A qualitative inquiry into the motivating aspects of robotics

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Assessment and Evaluation

Background

The prominence of science, technology, engineering and mathematics to the economic future of society and for the progression of mankind is broadly recognized. However, a study by Wong states that there are fears that ethnic minority students are underrepresented, and even omitted from postsecondary science, technology, engineering and mathematics education and careers (Wong, 2015). Another study by Medina uncovered continuing racial and ethnic disparities affecting graduation rates in Science Technology, Engineering and Mathematics (Medina, 2015). The study also revealed that several institutional factors (Pell Grant Aid, faculty salaries, expenditures and average student age) were not significantly associated with underrepresented minority student's graduation rates (Medina, 2015). This study therefore,

focuses on factors that could encourage underrepresented populations to education and training in science, technology, engineering and mathematics fields. Research conducted by Chin, Hong, & Chen, in 2014 found that motivating factors of attention, relevance, confidence, and satisfaction increased when using an educational robot-based learning system (Chin, Hong, & Chen, 2014). The study proposed here will query students in an attempt to obtain their opinions as to what characteristics robotics education possess that make it engaging. These beneficial characteristics could then be used in other forms of learning to increase success rates of underrepresented minorities in science, technology, engineering and mathematics.

The Chin, Hong, & Chen study also states that consistent data endorsing the success of educational robots remains inadequate, thereby, further justifying the work conducted in this study (Chin, Hong, & Chen, 2014).

The research questions for this investigation are:

1. What characteristics of robot based learning systems empower minority children and improve their perspective on their future?

2. What features of robot based learning change minority views about self-esteem by increasing their confidence levels?

3. Which robotic education platforms do students prefer when working with different systems to solve science, technology, engineering and mathematics problems?

Relevant literature

The use of project based, hands-on learning in education has been popular since of Seymour Papert increased its popularity. He worked with Piaget in the 1960s where he became involved in the study of the process of thinking and learning using constructivist strategies (Papert, 1980). Children advance personal knowledge of their environment and formulate

understanding in constructivism (Martin-Stanley, & Martin-Stanley, 2007). Papert advanced constructivism with the expansion of the formulation of constructionism. This engages students adapting their knowledge into tangible thoughts and construction of a concept facilitated by technology (Papert & Harel, 1991, Bers, et. al, 2002). The constructionist approach engages students in a problem or situation they can relate to. Solutions to the problem necessitates that students propose and organize a resolution, and employ objects (e.g., robots) to test their solutions (Papert, & Harel, 1991). The management and examination of solutions are the foundation for knowledge construction as students acquire understanding (Jonassen & Strobel, 2006).

In an attempt to evaluate the effectiveness of new technology in education Benitti reviewed articles of newly issued works on the use of robotics in schools, in order to:

> " (a) identify the potential contribution of the incorporation of robotics as educational tool in schools, (b) present a synthesis of the available empirical evidence on the educational effectiveness of robotics as an educational tool in schools, and (c) define future research perspectives concerning educational robotics." (Benitti, 2012).

His evaluation proposed that educational robotics frequently act as a component that improves learning, however, this is not consistent. He found that there are investigations that have shown circumstances in which there were no advances in knowledge, thus leading to the need for more research (Benitti, 2012).

Methodology

This is a qualitative study of the views of minority students. The overall aim in the study is to explore critical influences in the motivation of students when entering in science, technology, engineering and mathematics (STEM) fields. Data collected is reported in text obtained from the participants during the study. The focus on the participants' perceptions and

experiences and how educational robotics motivate them in their academic career will be collected. The qualitative research approach has been chosen for this study because it is the most practical approach in explaining personal viewpoints of the participants (Creswell, 2014). Two other reasons the qualitative approach was chosen are the researcher is attempting to reconstruct meaning by interpreting the data obtained from human sources, and the data is not quantifiable because it is obtained from intuition and feelings (Creswell, 2014).

The researcher is the primary instrument in data collection. This is to reduce the uncertainties and complications of extracting significance from vague and compound data (Barrett, 2007).

The methodology used in this study is Grounded Theory. This was selected because educational robotics as a motivator for students has been demonstrated by Benitti in 2012, Chin, et al in 2014, and Shiomi et al 2005. It is the purpose of this study to determine what characteristics of robotics participants deem motivating (Charmaz, 2003). This study is an attempt to identify and categorize opinions in an inductive manner. The researcher has exposed no current theory explaining what about robotics motivates students; therefore, it is the goal of this research to generate one.

Twenty to thirty participants will be selected because they are easy to recruit for the study. Even though it would be idyllic to test the entire population, obtaining a sample from all underrepresented minorities to include every individual is not feasible because of cost, time and availability of participants. Convenience sampling will be employed for this reason. Creswell states this number is sufficient to data to reach the level of theoretical saturation. This is a level where no new codes will be developed (Creswell, 2014).

Independent Review Board approval from New Jersey City University will be sought before data collection is initiated. The setting for the study will be a seventh grade at a middle school located in an urban county in the state of New Jersey. The school is composed of a high percentage of underrepresented minority. The school has agreed to participate in the study by completing written permission by the superintendent, principal, and parents of the participants. Special focus on videotaping students was conducted. All individuals were insured that no video would be used outside the study.

The activity that participants will be asked to complete involves programming three different robot platforms to push marbles into a corral. They will be videotaped while being asked questions concerning their opinions of the activity. The robot products used will be Dash and Dot, Lego EV3 and VEX IQ. The corral will consist of a six foot square delineated by tape on the floor. Along one side starting at a corner will be a box measuring two cubic feet. Five marbles will be scattered throughout the corral. The task students must complete is to program the pre-constructed robot to push all the marbles into the box using the plow built onto the front of the robot.

Dash and Dot	**EV3**	**VEX**
		

Figure 1 – Robots included in the study

At the conclusion of the task the researcher will ask the following questions:

1. Why was moving all the marbles into the box an enjoyable experience for you?
2. Why do you feel that you would want to conduct this type of activity for a career?
3. Which robot did you feel most confident with?
4. Why did that robot make you feel most confident?
5. Why did you feel good about yourself after completing the activity?

The design of the interview process has taken into consideration questions that will obtain as much evidence as possible to engage the intentions of the research. The questions are open-ended, impartial, and understandable (Gill, et al 2008). A pilot of the interview process on several respondents prior to data collection will be implemented. This insures a clear, understandable and capable process and provides an opportunity for any changes to the interview method to be employed. The length of interviews varies depending on the participant, however, on average, interviews last five to ten minutes (Gill, et al 2008). Participants will be educated on the research particulars and provided assurance of privacy. This offers respondents comfort, and increases honesty. Interviews will be conducted in a place that has limited disturbances. One of the most important skills of the interviewer is the ability to listen attentively to what is being said, so that participants are able to recount their experiences as fully as possible, without unnecessary interruptions. All interviews will be videotaped and transcribed verbatim afterwards, to protect against bias and provide a permanent record of what was and was not said. Field notes will also be transcribed throughout and directly following each interview about

clarifications, and views about the interview, as this can help in data analysis process (Gill, et al 2008).

At the conclusion of the interviews, the researcher will arrange, summarize, and code the information collected from the video recordings and field notes.

Timeline for completion

Activity	Start Date	Completion Date	Duration
Write and refine research questions	October 2015	October 2016	1 year
Conduct literature review	October 2015	December 2016	1 year 3 months
Obtain IRB	March 2016	May 2016	1 month
Find a location to conduct the study	May 2016	September 2016	5 months
Obtain permission from district and participants	September 2016	November 2016	3 months
Develop interview questions	September 2016	December 2016	4 months
Build robots and corral	December 2016	December 2016	1 month
Conduct research	January 2017	January 2017	1 month
Data Analysis	January 2017	March 2017	3 months

References

Barrett, J. R. (2007). The researcher as instrument: Learning to conduct qualitative research through analyzing and interpreting a choral rehearsal.*Music Education Research, 9*(3), 417-433.

Benitti, F. B. V. (2012). Exploring the educational potential of robotics in schools: A systematic review. *Computers & Education, 58*(3), 978-988.

Bers, M.U., Ponte, I., Juelich, K., Viera, A., Schenker, J., (2002). Teachers as designers: Integrating robotics in early childhood education. Information Technology in Childhood Education. 123-145.

Charmaz, K. (2003). Grounded theory. *Qualitative psychology: A practical guide to research methods*, 81-110.

Chin, K. Y., Hong, Z. W., & Chen, Y. L. (2014). Impact of using an educational robot-based learning system on students' motivation in elementary education.*Learning Technologies, IEEE Transactions on*, *7*(4), 333-345.

Creswell, J.W. (2014). *Research design, 4th edition.* Thousand Oaks, CA: Sage.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British dental journal*, *204*(6), 291-295.

Jonassen, D.H., & Strobel, J. (2006). Modeling for meaningful learning-Chapter 1. Modeling for Meaningful Learning. Springer Netherlands. 1-27.

Martin-Stanley B.L., & Martin-Stanley, C.R. (2007). Constructivism and technology: Strategies for increasing student learning outcomes. National Social Science Association. Retrieved on January 25, 2012. URL: http://www.nssa.us/journals/2007-29-1/2007-29-1-15.htm

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: Basic Books.

Papert, S., & Harel, I. (1991). Situating constructionism. constructionism. New Jersey : Albex Publishing Corporation. 1-12.

Medina, C. N. (2015). Graduation Rates of URM Students in STEM Disciplines: An Examination of Institutional Differences at Selected Four Year Campuses within a Large System of Public Higher Education.

National Research Council (NRC). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Shiomi, M., Kanda, T., Howley, I., Hayashi, K., & Hagita, N. (2015). Can a Social Robot Stimulate Science Curiosity in Classrooms?. *International Journal of Social Robotics*, 1-12.

Wong, B. (2015). Careers "From" but not "in" science: Why are aspirations to be a scientist challenging for minority ethnic students?. *Journal of Research in Science Teaching*.