Engineering girls gone wild:
Developing an engineering identity in Digital Zoo

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Abstract: In the Digital Zoo *epistemic game*, middle school girls work as engineers to design virtual, ambulatory creatures. The activities of the game were based on an ethnographic study of an undergraduate engineering design course. As a result of gameplay, the girls demonstrated an increase in thinking of themselves as engineers. Moreover, both the girls and undergraduates linked their engineering identity development to meeting with – and getting feedback from – external clients and experts.

The "incredible shrinking pipeline" (Camp, 1997) of women engineers – the decreasing number of women graduating with bachelors degrees in engineering – is attributed in part to girls being unable to envision themselves as successful engineering professionals. Initiatives such as "Introduce a Girl to Engineering Day" and the "Engineering Girl**!**" website (www.engineergirl.org) provide young women with information about the profession, but do little in the way of engineering identity development. Here, we examine a different approach to helping girls see themselves as engineers. In the Digital Zoo *epistemic game* (Shaffer, in press), middle school girls work as engineers by engaging in activities modeled after an undergraduate engineering design course. In this poster, we analyze how gameplay based on the profession of engineering can foster the development of engineering identity in young women.

Theoretical Framework

Becoming an engineer means developing the *epistemic frame* (Shaffer, in press) of engineering – the particular combination of skills, knowledge, values, identity, and epistemology that characterizes the profession. Like most professionals, engineers develop this frame in a practicum: a structured learning environment in which new members of a profession work on authentic problems under the guidance of an experienced mentor. The theory of *epistemic games* suggests that a game which simulates the conditions of a professional practicum – such as an engineering design course – can help young players develop the epistemic frame of a profession. Designing such a game requires a detailed understanding of how the curriculum, tools, and interactions contribute to the development of the epistemic frame in the professional practicum.

In this study, we look at a key element of an epistemic frame, professional identity, and how it is cultivated both within an epistemic game and in the professional practicum on which it is based. Specifically, we investigate how undergraduates in an engineering design course and the players in Digital Zoo come to see themselves as engineers. We ask: 1) whether conducting an ethnographic study of an engineering practicum uncovers salient processes through which an engineering identity is developed; 2) whether creating and implementing an epistemic game for girls based on these results help them develop an engineering identity, and 3) whether the process of professional identity development for the students in the practicum and girls in the epistemic game is similar.

Methods

Ethnographic study

An ethnographic study was conducted on Biomedical Engineering (BME) 201, a design course at a large Midwestern state university. During the semester, sophomore engineering students work in teams on actual design problems from external clients. Data was collected in observational field notes, individual interviews with professors, and three focus groups. Data was analyzed within a grounded theory framework (Strauss & Corbin, 1998).

Epistemic game

The design of Digital Zoo was based on the ethnographic study of BME 201. In the game, students develop wire-frame prototypes of ambulatory characters for an upcoming animated film within a computational spring-mass

modeling environment. At the end of each week, formal design reviews are held with external engineering experts who provide players with input and feedback on their designs. In the summer of 2005, seven middle school girls played Digital Zoo during a three-week summer program. Six of the players were students of color. Clinical pre- and post-interviews with the players were transcribed and analyzed within a grounded theory framework.

Results

BME 201 undergraduates developed an engineering identity

One emergent theme from the focus group data was the development of engineering identity throughout BME 201. Of the 12 focus group participants, 10 (83.3%) responded positively to the question "Do you feel like an engineer?", and 7 of 12 (58%) students linked their engineering identity to client interaction. In addition, there was a statistically significant correlation between student references to client interaction and receiving client feedback ($r = 0.85$, $p<0.01$). For example, in response to the "Do you feel like an engineer?" question, one student said:

> Yeah, I do, especially when talking to the client. Coming in [to their office] and asking them to see what to do is helpful. A lot of [engineering] comes down to communication with the client.

In other words, meeting with the external client and receiving feedback on their design work were essential to the process of engineering identity development for the undergraduates.

Digital Zoo players developed an engineering identity

The number of Digital Zoo players who indicated they had thought of themselves as engineers increased from pre- (2/7, 29%) to post-interview (7/7, 100%, $p<0.01$), with all players responding positively to the "Have you ever thought of yourself as an engineer?" question in the post-interview. Five players (71%) linked their engineering identity to external expert interactions. In addition, there was a statistically significant correlation between player references to expert interaction and receiving expert feedback ($r = 1.00$, $p<0.01$). For example, when asked whether she had ever thought of herself as an engineer in the post-interview, one student responded, "Yeah, during Digital Zoo." When asked when specifically she felt like an engineer, she replied:

> Like the [Friday] presentations and the presentation at the end. That was when I saw myself as an engineer…I liked presenting my things and showing everybody what I made… I learned that there were things I could change about [my designs] because they like they had certain things to say about it – like some things worked better than like another thing… so then I could like… make mine even better.

In other words, meeting with the external engineering experts and receiving feedback on their virtual creatures were essential to the process of engineering identity development for the Digital Zoo players.

Discussion

Both the undergraduates in BME 201 and the players in Digital Zoo developed an engineering identity, and interacting with clients or experts external to the learning environment contributed to that development. Moreover, the significantly high correlations between client/expert interaction and client/expert feedback suggest that it was not only the external interaction, but also the content of the interaction, that impacted both groups.

The close alignment between the engineering identity development experiences of the BME 201 undergraduates and the Digital Zoo players suggests that: 1) conducting an ethnography of an engineering design course is a useful way to uncover the salient activities and interactions that contribute to professional identity development, 2) designing and implementing an epistemic game based on this ethnographic study can help middle school girls develop and cultivate an engineering identity, and 3) the processes of identity development for epistemic game players and practicum students were, in fact, similar. Thus, by helping girls see themselves as engineers, epistemic games such as Digital Zoo are potentially powerful and transformative tools for addressing the lack of women in engineering.

References

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