University of Calgary

PRISM Repository **https://prism.ucalgary.ca**

Conferences National Pedagogical and the Faculty of Education of the University of Calga

2013-02

Lego robotics teacher professional learning

Francis-Poscente, Krista

Francis-Poscente, K., Davis, B. "Lego robotics teacher professional learning" 2013. In Preciado Babb, A. P., Solares Rojas, A., Sandoval Cáceres, I. T., & Butto Zarzar, C. (Eds.). Proceedings of the First Meeting between the National Pedagogic University and the Faculty of Education of the University of Calgary. Calgary, Canada: Faculty of Education of the University of Calgary.

http://hdl.handle.net/1880/49741

Downloaded from PRISM Repository, University of Calgary

LEGO ROBOTICS TEACHER PROFESSIONAL LEARNING

Krista Francis-Poscente and

Brent Davis
University of Calgary

This paper describes an upcoming design based research study for learning how to assess spatial reasoning in young children: children need spatial reasoning skills to succeed in STEM disciplines. In a professional learning initiative, twenty-one children aged 9-10 and seven teachers will meet at the University of Calgary to participate in a Lego robotics challenge. Teachers and researchers will work alongside of children to learn how to recognize and assess spatial reasoning. The data collection from the children will include pre camp interviews, pre-post spatial reasoning assessments, observational data including video recordings and digital artefacts. The data collection from the teachers will include pre camp focus interviews, observational data including video recordings and digital artefacts. The aim of the research is to build capacity, develop strategies and curriculum for implementing robotics in classrooms to enhance spatial reasoning. The expected outcomes of the study are (1) to learn how to identify, assess, and develop spatial reasoning, (2) to further understandings of how to foster spatial reasoning in young children.

El propósito de esta artículo es describir una Academia de Verano de Jóvenes Científicos para promover el razonamiento espacial en niños pequeños con la robótica. Dada la necesidad crucial del razonamiento espacial para la educación en CTIM, hemos decidido tomar como objetivo la robótica como un inicio para aprender cómo promover el razonamiento espacial en el aula. Mientras los niños estarán aprendiendo cómo crear sus robots durante la Academia de Verano, los profesores estarán aprendiendo: (1) como usar la robótica en sus salones de clase, (2) la relevancia de la robótica para la enseñanza y el aprendizaje de matemáticas y ciencia y (3) la relevancia del razonamiento espacial en la instrucción en matemáticas. Los profesores trabajaran junto con científicos, ingenieros e investigadores para tener un mejor entendimiento para identificar, promover y evaluar el razonamiento espacial. Este estudio es importante para la educación en CTIM para entender mejor acerca de la directa y multifacética conexión de la robótica con razonamiento espacial y aprender cómo promover las habilidades del razonamiento espacial en el salón de clase.

This paper describes an upcoming design based research study for learning how to assess spatial reasoning in young children. While crucial to success in STEM disciplines, little is known about how to recognize and assess spatial reasoning in young children. This upcoming study will attempt to provide insight into this gap.

The University of Calgary's Faculty of Education and the Imperial Oil Foundation implemented a joint commitment in 2012 to develop and implement high-impact early years educational experiences for in Science, Technology, Engineering and Math (STEM) education. Imperial Oil contributed $2.5 million

2013. In Preciado Babb, A. P., Solares Rojas, A., Sandoval Cáceres, I. T., & Butto Zarzar, C. (Eds.). Proceedings of the First Meeting between the National Pedagogic University and the Faculty of Education of the University of Calgary, pp. 113-117. Calgary, Canada: Faculty of Education of the University of Calgary.

over five years. Each year the university will host (1) a Summer Institute (a think tank for local, national and international researchers), (2) a Summer Colloquium (a collaborative evening with teachers and researchers) and (3) a Young Engineers and Scientists Summer Academy (a summer camp for children combined with professional learning for teachers). Rather than unique separate events, each event is intended build on the previous to contribute to the development of high quality STEM education. Teacher professional learning is an integral part of the STEM initiative at the Faculty of Education at the University of Calgary.

STEM is an acronym for Science, Technology, Engineering and mathematics. STEM education is defined a variety of ways. Morrison (2006) defines STEM education as a meta-discipline created by the integration of the disciplines to create a new 'whole.' STEM education is a multidisciplinary and interdisciplinary approach (Kelley, 2010). STEM literacy is the knowledge, skills and understanding necessary for solving problems and achieving goals (Committee on Highly Successful Schools or Programs in K-12 STEM Education; National Research Council, 2011) and the synergy of integrating the strands to develop a more comprehensive total that is more than the sum of the parts (Zollman, 2012). Commonly, STEM education integrates science, technology, engineering and mathematics disciplines through inquiry or problem solving approaches.

In Canada, elementary teachers are generalists and teach all subjects. Most elementary teachers have a humanities. Very few have a science and mathematics background. A lack of specialized science and mathematics elementary teachers affects children' aptitude and interest in STEM subjects. By junior high, children may have lost interest or have knowledge gaps that limits their ability in STEM subjects. The STEM initiative at the Faculty of Education, University of Calgary intends to build capacity and skills of elementary teachers.

As part of the STEM initiative, researchers at the first 2012 IOSTEM Summer Institute identified spatial reasoning as a key factor for success in STEM disciplines. Spatial reasoning is a predictor of academic achievement in STEM disciplines (Benbow, 2012; Clements & Sarama, 2011; Sherman, 1983; Stumpf & Haldimann, 1997) and beyond (Rohde & Thompson, 2007). A 'use it or lose it' skill, spatial reasoning can be developed (Hsi, Linn, & Bell, 1997; Sorby, 2009) and it can be lost (Lehrer, Jenkins, & Osana, 1998).

In tests of spatial reasoning in engineering students, women were three times as likely as men to fail (Sorby, 2009). Women were also more likely to fail or drop out of engineering. Sorby developed an optional course for first year engineering students to improve their spatial reasoning. Curricula in the course included sketching objects and isometric projections, paper folding, 3-D coordinate systems, object transformations, and combining objects. In pre-post spatial reasoning tests students significantly improved with large gains of greater than 25%. The gains were significant for both males and females. The improvement in spatial reasoning skills correlated with higher academic achievement compared to students who did not take the spatial reasoning course. Spatial reasoning skills can be developed with practice (Sorby, 2009).

Lehrer el al. (1998) found that spatial reasoning can also diminish over time. In a three-year longitudinal study of 13 first to third graders, 12 second to fourth graders, and 12 third to fifth graders were individually interviewed six times per year (18 total interviews each). The interviews were about form, drawing, graphing, angle, length, and area measure. Lehrer et al. found that despite daily mathematical instruction, over time children were less likely to notice attributes of contrasting forms. Not only did the instructional practices not promote conceptual change, children's spatial reasoning worsened.

Key questions for our research are (1) what is spatial reasoning and (2) how is spatial reasoning assessed. We decided to target robotics as an entry for learning how to identify, assess, and foster spatial reasoning in classrooms. Robotics encompasses the STEM disciplines and demands spatial reasoning. At the 2013 Summer Academy, a robotics challenge will provide learning opportunities for children, professional development opportunities for teachers, and the opportunity to study spatial reasoning. While the children will be learning how to create their robots during this Summer Academy, the teachers will be learning: (1) how to enact robotics in their own classrooms, (2) the relevance of robotics for learning and teaching mathematics and science, and (3) the relevance of spatial reasoning to mathematics and science instruction. The teachers will work alongside scientists, engineers and researchers to gain insight into identifying, fostering and assessing spatial reasoning. This study is important to STEM education to understand more about the direct and multifaceted connection of robotics to spatial reasoning and learn how to foster spatial reasoning skills in classrooms.

METHOD

A Design Based research approach will form a multi-faceted study of an intervention in context linking processes of enactment to outcomes. Design based research "has power to generate knowledge that directly applies to educational practice. The value of attending to context is not simply that it produces a better understanding of an intervention, but also that it can lead to improved theoretical accounts of teaching and learning' (The design-based research collective, 2003, p. 7). Design research is "iterative, formative and progressive in nature" (Dai, 2012, p. 13). This emergent and open-ended framework necessitates multiple data sources and analyses to gain insight. The multi-faceted approach requires the collection of excessive amounts of data because it is impossible to know in advance what information will be pertinent. Participants will include 21 children entering Grades 4-5 and seven elementary teachers. Data sources will include:

Data from children:

- Interview data: Pre camp audio recorded and transcribed conversational interviews with children to discuss the perceptions of school, science and mathematics.
- Statistical data: Pre-post Summer Academy test for spatial reasoning ability. Six month follow up test for spatial reasoning. (see attached sample instrument)
- Observational data: Video recordings of teachers and students, digital images, field notes, informal conversations, and teacher and student journals

Data from teachers:

- Interview data: Pre-post camp audio recorded and transcribed conversational focus interviews with teachers about pedagogical attitudes science and mathematics education. Six month follow up conversational focus interviews with teachers to discuss changes to classroom practice.
- Statistical data: Pre-camp spatial reasoning test to determine pedagogical understandings of spatial reasoning. The test is not to assess teachers' spatial reasoning, but to assess what teachers are attentive to.
- Observational data: Video recordings of teachers and students, digital images, field notes, informal conversations, and teacher and student journals

SUMMARY

An upcoming research study will investigate how to recognize and assess spatial reasoning in young children as they engage in a robotics challenge during a 4-day summer camp. Working alongside of researchers and engineers, teachers will learn how to enact robotics in their own classrooms, (2) the relevance of robotics for learning and teaching STEM disciplines, and (3) the relevance of spatial reasoning to mathematics instruction. Consistent with design research, we will use a multifaceted approach for data collection and analysis.

The aim of the research is to build capacity, develop strategies and curriculum for implementing robotics in classrooms to enhance spatial reasoning. The expected outcomes of the study are (1) to learn how to identify, assess, and develop spatial reasoning, (2) to further understandings of how to foster spatial reasoning in young children. The results of this study will inform STEM professional development and STEM curriculum development.

References

Benbow, C. P. (2012). Identifying and Nurturing Future Innovators in Science, Technology, Engineering, and Mathematics: A Review of Findings From the Study of Mathematically Precocious Youth. Peabody Journal of Education, 87(1), 16–25. doi:10.1080/0161956X.2012.642236

Clements, D. H., & Sarama, J. (2011). Early childhood teacher education: The case of geometry. Journal of Mathematics Teacher Education, 14(2), 133–148.

Committee on Highly Successful Schools or Programs in K-12 STEM Education; National Research Council. (2011). Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics. Washington, D.C.: The National Academies Press.

Dai, D. Y. (2012). From smart person to smart design: Cultivating intellectual potential and promoting intellectual growth through design research. In D. Y. Dai (Ed.), Design research on learning and thinking in educational settings: Enhancing intellectual growth and functioning (pp. 3–40). New York, NY: Routledge.

Hsi, S., Linn, M., & Bell, J. E. (1997). The role of spatial reasoning in engineering and the design of spatial instruction. Journal of Engineering Education, 86(2), 151–8.

Kelley, T. (2010). Staking the Claim for the "T" in STEM. Journal of Technology Studies, 36(1), 2–11.

Lehrer, R., Jenkins, M., & Osana, H. (1998). Longitudinal study of children's reasoning about space and geometry. In R. Lehrer & D. Chazan (Eds.), Designing Learning Environment. Routledge.

Morrison, J. S. (2006). Attributes of STEM education. Cleveland, OH: Teaching Institute for Excellence in STEM. Retrieved from http://www.tiesteach.org/assets/documents/Jans%20pdf%20Attributes_of_STEM_Education-1.pdf

Orpwood, G., Schmidt, B., & Jun, H. (2012). Competing in the 21st century skills race (p. 18). Ottawa: Canadian Council of Chief Executives. Retrieved from http://www.ceocouncil.ca/wp-content/uploads/2012/07/Competing-in-the-21st-Century-Skills-Race-Orpwood-Schmidt-Hu-July-2012-FINAL.pdf

Rohde, T. E., & Thompson, L. A. (2007). Predicting academic achievement with cognitive ability. Intelligence, 35(1), 83–92.

Sherman, J. (1983). Factors Predicting Girls' and Boys' Enrollment in College Preparatory Mathematics. Psychology of Women Quarterly, 7(3), 272.

Sorby, S. A. (2009). Educational Research in Developing 3-D Spatial Skills for Engineering Students. International Journal of Science Education, 31(3), 459–480.

Stumpf, H., & Haldimann, M. (1997). Spatial ability and academic success of sixth grade students at international schools. School Psychology International, 18(3), 245–259. doi:10.1177/0143034397183005

The design-based research collective. (2003). Design-based research: An emerging paradigm for educational inquiry. Educational Researcher, 31(1), 5–8.

Zollman, A. (2012). Learning for STEM literacy: STEM literacy for learning. School Science and Mathematics, 112(1), 12–19.