

## Measuring Social Identity Development in Epistemic Games

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**Abstract:** Learning is an inherently social process and is most effective when it is situated. Situated learning is modeled in communities of practice when new members begin their initiation into the practice and begin to develop a social identity in the context of the group. Games and simulations are one way to initiate newcomers into communities of practice. This study examines pre and post survey data and chat discourse from an engineering epistemic game to determine if students develop an engineering social identity by exhibiting forms of interdependency and depersonalization. The study concludes with how examining players' epistemic frames in CSCL environments that model real-world communities of practice, like epistemic games, can aid in the development of one of the key aspects of social identity—the process of depersonalization.

### Introduction

Learning, thinking, and knowing are fundamentally social. When people make meaning of the world around them, it is a socially negotiated process because the world around is socially constructed. Thus, effective learning is situated within real-world situations and practices (Lave & Wenger, 1991) or communities of practice (Wenger, 1999). Educational researchers and practitioners are attempting to translate this concept into concrete learning environments and tools such as computer support collaborative learning (CSCL) environments. This paper examines how a CSCL learning environment can facilitate membership into a community of practice.

### Theory

Decades of research in the learning sciences has shown that effective learning is situated and social (Anderson, Reder, & Simon, 1996; Bandura, 1986; Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Vygotsky, 1978), meaning that learning takes place in the same context as which it is applied. In other words, learning is a social process where knowledge is co-constructed in some specific social environment—that is, within some community.

Analytically, such learning communities have been described as *communities of practice*—groups of people that share ways of working, thinking, and acting in the world. Such communities change over time as existing members (oldtimers) leave and new members (newcomers) begin their initiation into the practice.

Before newcomers become full members of the community, however, they need to go through a process of initiation, which Lave and Wenger (1991) refer to as *legitimate peripheral participation*. Legitimate peripheral participation is a sequence of activities through which a newcomer experiences a reduced role in the full practice—a form of simulation of the full role of a community member, which, with guidance and supervision, includes interactions that are similar in form to those of the real practice but with less intensity, pressure, and risk than the practice itself. Through this process a newcomer progressively internalizes both the practices and the identity of the community. Put another way, in legitimate peripheral participation, newcomers do not join the community simply by observing a community of practice. Instead, the three key pieces of this process are: (1) developing relationships with members, (2) understanding how members make decisions, and (3) learning the tools, language, artifacts, and routines of the community (Wenger, 1999).

Thus, a newcomer develops an affiliation with a community of practice through the development of a *social identity* within the context of the community. Tajfel (1981) and others (Abrams & Hogg, 1990; Stets & Burke, 2012; H. Tajfel & Turner, 1979) have described social identity as an individual's self-perception acquired from group membership. Jackson and Smith (1999) build on this work and posit four dimensions of social identity:

1. *Intergroup context*: the extent to which the group is different from other groups
2. *Attraction*: the positive affect one feels toward the group
3. *Interdependency*: the shared ideas toward future well-being, and
4. *Depersonalization*: thinking in terms of a group member and less as an individual.

In these terms, a key goal of legitimate peripheral participation is to facilitate these processes and thus develop a newcomer's social identity within the community of practice.

One way to help young people develop such situated social identities is through games and simulations, which can provide young people with a low risk learning environment (Gee, 2003; Shaffer, 2007) in order to increase engagement and excitement while learning domain-specific content (S. Barab & Dede, 2012; Klopfer, Education, & Squire, 2008). In the base case, educational games can help build an identity within a community of practice (S. A. Barab, Barnett, & Squire, 2012; Gee, 2003; D. Hatfield & Shaffer, 2008; Steinkuehler, 2006).

To accomplish this, some game designers have developed *alternative reality games* (Mcgonigal, 2011) or *augmented reality games* (Squire & Jan, 2012), which mix real-world scenarios and game elements. Some results suggest that such games engage and motivate young people to solve real world problems (Squire, Devane, & Durga, 2008). However, although these games are engaging and attractive to players, they typically offer only one piece of developing a situated social identity: attraction to the group. Most games are not actually situated in a realistic simulation of a real-world community of practice. In other words, players are learning domain concepts out of their real-world context. As a result, young people in these learning programs may not have an opportunity to fully develop social identities of real-world communities of practice.

Epistemic games are also CSSL environments that help young people develop positive associations with communities of practice (Bagley & Shaffer, 2011; D. L. Hatfield, 2011). But epistemic games additionally provide a space for students to experience a simulation of a professional practice. For example, in the epistemic game *Nephrotex*, students play the role of engineering interns at a medical device company. They work together to design a filtration membrane for a hemodialysis machine, in a way that is similar to how professional engineers would design, build, and test a product (Chesler, Arastoopour, D'Angelo, Bagley, & Shaffer, 2012). Previous studies have shown that after participating in *Nephrotex*, women have more positive associations with a career in engineering (Arastoopour et al., 2012). In this sense, epistemic games may provide more complete opportunities to develop social identities in that they:

1. Are simulations specific to a particular professional practice (intergroup context),
2. Generate positive affect (attraction to the group),
3. May motivate young people to imagine a future within the profession (interdependency), and
4. Are situated within professional communities of practice which may allow young people to learn the epistemology of a practice (depersonalization).

Shaffer (2004, 2006, 2007) has operationalized the learning that occurs in epistemic games (and in communities of practice more generally) in terms of an *epistemic frame*. Epistemic frame theory suggests that every practice has unique collections of skills, knowledge, identities, values, and epistemologies that construct an epistemic frame. Members in a practice rely on domain-specific skills and knowledge to make and justify decisions. They have characteristics that define their identities as members of the group, as well as a set of values they use to identify important issues and problems in the field. Developing an epistemic frame means making a network of connections between these skills, knowledge, identities, values, and epistemological elements that are characteristic of the community. Using epistemic frame theory, we can thus examine newcomers' epistemic frames to determine whether they are learning to link knowledge, skills, and values to make and justify decisions in ways that model those of oldtimers of a community.

Previous studies of epistemic games have shown that they are able to accomplish the first two aspects of social identity development: intergroup context (D. L. Hatfield, 2011) and positive affect (Arastoopour et al., 2012). In this study we consider whether such games can create the interdependency and depersonalization that facilitate initiation into a community of practice.

To accomplish this, we look at data from the epistemic game *Nephrotex* and ask:

- 1) Does *Nephrotex* facilitate the development of interdependency: that is, after playing *Nephrotex*, are students more confident in their ability to succeed, and committed to pursuing the field of engineering?
- 2) Is this process of interdependency connected to the process of depersonalization: that is, do students who make more connections to epistemological elements in their epistemic frames wind up more confident and committed to engineering than those who do not?

## Methods

### Participants

We collected survey data from 268 students from three different studies. Students were either in the experimental *Nephrotex* group or a control group. Students in the control group were enrolled in an introductory engineering course. Figure 1 summarizes and compares activities between *Nephrotex* and the introductory course.

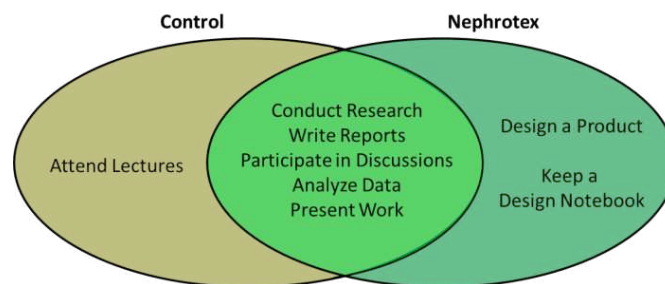


Figure 1. Venn diagram of control group and *Nephrotex* activities.

We collected pre and post survey data from all students in the experimental and control group and discourse data from students in the experimental group. Participant information is summarized in table 1.

Table 1. Participant information from three studies including experimental group and number of participants

Study	Total
University of Wisconsin-Madison, Control (Traditional course)	130
University of Pennsylvania, Experimental (Nephrotex)	102
University of Wisconsin-Madison, Experimental (Nephrotex)	36
<b>Total</b>	<b>268</b>

### Pre and Post Survey

Students in the Nephrotex condition and in the control group answered 20 Likert-scale questions on their perceptions of engineering careers and their commitment to the field in a pre- and post-survey. We identified questions that were correlated with the survey question *How committed are you to a career in engineering?* or with *I feel confident in my ability to succeed in engineering.* at greater than .25. This resulted in a subset of eight highly correlated items: *The future benefits of studying engineering are worth the effort*, *Someone like me can succeed in an engineering career*, *I like the professionalism that goes with being an engineer*, *Engineers are innovative*, *From what I know, engineering is boring* (negatively correlated), and *I enjoy taking liberal arts courses more than math and science course* (negatively correlated).

We conducted a principal component analysis on this subset of eight items. This resulted in one significant principal component (accounted for 48% of the variance)—Commitment and Confidence.

### Discourse Analysis

All chat discourse from the virtual internship was segmented by utterance. An utterance, in this case, was when a student sent a single instant message in the chat program. We coded the discourse using a set of 20 codes. The codes were developed from ABET criteria for undergraduate engineering program outcomes (ABET, 2011) and using epistemic frame theory as a guide for professional practices. Each utterance segment was coded separately (1 = present, 0 = absent) for evidence of the codes. The excerpt in figure 2 is an example of a coded utterance.

<i>Putting patient's care as a first priority, our team agrees that reliability and flux are the most important characteristics of a device. We put them as one because with higher flux, reliability increases as well. Together, higher flux and reliability decreases the amount of time a patient has to spend in dialysis care improving the patient's quality of life and treatment.</i>	Value of Client	Valuing the client/patient or stating that their needs are important
	Skill of Collaboration	The action of collaborating or participating in a team action.
	Knowledge of Attributes	Referring to attributes: reliability, flux, biocompatibility, marketability, and cost.
	Epistemology of Design	Justifying decisions using design references such as device specifications ranking/priority of attributes, or tradeoffs in design.
	Epistemology of Client	Justifying decisions by referring to the client's or patient's safety or health.

Figure 2. Example of an utterance from Nephrotex chat data coded for five engineering epistemic codes.

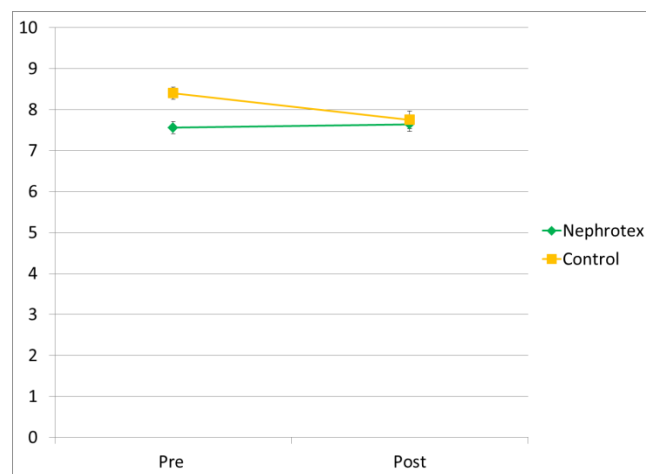
We used the method of epistemic discourse coding to code for the presence of all 20 codes. This automated coding process has been validated by comparing hand-coded utterances by multiple, independent

human coders, and by comparing hand-coded utterances to the automated coding system. Cohen's kappa scores were between .80 and .98 between the automated system and human coders. These results compare favorably to previous human-to-human coder outcomes, and, in some cases, outperform them (D'Angelo et al., 2011).

ENA measures relationships between epistemic frame elements by quantifying the co-occurrences of those elements in discourse (Orrill & Shaffer, 2012; Rupp et al., 2009; Rupp, Gustha, Mislevy, & Shaffer, 2010; Shaffer et al., 2009). We used ENA in the epistemic game, *Nephrotex*, to measure students' development of connections made between skills, knowledge, identity, values, and epistemology, and not simply quantify the isolated occurrences of these elements. For this analysis, the data was segmented into stanzas defined by all utterances from each student in each class session. We created an adjacency matrix for each stanza that identified if codes co-occurred with each other. Each of the adjacency matrices were unwrapped into adjacency vectors, normalized to a unit sphere, and a principal components analysis was conducted on the normalized data.

## Results

At the end of the course, *Nephrotex* students were significantly more confident and committed to engineering than students in the control group. There was a significant difference between *Nephrotex* student ( $M=.067$ ,  $SD=1.54$ ) and control student ( $M=-.52$ ,  $SD=1.91$ ) delta scores;  $t(247.9)=2.79$ ,  $p=.005$ .



**Figure 3.** *Nephrotex* and control pre and post survey scores on Commitment and Confidence (Mean  $\pm$  Standard Error)

For example, one student responded to a short answer post survey question:

*Before Nephrotex, I was unsure of the field of bioengineering. But I think that this internship has allowed me to understand what a bioengineer does in their day to day lives and I have realized that this is something that I like and want to do in the future.*

*Nephrotex* students who had higher delta scores on confidence and commitment were focused mostly on epistemology of engineering during the virtual internship. There was a positive correlation between the first component of ENA (high score = focus on epistemology of data analysis and engineering design, low score = focus on other elements) and the first component of the survey (high score = high confidence and commitment, low score = low confidence and commitment),  $r = .185$ ,  $n = 135$ ,  $p = .030$ .

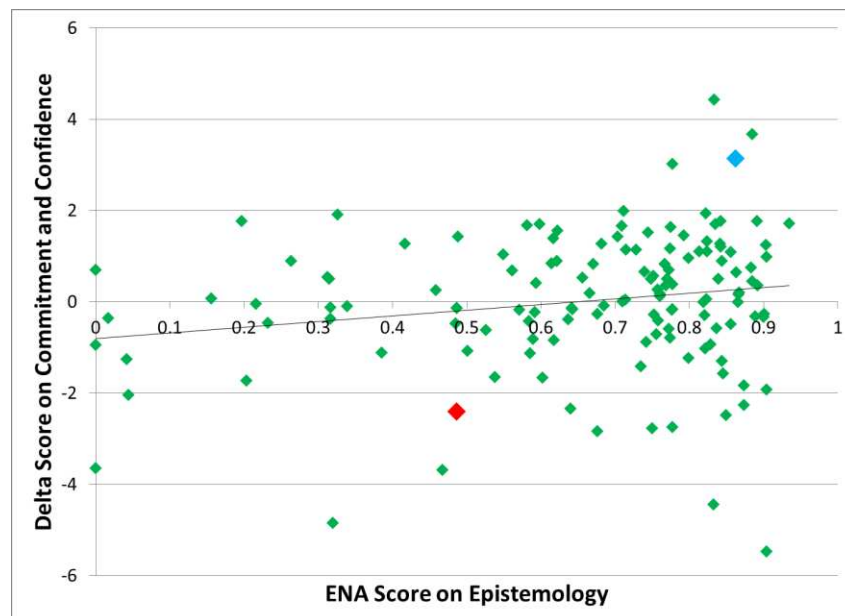


Figure 4. Scatterplot of *Nephrotex* student delta scores on *Confidence and Commitment* vs. ENA scores on *Epistemology*. Red point is a student with a low delta score and low epistemology score. Blue point is a student with a high delta score and high epistemology score.

During the second design iteration activity, interns discussed and designed final devices with their teams to send to the lab for testing. We selected two students as representative samples of students that had low commitment and confidence and low epistemology scores (Janice is represented by the red point) and of students that had high commitment and confidence and high epistemology scores (Allison is represented by the blue point). Janice (blue point) justifies her decisions with design parameters and data. She also draws on her knowledge of carbon nanotubes and attributes. On the other hand, Allison (red point) makes descriptive statements about materials, data, and manufacturing processes without justifying her statements or making epistemological statements.

Janice	<i>Yes, there are always going to be trade-offs, which is why we had to rank the attributes.</i>
High commitment and confidence High epistemology ◆	<i>but based on the conclusions from the other devices, I would recommend using 2% CNT because it lowers the cost and has the same results in terms of quality</i>
Allison	<i>The most reliable device had mediocre marketability, flux, and biocompatible values, and a high cost of \$100/unit</i>
Low commitment and confidence Low epistemology ◆	<i>The most marketable PSf product had a value of 500,000. It is also the most biocompatible of the models, with a value of 65.56. It was treated with a steric hindering surfactant and manufactured through phase inversion.</i>

Figure 5. Chat discourse samples from a design activity in *Nephrotex* from two students.

## Discussion

Our results thus show that students in *Nephrotex* were more confident and committed to engineering than those in a control group. Further, students who became more confident and committed to engineering were the ones who had made more connections between epistemology and other frame elements in their epistemic frames. In the context of Jackson and Smith's framework for social identity development, *Nephrotex* provides an opportunity to develop the final two aspects of a social identity: interdependency (in terms of commitment to the group) and depersonalization (in terms of making connections to epistemology in the epistemic frame). In particular, examining connections to epistemology in epistemic frames was an effective way to determine an individual's depersonalization within a group.

Depersonalization, in fact, has been widely assumed to be the central cognitive process when developing a social identity (Hogg & Terry, 2012; Stets & Burke, 2012; Turner & Oakes, 2011). Change in the

perception of the self as an embodiment of the group is a critical component of entering into a new community. In turn, determining a person's level of depersonalization provides a useful measure of their social identity development relative to a particular group.

Thus, our study has two significant findings:

- (1) A key element of using a CSCL game such as *Nephrotex* to initiate affiliation with a community of practice is to offer a *realistic simulation of the epistemology of the community*; and
- (2) Epistemic frame theory can be used to *assess depersonalization*, the central piece of developing a social identity with a group.

Therefore, epistemic frames can play a central role in assessing the extent to which a CSCL environment is providing opportunities for legitimate peripheral participation and a context for situated learning.

Further studies will be needed to examine the links between students' development of attraction, interdependency, and depersonalization in a single study. This will provide further insight into social identity develop in real-world situated computer supported collaborative learning environments.

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