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ADDING TO, NOT TAKING AWAY: MATHEMATICS AND MUSIC IN THE PRIMARY CLASSROOM

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Abstract

This article explores the curriculum integration of two learning areas: mathematics and music. We review the literature around effective integration and describe what integration might look like within a primary classroom. Integrating learning areas provide students with the opportunity to encounter key ideas/concepts in a variety of contexts. Students are able to utilise their knowledge and strength in one area to support their learning in another. As students make connections across learning areas there is an opportunity for them to develop a deeper understanding of the underlying concepts. We draw on our shared knowledge of our respective fields, music and mathematics education to offer an example of what a planned learning experience might look like. A plan that explores the concepts of pattern while maintaining the integrity of the learning in both music and mathematics.

Keywords

Mathematics; music; authentic integration

Introduction

The theorisation of the connections between mathematics and music has been of interest to philosophers, educators and researchers since the time of Pythagoras (Cranmore & Tunks, 2015). The connections between these two learning areas may be considered from different viewpoints – the cognitive processes involved in both mathematics and music (Sposet, 2008) and the pedagogical content of mathematics and music programmes (Song & Tillman, 2015). The notion of a mathematics and music integration in primary classrooms is not new. Many of us will recall singing number songs during our primary school years, a practice used to teach or reinforce the learning of, for example, number patterns and counting skills. The purpose of this paper is to explore possibilities of integrating mathematics and music that go beyond obvious connections such as chanting or singing counting songs.

Using a holistic approach to the teaching and learning of mathematics and music can provide educators with ways to capture children's interest and make learning meaningful (Trinick, Ledger, Major & Perger, 2016). Mathematics and music are integral components of young children's daily lives. In the early years, mathematics and music are not seen as separate learning areas. Yet as children progress through primary school, the formalisation of mathematics and music means they are often taught as two distinct and separate subjects. This separation of learning in the primary years may reinforce the idea for children that there are no connections between music and mathematics. Sndyer (1999) claims there is a need for learning programmes to be less fragmented, reflecting the holistic styles of learning that children have experienced in early childhood settings (Perger & Thomson, 2008).

A step towards holistic teaching and learning in the primary classroom is the use of integration, a term that appears to be used loosely to describe any sort of curricular partnership. Curriculum integration is not a new idea, connecting learning areas for teaching and learning has a long history (McPhail, 2017). Dowden (2014) defined curriculum integration as meaningful learning experiences designed to "cross discipline boundaries…with the purpose of helping students to create and enhance knowledge and understanding" (p.18). Whilst we acknowledge the differing views on the meaning of the term

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curriculum integration, for the purpose of this paper, we took the view of curriculum integration to refer to connecting content and skill in music and mathematics around a theme common to both of these learning areas: patterning.

Effective integration refers to learning where knowledge is meaningfully related and connected to all areas of intended learning (Morris, 2003). The integration of curriculum areas can be seen as a great opportunity to explore broad themes in meaningful ways. However, integration does have its inherent pitfalls (Snyder, 1999, McPhail, 2017). A theme or concept that cuts across learning areas can mean that the integrity of one or more of the subjects may not be maintained or apparent. It is not the intention of integration for one subject to be in the service of another. Rather, an integrated approach provides students with opportunities to create generalisations supporting a deeper understanding of underlying concepts in both subjects (Morris, 2003). Integration also provides students with the opportunities to encounter key ideas and concepts in a variety of situations as well as encouraging the interaction of ideas that can lead to new and different ways of communicating meaning (Radford, Edwards & Arzarello, 2009).

A well planned learning experience encourages students to make connections across learning areas and can support the teacher in the delivery of a busy curriculum, by providing more learning opportunities for subjects, for example, music in mathematics time and visa versa. Authentic integration allows students to utilise the skills and knowledge of one subject to support learning in another (Bolstad, 2011; Barrett & Veblen, 2012). This article provides an example of a planned integrated learning experience supporting the connection of skills and knowledge through the use of a subject context, providing a setting in which students are provided with opportunities to use their knowledge from one learning area to make sense of new learning in another (Snyder, 1999).

Some view the connection between mathematics and music as logical and theoretical (Bobis & Still, 2005), rather than just creative and artistic. There is an assumption that music is a 'creative' subject and mathematics a 'logical' one, therefore lacking in creativity. Yet Goodkin, (2002) states the arts do not always need to be creative and that other learning areas can be, as it is more about how they are taught. If these preconceived ideas are put aside there are many opportunities where mathematics and music can naturally connect. For example, humans express and construct meaning through multiple sign systems. Mathematics has its digits and symbols and music its written forms of notation. Connecting these learning areas exposes children to multi-modal opportunities for learning (Johnson & Edelson, 2003). Another well-recognised connection between mathematics and music is the mnemonic strength of music, particularly song. For example, the memory of a counting song rhythm may prompt the memory of the words that accompany that rhythm (Salcedo, 2010). In mathematics contexts, mnemonics serves as a useful tool in enabling children to use their brains efficiently when solving problems involving complex cognitive processes, such as perception of patterns (Medina, 2002). Recognition of this important connection is evident in counting songs, and number chants. However these practices tend to be instinctive rather than planned, and the benefits may be undervalued (Johnson & Edelson, 2003).

When planning to bring together two or more learning areas there will be times when they are integrated to different degrees so as to maintain overall integrity of both. It may be that the teacher will have to move in and out of the integrated context to enable specific learning in an area that is impeding student understanding of the wider context (Bobis, & Still, 2005). For example, when working with mathematics and music, analysing rhythmic notation in music may not be possible if the students do not yet have a knowledge and understanding of fractions. To ensure the integrity of each subject, specific learning goals need to be identified for each area when planning the learning experience (Snyder, 1999). Teachers should aim to assess learning intentions through the use of the same activity or theme whenever possible. For example, a theme of repeating patterns could be assessed when students read music notation and play repeated phrases using different forms of body percussion. In mathematics, the assessment would focus on the student's ability to identify the unit of repeat in the notation (visual) or played piece of music (aural).

Integration in Action

In mathematics, algebra is about patterns: making, finding, continuing and describing them, and using them to solve problems (Ministry of Education, 2007). There are three distinct aspects to teaching patterning: number patterns (counting), repeating patterns (having a consistent 'unit of repeat') and growing patterns. Thinking and reasoning skills are developed as students analyse a pattern to work out the rule. Students need to be able to communicate the rule using different media, for example, one, two, one, two or clap click clap click. They also need to be able to predict what comes next in the pattern. Patterns are also a key concept in music. As students explore rhythm and beat in music they are introduced to ostinato - a short melody or rhythm that is repeated. The concept of patterning can be seen developing in infants. For example, young children naturally copy and repeat patterns of clapping when participating in music exploration. This type of pattern repetition supports the development of early algebraic conceptsLike mathematics, music has its own distinct language, using verbal and non-verbal conventions to communicate meaning. The following learning experience looks to connect the mathematical concepts of patterning and corresponding language, with these elements reflected in music concepts. As noted earlier, Morris (2003) states that for integration to be effective, knowledge needs to be connected to all areas. The learning sequence connects concepts of the repeating pattern of algebra with the ostinato in music. Learning outcomes associated with both of these requirements can be assessed through the same experience, maintaining the integrity of both curriculum areas (Snyder, 1999). The following learning sequence should not be viewed as a single lesson, rather as an experience spread over time.

The learning experience was designed in line with the New Zealand curriculum (Ministry of Education, 2007). The New Zealand curriculum document describes elements of best-practice for effective pedagogy, which includes making "links within and across learning areas" and making "connections to prior learning and experience" (Ministry of Education, 2007, p. 9). It is the work of the teacher to design and plan learning experiences that provide opportunities for students to meet the achievement objectives noted in the curriculum document. In the following example of an integrated learning experience, the students (6-7 year olds) will explore patterns and relationships, finding rules for the next member in a sequential pattern by creating and continuing a pattern, and identifying the unit of repeat (algebra). Students will also develop practical knowledge of musical elements such as beat and rhythm patterns. Students will be encouraged and supported to use visual symbols to represent recurring rhythmic patterns (Ministry of Education, 2007).

Table 1: INTEGRATED LEARNING EXPERIENCE - "PATTERNS"

Mathematics	Teaching / Learning Sequence	Music
Students may identify repeating patterns that involve number – skip counting e.g. 2, 4, 6, 8 or other types of patterns e.g.  Students are identifying the unit of repeat. Students are using symbols to represent the sounds in their patterns e.g. ** / / * * / /	**Setting the scene** - As children settle or enter the room have a popular song (with a strong recurring beat) playing in the background. **Learning Sequence** Ask students to demonstrate a repeating pattern in maths / music / movement; – Use text and/or symbols to represent the patterns children demonstrated above, – Ask students to compare their patterns. What is the same? Different? What is a pattern? **Think Peer Share (TPS)** – Play the music used in setting the scene. – Ask children to listen carefully for repeating patterns in the music. – In pairs, students share one pattern with their partners – 'play' the pattern 4 times (and stop). Partner continues the pattern for one sequence (one bar/unit of repeat). – Repeat for other partner. – Each pair of students chooses one of the two patterns and represents the unit of repeat using visual symbols – record four repeats of the identified pattern – Share with class – the visual representation of the one bar/unit of repeat. Demonstrate pattern using body percussion (demonstrators 'play' the pattern twice, then classmates continue the pattern for two more units/bars). – Play the original piece of music with students 'playing' their identified	Students could use body percussion to demonstrate their patterns. Non-conventional symbols (for example clap clap click click could be represented with ** / / * * / / Visual symbols" should not necessarily be 'conventional music notation.' Encourage students to invent their own symbols to represent their rhythmic ideas.

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Students need to understand that each repeat of the pattern must be represented with the same set of symbols. When looking at these written patterns students could be asked to identify and justify the next member of the pattern sequence. Students are identifying the next member in a repeating pattern.	patterns as they listen. Teacher facilitates a discussion about the importance of patterns in both mathematics and in music. **Extending Ideas** – Teacher selects one pattern and repeats it four times using body percussion. – Teacher asks the students how what had just been 'played' could be represented – together agree on symbols to record the pattern. – Teacher and students perform the pattern (four times). – Teacher then claps it once, and adds two more beats of the four, so it is an incomplete pattern – Together the students clap to 'finish off' the pattern. – Students sit in a circle. The teacher starts the pattern as above, the student to his/her left then claps to complete that pattern, claps one more pattern before adding 1,2, or 3 more beats. The student sitting on their left 'completes' that pattern and adds one complete pattern before adding 1, 2, or 3 beats before passing it on to the next student in the circle. Continue around the circle. To conclude, use a code or signal to encourage children to 'break away' from the repeated pattern and improvise rhythmically, then return to the repeated pattern.	This activity may need several 'practice runs'. This activity will strengthen the notion of pattern in music.

In the learning experience described, students are exploring the idea of repeating patterns. Although music is providing a realistic context for the mathematical concepts to be developed, it is not the 'poor cousin' in the relationship. The musical understanding of patterns (ostinato) is central to the activity and learning, and both subject areas are benefiting equally. This multi-modal approach to learning allows opportunities for students to communicate meaning in different ways and enables teachers to make their own judgements about students understanding of concepts, across both curriculum areas. The challenge in taking this learning forward is in teachers supporting students to see the connections between the learning areas. It is the application of learning in one area to another that draws on understanding in multi-modal ways that challenge students' thinking (Song & Tillman, 2015).

Integrating with integrity requires students to be able to transfer knowledge learnt in one curriculum area into another (Snyder, 1999). The learning experience above could be the motivation for further exploration of patterns in music and mathematics, or in other learning areas such as dance or visual arts. The musical patterns developed in the learning sequence could be extended further into a musical performance. The understanding of pattern demonstrated in this learning experience could be the prior knowledge required for exploring number patterns in mathematics, leading students to make generalisations to identify the next member in a given sequence. In each of the suggested extensions, students would be recalling the knowledge learnt about repeating patterns in this learning experience and applying it to a new situation.

The integration, correlation and connections between mathematics and music have creative potential (Ings, 2017). Goulder and Lodge (2008) state that to make the most of these connections teachers should aim to "consciously draw out" the parallels between mathematics and music (p.1). Providing students with opportunities to learn and/or encounter key ideas in a variety of situations; in this case, mathematical repeating patterns alongside musical ostinato has the potential to support a deeper understanding of the concepts (Morris, 2003). For some teachers, the notion of integration is ''breaking norms'. Ings (2017) encourages teachers to grasp the possibilities of integration, persevere until they succeed so that they can think in a richer deeper way. The challenge for teachers is to find ways to enact these possibilities within a classroom situation, providing opportunities to 'add to' potential learning and not 'take away' from the integrity of either curriculum area.

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