Towards MathsBeats

A Constructionist Approach Combining Music, Movement, Coding and Mathematics in Primary Classrooms

Christie Haddad[1], Abhinand Shibu[1], Eirini Geraniou[1], Sokratis Karkalas[1], and Manolis Mavrikis[1]

[1] UCL Knowledge Lab, University College London, UK

Abstract

This contribution provides an overview of MathsBeat, an interdisciplinary constructionist learning activity designed to engage primary pupils with digital and physical artefacts through rhythm-based composition activities and interactive coding exercises. Framed within a Design-Based Research methodology (Barab & Squire, 2004), we present insights from iterative classroom implementations and practitioner feedback to explore how interdisciplinary tasks can bridge mathematics, music, movement and computational thinking. Our goal with the design of this activity is to engage primary school students with their mental models relating to bodily movement, musical timings, mathematics and computational thinking to capture something they find fascinating – potentially reducing stereotypical views of mathematics as a purely formal domain. Our overarching question during this DBR phase is how students' and teachers' experiences MathsBeat inform its iterative design and their views on its potential as an interdisciplinary activity.

1. Activity Overview

The implementation of the project followed a structured approach across two iterations. The initial phase (Iteration 1) involved testing the first set of activities with two Year 4 students. Feedback from this phase informed refinements to the design and methods. The refined activities were then implemented with a larger group of 10 Year 4 students (Iteration 2), providing broader insights and validation of the improvements made. Each iteration included two separate sessions: Session 1: Students compose a rhythm-based musical composition using fractions on Amplify's Polypad application, fostering the application of their mathematical understanding of fractions through a creative medium.

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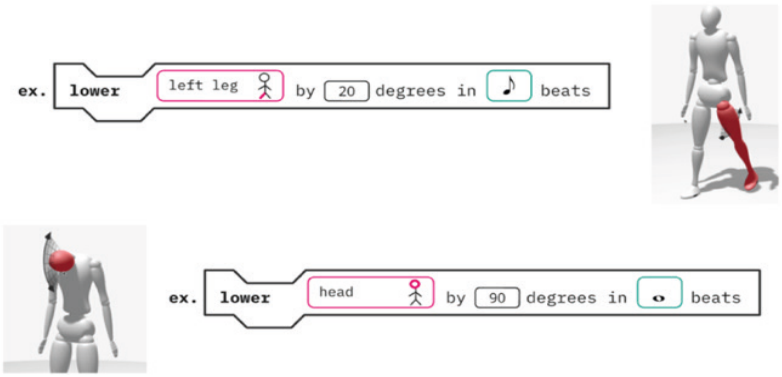

Figure 1: The proposed language allows the expression of 3D movements as a procedure.

Session 2: Building upon Session 1, students were introduced to an unplugged coding activity where they had to interpret and develop code to instruct each other to perform movements to their musical compositions (see Figure 1 and Figure 2). This approach aligns with common K-12 definitions of computational thinking (e.g. Grover and Pea, 2013) and resonates with a view of constructionism of technology as expressive media for individual and collaborative mathematical meaning making (Kynigos, 2015).

2. Methodology and Results

At this phase of our DBR study we did classroom observations with 10 primary pupils, in-situ student reflections, and feedback sessions with four primary teachers, followed by a qualitative thematic analysis to refine the MathsBeat activity. Classroom observations and student reflections showed high engagement of the students who made meaningful connections between fractions and musical notation, deepening their understanding of equivalence through embodied exploration. The coding component encouraged decomposition and debugging, with students breaking down complex movements and identifying and correcting errors of each other. At points this required introducing reusable procedures, suggesting a potential for introducing computing concepts like functions in a tangible and motivating way. On the teacher side, thematic analysis of feedback from the four teachers highlighted several key themes: feasibility, scalability, accessibility, and curricular alignment. Most of the teacher concerns revolved around the need for preparation time and professional development. However, there was an overall enthusiasm for the activity's potential, and they provided several suggestions including making video introductions and tutorials, and integration with existing programming platforms.

3. Discussion and conclusion

MathsBeat showcased how creating meaningful artefacts, a core principle of constructionism, made the activities both engaging and pedagogically sound. Most of the students expressed surprise and appreciation for the integration of music and mathematics. The activity helped make abstract concepts like fractions tangible through music and movement, reinforcing findings on the value of arts integration in STEM education (Henriksen, 2017). This aligns also with constructionist principles around fostering a sense of ownership and autonomy in their creations and, more generally, we noticed a 'sweet spot' of meaningful interdisciplinary integration, potentially enhancing engagement by revealing meaningful interdependencies across different domains. However, as expected in this context, practical challenges were raised regarding implementation in typical classroom settings emphasizing the

importance of scaffolding and professional development when introducing such interdisciplinary approaches (Haddad, 2024). The next phase of MathsBeat will develop teacher training resources and move beyond the unplugged activity by designing a digital coding component.

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References

Barab, S., & Squire, K. (2004). Design-Based Research: Putting a Stake in the Ground. *The Journal of the Learning Sciences*, 13(1), 1-14.

Fishman, B. J., & Penuel, W. R. (2018). Design-based implementation research. In F. Fischer, C. E. Hmelo-Silver, S. R. Goldman, & P. Reimann (Eds.), *International handbook of the learning sciences* (1st ed.). Routledge. https://doi.org/10.4324/9781315617572

Grover, S., & Pea, R. (2013). Computational thinking in K–12: A review of the state of the field. *Educational researcher*, 42(1), 38-43.

Haddad, C. (2024). *Technology-Enhanced Professional Development in Music for Early Years Practitioners: A Design-Based Study*. PhD Thesis. UCL (University College London). https://discovery.ucl.ac.uk/id/eprint/10201166/

Henriksen, D. (2017) "Creating STEAM with Design Thinking: Beyond STEM and Arts Integration," *The STEAM Journal*: Vol. 3: Iss. 1, Article 11. https://doi.org/10.5642/steam.20170301.11

Kynigos, C. (2015). Constructionism: Theory of Learning or Theory of Design? In S. J. Cho (Ed.), *Selected Regular Lectures from the 12th International Congress on Mathematical Education* (pp. 417–438). Springer International Publishing. https://doi.org/10.1007/978-3-319-17187- 6_24

Papert, S. (1980). *Mindstorms: Children, Computers, and Powerful Ideas*.