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Making Space for Gender Equity in Makerspaces

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Abstract: Maker education stands out as an approach to STEM learning that has several benefits. However, despite the recent rise in its popularity, making in education may be excluding some groups of learners. In this poster, we report partial findings of a mixed-methods research project carried out in two high schools serving blue-collar, working-class families in Southern Brazil. We find that factors associated with shifts in self-reported attitude towards STEM and self-efficacy in engineering differ across genders.

Introduction

Maker education has recently undergone major growth in popularity and has become a global phenomenon in education. Scholars in maker education claim that this approach to STEM learning could lead to empowerment and emancipation (Blikstein, 2008), foster critical thinking (Kafai & Peppler, 2014), and engage kids in powerful learning (Halverson & Sheridan, 2014). Despite the rise in popularity, however, we know that maker education is not evenly distributed across regions, social classes, and demographics. Additionally, the themes explored by maker activities in school settings may not cater to all. Therefore, some groups of students may be excluded from learning environments that promote those practices. It is known, for example, that learners from different genders and social, economic, and racial groups are underrepresented in maker environments, such as maker faires and fabrication labs (Holbert, 2016).

In order to investigate gaps that hinder the achievement of equitable maker education, we conducted an investigation in Southern Brazil. In this paper, we report partial findings of a study conducted in two tuition-free schools serving families of blue-collar workers, run by a non-profit institution. *Since the project is ongoing, and due to the nature of a poster, here we focus on survey data, although the data set also includes in-depth interviews with teachers and students -- we are aware, however, of the limitations of data collected via surveys.* The data analysis reported here seeks to shed light on the differences and similarities between male and female students in terms of their self-efficacy in engineering and attitude towards STEM. Responses were analyzed in search of patterns that help explain variances (and lack thereof) in those attributes across genders in students.

Methods

242 high school students answered an online survey based on validated instruments (Siegel & Ranney, 2003; Wang & Berlin, 2010). It contained open-ended, multiple-choice, and multiple-answer questions, and also collected students' names. 140 respondents were female, 101 were male, and 1 preferred not to say their gender; 90 students were in the 10th grade, 77 in the 11th, and 75 in 12th grade. The questionnaire had 7 sections, of which 3 are relevant in this work:

- Dimensions of interest: ***Self-efficacy (engineering)***: A section containing 10 items. ***Attitude towards STEM***: A section with 16 items. Both were composed of Likert-scale items ("Strongly disagree" -- "Strongly agree"), which were recoded to a 1-4 scale.
- General information: ***Gender***: students were given 4 options: "Female," "Male," "Other," and "Prefer not to Say." ***Frequency of classes at the makerspace***: the frequency ranged from "less than once a week" to "more than 5 times a week." ***Frequency of experiments or hands-on projects in STEM classes***: the frequency ranged from "never or almost never" to "every day or almost every day." Data from this section were used to analyze the dimensions of interest.

Results

We ran factor analyses (Grice, 2001) to model non-observed variables of interest for the dimensions of interest. Due to the ordinal nature of these variables, we used polychoric correlation matrices to predict regression scores for each respondent in each of the factors. Then, we ran statistical tests to compare the predicted scores between genders. For the factors whose distributions did not follow normality, we ran Mann-Whitney-Wilcoxon (MWW) two-sample tests. Otherwise, we ran t-tests. Then, again due to the shapes of distributions, we ran MWW tests to analyze how predicted factor scores differ within each gender according to the two frequency scales.

Factors obtained through factor analysis

Self-efficacy (engineering): 1) SEE: Designing, making, and constructing (range of predicted scores: -3.23 -- 1.79); 2) SEE: Tackling difficult problems (range of predicted scores: -2.91 -- 2.01); SEE: Active invention and fixing (range of predicted scores: 2.37 -- 2.02). ***Attitude towards STEM:*** 1) ATS: Learning through designing, developing, and building (range of predicted scores: 2.79 -- 1.49); ATS: Feeling good at school (range of predicted scores: -3.41 -- 1.21); ATS: Learning with new materials (range of predicted scores: -2.69 -- 2.26).

Comparing the factors across genders

Our analysis shows that there was no statistically significant difference between female and male students in any of the 6 factors that make up "Self-efficacy (Engineering)" and "Attitude Towards STEM."

Comparing factors of self-efficacy (engineering) and attitude towards STEM among male students, according to the frequency of classes at the makerspace

Variation in "active invention and fixing" among boys: A one-sided t-test showed that *there is a statistically significant difference* in the predicted score for this factor between boys with a low and those with a high frequency of classes at the makerspace (M = -0.17, SD = 0.92; M = 0.23, SD = 0.94, respectively); t(80.406) = -2.38, p = 0.023. ***Variation in "feeling good at school" among boys***: A MWW test indicates that *there is a statistically significant difference* in this factor between boys with a low and those with a high frequency of classes at the makerspace (Mdn = -0.74 and Mdn = 0.51, respectively), U = 655, p = 0.007.

Comparing factors of self-efficacy (engineering) and attitude towards STEM among female students, according to the frequency of experiments or hands-on projects

Variation in "tackling difficult problems" among girls*:* Through the MWW test we found a *statistically significant difference* in this factor between girls with a low and those with a high frequency of experiments or hands-on projects (Mdn = -0.78 and Mdn = 0.34, respectively), U = 1135, p = 0.013. ***Variation in "feeling good at school" among girls***: The MWW test indicates that there is a *statistically significant difference* between girls with a low and girls with a high frequency of experiments or hands-on projects (Mdn = -0.60 and Mdn = 0.59, respectively), U = 937.5, p = 0.001.

Discussion and conclusion

In contrast to what is commonly seen in the literature, in this context in Brazil female and male students report similar attitudes towards STEM and self-efficacy in engineering. Nonetheless, a closer look at the components of the school experience for these students reveals that the frequency of classes at the makerspace is associated with differences among male students, and the same is true with the frequency of experiments and hands-on projects among female students. In summary, the data suggest that simply being present in makerspaces is not enough to promote meaningful learning and a sense of belonging in STEM for female students -- a finding that might apply to other minoritized groups. In the future, we plan to further triangulate qualitative data (interviews with students and teachers) to investigate the causes that contributed to the results reported in this paper.

References

Blikstein, P. (2008). Travels in Troy with Freire: Technology as an agent of emancipation. In *Social Justice Education for Teachers* (pp. 205-235). Brill Sense.

Grice, J. W. (2001). Computing and evaluating factor scores. *Psychological methods*, *6*(4), 430.Kafai, Y. B., & Peppler, K. A. (2014). 12 Transparency Reconsidered: Creative, Critical, and Connected Making with E-textiles. *DIY citizenship: Critical making and social media*, 179.

Halverson, E. R., & Sheridan, K. (2014). The maker movement in education. *Harvard educational review,* 84(4), 495-504.

Holbert, N. (2016). Leveraging cultural values and "ways of knowing" to increase diversity in maker activities. *International journal of child-computer interaction*, *9*, 33-39.

Siegel, M. A., & Ranney, M. A. (2003). Developing the changes in attitude about the relevance of science (CARS) questionnaire and assessing two high school science classes. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *40*(8), 757-775.

Wang, T. L., & Berlin, D. (2010). Construction and validation of an instrument to measure Taiwanese elementary students' attitudes toward their science class. *International Journal of Science Education*, *32*(18), 2413-2428.