Title: Makin' Math Move: An Interactive Educational Video Game for Minority Students to Reinforce Algebraic Concepts

Keywords: minority, STEM, human computer interaction, educational video games

Background: In a 2010 study by NSF, men represented 72% of the scientists and engineers employed in their field. Women, of all races, totaled only 28%, while African Americans (of both genders) only contributed to 5% of scientists[1]. The disparity is often studied at the pre-collegiate and collegiate level and has been tried to be resolved with bridge programs and mentorships. These programs have had some success, but it fails to reach those who are affected by a "leak" much earlier in the STEM pipeline. Studies have shown that insufficient K-12 preparation in mathematics and science of low-income and minority students due to unavailability of demanding courses and/or unqualified subject matter teachers has impacted the level of interest. Psychologically, minority students deal with issues of self-efficacy and overcoming the typecast of the White male dominated STEM industry.[2]

The goal of Makin' Math Move is to stimulate and intrigue middle school-aged minority students with a video game akin to Dance Dance Revolution (DDR), which will allow students to hone their math skills through active learning. Educational video games have been designed as engaging, yet informative, ways to pique the interest of students. HCI research has shown that STEM-centered educational video games not only increase self-motivation, but also improve causal reasoning, problem solving, and critical thinking skills.[3] Likewise STEAM, the incorporation of the arts (A) in STEM education, has shown to increase cognitive abilities and provide many neurological benefits. Studies have shown that it easier to retain and recall information associated with movement. Also, spatial awareness is improved as a result of movement. Studying the benefits of music education on cognitive processes via an augmented virtual reality guitar learning system is one way in which the HCI field has explored the idea of STEAM.[4] Yet there lacks research on STEAM-inspired (particularly, dance-specific) educational video games.

Proposed Solution:. The software will feature various modes corresponding to different topics covered in a standard Algebra class. The student will be able to see the proposed math problem, the answer arrows, as well as themselves on a virtual dance pad. The arrows that the students will step on will be mathematical operation symbols (+,-, x, /) or the answer choices to the problem displayed on the screen. As the student beats each level within the mode, they will be

[1] National Science Foundation, National Center for Science and Engineering Statistics. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/.

[2] Perna, L., Lundy-Wagner, V., Drezner, N. D., Gasman, M., Yoon, S., Bose, E., et al. (2009). The Contribution Of HBCUS To The Preparation Of African American Women For Stem Careers: A Case Study. *Research in Higher Education*, *50*(1), 1-23.

[3] Tawfik, A., Moore, J., He, Z., & Vo, N. (2012). Human-Computer Interaction Factors in Designing Educational Video Games. *Current Issues In Education, 15*(3). Retrieved October 30, 2013, from http://cie.asu.edu/ojs/index.php/cieatasu/article/view/987

[4] Keebler, J., Wiltshire, T., Smith, D., & Fiore, S. (2013). Picking Up STEAM: Educational Implications for Teaching with an Augmented Reality Guitar Learning System. *Virtual, augmented and mixed reality systems and applications : 5th International Conference, VAMR 2013, held as part of HCI International 2013, Las Vegas, NV, USA, July 21-26, 2013, Proceedings.* (pp. 170-178). Berlin: Springer.

able to challenge themselves by answering the same amount of questions in a shorter amount of time; seeing how well they think on their feet, literally.

Methodology: This project will be carried out under the supervision of Dr. Juan E. Gilbert, Associate Chair of Research of the Computer and Information Science & Engineering Department at the University of Florida. Participants will be recruited from Gainesville-area middle schools with a large minority population.

Phase 1 (Research): I will conduct research on learning technologies as well as take classes such as *Games and Simulations for Teaching and Learning* and *Human Computer Interactivity and the Learner* to help with design and implementation in phase two. During this initial phase, I will create a pre-assessment to measure the students' performance and attitudes towards math and science prior to interacting with the game.

Phase 2 (Implementation): I will design and implement the video game application. As a result of previous research with Dr. Ayanna M. Howard of Georgia Tech, as well as Dr. Gilbert, I am familiar with programming the Microsoft Kinect for Windows' motion sensor. I will use C# programming and the OpenGL API in order to render the graphics for the application. The monitor's display will feature the user's image, an overlay of the four quadrants that the user can choose to step on, directions, the question and the user's score. Using the Kinect sensor (approximately $150) to detect the students' movements provides a cheaper alternative than RM's *Dance to Advance* software bundle, which prices range from $300-$1,000.[5]

Phase 3 (Evaluation): Willing participants will use the software over the course of a semester. I will evaluate the quantitative and qualitative effect of the game on the students' comprehension level of the math skills that the game focused on, by re-administering the initial assessment. The results will be disseminated by publication in HCI and educational technology conferences such as CHI and FETC.

Outcomes and Broader Impacts: Makin' Math Move will be an educational technology to reach out to those underrepresented minorities who may lack confidence in the STEM areas. As a tutor for two summers I witnessed lack of self-confidence of the students, who were primarily African American children from low-income families, in their mathematical abilities. I also noticed their eagerness when it was time to switch to an activity that allowed them get up and move. This revelation, coupled with me being a dancer for 15 years, triggered the idea to make STEM learning more interesting by incorporating the art of dance. The integration of the two seemingly dissimilar areas will not only raise the math and science literacy of future generations, but boost their confidence and open their eyes to the myriad of opportunities available to them.

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[5] RM Dance to Advance | RM USA. (n.d.). *RM Dance to Advance*. Retrieved October 5, 2013, from http://www.rmeducation.com/us/shops/rmusa/Product.aspx?cref=PD1645897&rguid=853d9900-cbf2-49bf-99e2-1f377bd8e640