The Role of Feedback in Interest Development in an Out-of-School Engineering Setting

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Abstract The poster describes work-in-progress on interest development in an out-of-school robotics competition. Hidi and Renninger's (2006) Four-Phase Model of Interest Development is used to develop an interest assessment, along with a field-based observation protocol. High school students (N = 150) and their adult team leaders are drawn from 6 robotics clubs: Rookie v. veteran clubs, crossed with high, low, and mixed SES populations.

The need for increasing recruitment and retention of high quality entrants into the STEM workforce is well documented (National Academies Press, 2007). In order to meet this need, students must be encouraged and motivated at a relatively young age to enter the "pathways" into these fields, which will require (among other things) developing and maintaining interest in STEM areas from elementary and middle school, through high school and into post-secondary education (Katehi, Pearson & Federer, 2009). An increasingly sophisticated view of interest development is emerging among scholars, just as hands-on, competition-based clubs and afterschool programs designed to foster interest in STEM education and career pathways is proliferating.

This study focuses on students participating in the FIRST Robotics Competition (FRC), an out-of-school robotics competition that now involves approximately 250,000 high school students in the US. Studies of the impact of robotics clubs on interest and motivation have been mixed (NAE/NRC, 2014). However, Melchoir et al. (2005), in a study using interviews of alumni of the program, found FRC to have a high impact on choosing engineering as a college major. The Melchoir study recommends further investigation into the *initial interest* of FRC participants. This study will develop an interest assessment and a field-based observation protocol based on Hidi and Renninger's (2006) *Four-Phase Model of Interest Development (FPMID)* as its framework.

Major Issues Addressed and Potential Significance of the Work

Our central research question is: Does receiving feedback appropriate to a student's phase of interest development help sustain or increase the student's interest over time? This investigation will document the nature of feedback club members receive over time. It will also provide a greater depth of understanding on how STEM interest develops *in situ*, by providing examples leaders can utilize. If FPMID has predictive validity, and the interest measurement tool reliably categorizes students in their current phase of interest, then a method of formative assessment for interest for team leaders would be proposed to best meet the developmental needs of their students. Thus, this inquiry addresses the need identified in the literature for understanding how interest is maintained once it is triggered (Renninger & Hidi, 2011), as well as testing the validity of the FPMID.

Theoretical Framework

The FPMID identifies four progressive phases of interest: Triggered Situational, Maintained Situational, Emerging Individual, and Well-Developed Individual. It provides descriptive characteristics of students in each phase, as well as descriptions of the specific (ideal) feedback needs of learners in each of these phases. Previous research on effective student feedback sometimes uses a "one size fits all" approach by recommending feedback that will have positive results for *all* students. However, current research in interest development recognizes that feedback that may have positive results for one student, may be inappropriate for students at a different phase of interest, and can have a negative impact on later interest development (Renninger, 2010).

The Model is used to develop two methodological tools. The first tool, the phase of engineering interest survey is being developed as an instrument to reliably categorize students into one of four interest phases. Currently there are no tools to reliably measure phase of interest development in this model (Renninger & Hidi 2011), and there is a demonstrated need for this type of tool (Renninger & Hidi, 2011; NAE/NRC, 2014). The second tool is an observation protocol developed for field use among FRC sites. This will be used to document feedback that participants receive from their team leaders and peers before, during and after an FRC competition season, as well as each team member's participation. The observation protocol will independently assess students' interest through their participation. Combining field observations with survey responses allows for a level of validity assessment of the model.

Method

Baseline interest will be assessed prior to the competition season using a 64-item Likert scale interest survey administered to 150 high school students from six Midwestern FRC teams representing high, low and mixed

socio-economic status populations, crossed with rookie and veteran (more than three years of experience) teams. Survey results will be coded to derive a score for each participant, in six categories of interest phase characteristics: basic interest, positive feelings, content engagement, use of feedback, independent questioning, and perseverance. Initial survey responses will be used to match participants with their baseline phase of interest development. Observational data will be collected during the first week of the FRC competition season to validate the student participant's phase of interest identified by the pre-competition survey.

Observational data will be collected during the remainder of the FRC season the team's regional competition through observations and audio recordings of team meetings. This includes five weeks of a "build season" where students work to design, create, test and improve a unique robot built for a novel game unveiled at the start of the season (e.g., during the 2012 season, robots competed for the most basketball shots in two minutes, and then cooperatively balancing on a bridge with other team's robots). Observations will be coded for instances of types of feedback received by participants during the season. For example, the FPMID describes those who have a "Level 3: Emerging Individual Interest" as needing feedback that "enables him/her to see how his/her goals were met." An observed instance of this type of feedback would be coded as "Level 3" feedback, and compared with the student's developmental needs.

Student participants will also be administered the interest measurement survey (post) after completion of the FRC season. Pre- and post-season survey scores will be compared to measure interest changes for individual student participants. According to our research hypothesis, a greater proportion of students who have their feedback needs met will maintain their current interest phase or move to a higher interest phase than those student participants who do not receive the appropriate feedback.

Conclusions and Implications

According to FPMID, students in a particular phase of interest have specific feedback needs in order to maintain or increase their level of interest. The aim of this study is to explore the predictive validity of the model in an out-of-school STEM learning environment using survey responses and field-based observations across a set of students in rookie and veteran clubs that attract high, low or mixed SES participants. This work can potentially test the predictive validity, while producing exemplars of matched and mismatched feedback as it occurs *in situ*. This work can lead to empirically based principles for maintaining and increasing interest in STEM. It may contribute to the design of formative assessments of interest for STEM learning environments that may help promote young people's interest in STEM education and career pathways.

Relevance to the Theme of the Conference

This study is relevant to the 2014 theme of the conference, "Learning and Becoming in Practice," because of its focus on interest development in an out-of-school robotics competition. FRC promotes learning by engaging students in the *practices* of engineering. Students work side by side with teachers, and engineering professionals and students, to develop a working robot to compete in a real contest. The impetus for studying interest development in this environment is to better understand how students choose to engage in STEM subjects and activities, and ultimately how they take on the practices and habits of mind that allow them to *become* quality professionals in a STEM field.

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