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Musical architects: Immersive learning through design thinking in a kindergarten music composition curriculum

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Abstract

This qualitative study focuses on building a fully immersive musical-architecture composition curriculum for three general music classes of kindergarteners (N=45). Students composed original music using a set of engineering and design precepts. As part of the compositional process, they used Lego bricks to construct three-dimensional representations of their compositions. The children also wrote musical scores using their own notation as a mnemonic device, a "blueprint," which they read while they played their pieces. They could then choose to perform their completed pieces in class and record them as part of their creative process.

Each child composed using a keyboard, which allowed individual children to work at their own pace over several weeks. Curriculum design was founded on the following elements: 1. Differentiated teaching practice. 2. Process-oriented learning environment. 3. Acknowledgement of the children's acquired musical and general knowledge. 4. Embedded skills in STEAM (science, technology, engineering, visual art, and math), which were used in service of musical thinking. 5. Engineering "habits of mind."

Data collection included: Videos of children reading and playing their original pieces; children's written musical scores; researcher observational notes; and interviews with the children about their creative processes. Data were analyzed for individual children and then examined for trends within the whole group. Results showed evidence of immersive learning, accelerated development of musical thinking, and clear application of STEAM skills within the compositional process.

Keywords: Kindergarten, music, STEAM, immersion, composition, design thinking

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Musical architecture

Architecture is both a highly expressive and utilitarian art form, the best of which contributes to the beauty of a community while providing necessary shelter: Home, work place, social center, learning space, and spiritual dwelling. Frank Lloyd Wright once wrote, “There should be as many kinds (styles) of houses as kinds (styles) of people and as many differentiations as there are different individuals” (Wright, 1992, p. 8). Each individual experiences a structure uniquely – associations with different types of architecture may elicit aesthetic and emotional responses that develop into a personal identity (Able, 2000). For example, a school building may represent many things to many people, the structure becoming as important as what goes on inside. Far from being superficial, the building itself, the literal form of artistic expression, becomes rooted in a community’s identity (Carter & Cromley, 2005). In some ways, cultures define themselves by and through the functional structures they create (e.g., J. E. Young, 1993).

Music is a highly expressive and utilitarian art form. When experienced or made, music elicits direct emotional and aesthetic responses that stem from an individual’s deepest sense of connection to the world (Dissanayake, 2000, 2009). When understood as a form of architecture, music is visible from the inside out – the internal materials, familiar structures, forms, and elements connected together to form an entirely new piece of artistic expression. The most complex creative form of musical construction happens through connecting these building blocks. The composer constructs music as the architect designs buildings that will stand as a testament to culture and society.

The connection between music and architecture receives discussion in the literature from various perspectives, where the discussion generally covers two strands: 1) Music has architectural forms embedded in it (Atlas, 2010; Sylvestre & Costa, 2010), and 2) architecture reflects the properties of music composition (Goethe, Eckermann, Soret, & Oxenford, 1850; Leitner, 1974; Martin, 1994; Morimoto, 2016; Walden, 2014; Wheatley, 2007). For example, architecture deliberately borrows common descriptive language from music such as form, structure, symmetry, and harmony to define specific building practices and the artistry of building (Walden, 2014). The origin of use dates to the ancient philosophy of Pythagoras, which used mathematical elements of harmony to describe astronomical movement – the "music of the spheres" (Rogers, 2016), where "the individual soul, nature, the heavenly spheres, and the divine were linked through music" (Blackstone, 2011, p. 9). Furthermore:

> The metadimensions deal with the bigger questions of the discipline, which are more easily linked to other ways of thinking and knowing…If we substitute *unity* or *sense of the whole* for *ensemble* and *structure* for *architecture,* the rest of the metadimensions could easily be used as lenses for developing understanding of the other arts. (Wiggins, 2001, p. 211)

Children's Musical Lives

Young children's experience of the world are understandable as both musical (e.g., Campbell, 1998) and architectural (Harel & Papert, 1991) as they build knowledge through active engagement with their surroundings. Children acquire understanding of how the world works through study, experimentation with its continual processes of success and failure, and de-constructing and re-constructing both the physical materials and the ideas present in their environment (Eshach, 2007).

Studies show that music may act as a medium through which children develop and practice a diverse set of foundational skills (Hallam, 2010), formally and informally (Folkestad, 2006; Lill, 2014), including: social interaction (Gerry, Unrau, & Trainor, 2012; Ilari, 2016; Kirschner & Tomasello, 2010; Ulfarsdottir & Erwin, 1999), emotional regulation (Saarikallio, 2008; Tol, Edwards, & Heflick, 2016; Toyoshima, Fukui, & Kuda, 2011; Winsler, Ducenne, & Koury, 2011), identity formation (Amir, 2012; Margaret S. Barrett, 2011; Davidson & Borthwick, 2002), listening (Reybrouck, Verschaffel, & Lauwerier, 2009), aesthetic appreciation (M. Barrett, 1996; Elkoshi, 2015), and artistic expression (Jaquith, 2011; Kaschub & Smith, 2016; Lau & Grieshaber, 2010; Webster, 2016). Further, active musical participation may strengthen adaptive skills such as resilience (Pasiali, 2012, 2014; Zarobe & Bungay, 2017), critical thinking (M. Kaschub & J. Smith, 2009; Major & Cottle, 2010; Pogonowski, 1987, 1989), creative problem solving (Burnard & Younker, 2004; J. H. Wiggins, 1999), and collaboration (Muhonen, 2014; Stringham, 2016; J. H. Wiggins, 1994). From a developmental standpoint, children's musical interactions can be architectural; where their innate musicality is the foundation for lifelong creative process.

Music Composition as Curriculum

Music's salience and ubiquity in children's lives make it ideally suited for highly complex learning in formalized instruction beginning in early childhood. Research shows that prior to starting school, young children consistently engage in all aspects of musical play (Marsh & Young, 2006; Niland, 2009) as integral to their lives: Singing (Custodero, 2006; Mang, 2005; Niland, 2015; Sole, 2017), moving (Alcock, 2008), instrument playing (S. Young, 2008), listening (Ilari, 2009), improvising (Custodero, 2008), composing (e.g., Margaret S. Barrett, 1997, 2006; Guderian, 2012; Major & Cottle, 2010; Strand, 2016), rhythmic chanting (Harwood & Marsh, 2012; Marsh, 2008), and using music technology (Burton & Pearsall, 2016; S. Young & Gillen, 2007). Designing a music curriculum for children as they begin formal schooling might therefore begin with the premise that young children, in this case kindergarteners, are musically sophisticated. This conclusion led to the development of a kindergarten music education program designed with music composition at its core, which focused on working with music as a complex artistic material.

For this program to be effective, I also considered how to match the abstract, dynamic nature of music as an art form with developmentally appropriate practice in kindergarten, where children ages 5 and 6 years need concrete experiences to help them with representational expression (Pramling & Samuelsson, 2008; Trepanier-Street, 2000). The music/architecture metaphor provided a way to ground the experience in concrete means while allowing for complete creative freedom. Further, the curriculum became multifaceted as it developed into a fully immersive experience, which called upon the students' skills and knowledge of STEAM taught in the general kindergarten curriculum.

Presently, a core body of literature exists concerning research on and practice of compositional techniques in formalized music instruction (e.g., Barrett, 2003; Burnard & Younker, 2004; Hickey, 2001, 2003; Hogenes, Oers, Diekstra, & Sklad, 2016; M. Kaschub & J. Smith, 2009; M. Kaschub & J. P. Smith, 2009; Smith, 2008; Stauffer, 2002, etc.). Studies and curricula emphasize various perspectives on children's musical creativity and how to build effective music education programs around it (Hickey, 2012; Kaschub & Smith, 2017; Stringham, 2016; J. Wiggins, 2015). However, few studies exist that focus on connected learning in STEAM education where music composition is the primary mode of study, on musical architecture as artistic process with young children or on immersive learning through music composition in a kindergarten classroom.

Integrated and Immersive Learning

Initially, I had planned a deliberately integrated curriculum with STEAM subjects used in the service of teaching music composition. However, my students showed a natural tendency to draw on prior skills and knowledge to compose their pieces – and I did not want to lose sight of music as the focus of the curriculum. I discovered that a qualitative difference between immersive and integrated learning is in the perspective of the learner. In general education integrated practice, the teacher knits together aspects of major subject areas for students to apply to solving an overarching problem (e.g., local sustainability) or to complete a project that may have a physical outcome (e.g., building a scaled bridge) (Hutchinson, 2002; Tippett & Milford, 2017). Immersion learning focuses on the experiential aspects of gaining and applying knowledge, where students use all of the skills and materials at their disposal to further their understanding about how the world works (Gopnik, Meltzoff, & Kuhl, 1999; Vuk, Tacol, & Vogrinc, 2015).

Inherently, learning experiences for young children are seamlessly integrated as they explore to gain seminal knowledge about being human through questioning, experimentation, and close observation of adult and peer behavior (e.g., Gopnik et al., 1999). Before formal education begins, skills and subjects are not separated into discrete areas (Tookey, 1975); rather, learning happens constantly and consistently as children draw on previous knowledge and experience to further understanding (Piaget, 1960).

The many studies relating to immersive learning mainly focus on determining effective teaching strategies and assessing quality of learning in four areas of education. Each of these areas defines “immersion” according to context:

1. Teaching English language learners beginning in elementary school, where immersion refers to placing students in classrooms where English is mainly spoken rather than placing them in separated or bi-lingual classrooms (e.g., Burkhauser, Steele, & Li, 2016; Gersten & Woodward, 1985; Gersten, Woodward, & Moore, 1988; Jared, Cormier, Levy, & Wade-Woolley, 2011; Steele, Slater, Li, Zamarro, & Miller, 2013).
2. Teaching core curriculum subject areas through various kinds of immersive technology such as virtual reality, augmented reality, and computer games (e.g., Bhattacharjee, Paul, Kim, & Karthigaikumar, 2017; Chen, Ho, & Lin, 2015; Dalton & Smith, 2012; Dawoud, Al-Samarraie, & Zaqout, 2015; Hamari et al., 2016; Huang, Chen, & Chou, 2016; Johnson-Glenberg, Birchfield, Tolentino, & Koziupa, 2014).
3. Teaching in medical school or in nursing programs, where adult students learn through real-life experiences with patients in internships or assistantships working alongside mentors (e.g., Caldwell, Tenofsky, & Nugent, 2010; Zink, Halaas, Finstad, & Brooks, 2008).
4. Teaching through experiential programming in multi-context, pre-service teacher and music teacher education, where immersion refers to holistic experiences designed to expose student teachers to potential future teaching situations (e.g., Burnard, Dillon, Rusinek, & Sæther, 2008; S. Chapman, 2015; S. N. Chapman, 2015; Lavery, Cain, & Hampton, 2014; McDowell, 2007; Russell-Bowie, 2013; Schmidt, 2010; Southcott, 2004; Waddell, 2011; Zhao & Source:, 2009).

In the aggregate, these studies show that immersion learning: differentiates, intensifies, and streamlines intellectual development; requires the learner to rely on a particular set of acquired skills and experience as a foundation for gaining new knowledge; and requires the educator to act as a mentor, to foster skills development within an open-ended framework where experimentation is integral to learning.

Immersive Learning in Music Education

Although immersion learning in the arts might seem to be a natural fit for young students given their propensity for holistic experiences, few studies exist on this connection from an early education perspective, especially in elementary music education. Barrett (1992) examined music education generally from a "natural learning" perspective (Barrett, 1992, p. 28), which includes creating immersion environments in primary school music classrooms. Here, the author gives instrument construction as an example of an immersive musical activity where children might use their creations for various forms of music making throughout a unit of study. Other research has focused on various aspects of immersive learning, including: Children's immersion in the musical elements of an elementary school environment and the diversity of musical activities they experience daily (Lum & Campbell, 2007); second grade children's effective song acquisition as an immersive process (Klinger, Campbell, & Goolsby, 1998); and secondary school students' interest and retention in a music program designed around providing meaningful music education where, "In reality, developing tasks that build immersion in music, rather than fun," may be most effective in creating wholly engaging musical experiences in the classroom (Lowe & Coy, 2016, p. 45).

When immersion learning theory was applied to designing a music composition curriculum, four necessary elements of planning became clear: 1. Changing perspective from teaching music *to* children to working *together* using music as an artistic material. 2. Looking at music from an experimental standpoint, as a flexible building material, where children could pull it apart and put it back together in various ways. 3. Mentoring students through the process of becoming musical architects, which included skills learning and practice underlying creative process. 4. Making differentiated teaching and meaningful, complex learning foundational to student work.

"Thinking Like an Engineer" in Music Composition

Approaching music composition from an architectural standpoint, "thinking like an engineer" (Lucas & Hanson, 2016, p. 4) is the corollary to immersive learning in music. Within this framework, I encouraged the participant music students to develop an "engineer's habits of mind (EHoM)" (Lucas & Hanson, 2016, p. 4), which include the types of cognitive skills also necessary for complex artistic creation. Lucas and Hanson (2016) define six habits of mind that are directly relevant to the compositional process: Systems thinking, problem finding, visualizing, improving, creative problem solving, and adapting. The table below shows Lucas and Hanson's (2016) verbatim explanations of their identified EHoM's compared to the applications in music composition used in the kindergarten music curriculum (see Table 1).

Table 1

Connections between EHoM and the Music Composition Curriculum

EHoM's (Lucas & Hanson, 2016)	Applications in Engineering (Lucas & Hanson, 2016, p. 6)	Applications in Music Composition
Systems Thinking	Seeing whole systems and parts, and how they connect, pattern-sniffing, recognizing interdependencies, synthesizing	Seeing a music composition as a whole system where it is greater than the sum of its parts, identifying parts from smallest to largest (motive to overall form), analyzing patterns and interconnections
Problem Finding	Clarifying needs, checking existing solutions, investigating contexts, verifying	Identifying end goals, analyzing existing compositions, thinking divergently about what music is and how it works where the

		"problem" is to create an original piece of music
Visualizing	Moving from abstract to concrete, manipulating materials, mental rehearsal of physical space and of practical design solutions	Using concrete materials to anchor understanding of an inherently abstract and dynamic art form, manipulating those materials, mental rehearsal of composed music (audiation) and of musical solutions (where "solutions" refer to student-driven decisions about when a piece is "done"), and creating musical "blueprints" or scores as a visual corollary
Improving	Relentlessly trying to make things better by experimenting, designing, sketching, guessing, conjecturing, thought-experimenting, prototyping	Refining compositions over time with teacher mentoring through experimenting, sketching, guessing, conjecturing, drafting
Creative Problem Solving	Applying techniques from other traditions, generating ideas and solutions with others, generous but rigorous critiquing, seeing engineering as a "team sport"	Applying techniques from informal music learning outside of school, generating ideas through sharing music with peers and teacher for feedback on process, identifying oneself as a composer
Adapting	Testing, analyzing, reflecting, re-thinking, changing (physically and mentally)	Testing musical ideas, analyzing them, reflecting on how they work together, re-thinking how they sound, and then changing them to reflect more closely the composer's creative intentions

Once I established the engineering guidelines, a method for how to teach musical architecture required construction, grounded in skills, practice, and educational standards. For each general principle of engineering practice, children drew on sets of STEAM skills that they were developing outside of the music classroom (M. D. o. E. a. S. Education, 2016, 2017; Standards, 2014) (See Table 2). For information on standards, I consulted the Massachusetts State Department of Education rather than the National Department of Education, which aligned with my school's practice. The state standards that most closely matched the musical-architecture curriculum ranged from Kindergarten to Grade 3, with technology and engineering practices being at the more advanced grade levels.

The kindergarten music education program incorporated these and comprehensive musical skills (e.g., listening, singing, moving, improvisation, etc.), which were necessary to the compositional process. Taken together, STEAM skills when applied to engineering processes in the service of music composition, created an immersive learning experience where students ultimately identified themselves as composers.

Research Question

What would kindergarten students' musical outcomes be in an immersive musical-architecture curriculum based on engineering processes, where students would use STEAM skills in service of music composition?

Table 2

Massachusetts State Standards Expectations in STEAM subjects

Science†	Technology/Engineering	Visual Art†	Mathematics†
• ask and/or identify questions that can be answered by an investigation • develop and/or use a model to represent amounts, relationships, and/or patterns in the natural world • distinguish between a model and the actual object and/or process the model represents • show development of investigation and communication skills • application of science concepts to designing solutions to problems	• Generate multiple solutions to a design problem and make a drawing (plan) to represent one or more of the solutions.* • Analyze data from tests of two objects designed to solve the same design problem to compare the strengths and weaknesses of how each object performs. ** • Generate several possible solutions to a given design problem. Compare each solution based on how well each is likely to meet the criteria and constraints of the design problem.*** • Present different representations of a design solution.***	• Create art that represents natural and constructed environments • Engage in exploration and imaginative play with materials • Through experimentation, build skills in various media and approaches to art- making • Explain the process of making art while creating • Describe what an image represents	• Make sense of problems and persevere in solving them. • Reason abstractly and quantitatively • Construct viable arguments and critique the reasoning of others • Model with mathematics • Use appropriate tools strategically • Attend to precision • Look for and make use of structure • Look for and express regularity in repeated reasoning (patterning)
†PreK-Grade 2	* Grade 1 ** Grade 2 *** Grade 3	†Kindergarten	†Kindergarten

Methodology

Overview

I implemented this longitudinal, qualitative research project over one year with three kindergarten classes (N=45) attending an independent school outside of Boston, MA. About one-third of the population at this school includes children with diverse levels of special needs and learning profiles. Children typically met for music lessons once per week for 50 minutes. The unit described in this study happened over 10 weeks, with school vacations taken into account.

The music room was set up as a keyboard laboratory where children sat one to a keyboard. Each keyboard set up included a set of headphones, a desk, a pencil box (filled with colored pencils, crayons, and markers), and a stool for sitting. The keyboards had stickers to indicate the letter names of the white keys.

Data collected included written observational notes, children's written musical scores, video recordings of student process, and interviews with the students. I examined the data in the context of the yearlong curriculum planned for kindergarten, which covered the children's before-kindergarten musical experiences to the skills they would need to enter first grade. I transcribed the written scores of the students' musical pieces and videos and then analyzed them for form and content. The organization of the transcriptions was across several weeks of the curriculum so that the process of student work became clear. I transcribed student interviews and examined them for descriptions of how they approached composition. There were minimum interview questions to allow for open-ended discussion. For example, each interview began with, "Please tell me how you wrote your piece," and then expanded from there depending on the students' answers. In this way, interviews remained conversational and comfortable. I paired the interview transcriptions with the videos of children's compositional processes to provide richer data on each student. Analysis of the sets of data on each student was on an individual basis and then in the aggregate to determine connections across group experience.

Unit Description

Musical architecture lessons involved experimentation and improvisation, work with a smart board and electronic keyboards, application of engineering processes to concrete architectural elements (including using Lego bricks) and musical structure, visual planning through drawing, and mathematical references to patterning through work with visual and aural patterns. At first, I closely scaffolded the lessons, giving students specific sets of instructions that deliberately provided structure but left the written content up to the students (e.g., I might ask the students to write a melodic pattern in "question and answer" form but not specify notes or rhythms.) As the students' knowledge and experience progressed, these instructions became less specific until the students were comfortable working on their own to develop particular musical ideas over several lessons. Over time, I became less instructor and more facilitator where students could ask me specific questions about their individual work.

At the beginning of the unit, the students associated musical patterns to visual patterns through the following sequence: Students saw visual patterns on a Promethean smart board; they analyzed these patterns using the smart board pen to mark sections of repeating visual elements (this part of the music lesson directly related to the general kindergarten curriculum in math); students moved to the keyboards; they improvised/created musical patterns directly related to the visual patterns they analyzed with each visual element paired with a musical element; as the students settled on music that they liked, they wrote down this music using their own systems of notation (Barrett, 1997; 2004; Lau & Grieshaber, 2010), which acted as mnemonic devices;

students knit these musical/visual elements together into larger, patterned compositions both at the keyboard and written as a musical blueprints, which eventually became scores (see Figure 1).

After the students progressed through this process of musical patterning, they met for a group discussion of the next set of lessons. They saw Lego bricks of three different colors (blue, green, and yellow) and were told that their mission was to write a three-note motive using their Lego bricks to help them. The students received the following instructions:

- Think of each Lego brick as one note on the keyboard
- Choose any three notes you wish and then assign each note a Lego brick
- Figure out the order in which you want to play your notes – this order will stay the same every time you play it
- On a blank sheet of drawing paper, draw your Lego bricks and your notes in the pattern that you have chosen

Each student's three-note set became the foundation for gradually more complicated compositions later in the unit. Each student later received a set of three Lego bricks. They instructions were to move to their individual keyboards and to start their work. I moved around the class answering questions as they arose and listened to the beginning three-note motive.

As each student completed their motive, they received another set of three Lego bricks – so that they were now working with two sets of three colors each. The students' task was to rearrange the same three notes into a different pattern, which they added, physically (connecting the Lego bricks together) and musically, to the first motive they wrote. In this way, students built the beginning composition using the Lego bricks to show a concrete connection between a sound/music structure and a visual/kinesthetic structure (see Figure 2).

Architectural rules of proportion, symmetry, and pattern applied to each stage of the unit as did allowing students complete creative freedom within this structure. I instructed students to follow particular color patterns, which mirrored musical forms (e.g., (ABA) could be (Yellow Blue Yellow) or Rondo form could be (Yellow Blue Yellow Green Yellow…). While the structures were static (i.e., the music for each color would remain the same), the children were not given instructions as to the musical content of each color, which gave them creative freedom within the forms. Eventually students improvised and then assigned a musical phrase to each Lego brick and connected these longer pieces of music into larger patterns (i.e., musical forms). Students applied engineering processes to musical play, approaching composition as an experimental process where they used various skills to visualize and play complete, balanced, original musical pieces.

Results

Group Experience

This method of teaching music composition to kindergartners produced results strongly correlated with the guidelines published through the National Coalition for Core Arts Standards for music education (N. A. f. M. Education, 2015; Standards, 2014); furthermore, the results demonstrated that the students were achieving standards set for higher grade levels. Each student produced a clearly patterned, highly organized composition. The multi-modal nature of the assignments served to allow every student access into complex creative processes. Each piece written vastly differed from every other piece so that each student wrote truly original music.

Considering the United States National Standards for Music Education (N. A. f. M. Education, 2015), the closest set of listed criteria to the musical architecture curriculum outcomes is mainly in the second-grade expectations. These more advanced standards for music education most closely describe how the kindergarten students worked within an integrated music unit (See Table 3).

Table 3

Music and Engineering: Closest standards listed for composition lessons

Music**
• Improvise rhythmic and melodic patterns and musical ideas for a specific purpose. • Demonstrate and explain personal reasons for selecting patterns and ideas for music that represent expressive intent. • Use iconic or standard notation and/or recording technology to combine, sequence, and document personal musical ideas. • Demonstrate understanding of relationships between music and the other arts, other disciplines, varied contexts, and daily life. • Improvise rhythmic and melodic patterns and musical ideas for a specific purpose. • Convey expressive intent for a specific purpose by presenting a final version of personal musical ideas to peers or informal audience
** Grade 2

Because the students received an introduction to a new concept through use of familiar materials (i.e., Lego bricks), they became instantly comfortable thinking with and using architectural/musical concepts. Preparatory lessons in patterning and structure also made possible the students' success with this unit. Video analysis of children playing and then speaking about the process revealed high levels of engagement with musical and architectural thinking. The following three examples of student interviews give glimpses into their process:

1. **Skills practiced:** Patterning, organizing, reasoning, planning, problem solving, and building

Teacher: "Please tell me how you wrote your music."

Kindergartener: "So I used both of these keys. I didn't want it to just be D, D, D, C, C, C. Because I wanted it to be alternating keys. So, then I put the C [on its own] so that it wouldn't get mixed up. And I put these two different lines so that I could know which one was which." (See Figure 1)

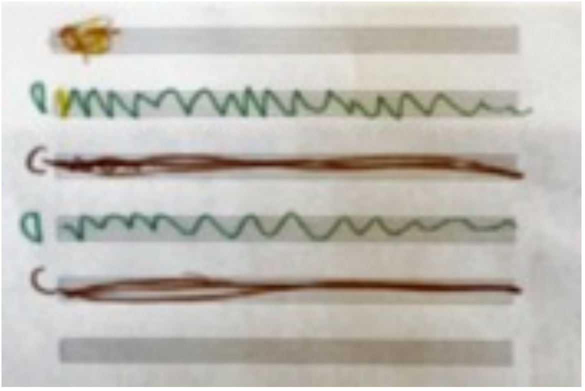

Figure 1. Example score 1.

2. **Skills practiced:** Patterning, experimenting, organizing, trial and error, building, and problem solving

Teacher: "How did you figure out how to make your music?

Kindergartener: "So I started with these two (indicating two of the Lego bricks and playing the attending notes). And then I said to myself, 'that's not a pattern,' so I needed to add one in the middle and then it worked after." (See Figure 2)

Figure 2. Student example of score with Lego creation.

3. **Skills practiced:** Building, organizing, planning, connecting ideas, visualizing, adding, patterning

Teacher: "Please explain how you wrote your music."

Kindergartener: “Well, the yellow (Lego bricks) are A and B (played together). And the greens were C and B and A and D (played together). And the blues were D and C and B and A and G and F (played all together). (The visual score shows these musical chunks.) (See Figure 3)

Figure 3. Student work example with score and Lego creation.

The three examples given are indicative of the work across all of the three kindergarten classes. Ultimately, the data show that every child participated fully in the lessons and was able to integrate STEAM concepts into their creative work within the musical architecture curriculum.

Setting up this project, the children received the following instruction: “Write down your music any way you can remember it – you may use lines, shapes, pictures, letters, words – whatever way is comfortable for you.” The freedom from a particular structure of visual communication allowed the children to express their music *directly* onto the page. They read their scores as adult musicians might read Western notation. In performance of their pieces, children showed reliance on their own written systems of notation to remember what they had written. Writing musical scores became a familiar part of composition – just as using Lego bricks to write complex music removed a barrier to musical creation. The visual and kinesthetic aspects of this project gave the children a path into composition. This learning process was completely creative and engaging and encouraged musical understanding (e.g., Gardiner, 2000).

Individual Experience

The analysis of each student's work revealed completely differentiated results, which connects directly to how they individually experienced the process of composition. Each student's engagement with the lessons also produced such rich data that I have chosen one child's composition process as a representative sample of work that happened across the whole sample (N=45). The case below presents Joy's compositional development over three weeks, working on the same piece. Every student who participated in the musical-architecture unit produced compositional results similar to Joy's. Each of the forty-five compositions show similar detailed understanding of how to "build" a musical composition while retaining the individual character of each student's musical thinking both in structure and content. Joy's data comprises transcriptions of the music, visual representation both drawn on paper and built with Lego bricks, and a researcher-produced color coded "map" of compositional form.

Week 1. At first, students received time to improvise melodies at the keyboards and to work until they found music they liked. Again, they were to write this music "any way they could remember it" so that when they came back to it over several classes, they would be working with the same material. Keeping consistency as part of the process was important for the development of musical thought – the architectural structure gave parameters for that creative development. In the example below, notice the expression of the initial ideas and the open nature of the writing: There are three sections that seem distinct, yet connected, and that elongate through rhythm and melody as the music progresses. This piece is 10 measures long with the last 6 measures devoted to material that seems more improvisatory or experimental, where they loosely tie into the stepwise motive, first ascending and then descending in augmentation (see Figure 4). The Lego structure reflects the musical ideas, with the elongated part of the piece built at the top. However, the music/brick relationships do not seem to be one-to-one but rather a reflection of whole musical thought (Moylan, 2015), as if Joy's architectural creation initially expresses a general idea of her piece's structure rather than specific motives. As Moylan (2015) states, "It is the human perception of form that provides the impression of a global quality that crystallizes the entire work into a single entity. Form is the piece of music as if perceived, in its entirety, in an instant..." (p. 63). In the score, the writing seems to be more about quick sketching for future reference than about permanent written expression (see Figure 6).

Figure 4. Joy 5.8.15 – Transcription (10 measures).

Figure 5. Joy 5.8.15 – Lego structure. Read from the bottom to the top – music/brick color relationship not obviously clear to observer, although shorter bricks leading up to longer bricks may indicate the music's overall shape).

Figure 6. Joy 5.8.15 – *"Blueprint".* The score shows bare-bones writing, as if Joy made quick notes to herself to remember her initial ideas.

Week 2. At the start of class, Joy picked up her work and began immediately to focus on continuing with her writing from the week before. In listening to the recording of her piece and looking at the transcription (see Figure 7), it became clear that the musical material had developed around two specific motives: A rising, scalar pattern and a falling scalar pattern. These two motives remained intact while Joy continued to experiment with connecting material. Compared to her initial composition, this one seems less improvisatory as Joy became more focused on finding patterns that match the chosen two that she had retained from her first writing. This iteration is shorter than the material from Week 1, 7 measures, with the final measure referencing the improvisatory writing. Here, we can see musical thought developed most of which will become part of the final composition. Although the Lego structure remains somewhat amorphous, it is also more streamlined, as if referencing more specific musical material (see Figure 8). The score seems to reflect the development of her musical thinking with more detailed writing and the beginnings of color coordination between the motives and Lego bricks (see Figure 9).

Figure 7. Joy 5.15.15 – Transcription (7 measures).

Figure 8. Joy 5.15.15 – Lego structure.

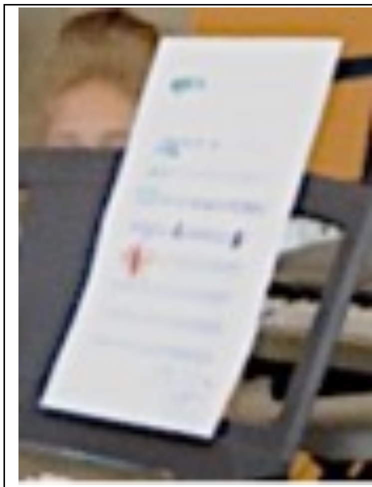

Figure 9. Joy 5.15.15 – "Blueprint". More specific written work, which develops initial ideas further. Color associations are starting to become pronounced.

Week 3. As with the previous week, Joy began working on her composition seemingly as if no time had passed in the interim, without questioning where she had left off or mentioning issues with remembering her earlier work. Towards the end of this lesson, Joy indicated to me that she completed her piece. The final composition retained the motivic elements she developed over time and new material showed direct connection to the original motives, completely replacing the improvisatory sections. This iteration became much longer than the previous two, indicating further development of musical thought and overall patterning (see Figure 10). The piece contains 19 measures, which under analysis reads in a highly-organized form: ABAC BABAC BAC BC (see Figure 12). Calling attention to the form shows how Joy used her musical "building blocks" to create a balanced, coherent composition over time. Reading the Lego structure from top to bottom, it shows further concrete structural development through one-to-one relationships, color brick to musical motives (see Figure 11). On the score, Joy's writing seems more confident with definite color associations and bolder expression of ideas, as if marking the final version of her work (see Figure 11).

Figure 10. Joy 5.22.15 (Final composition) – Transcription.

Figure 11. Joy 5.22.15 (Final composition). Lego structure and "blueprint" (The Lego structure shows specific one-to-one relationship between music and color bricks. In the score, Joy shows definite color coding and clear written association with musical thoughts.

Figure 12. Observer's visual analysis of Joy's final composition. Read from top to bottom with repeat of motives in the center – one-to-one music/brick relationship obviously clear to observer.

Discussion

In the examples given, each child's musical processes became clear as they created music "thinking like an engineer." The highly structured nature of the composition curriculum allowed the children freedom to create truly original music through an immersive process. This process included designed learning experiences where children relied on previous experiences and knowledge to further their musical development. Using the Lego bricks provided the children with concrete, kinesthetic/visual materials connected directly to sound play. Bringing this familiar "toy" into the music classroom gave the children a way into composing that drew on previous experience: All of the children already knew how to use Lego bricks to create structures; however, none had used them in music composition.

Through the one-to-one relationship between musical material and concrete manipulatives, the children understood how to engineer music and the specific skills necessary to create an original composition. Specifically, as time passed, the children gained stronger ability in the following areas: Manipulating and understanding patterns; organizing small parts to create a larger whole; structural balancing, where a piece of music, as a building design, must have an internal sense of logic to work; understanding that being an effective composer/creator relies on skills, knowledge, experience, creative problem solving, memory, focus, and perseverance.

The compositions showed high-level musical thinking that went beyond listed expectations for grade-level musical abilities and goals. Applying engineering standards and habits of mind to the music curriculum situated the children's STEM skills within a *musical* framework. Rather than making music subservient to other subjects, the perspective on music composition as a form of architecture and design encouraged the children to view their musical creations as important in their own right because they had become, in the words of one student, "real composers."

This paper focuses on only one aspect of an entirely integrated kindergarten music program, which included connections to literacy, science, social studies, and language learning. Further analysis is necessary to determine how the music/architecture integration worked as compared to other subject integration units. This project happened as part of long-view teaching strategy where students received education in a coherent, connected K-5 program. Further analysis of the kindergarten children's work as they moved through higher grades is necessary to determine if this type of long term, integrated teaching is well designed for student skill building, knowledge retention, and musicianship development.

Although this study was small in scale, it suggests some wider implications for designing curriculum for a kindergarten music classroom. If integrating other core subjects into music lessons creates a higher level of engagement with musical materials, music teachers may consider re-thinking pieces of a music curriculum to reflect a more connected educational experience. Kindergarten music teachers may consider designing some of their lessons to incorporate what they observe of their students' natural musical practices and then build on this knowledge toward developing immersive music education. Through this work, I discovered ways to reevaluate what my students' musical thinking actually looks like. The curriculum design allowed for a holistic and imaginative process of teaching and learning music, which drew on my students' ability to create effective compositions through use of concrete architectural forms. This explicit connection between the abstract, dynamic nature of musical material and the Lego bricks gave my students a defined structure within which to create complex music.

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