group discussions, email correspondence and reflection notes from the participating teachers. This resulted in the identification of the development of site-specific strategies, activities and challenges (as well as opportunities) consistent with constructivist grounded theory (Charmaz, 2017). These themes and patterns were later analysed to identify the mechanisms for effective co-construction, conceptualised here as strategies which enabled the co-teaching of music and mathematics through professional collaboration (Sewell et al., 2015).

The participating staff included both the specialist teachers for mathematics and music in each school context, as well as the generalist class teachers for Years 2-5 (pupils aged 6-10 years). Academics from UCL Institute of Education specialising in music and mathematics education, met regularly with the participating teachers to support facilitated discussions around the potential learning opportunities and issues that arose.

In each school, class teachers took part with the support of both the music and mathematics coordinators, as well as a mathematics specialist and music specialist from UCL Institute of Education. The project adopted a multi-site case study approach using a variation of Lesson Study (Stigler & Hiebert, 2009), through which the class teachers were supported, to design, plan, deliver and reflect upon learning activities that combined mathematical and musical learning. Lesson Study is a method that supports a collaborative approach to on-going professional development for teachers, first established in Japan (Stigler & Hiebert, 2009) and subsequently adopted internationally across educational contexts. Lesson Study provides opportunities for focused examinations of children's learning with colleagues observing children engaging in activities, so as to support professional learning. Teachers work collaboratively to plan, teach and reflect revising their practice over a series of iterations (Stigler & Hiebert, 2009). In this way they create a professional learning community with a focus on building knowledge together.

Research design

Following initial meetings to explain the project and obtain ethical consent for participation, the project took place during the autumn and spring terms, during 2019-

20, but was interrupted due to school closures in 2020, due to the COVID-19 pandemic. Both UCL Institute of Education researchers planned and delivered professional development sessions for each of the case study schools. This included modelling suitable activities to enable teachers to explore musical and mathematical learning and begin extended dialogues about the types of learning that might best suit the needs of their students. Following this, teachers worked together to plan and deliver learning activities (the duration, frequency and topic of learning was decided by each class teacher). The researchers arranged to meet with class teachers in each case school, twice a term, so as to support an extended reflective dialogue in which the nature of musical mathematical learning is considered. The additional workload for each class teacher included attendance at professional development sessions (1 hour), two meetings with the researchers (1 hour) each half term. All meetings took place at school, so as to minimize disruption for the participant teachers.

Participants

The research took place in two schools, with seven teachers in total (three from one school and four from the other). The generalist class teachers in each school were supported by the music coordinator and mathematics coordinator at each site.

Data collection and analysis

After the first visit, each visit involved group interviews with all of the teachers involved. The interviews were audio-recorded and later transcribed. This was supplemented by field notes to include discussion themes and teacher responses, with some photocopies made of pseudonymised teaching materials and pupil work. Thematic analysis was used to identify patterns and themes (Braun & Clarke, 2006).

Initial findings

Effective early years and primary teachers have embraced an interdisciplinary approach for a number of years although the relationship between music and mathematics has been identified as one that would benefit from further examination (Edelson & Johnson, 2003; Viladot et al., 2018). Despite innovative work (e.g. An et al., 2013) the co-teaching of music and mathematics has not been widely adopted as part of initial teacher education in the English context. In response to such calls for further professional development, this research has sought to highlight the emergent issues and begin to better understand how this might be achieved.

The schedule of meetings to review and discuss the learning and teaching activities with participating teachers is ongoing and therefore initial findings from the research are reported below. It is expected that both the focus and level of detail reported by teachers will evolve as their experiences and understandings of the research project deepen. Initial findings from teachers' self-reports, indicate that the co-teaching of music and mathematics was a useful addition to pedagogical practice in the primary classroom with respect to three key areas. The approach supported: i) a meaningful context for both exploration and mastery with both the musical and mathematical domains; ii) the opportunity for extended dialogues within both the musical and mathematical domains; and iii) collaborative dialogues between teachers focused on problem solving and learning in preference to previous foci around content and repetition. In addition, the collaborative working between participating teachers within each school context identified a need for further examination of the impact of

teacher identity on issues including (but not restricted to) planning, understandings of craft and professional knowledge and the understanding of expert.

The open-ended nature of many of the learning activities supported exploration and problem solving. Other activities were designed to support mastery of specific material. In the most effective cases, teachers reported that this required careful planning, so as to ensure that learning in both music and mathematics was achieved. Without this, one curriculum subject was likely to act as a vehicle for the other, with music most often relegated to this role. Extended dialogues were reported by participating teachers in both the musical and mathematical domains. Students entered into the discourse through the domain that they felt most comfortable with, asking questions, hypothesising and drawing upon a range of language and representations to explain their thinking.

Collaborative dialogues between teachers played a critical part in the effective planning of and reflection upon learning activities. The participating teachers reported being more confident of their own skills and understandings in either the musical or mathematical domain. By working closely with specialist teachers and the researchers, dialogues unfolded based largely around problem solving as the teachers had to approach the learning activities from the student's perspective. They described 'lightbulb' moments, where their own understanding of a concept shifted.

Finally, the impact of teacher identity has arisen as a potential factor in the effective embedding of this approach and requires further investigation. Generalist teachers who self-report as 'non-musicians' may require long-term support so as to increase confidence in their musical skills and subject knowledge (Holden & Button, 2006). This has also been found of early career teachers working in the mathematical domain, particularly in relation to mathematical content knowledge and pedagogical content knowledge for teaching mathematics (Rowland et al., 2009.

Conclusion and implications

The research is ongoing, with fieldwork in the participating schools seeking to establish and embed communities of practice amongst teachers and learners (Saunders & Welch, 2012). As highlighted (Viladot et al., 2018) there is a need for further professional development in this area. To this end, the early research findings have been used to inform further opportunities for professional development for in-service primary school teachers across London. In addition, the research findings have informed initial teacher education. Through the sharing of effective practice and the support networks through which teachers can continue to communicate, it is envisaged that the co-teaching of music and mathematics in the primary context may be established as a worthwhile addition in the wide repertoire of approaches that teachers use to create engaging, creative and stimulating learning for their students.

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