INTRODUCTION

Fluency in mathematics is essential for success in STEM learning/work. Regrettably, yet many students find their mathematics experiences to be alienating and marginalizing, often because the field is portrayed as **abstract**, **formulaic**, and **solitary**. This reputation leaves many students feeling unsatisfied, whether by failing to meet their learning styles or to present mathematics as motivating and relevant to their lives (see, for example, Chickering & Gamson, 1987; Davis 2009).

We tried to reimagine mathematics as something you can do with your body, something you can do to express creativity, and something you can do with friends. This was the primary motivation for our project **Geometris**. Our proposal will attempt to explore how we could expand Geometris to allow for more engaging and diverse modes of instruction and consequently, a wider accessibility to learning tools.

ABOUT GEOMETRIS

In its current form, Geometris - a hybrid between Twister and Tetris - prompts users to produce geometric shapes on a 6' x 6' square mat. A computer projects a series of shapes onto the floor, and users must use their limbs to activate the specific regions on the mat to reproduce each prompted shape. When the game is over, a geometric pattern - the result of overlaying all successfully created shapes - is visually shared with players. An image of the setup can be found here and the gameplay, here.

We pilot tested the infrastructure - the hardware included a mat, pressure-sensitive touchpads, Arduino Uno, projector and a screen and the software was through Processing with help from the Firmata library - over two days which involved adult users during a project showcase (video). During the tests, we observed high levels of user engagement and users seemed to pick up the idea of the game with little to no instruction. We were also excited to observe interactions and emerging collaborations between users, especially in cases where a user who had just finished playing the game would explain it to someone who had just approached. Since there were multiple ways of creating the same shape, it was also interesting to see users delegate and negotiate to complete the challenges.

WHAT WE INTEND TO DO

We intend to test this game with children ages 6-12 to observe the level of engagement and the learning potential of the game and based on the outcome of the tests, we plan to improve its design. This is in addition to correcting the usability and programming flaws that we had observed in our pilot tests.

While we were encouraged by the high level of user engagement, we would like to expand Geometris not just as a singular shape forming tool but as a more generative experience as an open source tool. Within the realm of shape making, we envision children designing their own shapes through an intuitive UI and trying it on themselves, their peers or their parents. Beyond geometry, it must be noted that we reused the same hardware infrastructure to build a physical and collaborative musical instrument by reusing some of the functions we used to build Geometris. Seeing how most users worked up a sweat while trying on Geometris, we also see its potential as a fitness tool. Other possibilities like creating a customized game or using the mat as a storytelling tool start to emerge however, to accomplish this additional design effort will be needed to make the software more generic, scalable and user-friendly. Our intention to generalize Geometris also comes with an awareness that we have only barely scratched the surface of learning possibilities with this baseline infrastructure. We

therefore, seek to spread its visibility to the open source community for newer ideas and suggestions for improvements in performance.

HOW WE INTEND TO ACCOMPLISH IT

We seek mentorship and financial support to expand Geometris as a user-friendly platform that can be enjoyed by users with diverse coding skills - a potentially WYSIWYG environment for beginners and perhaps a readily implementable library for advanced users - to create, share and learn with other users.

With IRB approval in place, we plan to begin working with pairs of children, aged 6-12, in a lab on UC Berkeley campus to improve the existing game. Using professional connections to local teachers from Berkeley's Masters and Credential in Science and Mathematics Education program, we could recruit students for whom we can access academic and demographic background information. Such information would help us ensure that our work suits learners of diverse and underrepresented backgrounds and learning needs.

QUALIFICATIONS

We identify as a team of three user-centered designers from various backgrounds passionate about a common objective of designing an engaging and accessible learning environment for children. It must be noted that our programming background is not advanced; none of us had previously attempted a programming project of this scale. While we are uncertain about some of the technical expertise required to build a platform, we are confident that we would be able to accomplish our objectives under our mentor.

Elena Duran, a 3rd year PhD student leverages her 5 years of experience designing science activities for children and a continued passion for creating child-centered, engaging activities. Leah Rosenbaum, a 2nd year PhD, brings a theoretical background in mathematics learning, and embodied learning in particular, to ensure that the team's work is grounded in the literature. Ganesh Iyer, a 2nd year Master's Student and a recent convert to front-end programming led the software design of the game. We are ably advised by Kimiko Ryokai, Associate Professor and Noura Howell, PhD student, both at the UC Berkeley School of Information.

EXPECTED RESULTS

We predict that a more research-driven approach will help make the game better for students and their learning needs. Our plans to expand Geometris as a platform could hopefully encourage students to learn coding through Processing in making new and complicated shapes within Geometris or even new games altogether. This is our targeted outcome in the timeline specified.

EXPANDING PROCESSING

By bridging our research-driven methods with Processing, we hope to make a reusable knowledge base of research insights in the learning space available to the greater Processing community. To build a comprehensive platform we aim to create newer datatypes and libraries that can be reused for myriad requirements. By having a baseline platform made open source, we hope this would spawn more innovative implementations and interpretations of Geometris in various domains by other Processing enthusiasts.