

The Integration of Mathematics and Music in the Primary School Classroom

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Teaching via an integrated approach is regarded as beneficial to students because connections are drawn between content areas so as to help them develop greater understanding of concepts inherent across disciplines. This paper presents the results of a case study that was designed to explore the knowledge, beliefs and practices of primary school teachers who integrate mathematics and music. The study extends our knowledge concerning teachers' beliefs and practices and broadens our understanding of issues surrounding subject integration.

Music is universal, crosses cultural, historical, and intellectual boundaries, and is grounded in mathematics. Mathematics is also universal, crosses cultural, historical, and intellectual boundaries, and is reflected in music. The interconnectedness of math and music pulsates with a rhythm and harmony of its own. (Garland & Kahn, 1995, p.5)

To many, mathematics and music are logically connected. For example, Nisbet (1990) noted that music and mathematics were theoretically connected in areas such as harmony, with evidence of this dating from the time of Pythagoras. Mathematical qualities are also inherent in other aspects of music, such as rhythm, tempo and melody. When it comes to the written recording of both of the disciplines, the use of clefs, quavers, stave and bar lines are the internationally-recognised symbols for music, whereas, for mathematics it is numbers, signs of equality/inequality and algebraic notation (Smith, 1993). New syllabus documents even highlight this connection (e.g., Board of Studies, New South Wales [BOSNSW], 2002, p.65). There is also research demonstrating a positive correlation between students' musical abilities and their mathematical achievement (Cheek & Smith, 1999; Geoghegan, 1993; Nisbet, 1998; Vaughn, 2000).

A result of the strong connections between mathematics and music, is the many activities written to help teachers integrate mathematics and music in the classroom (e.g., Fernandez, 1999; Greeley & Offerman, 1998; Johnson & Edelson, 2003; Stevens, Sharp & Nelson, 2001). According to Shilling (2002), embedding music activities naturally into children's engagements with mathematics and movement provides a way for children to simultaneously develop their logical/mathematical and musical/rhythmic intelligences.

Definitions of integration differ. For example, Usiskin (2003) defines integration as the simultaneous consideration of different aspects of knowledge and the BOSNSW (1996) defines it as the "purposeful planning by teachers, of strategies and learning experiences to enhance learning across key learning areas". Teaching via an integrated approach is considered to benefit students because concepts and facts are generally presented in context, usually thematically. Often connections are drawn between content areas so as to help build students' understandings of concepts they know or are being introduced to across disciplines (Seely, 1995). The BOSNSW (1996) sees a purpose of an integrated teaching approach as to enhance and maximise learning both within and across the key learning areas of the primary curriculum. The approach is recognised as an important aspect of learning and primary curriculum organisation as it enables teachers and learners to identify and utilise the connections between syllabus requirements. Additionally, the NSW Department of Education and Training (2003) considers quality teaching in schools

needs to involve *significance*. Here *significance* refers to pedagogy that helps make learning meaningful and important to students. Such pedagogy draws clear connections with students' prior knowledge and identities, with contexts outside of the classroom, and with multiple ways of knowing or cultural perspectives.

Despite support for the adoption of such an approach by education system authorities and from curriculum support materials, evidence suggests that integration, particularly that involving mathematics and music, is rare (Kleiman, 1991). Guidelines on how to teach utilising an integrated approach are at best vague—mainly consisting of a collection of sample lesson plans or ideas for teachers to implement. We consider that an integrated approach to teaching involves not just specialised knowledge, but a change of beliefs surrounding teachers' views of curriculum organisation, teaching and how children learn.

In this paper, we report the results from the case study component of a larger study designed to explore the knowledge, beliefs and practices of primary school teachers about the integration of mathematics and music. The findings of this study extend the knowledge-base concerning teachers' beliefs and practices towards teaching and learning mathematics. In particular, they will assist in understanding a range of issues and concerns surrounding the implementation of teaching approaches involving subject integration.

Background to the Study

The original research focused on the integration of mathematics and music in the classroom through two major components. The first component consisted of interviews with four primary school teachers who described themselves as practitioners of integration involving mathematics and music. Results from this component revealed that this group of teachers held specific subject knowledge and an explicit set of beliefs about how children learn. For example, each teacher had an extensive background in music as revealed by their abilities to play several instruments, their attainment of formal qualifications in the subject outside of normal schooling and their involvement in public performances via membership of a band or choir. Conversely, only one teacher identified himself as having a strong background in mathematics and this was characterised by the level of mathematics studied in formal schooling and his self-reported level of confidence in the subject rather than *extra* qualifications gained in the area. However, what seemed more important as a predictor of their decision to adopt an integrated approach to instruction, was the shared belief in the importance of educating the “whole” child and preparing them for life in an “integrated world”. In addition, each teacher expressed the significance of “hands-on” learning that was relevant, significant and engaging for the children as well as encouraging the development of creativity. While only involving a small number of teachers, the interviews provided a tentative starting point for our exploration of why some teachers utilise integration as an instructional strategy.

The point at which the teachers differed markedly was in the actual planning and implementation of integration. This became the focus of the second component of the research project—an in-depth case study of one of the primary school teachers from the first component who reported practising the integration of mathematics and music and who was willing to participate in the study. The case study involved interviews, observations and documentation. It aimed to identify and further explore in detail issues highlighted by the interview component of the study and to provide information pertaining to how a teacher plans, programs and implements instruction involving the integration of mathematics and music.

The Study

The case study took place across three weeks in May and June 2004. A total of seven 2 hour-long observations were undertaken, always between 9am and 11am. Documents were collected throughout this time, and a teacher interview took place prior to, and at the conclusion of, the case study.

Adam conveyed an immense love of teaching through his actions and the passion with which he spoke about teaching in both the initial and final interviews. It was obvious that he took his job very seriously and cared about his students deeply. Adam has an extensive background in music having played guitar, violin and recorder since he was young. In his young adult life, he sang with the Sydney Philharmonia Choir. While experienced in different types of music, he has a special place for music from other countries because of his background as an anthropologist. He was found to have a "...commitment to bringing music to the children" because he believed that all children should grow up to be competent musically. Adam claimed that he was not a "naturally good mathematician" but he enjoyed mathematics and was interested in learning about "unusual aspects" such as projective geometry and the concept of infinity.

Working at a private school in metropolitan Sydney, Adam was teaching Year 3 (8-9 year olds), which he had taught since Year 1 and would take through to Year 8. The Year 3 was comprised of 29 students, including one student in a wheelchair who was supported by a teacher's aide most of the time. The school has approximately 500 students comprising a single-streamed kindergarten to Year 6 and a double-streamed high school. It holds a clearly articulated educational philosophy and methodology focused on "providing meaningful support for children on their journey through the developmental phases of childhood" (school prospectus).

Method of Analysis

The first stage in analysing the case study data (interview, documents and observation notes) involved classifying the material into themes, issues, topics, concepts and propositions. Some coding began while the data was still being collected to assist the process in focusing on essential features of the project as they developed. Content analysis was used to identify themes, concepts and meanings. This involved the technique of comparing and contrasting during all stages of analysis; that is, identifying data segments, naming a topic/category, and grouping each data segment into a topical category (Schumacher & McMillan, 1993). Hence, the data was analysed under the following categories:

- A Typical Lesson
- Style of Teaching
- Impact on Students
- Degrees of Integration

Results and Discussion

A Typical Lesson

Seven main lessons were observed across three weeks of an integrated unit created by Adam called 'Return of the Time Lord: Time in Maths and Music'. An extract from Adam's program indicates that the main lessons in this unit emphasise "the integration of Maths and Music by bringing together elements common to both: time in all its aspects,

including rhythm and pattern”. There were two aims of the unit: first, “to integrate mathematics and music through the measurement and understanding of time”; and second, “to foster an appreciation of the value of using time in a healthy manner” (extract from program).

Every main lesson had basically the same structure and routine each day and the students appeared to work and respond well under this routine. The morning began with singing scales and songs, followed closely by the drilling of times tables that was executed via chanting and rhythmical movements around the room. Recorder practice came next, with the students playing the recorders completely by ear, just echoing what Adam played. There was no music notation until later on in the unit when Adam began to introduce how to read music.

Stories were an essential element in every main lesson and Adam once stated, “I make up a story that I feel will carry the aims imaginatively”. According to Adam, “through the story, they create this picture in their own mind and then they use that, as like the hook to hang concepts on...”. When the students were recalling the story, they were also recalling what they had learnt about time, making it a clever teaching tool.

After recalling the story from the previous day, the lesson moved into the main teaching session for the day. Adam would either focus on an aspect of time in music or an aspect of time in mathematics and the students would complete related exercises in their workbooks. Examples of activities included a times tables grid, rhythm and pitch review, trading in subtraction, and discussions about the world clock. This was the period in the lesson when the students were being introduced to new ideas about time.

Adam does not write his official program until a unit is complete. However, he has the goals and aims of a unit written down from the outset. He plans each day according to where the students are at the previous day. This gives him the flexibility to slow down, speed up or change the program, depending on students’ needs.

Style of Teaching

Adam revealed his clearly defined educational philosophy in the initial interview. In summary, he believes in educating the whole person and he works by a teaching method he called the “three-fold human being” which dictates that a person needs to think, feel and do in order to learn. Adam seeks to teach in a way that involves his students thinking, feeling and doing in order to create deep learning and significance, stating “the more you’re engaged as a whole person in anything, the more you will learn it”.

Throughout the observation period, it became apparent that Adam utilises reform-orientated teaching practices that are aligned with constructivist approaches to learning. That is, he scaffolds the students’ learning through small sequenced steps, always giving the students ownership of their learning by encouraging them to make discoveries for themselves. His method is based on giving students experiences, which hopefully leads them to discover new concepts. This is different to a more traditional form of teaching, in which teachers present or ‘tell’ stories about a new concept and then give them experiences to consolidate that new concept. For example, in teaching the students to read music, Adam used songs that the students already knew from singing. Therefore, when they played the written notes on the recorder, they recognised the tune and could tell if a note had the incorrect timing.

Music is used extensively because he believes that it helps to “build a more cooperative environment so it’s really community building in the classroom”. Lastly, Adam pictured education as a journey, full of creativity and imagination, preparing students for life. He

stated, “in a whole class there’ll be a whole range of different ways they’ve actually understood it but they’ve got there out of their own little journey and the idea is that this is actually preparation for life”.

Impact on Students

Through the observations, it was obvious that most of the students were keen learners. For example, a conversation between students before school involved the them talking about their times tables and offering to help each other with the times tables grid they were completing in class. The students also demonstrated great engagement whilst the story was being told. Their ability to recall the details of the story from the day before and ask numerous questions supports this sense of engagement. The students also appeared excited about solving mathematics problems when they came from the story. For example, another conversation between students in the classroom included the comment, “Don’t you like Minda Minus? I love Minda Minus”. It was observed that the excitement about the characters in the story flowed into excitement about solving mathematics problems.

At the beginning of the unit, the students were unable to see the relationship between mathematics and music in time. In the first main lesson, Adam asked them to brainstorm everything that related to time. The students produced numerous responses such as clocks, school, and birthdays. It was not until Adam repeatedly prompted the students that they were able to identify the importance of time in singing and playing the recorder, and therefore music. The scaffolding of learning used by Adam meant that the students quickly became confident in reading rhythm patterns and then combined that understanding with pitch.

Degrees of Integration

Through reflection during the observation period, it became apparent that different degrees of integration were occurring. Indeed throughout the case study, Adam’s view of integration appeared to change as he began to realise that integration could occur in many different forms and levels.

In the final interview, Adam raised this issue himself, responding with “in a sense, time is like the overarching concept and then we looked at it in the two areas of music and maths”. He believed that his program consisted of real life integration “it manifests in practical terms, in concrete terms in two different areas but what unites it is a reality that is beyond either maths or music”. In reflection, he commented “looking back I feel there were two activities that ran together and what held them in common was something like the meta-level or the concept we were dealing with—time overall”. He was concerned about the integrity of each subject and of forcing integration for its own sake. He thought that some teachers might see chanting the times tables as integrating mathematics and music, but he considered it not to be a “sophisticated integration”. He concluded that given the age of his students it seemed impossible to be able to make it even more integrated but that as students got older, the integration could occur at deeper levels.

Adam listed and discussed a number of connections between mathematics and music in the initial interview, such as ratios, number patterns and rhythm. He talked a lot about “just feeling” that mathematics and music were connected “I think it’s to do with the fact that they’re both about relationships between things” (initial interview). However, he considered that the integration between mathematics and music involves more than just

knowing or feeling these connections; it is about making these “connections come alive in instruction to students” (initial interview).

Adam was aware that the activities the children were engaged in throughout the unit ranged in their degree of integration. For example, at the surface level of integration, was the chanting of times tables at the beginning of every day. This was connecting mathematics with music at a surface level because the students needed the correct rhythm and timing in order to be able to express mathematical facts. This connection became deeper when Adam introduced counting and clapping on the multiples of four and three. The students were easily able to clap on the multiples of four, but struggled to clap on the multiples of three. This difficulty, as explained by Adam, could be linked to the way the children were naturally beginning to feel simple quadruple time in their music (four beats in a bar) but were struggling to feel simple triple time (three beats in a bar) because this is not as common.

Many of the activities with time used in this unit actually kept mathematics and music separate. For example, looking at reading music and time signatures related to time in music but not mathematics. This was similar to looking at the world clock and how to tell the time, which related to time in mathematics but not music. This indicates that Adam used a broader view of integration to that of Usiskin (2003) to create this unit, using time as the integration focus “it’s like the imaginative picture you have in mind is what integrates at different levels”. He considered that having a focus on subtraction at one stage, was a tangent to the purpose of the unit, but important to maintain the children’s developing skills in this area. So Adam was aware of his movement in and out of an integrated teaching approach when the need arose. Such a shift among approaches to instruction and levels of integration were also noted in secondary mathematics teachers required to teach using a thematic approach (Handal & Bobis, 2004). Understanding the reasons why teachers shift their approaches to instruction in this manner are important because they highlight what some teachers perceive to be barriers to such approaches being fully implemented.

Conclusion and Implications

This paper has reported the results from the case study component of a larger study designed to explore the knowledge, beliefs and practices of primary school teachers about the integration of mathematics and music. An in-depth case study of a primary school teacher who reported practising the integration of mathematics and music helped provide information pertaining to how a teacher plans, programs and implements instruction involving the integration of mathematics and music. The findings of this study not only provide a practical model of the integration of mathematics and music in the classroom, they also assist in understanding a range of issues and concerns surrounding the implementation of teaching approaches involving subject integration. For example, it was revealed that in-depth content knowledge in at least one of the subject areas being integrated was a common trait among primary teachers who reported integrating instruction in mathematics and music. While this expert knowledge always occurred in music, we are aware of many other primary teachers with similar expertise who did not report using an integrated approach to teaching. What seemed more indicative of a teacher’s decision to utilise integrated instruction was their belief that such an approach would assist students build a deeper understanding of the concepts taught.

The case study also revealed how complex teaching via an integrated approach can be, especially as teachers move in and out of such an approach or are required to utilise a less-

sophisticated form of integration for various reasons. For instance, Adam interrupted his integrated unit on time to revisit skills in subtraction. He also adopted a surface level approach to integration at times so as to practice basic facts. Adam was aware that he had compromised his belief in the importance of integration and was not comfortable with such decisions. However, he could not think of an alternative strategy that would achieve the same outcomes and maintain the integrity of both subjects. Importantly, Adam was aware of his decisions to shift his teaching approach when the situation warranted it. It is possible that many teachers may see this need to shift approaches as a barrier to utilising an integrated approach in the first place.

Finally, the results of this research also raise many questions about teaching mathematics through an integrated approach that need to be explored in future studies. Do teachers need 'expert' knowledge in all the subject areas to be integrated to enable them to do so successfully and maintain the integrity of each subject? Can we still refer to instruction being an 'integrated approach' when it is characterised by shifts to non-integrated approaches? The findings of this study provide a starting point in which we can begin to understand the range of issues and concerns surrounding the implementation of teaching approaches involving subject integration.

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