Early childhood music and maths: The language of patterns

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Abstract

This paper examines the relationship between early childhood music and maths. The emphasis is on children as intuitive pattern makers as they explore, categorise and imagine their worlds. We argue for the careful listening of childhood languages and reason that music and maths are expressive languages that young children use to investigate and experiment. This concept is based on Malaguzzi's idea of the hundred languages of children. Children's explorations of patterns, whether music, maths or other media will follow the principle of symmetry. We observe the intersectionality of language/s. Data are drawn from video and teaching materials prepared for early childhood teachers in-service training in Australia. Framing the discussion with Vygotskian and developmental theories we identify the patterns a child makes in a music discovery video and categorise the child's actions to combine both musical and mathematical concepts within the one action. The aim of the research is to revisit early childhood curriculum and pedagogy, rethinking sources of knowledge and the value of treating arts and sciences as being of equal importance as children discover and define their worlds.

Key words: early childhood music and mathematics, intersecting knowledge, early childhood integrated curriculum

Introduction

The child
Is made of one hundred.
The child has
a hundred languages
a hundred thoughts
a hundred ways of thinking
of playing, of speaking.

From the poem: *No way. The hundred is there*.
Loris Malaguzzi.

In this paper, we examine the idea of children as pattern makers and relate this to children's encounters with elements of music and mathematics. The aim is to seek connections between types of knowledge through children's discoveries based on playing within the world. Music and mathematics have long been associated and musical elements and mathematical principles can be discovered simultaneously as the child engages in exploratory play. Underlying ideas are based on the Reggio Emilia concept of the child having a hundred languages and such things as "reason and dream" belonging together (Malaguzzi, 1993). The approach to children's learning expressed in this paper is a constructivist one. This is a philosophical stance that expresses the view that children, in contexts that encourage play and discovery, construct their own minds, their world view. We draw on literature that promotes meaningful learning and promotes the acquisition of worthwhile knowledge in an environment where the child is an active protagonist. Here we explore the notion that children's explorations can have multiple meanings across disciplines. We have chosen music and mathematics, as languages of childhood, that are important sources of meaning making and conceptual development.

To achieve this aim, we have taken a video observation, designed for early childhood educator training, of a child's musical play at an outdoor interest area. The design of the music activity is

based on principles of best practice (Elliott, 2013). As the video observation and accompanying notes were developed for training and in-service for an Australian early childhood audience by the *Australian Children's Education and Care Quality Authority* (ACECQA, 2020a, 2020b) the Australian national early years curriculum is the policy context of the discussion. We extend the search for connections between the patterns of music and mathematics and different ways of seeing the same events (Clegg, 2007) and ask the question: How does children's pattern making help them discover the worlds of music and mathematics?

We discuss our findings in relation to implications for curriculum design and pedagogy.

Such questions are significant in an educational environment where policy makers increasingly privilege STEM (science, technology, engineering, and maths) at the exclusion of the arts, and curriculum is based on "evidence-based practice" (Elliott, 2013). We argue that separating knowledge into different areas and ignoring what children know leads to a diminished curriculum. We use the AECEQA video and notes as data to illustrate the child, Thomas, experimenting with an outdoor music play centre. We unpack Thomas' activities to explore the question of how pattern making in different media can reveal what children know and how this knowledge can be used for further learning across content areas. By identifying multiple concepts in one activity educators can design environments and interact with children to encourage integrated curriculum in practice.

In the literature review we discuss the value of identifying children's musical and mathematical knowledge in early childhood. The potential exists for those that design educational experiences to integrate children's experiences in relation to general learning and also engage with content knowledge across disciplines. Music and mathematics play can be seen as one intersecting action where children can develop understanding and appreciation of both disciplines at the same time (Viladot & Cslovjecsek, 2014). This notion is explained by Russell-Bowie (2009) who suggests there is a number of approaches to integration and suggests that symmetric correlations can be found when different disciplines use the same material for their own purpose. The role of the educator in creating the music activity described here is discussed and the potential of such practices highlighted. The project design is presented in the research section of the paper where we justify the selection of data and methods of analysis. Comments and discussion suggest the value in analysing an event from different perspectives (Irvine et al., 2015) to determine what learning is taking place and the future potential of such learning experiences for generalisation across content areas. The vignette, that forms the primary source of data, was filmed in Australia, and aimed at an Australian early childhood audience. We include a brief introduction to the Australian national early years curriculum as the significant policy document that forms a context for this study.

Literature review

The early childhood curriculum in Australia

The early childhood curriculum and the place of music and maths is the context of this paper. The Australian curriculum, *Belonging, Being and Becoming: An Early Years Learning Framework for Australia* (henceforth EYLF) (AGDE, 2022) is based on five outcomes. In the curriculum document these outcomes are interrelated with identified elements, principles, and practices (AGDE, 2022). To avoid being prescriptive, the outcomes are described as process outcomes:

- Children have a strong sense of identity
- Children are connected with and contribute to their world
- Children have a strong sense of wellbeing
- Children are confident and involved learners
- Children are effective communicators (EYLF).

Important to the EYLF is the promotion of a child's growing sense of identity and as the name suggests, a sense of belonging. However, there

is also a question of the relationship of content knowledge. Krieg (2011) comments that in many approaches to early childhood education "content knowledge is positioned negatively" (p. 48). One of the reasons for this perception is that curriculum is often understood as discrete, disciplinary knowledge associated with the idea of educators imparting information. In such an approach there is often a disconnect between children's everyday experiences and what is taught/learnt. Such a mix has elements of a behavioural evidence-based practice, developmental milestones and constructivism with its emphasis on building understandings through social relationships and experience. For this paper we explore different ways of exploring the selected data to focus on the potential of the situation in relation to musical awareness and extend this to the integration of mathematical concepts.

The Australian early childhood curriculum lends itself to integration as it is not subject based and as described above, the five outcomes are 'process' outcomes with an emphasis on the learner as a social participant in their own learning. Play is actively promoted and languages like music and mathematics are easily incorporated into such a framework. Viladot and Cslovecsek (2014) discuss how integration may be considered in different ways. They promote the idea of holistic learning which is a popular concept in early childhood (Haslip & Gullo, 2018). Within this frame there are two approaches suitable for the early childhood setting. The first is the idea of one area serving another, for example, using songs to encourage number awareness or, a situation where generic and specific learning outcomes can be generated from the same experience. This latter suggests there is more synergy in the relationship between the sources of knowledge. To achieve integration Viladot and Cslovecsek emphasise the importance of educator experience and training.

Examples of the relationship between music and mathematics are myriad in the early childhood literature with the relationship privileging what children can learn about mathematics by exploring patterns in musical elements (Bakar & Samsudin 2021; Geist, Geist & Kuznik 2012). Language used in these articles to explain how music is useful for mathematical learning include words like employ, incorporate, benefit and a common phrase 'learning mathematics through music'. The Australian EYLF takes a similar approach with music being referred to as an example of the arts that is useful to promote communication, literacy skills and well-being. However, in this same document mathematics is referred to as a discrete set of ideas and concepts with its own vocabulary. We argue that such an attitude is too narrow for both musical and mathematical understanding and suggest an approach that takes an integrated approach would develop a better awareness of music and mathematics and help children develop conceptual understandings through pattern recognition and creation of their own patterns.

Music and mathematics in early childhood

There is literature that emphasises children as pattern makers who develop their understanding of the world through observation, manipulation and relationships of physical and social properties that have significant repetitive features. Symmetry is important in both mathematics and music and much of this is created through repetition. Repeat features include contrasts in size, sound and form. Balance, harmony, mirror effect, spatial intuition, spatial perception and the elements of music that young children explore of beat, pitch, rhythm, dynamics, duration and timbre which are all associated with patterning. Wade (2011) stated:

> Patterning is a skill that may be generalized to many different subject areas and can influence the way children understand the world around them. Patterns may be perceptual, numerical, arithmetical, or spatial and the ability to recognize these patterns and others may bring order to a seemingly disjointed set of numbers or objects. (p. 45)

A significant aspect of children's ability to recognize patterns is the ability of adults to support such relational perceptions in the design of the

teaching and learning environment (Clements & Sarama, 2020). In this paper we have used the example of an outdoor music space to illustrate how the adult can provide an environment where children can immerse themselves in connected concepts like beat and rhythm and 1:1 correspondence or associate pitch with size and length of sound makers (van Vreden, 2018).

Experiences with musical elements will help children in the pursuit of mathematical concepts and skills through a classification of sounds and movement including measuring duration and dynamic intensity, ordering events and patterns, graphically representing data and counting. Young children's play experiences are action based (van Vreden, 2018). They use concrete materials and their explorations have the potential for them to translate and transform meanings in music and mathematics to become aware of the connections between the two. Such relationships can be observed in children's intuitive pattern making when painting (Booth, 2011). Booth likens the young painter to the scientist and contrasts the work of a child's painting to an equation by commenting that some elements are known in an equation, but others are not. It is through discovery with the medium of paint and brush that children can create from both an artistic and scientific perspective and develop their own view of reality. She suggests they can "spontaneously invent symbolic representation" (p. 19).

The more we integrate the arts across the early childhood curriculum the greater the opportunity foryoung children to explore and develop their own understandings. Embedding music and mathematical content knowledge into children's play environments will assist the adult to observe children's engagement with the world around them and assist in guiding their logical/mathematical and musical/rhythmic intelligences (Geist, Geist & Kuznik 2012). Observation enables the adult to note what knowledge children bring to an activity and can guide an expansion of the child's comprehension so it can be generalised across contexts.

The educator's role in designing the musical environment

In Figure 1 an outdoor wooden table is set up for music discovery. Metallic saucers, a colander and cylinders of different sizes lie on the table. There are wooden tapping sticks, thin metal rods or children can use their hands to 'play' the instruments. The sound environment consists of wood, the tapping sticks and the table and metal, the assorted objects on the table or hanging from a frame. There is contrasting resonance between objects lying flat and those hanging.

A sense of purpose in a structured play space is valuable. Aesthetics, comfort, levels of choice are part of the design. In this scene the music is in an outdoor space providing room for movement, the trees provide an aesthetic natural background and being outside allows experimentation with sounds without creating 'noise'. The learning environment should also be designed to promote further exploration in the same, or amended, space (Miller, 2017). The space invited interactions and we saw two children, Thomas and Jaye, engaging in collaborative inquiry during the video. Adult interaction was minimal and mainly focused on helping two other children move into the space without disrupting the play already occurring. Adult observations of Thomas's use of the space could potentially lead to professional learning and enhanced skills in developing such spaces (Miller, 2017). The design of this space is an example of part of the adult's role in providing opportunities for discovery learning.

The research: methodology, method, data and data analysis

The data we have used for this exploration of children discovering musical and mathematical patterns consists of a video made available for early childhood educators and academics involved in the training of early childhood educators (ECA, 2015b). This series of videos was designed to present viewers with children filmed in their preschool environment spontaneously responding

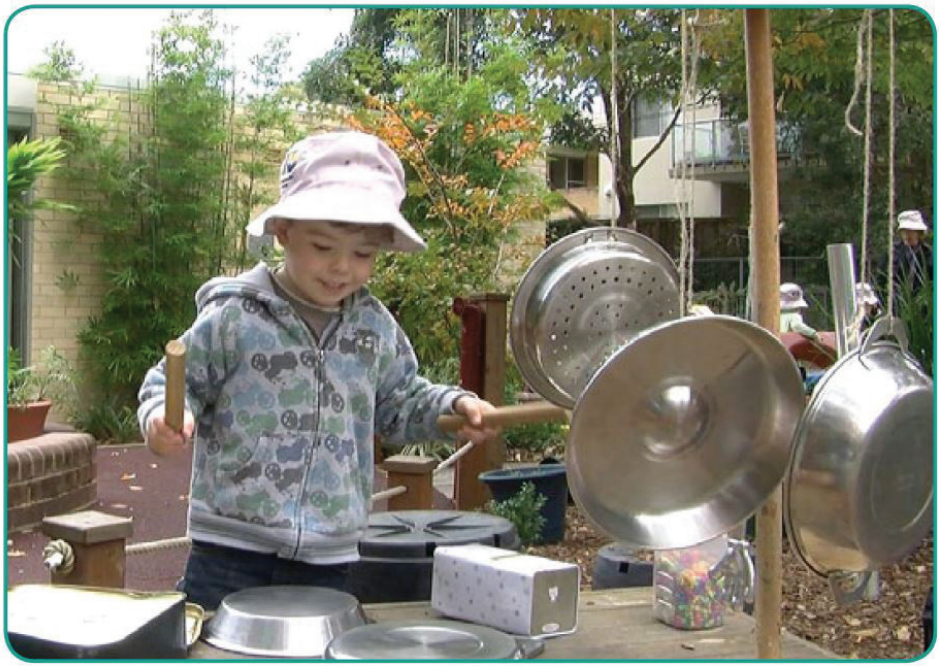

Figure 1. Image from video 'Discovering music'.

to the challenges designed for them. Each video is accompanied by teaching notes which are based on a learning story approach (Carr, 2001; ECA 2015a) and a transcript that follows a running record format (ACECQA, 2015; Hamer, 2003; Rodgers et al., 2021). The running record does not contain a developmental analysis which would usually be included in this type of observational record. The video data series are well produced, represent early childhood practices accepted as high quality and they are open access. In this case, an educator has carefully set up an outdoor music space and we analyse the video to extend the messages that can be derived from the child's musical free play within this environment. We pursue the concept of integrated curriculum (Haslip & Gullo, 2018).

Data set: vignette (video), transcript (running record), teaching notes (Learning Story)

Video recordings have become increasingly popular as a source of observation data in early childhood practice (White, 2020). Video can be re-examined and are therefore open to multiple cycles and forms of analysis. Such revisiting can strengthen the likelihood of generating findings that are reliable (Acker, Nyland & Jobson, 2017; Jewitt 2012; White 2020) and provide different interpretive lens. In this case observers have used a developmental frame and a socio/cultural frame to analyse the video. Irvine et al. (2015) have written of the value of "different analytical perspectives in one data set" and a collaboration that brings together different approaches to interpretation can provide rich insights for policy development and practice. For training the music video was

presented through the lens of 'best practice (Elliott 2013), developmental theory (Nolan & Raban, 2015) and a socio-cultural frame (Carr, 2001).

The theoretical approach of this project, like much early childhood research, is eclectic (Escamilla, Kroll, Meier & White, 2021). As described above, data comes from a government source committed to providing 'best practice' illustrations of pedagogy. We unpack the data using the analytical frames presented in the original resource though the Learning Story was rewritten to change the focus from adult learning to observing the child's actions and discoveries. We have extended the two examples to explore the question of integrated curriculum focusing on music and mathematics. The original transcript of the video (ACECQA, 2020b) used a developmental frame, the running record, as a formative assessment technique and this analysis provides a view of what the child in the video is doing. To this recorded observation, the running record, we added the two languages of music and mathematics (Rodgers et al., 2021). The running record is an example of how different aspects of experience can exist simultaneously and be connected. The second observation, to encourage reflection with those studying the resource, was prepared using a Vygotskian learning story approach. In the original the reflective story (ACECQA, 2020b) concentrates on the adult interpretation of the actions within the video to provide guidance for discussion. We have changed the emphasis of the reflection away from the adults to interpret the child's actions which are now reviewed in terms of dispositions to learning. The categories used to identify learning dispositions are part of the established technique for using Learning Stories when reporting on children's engagement and attitudes to learning (Carr, 2001). We sum up what learning has been visible and explore this in relation to the potential learning that could, or did, take place in relation to musical and mathematical pattern making. The following description of the video content is the observational data and context for the analysis.

Description of the video content and context: a story with a focus on the child Thomas as protagonist

Two children are using pots and pans as they engage with an outdoor music sound station (Figure 1) described above. Our focus is a child Thomas. Thomas is playing with rectangular cuboid wooden sticks. Holding a stick in each hand, he bangs on some of the objects on the table, repeating this action, alternating hands. The right-handed strikes are more accentuated. He then strikes some of the objects with both hands. Thomas pauses, looks at the camera and starts playing again, this time - with unchanged tempo.

He is also observant of the hanging objects and strokes them with his sticks, running both sticks in turn around a colander, creating a gentle melodious sound. He then turns to another hanging object and gives a big bang and turns back to the colander. After putting his sticks down briefly he starts again and repeats his previous piece. This time, he finishes with a loud beat which he shares with Jaye, a girl at the other side of the table, by smiling. He moves around the table next to Jaye. Jaye has initiated her own sound making exploration and is dropping a rod through a metal tube to make a chime sound.

Thomas joins in by banging his sticks on the hanging tube as Jaye drops her rod through the tube. Thomas taps his sticks on the tube making a louder chiming noise. Jaye holds one of the hanging metallic plates in a horizontal position and places the rod in it and bounces it. The children talk to each other about the size of the metal rod and Thomas thinks it makes a nice sound. They repeat their actions.

Amended running record transcript (ACECQA, 2020b) of the video vignette

The transcript starts with the statement:

This video features children using pots and pans as they engage with a creative outdoor music and sound station. This experience connects the children with making music, imagination and cooperation (ACECQA, 2020a).

We have used the transcript and the teaching notes that accompany the video as an example of best practice (Hydon, n.d.). Best practice is often defined by principles and in this case the principles that can be identified are adaptations of space, materials and equipment, 2) interactions, 3) adult guidance of free play and 4) communication. The transcript provides a running record across the time of the video highlighting the use of space, interactions, adult and children, adult guidance and how this is communicated. All formal language interactions have been transcribed.

A running record, or specimen record (Hamer, 2003) is used to record movement, language, spoken and body language and all activities including facial expression over a short period of time. Commentary categorises child's actions in areas of development. Hamer says the "objective is to provide a 'film strip in words' which gives as complete a picture as possible on everything that happens" (p. 36). Running records are time consuming and detailed and can be useful when focussing on a particular aspect of a child's actions. In this case musical discovery was the focus. Using the same time intervals as the original transcript this transcript adds an extra column to note musical discovery and identification of mathematical concepts that were displayed during the play sequence.

The revised video vignette notes of the Learning Story (ACECQA 2020b)

The second observation notes are based on a Learning Story format, a socio-cultural, approach that links the events of the video to the Australian *Early years learning framework* (EYLF) (AGDE, 2022). Learning Stories are a popular method of documenting and assessing children's learning (Acker & Nyland, 2020) that emphasises the importance of children's understanding, and their relationships with people, places and activities. The curriculum document (EYLF) is based on outcomes and ideas of continuous improvement. Evidence-based approaches and outcomes-based education has particular features that sit within a positivist 'what works' methodology (Elliott, 2013). The EYLF was designed to promote continuous improvement through outcomes and indicative standards that are evaluated to show progress. As the EYLF is not prescriptive the outcomes are expressed as aims to allow choice of theoretical underpinnings and educational practice.

Recommended discussion points in the notes link to particular standards within the national quality framework (NQF). When using this video for professional development it is suggested that the video is viewed three times. Each time a discussion focus is provided. The third viewing equates with the final analysis 'What next' of a learning story. For this study the original focus on the adult's practice has been shifted to the child. The example of the Learning Story follows the pattern recommended for exploring children's learning and the potential of the environment.

Data analysis

Our analysis of the video has relied on two observation techniques, a Running Record (Table 1) and a Learning Story, chosen because the original examples were expressed as such.

General comment from running record

Thomas displays right hand preference, hand, arm and body movements indicates physical competence as he holds sticks for different tasks and can control a rhythm pattern. He initiates a sequence with Jaye and comments on the sound she makes with the metal tube and rod. In relation to cognition, he is able to use objects purposefully and deliberately makes controlled sound patterns that have design elements that are both musical and mathematical.

The Learning Story

The Learning Story is a pedagogic tool for early childhood educators to assess children's learning and learning potential. It is a narrative based

Table 1. Running record with developmental comment. The first column is the original record describing actions performed by Thomas. The column on the right was added by the researchers to indicate some of the musical and mathematical patterning that was occurring.

Transcript	Musical & maths awareness
Video - outdoor wooden table set up for music discovery. Metal dishes of assorted sizes lie on the table. A colander, a cylinder and assorted metal dishes are hanging from a frame.	
Length of observation 2 min and 47 seconds	
00.06 seconds	
Child Thomas is holding a piece of wood in each hand. These are rectangular cuboid, about 10 centimetres long Holding a stick in each hand Thomas bangs on some of the objects on the table. One hand after the other. He starts with the right hand, followed by the left. The right-handed strikes are more accented. Beat unsteady and rhythm is />/>/>. He then hits some of the objects with both hands at the same time. Pauses, looks at camera and starts again. Playing alternate hands and beat now steadier.	One to one correspondence Binary pattern, 1,2; 1,2 repeated Accent, unaccented pattern repeated Right, left pattern with right the dominant beat Timbre - Explores using sticks in different way on hanging objects Repetition and rhythm
0.27 seconds	
Thomas moves to hanging objects and slides his sticks on them. A gentle melodious sound.	
0.35 seconds	
Adult mentions how loud drumming was yesterday. Thomas glances at her and continues to stroke the hanging objects with his sticks, running both sticks in turn around a colander.	Contrast Finale – finishes pattern –duration, understands finishing a pattern
0.40 seconds	
Turns to another hanging object and gives a big bang. Turns back to colander. Two strokes and a bang and puts the sticks down	Loud drumming and a bang Exploring dynamics and timbre and duration
0.47 seconds	
Picks up sticks and starts banging the objects on the table vigorously. He finishes with one loud beat with the right hand.	
0.51 seconds	
He looks at the girl, Jaye, standing at the other side of the table.	Comments on sound -Timbre
57.00 seconds	
Thomas hits the colander once with his stick as he moves around the table He watches Jaye drop a metal rod through a metal tube. It makes a chime sound	Observing different experiments with sound production
01.09 seconds	
Thomas bangs his sticks on the hanging tube as Jaye drops her rod through the tube again	Timbre Explores chime sound
01.15	
Thomas bangs his sticks on the tube making a louder chiming noise. //// Jaye holds one of the hanging metallic plates in a horizontal position and places the rod in it and bounces it Thomas bangs his stick under the plate to make the rod bounce. He is using his right hand. The rod bounces higher and makes a louder sound. Thomas makes slower and harder movements. Jaye continues to hold the plate	Dynamics and steady beat Acknowledges another approach, gradually controls movement to achieve a stronger steadier sound, physical and cognitive engagement
01.25	
Jaye takes the tube and places it in another plate. She says something inaudible Thomas follows and goes to hit under the plate, but Jaye drops it and the rod falls out	Pattern on wood, contrast, beat and timbre Beat and rhythm perception and body awareness of beat

01.34	
Thomas beats a quick pattern on the wooden tabletop with his sticks. Both hands, even rhythm, starts with right hand. Walks around the table playing the sticks like tapping sticks. His right hand is playing on top. //// even beats	Movement right to left, repeats one beat with one hand. Three different uses of hands
01.39 seconds	
Standing at table hitting the metal objects at random using alternate hands. Then uses one hand and repeatedly hits one large dish. Reverts to using the sticks as tapping sticks for a couple of moves	Alternate hands and beats with loud finale. Familiar with this pattern Repeats pattern
01.52 seconds	
Vigorously drums on the plates on the table, alternate hands and finishes with two strong beats with the right hand	
02.04 seconds	
Adult intervenes and helps Thomas move all the metal plates to one side of the table. Thomas looks at the two children who have joined the table. He starts to beat on the metal plates on the table. Right hand heavier beat, />/>	Complexity - Distinct pattern change moving from a pattern of two accents to a pattern of three
02.24 seconds	
Changes beat, two accented with right hand and softer beat with left hand //>//>//>	Rhythm, beat, repetition, balance
02.34 seconds	
Seems distracted as he looks away and drumming beat becomes haphazard.	

assessment that invites reflection. It is inclusive of relationships and cultural information about the learning environment. In this case we can observe Thomas's reactions and actions in a context purposefully designed for musical exploration. Learning Stories have been likened to Reggio Emilia documentation (Turner & Wilson, 2010). The Learning Story is presented here as another method of exploring Thomas's activities in the music area and assists the observer to articulate what learning occurred and consider implications for further planning and design.

The context and narrative

The Learning Story starts by describing the story. This information is provided above under the description of the content and context of the video. The following headings relate to dispositions for learning.

Taking an interest

Finding an interest here – a topic, an activity a role. Recognising the familiar, enjoying the unfamiliar, coping with change

Thomas is interested in musical play; he is exhibiting understanding of drumming as he is finessing his ideas.

Example: Thomas playing with tapping sticks. Bangs on selected objects. He repeats this action alternating hands. The right-handed strikes are more accentuated; beat is steady. Thomas decisively strikes some of the objects with both hands at the same time.

Being involved

Paying attention for a sustained period, feeling safe, trusting others. Being playful with others and/or materials

Thomas is aware that he is being recorded. He acknowledges the camera by direct gaze and pays attention to Jaye's presence and responds to her lead. He allows time to for playful exchange and joins a collaboration of testing sound effects by playing different objects.

Example: Thomas and Jaye work together. As the pipes chime, the rod rattles and pots clang, the children laugh.

"Does it fit through? Put it through," suggests Thomas.

"It fits", agrees Jaye.

"That's a nice sound, isn't it?" remarks Thomas.

Persisting with difficulty

Setting and choosing difficult tasks. Using a range of strategies to solve problems when 'stuck'

Thomas appears confident, but his play does change and expand. He is influenced by Jaye's play as she introduces new possibilities, and he joins in enthusiastically.

Example: Thomas bangs his stick under the plate Jaye is holding to make the rod bounce. The rod bounces higher and makes a louder sound. Thomas makes slower and harder movements.

Expressing an idea or feeling

In a range of ways e.g. oral language, gesture, music, art, writing etc.

Thomas communicates ideas through tempo, rhythm, timbre and dynamics. He also talks to Jaye about their joint activities.

Example: Thomas is able to repeat patterns and changes them through the use of musical elements and the objects he chooses.

Taking responsibility

Responding to others, to stories, and imagined events, ensuring that things are fair, self-evaluating, helping others, contributing to program

Thomas is respectful of built environment choosing to confine his actions to musical experimentation, collaborating with Jaye.

Example: Thomas repeats and extends his actions. He shares and is cooperative when other children move into the space.

Short term review. What learning was visible?

- Both children, through experimentation, are becoming familiar with each object and its acoustic properties.
- Thomas explores timbre, duration and dynamics.
- Thomas's choice to use pulse, metre, phrase structure and musical form is evident; he is building vocabulary.
- Thomas gradually controls movement to achieve a stronger steadier sound, physical and cognitive engagement.
- Thomas discovers musical patterns on wood as well as metal objects.
- Thomas is displaying 'one to one' correspondence and an ability to beat in patterns - binary pattern, 1,2; 1,2 repeated; he can accentuate beats, and repeat unaccented pattern, dynamics; he created a right, left pattern with right being the dominant beat; he understands the significance of ending – as he shortens the beat duration and increased the dynamics.
- His playing shows progressive complexity as he changes from a pattern of two accents to a pattern of three and finally – a loud finale.

What to do next? How might we encourage this interest/ability/ strategy/disposition to be :

- more complex
- appear in different ways.

Information from the video story and the two observations of Thomas indicate his interest in pattern making and how he manages his own learning. When considering 'what next' we can first consider the environment. Social interaction was built into the design of the activity and the setting. The table presented unexplored potential and does not need extra aids unless Thomas wants to seek out an addition for a specific purpose. Including children in planning and provision is significant (Miller, 2017).

The adult' role can become more focussed now that so much observational information is available. The table should be available for the continuation of children's explorations and experiments. The constant presence of this learning centre will allow

for the children's pattern making to be consolidated and become more sophisticated. Language as a teaching and learning tool is important and the adult can assist in the naming and labelling of patterns, notation can be encouraged as musical story telling based on a more formal application of patterns takes place. Booth (2011) calls this the typology stage of intuitive pattern making. The typology stage may consist of the deliberate choice of sounds for particular meaning, exploring the different sounds to describe actions and phenomena and finally creating a complete musical story, with or without words, that can be repeated and shared with others. The role of mathematical pattern making has a fundamental place in the child's growing communicative skills and as mathematical perception becomes part of purposeful storytelling the two languages. This integration of early childhood languages knowledge and growing communicative skill, based on musical and mathematical perception of sets can be significant for the early childhood curriculum. Bamberger and Disessa (2003, p. 123) contend that "topics in mathematics – patterns of change, transformations and invariants – might also expose, illuminate and account for more general organizing structures in music". They discuss the benefits of connecting children to experience, in this case music and mathematical experience. They suggest that exploring the relationship between music and mathematics can be done through the study of patterns and children can generalise pattern making across domains so other expressive mediums become accessible as communicative languages.

Conclusion

In this paper we have engaged in extensive analysis of a single video observation. There is no suggestion that such reflection is possible in everyday practice. Early childhood educators are busy people and often the most inspired teaching moments arise spontaneously. The significance lies in the knowledge of how much can occur in two minutes and forty-seven seconds and how the content knowledge displayed can be encouraged. The original training package was a video, transcript and the vignette notes giving those watching the opportunity to study the video three times looking at different aspects of the experience that occurred and the different players. In the everyday context such examples are presented as a way of thinking about and responding to experience. The lessons contained are the importance of the design of the environment, in this case the music tableau and the children and educators' responses and interactions. That children's pattern making, obvious in music, should be studied across domains and connections explored. We have added to the original data set by introducing observations on two important areas of content knowledge and have changed the focus of the Learning Story to the child's activities. This extension is significant as it has implications for the early childhood curriculum and the relationship to content knowledge at a time when issues of policy making, accountability, integrated curriculum and specialist knowledge for educators is being demanded (Haslip & Gullo 2018).

Integration means that music should not serve to 'teach' mathematical concepts. Mathematical language and ideas might be more meaningful and lead to better mathematical understanding in the future if the different languages of childhood are seen to intersect. Viladot and Cslovjecsek (2014) put educator training at the centre of integrated curriculum. This is an area to explore. The present relationship between mathematics and other areas of early childhood practice, like music, is that of a service relationship. We argue that both are languages in their own right and the relationship between the two sources of knowledge and thinking can be explored through the study of pattern making. In support of this, McDonnel (2015) speculates that "music and mathematics may mutually reinforce one another in early childhood through embodied, social learning processes and conceptual blending" (p. 59). We

have highlighted the importance of the planned environment for children to construct knowledge individually and collectively through exploration and guided investigation. The design of the learning activity should contain rich potential for children to engage at their own level and interest. The play setting described in this paper is an example of pedagogical practice that encourages social constructivism and perspectives on how the world is structured through physical and social relationships.

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