

# Identity and Belonging: Are You a Physicist (Chemist)?

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**Abstract.** When science undergraduates begin their upper-division coursework, their declaration of major becomes more concrete and meaningful as they have opportunities to interact more deeply with the community of their chosen discipline. In the process of completing a major, students transition their identity towards being a member of their field. In Wenger's community of practice framework, community membership is built on alignment of common goals, participation in social interactions, and perception of belonging in the community. But what does it mean to be a chemist or physicist from the students' perspective? In this study, we examine junior-level chemistry and physics majors' ideas about their science identity through semi-structured interviews and prompted reflective journals. We compare and contrast how chemistry and physics students negotiate their identity as members in their disciplinary field in terms of practice, qualifications, attitude, and in relation to other STEM communities.

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## INTRODUCTION

California State University Fullerton (CSUF) serves a diverse student population, including a large number of students who are members of underrepresented groups in STEM fields. There is no ethnic majority on campus (31.7% Hispanic, 30.2% white, 21.6% Asian and Pacific Islander, 4.5% international students, 2.7% African American, 3.2% multiple races, 0.3% Native American, and 6.0% unknown). Ethnic and background diversity among chemistry and physics majors is comparable to that of the campus. This potentially limits the formation of on-campus communities of students who identify with each other. Furthermore, CSUF is among the largest universities (35,000 students in 2010-2011 academic year) in the county and is a commuter campus. This means students can be overwhelmed by the sheer number of other students on campus and struggle to build strong communities with peers. Additionally, over half the students are first-generation college students or non-traditional students. For some students, this can result in difficulties in having personal communities who understand the challenges of being a college student.

These characteristics pose challenges to student success in a number of ways. Students may lack a sense of community and belonging due to having few peers with whom to identify. Research indicates that students who don't form formal (professors) and informal (friends and extracurricular activities) social connections are more likely to leave college, especially for minority students [1]. Also, students may feel like "impostors" who are not good enough to have the right to be in college [2].

In the process of completing a science major, students

face these obstacles to building and having access to supportive communities in addition to developing an identity to become a member of their science field. For students at CSUF, particularly the ethnic minority and first generation college students, this can be a daunting transition both socially and intellectually. We want to investigate student identity so that we can better support the process of becoming chemists and physicists in this context.

In this study we focused on junior-level students at CSUF who have declared their major as chemistry or physics and have begun to take upper-division courses specific to their own majors. This suggests a greater level of commitment to the chosen major compared to the lower division course requirements that typically service a large variety of majors. Their level of commitment and success in previous courses in their chosen field make them appropriate for studying identity development.

We present preliminary findings about students' perceptions of their identity as members of their classroom, broader academic, and general science communities.

1. What are the students' ideas about being and becoming a chemist or physicist?
2. How do students position themselves within the communities where they do chemistry or physics?
3. In what ways do chemist and physicist identities develop similarly or differently?

## CONCEPTUAL FRAMEWORK

Using the community of practice (CoP) [3] lens, we examine contexts where identity development is situated in

order to understand what it means for students to become chemists or physicists. In this framework, identity is the way people understand how to be part of a community through participation in social interactions over time [3]. Developing an identity towards becoming a chemist or physicist involves building a relationship with the discipline [4] and other CoP where one does chemistry or physics. Because these students have declared their major, there is a certain degree of alignment of personal goals and values with those of the disciplinary CoP. At a social level, the students must also develop a sense of belonging that is supported by the relationship with the CoP. Lastly, people participate in multiple CoPs throughout their daily lives and form identities that shift as they move between each CoP. The incorporation of these identities is the concept of a nexus of multimembership [3]. As majors, students are more likely to engage in disciplinary practices in CoPs beyond classes. Thus it is important to consider how students perceive and navigate these relevant CoPs.

## METHODOLOGY

*Study population.* We selected junior-level courses in each department that would give us access to students at an intermediate point in their majors. Student participation was voluntary and solicited in class at the start of the spring 2012 semester. We selected chemistry majors taking Physical Chemistry (CHEM361B, quantum/spectroscopy). The course was taught by an assistant professor in chemistry who taught this course and the preceding course (CHEM361A, thermodynamics) in the 2011-2012 academic year. The course is required for chemistry and biochemistry majors; 79 students were enrolled in the course and 57% were female.

We selected physics majors taking Thermodynamics, Kinetic Theory and Statistical Physics (PHYS310). The physics course was taught by a physics professor, is required for physics majors, and eleven students were enrolled in the course at the start of term. Of these students, nine were physics majors, one was a physics minor; only one of the students was female.

*Participants and Interview.* Consenting students in both courses were invited to participate in semi-structured, individual interviews during week 6-7 of the semester. Seven physics students were interviewed (one female physics major, five male physics majors, and one male physics minor). Four chemistry students were interviewed (three were female, all were biochemistry majors). At the start of the interview, each student was asked to create a personal meaning map (PMM) [5] which is a research tool used in museum studies to measure learning that takes into account the individ-

ual's prior knowledge and experiences. In our study, the PMMs were used to reflect the students' ideas and experiences as a focal point for discussion. Each student was given a sheet of paper with "physicist" or "chemist" printed in the center and the verbal prompt "write down as many words, ideas, images, phrases or thoughts as come to mind when you see or think chemist/physicist." The student was then left alone for five minutes to complete this task. In the remaining 25-55 minutes, the student was asked to discuss the PMM. Using the context of the PMM discussion, the interviewer incorporated the following set of five questions into the conversation of the interview.

1. What is a physicist? What makes someone a physicist? What do they do?
2. When/where do you get to be a physicist?
3. Are there ways that being a physics person comes up when you are doing things that aren't related to your classes/research/etc? Outside the university/department?
4. When do you think you started to feel like you could call yourself a physicist? What do you do that make you a physicist?
5. What do physicists do that you like/dislike doing?

The word "physicist" was replaced with "chemist" for the chemistry interviews. Students were compensated with a \$10 gift card for participating in the interview. Audio recordings of the interviews were transcribed and compiled with data from student PMMs.

## ANALYSIS

The goal of the interview was to elicit student ideas about being and becoming a chemist/physicist in and beyond class. To do this, the interviewer directed the conversation toward communities where students said they engaged in chemistry/physics practices. A priori codes were developed based on this goal, prior conversations with students, and literature about undergraduate student development [6, 7]. There were three main categories of codes: disciplinary practices, affective domains and traits of physicists/chemists. Traits included ideas about what characteristics and contexts makes someone (including oneself) a physicist/chemist. Disciplinary practices included specific actions, speech, and ways of thinking in chemistry/physics. Affective domains included feelings of belonging with the disciplinary community, feelings of multiple allegiance to different CoPs, and stereotype threats. These codes were refined in the interview analysis of transcriptions and PMM content.

The PMM were de-identified and coded independently by three researchers. The codes that emerged from the

discussion were compiled and grouped by themes. The recognition category was broadened to encompass traits that are recognized by different perspectives (such as disciplinary ideals and personal opinions) and CoP (including the disciplinary community, general society, family, and friends). The disciplinary practices category was extended to include a future aspect related to ideas about being able to or expected to engage in practices once they become chemists/physicists. The affective category incorporated feelings of identity conflict such as having multiple allegiances to CoPs. In the discussion below, we will focus on findings in recognition and disciplinary practices.

## RESULTS AND DISCUSSION

The most prominent results in the interviews involved the way the participants were viewed as chemists/physicists by various CoP. This perception of community views guided the roles they chose to play and their interactions with those communities. Within their own disciplinary communities, these students discussed the practices and attitudes that helped define them as chemists or physicists. Below we discuss some findings with a representative selection of student quotes from the interviews.

*Recognition of traits.* In the discussion of traits of chemists and physics viewed through the lens of various communities, the participants felt that being a chemist/physicist made them "different" or "unusual," and the participants described how they felt about and responded to such labels. Students discussed myriad communities that interact with their doing chemistry/physics. Their ideas about how they are perceived in those communities guide the role they choose to play while in those communities. These ideas also informed their feelings about being chemistry/physics majors and expectations about how to fit in within those communities.

For some of the participants, being viewed as different resulted in some frustration. (In the quotes CS denotes chemistry student and PS denotes physics student.)

CS25: I always get that "ooh!" Some type of sigh or weird noise that people make whenever I say I'm a chemistry major. It's always that sound.

However, most of the participants tended to wear this difference with acceptance and pride. A physics student wrote on his PMM that "physics is not easy, people who study it are brave." He explained that it took courage to do physics because "most people are just scared of science." Several physics students mentioned that society "just thinks we're crazy!" One physics student accepted this label because he had "realized you need a little ob-

session to do our craft," while another physics student proudly asserted that "I know I'm unique now... I finally came to realize I really am a nerd." One chemistry student further claimed that doing chemistry was "a big part of [her] identity now" suggesting that it was an inseparable part of who she was and who she wanted to be.

*Positioning in communities.* Knowing that they are somehow viewed as different by others, some choose to fit in while others choose to be misfits.

PS2: If I meet a random stranger I [...] tell them that it's really shitty and I work really hard [...] most people don't think that working 12 hours a day 6 days a week [...] is a fun thing to do. But if I'm talking to [a] person that I actually know already, then I'd be like it's awesome I got to work on this problem for 2 hours today and like the most fun I've ever had.

This student's descriptions of physics were very different and appeared to be motivated by the perception that being different would make him isolated. He wanted to fit in by agreeing with society that doing physics was not fun, but also respected because it was hard work. In contrast, it was acceptable to be someone who enjoyed doing physics within his close community of friends.

CS11: I feel like I think about it too much [...] mostly it's because my family is like 'ok you're annoying us now.' I'm like oh ok this must be bad. But I just... I really like it a lot and so I talk about it a lot. [...] that's a big part of my life.

This student knew that her family was proud of her achievements but recognized that she would alienating herself by fully expressing her chemist identity. This idea was supported in several similar anecdotes from the interview where she perceived disinterest from her family. With her husband who was a chemistry major before switching to computer science, she was able to be a chemist freely because "he's into science [and] he used to be chemistry with me." For another chemistry student, he asserted that his family "have no clue what I'm talking about. They just know oh acetone is nail polish remover." Being different in his family CoP appeared to be derived from a lack of understanding rather than a specifically directed negative attitude about doing science. His family was supportive of his pursuit of chemistry; his father was a mechanic and liked to talk about car chemistry.

These discussions about interaction suggest that the degree of support from those CoPs depend on others' ability to understand *and* willingness to participate. Both features are required. When one is lacking, the students are only comfortable expressing a limited version of their chemist/physicist identity.

*Disciplinary practices.* Through the discussion of specific practices, students differentiated between disciplines. Chemistry and physics majors have similar disciplinary practices and attitudes that are expressed in different ways. In particular, both groups strongly emphasized the practice of questioning what they are told and what they observe in order to gain understanding. One physics student defined a physicist as "one who... really curious about the universe and understanding... how it works." Another physics student pointed out the cyclic nature of this practice where "any time I find an answer it just leads me to more questions." Similarly, the following student described this practice in chemistry.

CS12: I think chemistry really gives you sort of the basis of how things work. And especially [...] biology, how cells work or how things affect you. [...] So to me that's why trying to understand how things really work is important.

While both groups focused on understanding, the physicists' questions focused on the universe in general while the chemists tended to focus on the lived-in world such as the environment, food chemistry, and research projects.

A second and related way that being a chemist or a physicist was different for the participants was the perceived purpose of doing science. The physics students' scope of exploration was significantly wider than that of the chemistry students. Four of the physics students wrote the word "universe" either on its own or in phrases such as "guardian of the universe" and "Why? How? Is the universe the way it is?" Most physics students motivated their choice of major in terms of understanding or improving the universe, life and space. The physics students spoke about their future work in a grander sense such as making space travel viable so that the human race can survive in the future or "seeking a purpose ultimately beyond the normal everyday needs."

In contrast, all of the chemistry students mentioned potential career choices as a reason to learn chemistry. These choices were specific in scope in that they were motivated by a desire to benefit people in their close community or society. One chemistry student was interested in pharmacy because of her father's experience with medical prescriptions that were a poor match to his condition. Another chemistry student was interested in teaching to help change societal views that as a chemist "all you do is blow things up."

## IMPLICATIONS

At a large, ethnically diverse university where it can be challenging to build supportive communities and a strong sense of belonging, these students have made a major choice that potentially isolates them from support struc-

tures. The students clearly felt a sense of being different, but their affective reactions to being different were not the same in all communities. Students perceived that society viewed them as dedicated, brave, and intelligent. Being a chemist/physicist with friends and family appeared to conjure mixed feelings; some felt at ease being different while others wanted to minimize differences so that they don't feel isolated from friends and family. These are potentially bigger issues for students who are more on the margin, and who do not feel like legitimate members who belong in the new community yet. As recognized members of the academic and disciplinary communities, teachers and other mentors can be in positions to help students understand the communities they are joining by pursuing their major.

Within the disciplinary CoPs, practices both united and divided the chemistry and physics students. Many practices were common across science disciplines; yet the way students engaged in those practices highlighted the differences between the disciplines. These distinctions suggest that there are subtle differences in how to connect these students to their disciplinary communities. The findings have implications for future research as well as instruction in the ways we support academic success and disciplinary identity development.

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## REFERENCES

1. M. J. Fischer, *The Journal of Higher Education* **78**, 125–161 (2007).
2. S. White-Brahmia, and E. Etkina, *Journal of College Science Teaching* **31**, 183–187 (2001).
3. E. Wenger, *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press, 1998.
4. J. Boaler, *For the Learning of Mathematics* **22**, 42–47 (2002).
5. J. H. Falk, T. Moussouri, and D. Coulson, *Curator* **41**, 107–120 (1998).
6. V. Tinto, *Leaving College: Rethinking the Causes and Cures of Student Attrition*, The University of Chicago Press, Chicago, 1993, 2nd edn.
7. S. L. Li, Ph.D. thesis, Oregon State University (2011).