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High School Students' Emergent Positions from Science Internships

Pei-Ling Hsu * and Dina Thomason

Department of Teacher Education, University of Texas at El Paso, El Paso, TX 79968, USA
* Correspondence: phsu3@utep.edu; Tel.: +1-915-747-6446

Abstract: Learning science in authentic settings, such as science internships in university laboratories, has been suggested as an effective way to enhance students' scientific knowledge and skills, expand their views on the nature of science inquiry, and inspire them to pursue science careers. However, little research has been done to study how high school students position themselves in science internships while working at the elbows of scientists. According to *positioning theory*, how students view and position themselves may greatly shape how they participate in educational activities. Thus, the purpose of this ethnographic study was to investigate high school students' emergent positions from their interactions with scientists in science internships. By analyzing students' *cogenerative dialogues* about their internship experiences, we identified ten categories of high school students' *positions* that emerged in science internships. Moreover, how each science laboratory team made unique contributions to high school students' positionalities and how these students positioned themselves during follow-up interviews eight months after their internships were further discussed. Science educators may model classroom environments that can promote and support the positions identified in this study as students learn how to research and experiment to answer scientific questions in an authentic science learning environment.

Keywords: positioning theory; science internship; high school students; identity development

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1. Introduction

The Next Generation Science Standards (NGSS) recommends that students engage in authentic science practices to fully understand the nature of science [1]. These authentic science practices include asking questions and defining problems, planning and carrying out investigations, and obtaining, evaluating, and communicating scientific results [1]. These practices are aligned with the work of professional scientists aiming to explore and understand the natural world. Incorporating those types of practices into daily classroom instruction can be difficult, however, for several reasons. First, teachers frequently struggle themselves to understand what scientists do in laboratories, and many teachers have little understanding of scientific inquiry beyond the traditional scientific method [2]. Second, there is a disconnect between science in school and science in professional settings because when students do laboratory activities in a science classroom, they often follow a set of recipe-like procedures rather than engaging in true scientific inquiry [3]. Other problems in school science include difficulties with technology, lack of staff development, student motivation, and the didactic nature of school itself [4]. Even teachers who attempt to teach using science inquiry methods often revert to a traditional lecture-style format or teacher-directed activities due to these limitations of the classroom setting [4].

One potential solution to address the disparity between K–12 science education and real-world science practices is to facilitate partnerships between science laboratories and K–12 students [5,6]. When students have opportunities to work in a laboratory with a scientist, they can learn that scientists do not follow a strict scientific method and recognize that science inquiry does not follow a linear path [7]. Providing opportunities for students to work in science settings outside of traditional schooling may enable students to position themselves as science insiders, particularly when given the opportunity to pursue open-ended projects based on their own interests [6]. Research on students' work with scientists in non-school settings has focused on the following student outcomes: students' scientific knowledge and skills [8], student understanding of the nature of science and scientific inquiry [9,10], student attitudes and interest in science [11,12], and student aspirations in pursuing science careers [13]. How students position themselves within a science internship when they work alongside scientists in a professional setting has not been fully investigated. Science internships can provide students with many opportunities to adopt a science role when they engage in science as scientists do. Further, observing the positions students develop in discursive interactions can reveal how students form science identities [14]. Thus, the purpose of this study was to investigate how high school students position themselves during reflective dialogues when they work closely with scientists in science internships.

2. Theoretical Framework

Positioning theory seeks to understand how individuals position themselves within social interactions as part of their storyline [15]. Positioning can be defined as "the discursive process whereby people are located in conversations as observably and subjectively coherent participants in jointly produced storylines" [16] (p. 37). A storyline in this case would be the acts and discourses of individuals during interactions. The discourse, positions, and storyline can be viewed as three points on a triangle. Each point in the triangle is affected by the other two. That is, if a storyline changes, then so does the discourse and the position. Individuals can define their own positions or obtain a position ascribed by someone else within a social interaction. For example, within a classroom, a teacher can position a student as a passive listener if the teacher is primarily imparting information to the student [17]. Alternatively, a student can redefine their position as an inquirer by asking questions and seeking additional information that the teacher may not have provided. In this example, the student has redefined the storyline and negotiated a new position within that social interaction. The student is no longer positioned as passive but as an active learner seeking information. The student therefore adopts a different identity in that interaction, even if only briefly, from that of receiver of information to seeker of knowledge. Positions within social interactions are not static and are continually being negotiated and redefined. During a classroom interaction, if a student shares knowledge gained from experience, the student can move from knowledge seeker to knowledge sharer. That change in position shapes what types of discourse the student will choose and affects the overall storyline, thereby shifting the three points of the positioning triangle.

Additionally, this study draws upon the theory of community of practice to observe how students position themselves in a professional setting [18]. In a community of practice, members of the community engage in shared activities, like problem solving or question posing within the group [19]. Members of the community learn from each other as they share their knowledge. In a science internship the community is the science laboratory, and the practice is the participation in the science research endeavor. As students participate within the shared practice of science research, they are building an identity as a science person within that practice. Students may initially be on the periphery of the community as they may not have the requisite knowledge to fully participate in the practices of the community. As they observe and learn from scientists, gaining knowledge and skills, they become more established within that community and may adopt different positions within the community, thus further developing a science identity.

Observing how students position themselves within a professional science environment may lead to a better understanding of what practices best support scientific learning [20]. For example, students who position themselves as "not understanding" can promote further collaboration among students and help sustain student engagement [21]. When educators recognize that students are positioning themselves as "not understanding", the educators can then likely facilitate collaboration that leads to better understanding.

These positions can be observed through discourse interactions. Discourse includes the multiple ways individuals interact using language. Observing discourse interactions can help identify how individuals are using language to construct themselves or others [22]. Positioning theory has been used to study how the balance and distribution of power within science classrooms can impact student learning [23,24]. Within a classroom, teachers can share power with students, thus providing them with a position of collaborator, or sharer of knowledge [17].

Because students' positioning is influenced by their interactions with others, students may position themselves differently in a professional learning environment than in a school environment. How students view and position themselves can greatly influence how they participate in educational activities and settings [25]. School environments typically expect "right" answers, but scientists' work is built on not having an answer. Typically, in school environments, teachers are the possessors of knowledge and students are the receivers of that knowledge, positions that highlight the power relations between teacher and student. In a science laboratory, however, researchers are seeking and building knowledge. When students work in research environments along with scientists, students may have more opportunities to position themselves as collaborators in building that knowledge as they gain confidence in developing science skills. Students working in science internships have been found to have increased confidence in presenting and communicating science information and working as a science team member [26]. If students are exposed to professionals posing questions that do not have easy answers, will they be more comfortable positioning themselves as knowledge seekers and science collaborators? These emergent positions and participation in science activities may strengthen students' science identity development in the long run. In this study, we particularly focused on how students positioned themselves when participating within a community of practice, because that self-positioning through participation may reveal aspects of identity development [27]. Therefore, drawing on positioning theory, this study aimed to identify the self-positioning that emerged for high school students when they worked closely with scientists in authentic science settings.

How students position themselves in a science class may contribute to the building of their science identities because positioning may become a positional identity. Positional identity relates "not only to the individual but also to contextual and relational meanings of who the person is and how the individual works within particular contexts, such as schools" [28]. The positions a student takes in classroom interactions can then impact their learning and their identity [29]. Identity is built through the negotiation of multiple positions in a social environment [30]. One's identity is "being recognized as a certain 'kind of person' in a given context" [31] (p. 99). When students assume different positions in social interactions in a science setting, they are revealing different aspects of their identity. That identity emerges through interactions with others, as an identity can be enacted through three crucial dimensions: competence, performance, and recognition [32]. Science identity is essentially how a person sees themselves as a science person as well as being recognized as a science person by others [32]. Thus, a science identity may be established when a student gains competence in a scientific area, demonstrates that scientific competence, and has that scientific competence recognized by others. As students position themselves as knowledge seekers, or questioners, they can begin to gain competence in those particular areas and then begin to establish a science identity as they start to see themselves as a science person. The position that is observed through discourse exchanges is an understood facet of that identity [33]. Thus, the positions students take in a science classroom can become part of their science identity if they are adopting positions that help them to see themselves as science people.

Overall, three key dimensions contribute to the formation of a science identity in students: a sense of belonging to a science community, consistent extrinsic and intrinsic attitudes towards science, and an alignment between school science and science in the real world [34]. Within a science community, students can develop science identities as they position themselves in social interactions within that community [35]. Being in an environment with other scientists can help build a sense of belonging to a science community and a sense of science identity [35]. When students are in a professional science environment, they are part of a community of practice that recognizes science as problem solving as opposed to being in school, where science might be presented as a set of facts or concepts to learn. When students learn the language of science as problem solving, they gain competence in problem solving and thus can begin to position themselves as problem solvers, creating a new identity position, one of science competence [36]. That identity position emerges when students begin to pose questions and look for solutions to problems through their discursive interactions.

How others position students can also impact students' science identities. How students position themselves is affected by how others see them. For example, when teachers position students in demeaning identity positions, students may have a hard time learning and developing a learner identity [37]. Positioning by teachers in a classroom can contrast with how scientists position students in a science laboratory. High school students working alongside scientists are positioned by scientists more as research collaborators as compared to what occurs in a classroom, which is more concerned with learning science content [9]. Importantly, how students view and position themselves can greatly influence how they participate in educational activities and settings [25]. Additionally, the cultural community of which students are a part can have an impact on their attitudes and motivation toward science learning [37]. Students working in a science laboratory can be members of the cultural community of that science laboratory [38]. By participating in that cultural community of science professionals, a student may begin to be recognized as a science person and their science positional identity can emerge, strengthening the student's science identity development. Thus, this study set out to investigate how high school students positioned themselves when they worked closely with scientists in professional science laboratory settings.

3. Materials and Methods

This study was part of a larger four-year research study titled "Work with a Scientist Program" that invited students from three high schools to partner with university scientists at the University of Texas at El Paso (UTEP). All three schools were Title I schools with a majority Hispanic (78.43%) and economically disadvantaged (61.77%) population. Eleventh-grade students were selected through an application process and participated in a seven-month internship program.

Students selected were chosen based on an online application including an essay and teacher recommendations. Potential candidates were then interviewed to determine level of interest and commitment to the program. Thirty-six students receiving the highest scores throughout the application process were chosen. The thirty-six students were divided into four groups of nine students and randomly placed in one of four labs with a scientist and 1–3 research assistants. The scientists were chosen based on their desire to work with youth and initial screening for scientists included recommendations from university students and interviews with potential candidates. Scientists had to be committed to working closely with students and were given incentives including summer salaries, research assistant salaries, and supplies. The data for this study were obtained from the third year of the program. For the third year of the program, the four scientists included a biologist, an engineer, a chemist, and an immunologist. The nine students in each lab then worked in smaller groups to create a research project related to the research area of the scientist.

Both high school students and science professionals were invited to participate in weekly cogenerative dialogues in January to May and twice-weekly dialogues in June and July. Cogenerative dialogues (cogens) are guided conversations between the students, scientists, research assistants, and mediators to reflect on their shared experiences within a classroom or, in this case, a laboratory [39]. Cogen follows three central principles: (1) participants are all given equal time and space to share; (2) participants actively listen to each other and respect others' points of view; and (3) a plan of action is generated for improving any identified issues [40]. Cogens provide a supportive and respectful space for science professionals and high school students to reflect together on their internship practices, identify issues that occur in the internship, and brainstorm solutions to address these issues.

Data for this ethnographic study regarding student positions were obtained from video-recorded cogens of four laboratory teams. In total, we collected about 88 hours of cogen video recordings. In addition to video recording, we also observed participants' internship activities, took field notes, and collected relevant articles throughout the entire internship to fully understand the conversations in cogens. Cogens can provide a good database for investigating students' positions because cogens support students to speak up freely about things and events that occur in the internship. Positions can be "identified in part by extracting the autobiographical aspects of a conversation in which it becomes possible to find out how each conversant conceives of themselves and of the other participants by seeing what position they take up and in what story, and how they are then positioned" [16] (p. 8). Transcripts of cogenerative dialogue provide access to participants' self-positioning through their discursive acts.

Additional data were collected from follow-up interviews with students eight months after the internship was completed. Interviews were semi-structured questions asking participants to reflect on their internship experience and their perception of cogenerative dialogues.

Cogenerative dialogue transcripts and interview transcripts were analyzed and coded to identify instances of student self-positioning. In total, we identified 251 instances in cogens when high school students positioned themselves, and we analyzed these instances using thematic analysis by generating codes that were descriptive of text interactions [41]. To validate the data analysis, two researchers coded data independently and debriefed the coding results continuously to establish high interrater agreement. Interrater agreement is the degree to which two independent raters assign the same nominal category to the same data. Cohen's Kappa, an appropriate index for measuring interrater agreement for nominal data [42], was used to verify agreement. Researchers randomly selected 20% of the data and worked through five iterations of coding until a high agreement of 0.82 was obtained. Generally, values between 0.40 and 0.75 are considered fair to good agreement and anything from 0.81 to 1.00 is considered almost perfect [42]. Once interrater agreement was established, data from follow-up interviews were also coded. Of the 36 original internship students, 31 participated in semi-structured follow-up interviews eight months after the internship was completed. The interviews were coded using the same positions identified during the cogenerative dialogue analysis.

4. Results: High School Students' Emergent Positions in Science Internships

During cogens, participants were invited to reflect on their previous internship practices and identify strengths and areas for improvement. When high school students were describing their experiences and justifying their rationales, they simultaneously described their positionalities. In the following sections, we capture all of the positions the students shared in cogens with others and discuss how each laboratory internship might have contributed to shaping these positions differently. We also analyze and discuss the positions that were identified in students' follow-up interviews.

4.1. Ten Positions Reflected in Cogens during the Science Internship

Through extensive revision of codes and analysis of transcripts, ten position codes were identified: (1) a person lacking scientific competence or knowledge; (2) a person gaining confidence, scientific competence, or knowledge; (3) listener; (4) articulator; (5) team collaborator; (6) science presenter; (7) problem solver; (8) risk taker; (9) potential scientist or engineer; and (10) science contributor. Definitions and examples of each position are shown in Table 1.

Table 1. Students' positions reflected in cogens during their science internships.

Position	Definition	Example
1. A person lacking scientific competence or knowledge	A student who positions themselves as a person who is unknowing, unskilled, unprepared.	"Well, I'm just saying our lack of knowledge that we have right now just, uh, we need to go over some of the stuff we haven't already learned." (Carlos, Lab 1)
2. A person gaining confidence, scientific competence or knowledge	A student who positions themselves as a person who is developing skills or knowledge in scientific subjects, sometimes by making mistakes.	"I like how it's, like, the things that we're learning, so you're showing us how, like, like, how they apply to real life." (Gloria, Lab 2)
3. Listener	A student who positions themselves as a person who carefully observes or listens to others' perspectives.	"When we listen to how, uh, how they think it's right, um, there's value in—there's value in what they say." (Kyle, Lab 3)
4. Articulator	A student who positions themselves as a person who expresses a voice by asking questions or making a statement.	"And in fact, um, I think us sometimes disagreeing just proves that we value those perspectives because it gives us an opportunity to show the contrast in what someone's saying, and to get our points." (Maria, Lab 2)
5. Team collaborator	A student who positions themselves as a person who can collaborate with others to reach a shared goal.	"Normally, I kind of take on the assignment myself. And it was cool having the team to help and actually working on projects." (Arrianna, Lab 3)
6. Science presenter	A student who positions themselves as a person who is able to communicate scientific information in public, even when they are nervous.	"I felt more confident because I actually knew what I was talking about. And because I was getting a lot of, like, feedback, and I really like it. So, I felt more confident about presenting." (Marcos, Lab 4)
7. Problem solver	A student who positions themselves as a person who is motivated to seek answers, solve problems, or research independently.	"It's pretty good that we're all trying to work on the program, trying to figure out—like a while ago we were researching different things, like maybe to fix the program to see what was wrong with it, like what we can change." (Gloria, Lab2)
8. Risk taker	A student who positions themselves as a person who is supported by others and is willing to take risks by doing different things, confronting their fears, and taking on new challenges.	"I'm gonna learn it the best I can and take on a new challenge. That's why I'm proud of myself for all of the stuff I've done so far. I've taken on a lot of challenges." (Katia, Lab 2)
9. Potential scientist or engineer	A student who positions themselves as a future scientist or engineer.	"I plan on working with like a research team. I think I plan on working like doing something with people." (Alejandra, Lab 1)
10. Science contributor	A student who positions themselves as a person who helps scientists advance or contribute to current scientific knowledge.	"We're just doing this compared to like all these scientists who have been doing this for their whole lives . . . like oh, maybe I'm gonna find a way to do it." (Samantha, Lab 1)

4.1.1. Position 1: A Person Lacking Scientific Competence or Knowledge

The position of lacking scientific competence or knowledge was defined as "a person who is unknowing, unskilled, or unprepared". For example, in a cogen excerpt from Lab 1, Sophia said:

> My confidence level is like not even close to have, what you guys have . . . you know, how I cannot [achieve] perfection, but I mean, [what can] help me get more confident is talking about where [I should be] studying more, and we'll be hopeless if we don't know the topics . . . so that we can be more confident. So that's something I can do too. (Sophia, Lab 1)

In this example, Sophia acknowledged her lack of confidence and knowledge in the subject matter as compared to the other students. Although she felt less confident, this positioning shows her metacognitive process as she began to understand and identify what knowledge she was lacking. Metacognition is concerned with the awareness a student has of their own learning process and how that process relates to a given situation [43]. In order to know, one must begin to understand that they do not know. Sophia recognized her own lack of knowledge and understood that she "needs to have that knowledge" to be more confident. Metacognition and science identity are linked as having an awareness of what needs to be learned, which leads to developing competence and thus helping to build an outward science identity [44].

In response to Sophia's concerns, research assistant Carl explained how common it was in science not to know, and responded:

> But what I'm trying to do is the more you speak science, the more you'll become a scientist. Don't worry about being hesitant because that's normal. And all the people in my senior seminar, my professional development seminar, I would say about 50 to 70% of the graduating seniors say, "Oh, I don't want to talk in class, and I'm so embarrassed about saying things" [and if you do that] you're gonna miss your life. You gotta get in there and try. (Carl, Lab 1)

Carl is acknowledging Sophia's positioning as lacking scientific competence, but also reassuring that not knowing is normal. By recognizing her position as lacking in scientific knowledge he encourages her to seek answers to questions and to "speak science" to further adopt the science identity. Carl is also inviting Sophia into the community of practice, starting to move her from the periphery of the community into becoming a more active part of that community.

A science internship exposes students' lack of science knowledge in professional settings. Students in the Work with a Scientist Program may have been "good students" at their schools, but when surrounded by other good students and professionals in the field, students' own lack of knowledge became more exposed and by understanding that they do not know they can begin to ask questions and seek understanding.

4.1.2. Position 2: A Person Gaining Confidence, Scientific Competence, or Knowledge

Once a student has identified what knowledge is lacking, they can begin to build knowledge in those areas. In this study, a person gaining confidence, scientific competence, or knowledge was defined as "a person positioning themselves as developing more knowledge or technical skills in scientific subjects". An example of a student gaining confidence in technical skills occurred when Elizabeth from Lab 4 confessed, "I have to say that I'm actually kind of proud of myself because my hand wasn't shaking as much as it has been, so I guess it really is like the practicing [helps] doing it so many times". Here, Elizabeth was using a micropipette while working on a microbiology project. She positioned herself as a person who had increased her competence in using this microbiology tool through practice in the lab. In another example from Lab 4, Diego stated:

> It's pretty cool because I actually understood this like a lot faster than the other stuff . . . Freshman year was when we did biology, but yesterday we were doing electric current and stuff [gel electrophoresis]; it just makes sense . . . I feel like I'm getting stuff relatively deeper than before. It's making sense to me more than it was . . . Now I feel like I'm actually doing it. (Diego, Lab 4)

This excerpt is in reference to a biotechnology lab being done in Lab 4. Although Diego had taken biology in high school, in the lab he understood the process "deeper than before" because he was "actually doing it". Besides becoming more competent in using the tools in the laboratory, students were positioning themselves as more knowledgeable. Competence and knowledge lead to a strong science identity and having strong pre-college science experiences can develop that competence and knowledge [32]. By positioning themselves as knowledgeable in science, students received recognition from both themselves and others as "science people". Identity in science comes from competence in science performance and knowledge, as well as recognition of that competence [32].

Students positioned themselves as gaining competence or scientific knowledge when they improved their technical skills using laboratory equipment ("When we were practicing . . . I was taking it too lightly over the top, [on] the real plate I could actually see it" [Elizabeth, Lab 4]), or when they related something they had been exposed to before but did not fully understand because they had not seen the application of that knowledge ("Now we actually have an understanding of why" [Samantha, Lab 1]). Being in the science internship allowed students to experience science as scientists do rather than just reading about science or listening to a lecture in the classroom.

4.1.3. Position 3: Listener

To gain knowledge and competence, students positioned themselves as listeners. The listener position was defined as "a person who carefully observes and listens to others". During cogen discussions, students would pick sticks labeled with a heuristic, or general principle governing the dialogue. Heuristics that came up often throughout the cogen dialogues were: "When others talk, I listen to what they have to say" and "Others try to learn from our oral contributions". These discussion starters provided opportunities for students to position themselves as listeners, as in the example from Lab 2 when Jorge said, "Okay. I got number 15: 'I try to learn from others' talk.' Uh, we all really do. We all listen to everybody, what everybody has to say". Students also positioned themselves as a listener when they evaluated how well they listened to each other when working in groups, as when Elizabeth from Lab 4 said, "I love listening to everybody, and I'm very open minded when it comes to everybody's ideas and everything".

Besides positioning themselves as listeners in the cogen discussions, students also described how they positioned themselves as listeners in laboratory activities, as in the following example from Lab 3 when Kyle stated, "Because I mean if you—if you didn't pay attention, we wouldn't have known if we were doing the lab right". Kyle was acknowledging the need to listen in order to gain understanding. Part of engaging in a community of practice involves listening and following the norms of that community. The position of listener shows the embodiment of a science identity in practice as students engaged in authentic science practices [45].

4.1.4. Position 4: Articulator

Being part of a community of practice also includes articulating ideas and posing questions to gain further knowledge. Within the science internship, the position of articulator was defined as "a person who expresses a voice by asking questions or making statements". Clearly, in any exchange of dialogue a person can position themselves as articulator. However, instances of articulator positioning coded in the data were specifically related to positioning within a science identity, as this exchange between two students in Lab 2 shows:

> Amber: I like how interactive it was today. Like, we weren't just sitting here, like—
>
> Maria:—listening to a lecture or something. Like, we were talking, and not only that, but every week we have done something on our computers to try to get, like, an actual perspective on what you're talking about. Which I think is very important because it allows us to relate to what you're trying to teach us.

As the students became more knowledgeable and comfortable within their lab, they felt more confident in speaking out and asking questions. Asking questions to gain knowledge can be seen in this statement by Elizabeth:

> Before this, in all of my classes, not just science, I never asked questions. If I didn't know anything [I wouldn't ask]. I [would] just figure it out some way or another. I'm actually getting better at that and I'm asking more questions. And I still need to get better at it. Like yesterday, I waited to the last minute when

> we were going up there to present what we knew and everything. That's when I asked my questions. So that's a big thing that has to be worked on. (Elizabeth, Lab 4)

Elizabeth described how she was participating in the science community by asking questions, whereas in school she "never asked questions". This positioning by articulating questions and engaging in discussions places students on an "identity trajectory" leading to the development of a science identity [46].

Students in the internship positioned themselves as articulators by posing questions to gain a better understanding of content or scientific knowledge. They also positioned themselves as articulators when they wanted to share their ideas and opinions when working in groups, as when Gloria from Lab 2 said, "There's a place for me to speak and I'm allowed to speak as much as I think, and so I get my opinion and so does everybody else". Because students were working closely together with each other and with mentors in small groups, they were able to develop a working relationship with one another and their mentors. The internship provided a space in which students were able to feel comfortable asking questions and sharing their ideas.

4.1.5. Position 5: Team Collaborator

Students often positioned themselves as a member of a group, or a team collaborator. Team collaborator was defined as "a person who can collaborate with others to reach a shared goal". Throughout the internship, students worked in groups and with other students to design and complete a culminating project.

The important role of collaboration within the lab can be seen in this example from Maria in Lab 2, when she said:

> I think what gives us a sense of belonging is just knowing that we all have the same purpose and the same goal. And I think, like, just also again we have so much teamwork here... We're proud of being in this lab too. (Maria, Lab 2)

While working as a team member, Maria exhibited a sense of ownership in the lab when she said, "We're proud of being in this lab too". She was contributing to a shared goal, and she identified herself as a member of the lab community. Science identity is shaped through social interactions in particular contexts, and identity is formed through positioning the self within those contexts [47]. When Maria positioned herself as a team member, she was developing her science identity as a member of the science community.

Students in the science internship collaborated through sharing ideas and producing a product. The internship provided the students with a space in which to collaborate, and during cogens, students were able to further resolve any differences. The internship provided a collaborative community through which students were able to position themselves as science collaborators, further strengthening their science identities.

4.1.6. Position 6: Science Presenter

Students collaborated on their projects and then had the opportunity to present their projects to their peers and to the scientists at the university. The position of science presenter was defined as "a person who is able to communicate science information in public, even when they are nervous". Throughout the internship, students positioned themselves as science presenters and gained more confidence in doing so, as the example from Maria in Lab 2 shows:

> I think another positive was pretty much how we presented our ideas today, because we did talk about last time our fears of presenting things, and just the idea of doing a project. And today was pretty easy ... We definitely can answer a question. Probably not immediately, because there's always a pause with us before we answer a question because we're thinking about what we're gonna say, and I think that displays being thoughtful. (Maria, Lab 2)

Maria was overcoming her fear of presenting and gaining confidence in her knowledge, and rather than seeing her pauses as a detriment, she recognized that it showed thoughtfulness and consideration of the question. When a person engages in the normal practices of science and demonstrates science knowledge, they are enacting a science identity [32]. By presenting their work, the students were engaging in authentic science practices.

Other examples of students positioning themselves as science presenters included times when students presented to their family members for practice ("I was telling my girlfriend that yesterday, because she was helping. She was asking me questions about it while I was presenting" (Marcos, Lab 4) or even when they just presented their ideas to the group ("I think another positive was how we presented our ideas today" (Maria, Lab 2)). The science internship provided multiple opportunities for the students to position themselves as presenters and practice presenting. Students presented with lab assistants, which helped them gain confidence to present on their own. Although they were nervous about presenting in front of "real scientists", they were given many opportunities for feedback and revision, which helped them develop their skills.

4.1.7. Position 7: Problem Solver

Throughout the internship, students had opportunities to position themselves as problem solvers. The position of problem solver was defined as "a person who is motivated to seek answers, solve problems, or research independently". Rather than have answers given to them, students had to do their own research and find solutions. For example, in a Lab 1 cogen, Samantha said:

> I also think that that's something that was good, was like Dr. Gonzales said, "You guys have to figure it out on your own". We're not just only depending on [the scientists], we also try and get it ourselves. Not that we don't want to ask questions, but so that we can try and figure it out. (Samantha, Lab 1)

When students are positioned or position themselves as problem solvers rather than just receivers of information, they are controlling the narrative of their science learning and developing their identities as scientists [36]. Students in the science labs were not given the answers automatically, but rather were directed to figure it out ("We're not just only depending on you guys, we also, like, it motivates us to try and get it ourselves" (Samantha, Lab 1)). Additionally, because the students were working on independent projects, the professors and lab assistants did not necessarily have the answers the students needed. The internship provided opportunities for the students to solve problems independently, as scientists do, further strengthening the students' identities as part of a science community.

4.1.8. Position 8: Risk Taker

When students have more freedom in what they are learning and choose projects based on their interests, they can take more risks. The position of risk taker was defined as "a person who is supported by others and is willing to take risks by doing different things, confronting their fears, and taking on new challenges". Students in the internship sometimes found themselves out of their comfort zone, but they confronted their fears, as when Katia from Lab 2 said:

> I have something new that I'm learning today. I'm gonna learn it the best I can and take on a new challenge. That's why I'm proud of myself for all of the stuff I've done so far. I've taken on a lot of challenges.

Katia may not have always felt comfortable with what she was learning, but with the support of the science internship, she was willing to take on those challenges and learn as best as she could.

Other examples of students positioning themselves as risk takers include not being afraid to ask questions ("We shouldn't be afraid to ask questions" (Katia, Lab 2)) or becoming more confident in speaking out and presenting ("I would be like ten times as nervous going up just, like, presenting the first time" (Gloria, Lab 2)). Some students were willing to take risks, but in the science internship they had more opportunities to do so, as when Daniela from Lab 4 said, "I wanted to do it because I like to challenge myself. I like to—I guess you could say I like to make myself comfortable being uncomfortable". Positive self-schemas, or impressions of oneself, contribute to persistence when one is confronted with challenging material [48]. Within the science internship, the support students received from their peers and mentors helped them develop positive self-schemas and enabled them to take risks, for example, when Gloria from Lab 2 said, "I've become more, not just comfortable, but I know that you guys, like, will help me with things I don't understand".

Having positive experiences when taking on challenges ("I wanted to do it, because I liked the challenge" (Daniela, Lab 4)) allowed students to be successful in a scientific community, helping to further develop their science identities. The science internship provided a safe space for students to take risks because they knew that they would receive support from their peers and mentors.

4.1.9. Position 9: Potential Scientist or Engineer

Participating in the science internship provided students with the opportunity to experience what scientists do daily. Students positioned themselves as potential scientists or engineers, a position defined as "future scientist or engineer". Some students may have already been interested in the engineering or science fields but through their experiences began to think differently about the career they wanted to pursue, as when Alejandra from Lab 2 said:

> I did really want to do environmental science and engineering, but I don't know if engineering is going anywhere, [but] because of this, I really like working in the lab, too. So that kind of influences what I was [thinking]. (Alejandra, Lab 2)

Alejandra had already considered going into science and engineering, but the lab showed her a different side of science, and she began to position herself as a potential science researcher.

Participating in the science internship helped students enact the kinds of people they wanted to be, identifying themselves as future scientists. Being part of a science community reconciled the narrated identity of "I want to be a scientist" with the embodied identity of "I can do science and I want to be a scientist". Science identity is developed not only through the stories students tell about themselves but also the practices they participate in [45]. Providing them with the opportunity to participate in the practice of science through a science internship allowed the stories to align with the practice.

4.1.10. Position 10: Science Contributor

The last identified position was science contributor, defined as "a person who helps scientists advance or contribute to current scientific knowledge". To position oneself as a science contributor is a fully realized scientific identity as one considers oneself a member of the scientific community and a person capable of adding to a body of scientific understanding. Although this position was not frequent, there were some instances of students positioning themselves as a science contributor, like when Steven from Lab 3 said:

> We were able to experiment further with the same chemical reaction. So when Dr. Roth came up with his own experiment . . . we might be able to even go further with that [and] that could lead to new things . . . It's a new idea. (Steven, Lab 3)

Steven's group was building on the research the professor was engaged in and was potentially going to be able to develop different products. Steven saw himself as an equal to science researchers and as a person who could contribute to scientific knowledge. Because students were working with scientists on projects based on science lab research, they were able to position themselves as a part of the community that researches and builds knowledge.

The student positions that emerged in cogen discussions demonstrated a progression of increasing affinity towards science and a strengthening of science identity throughout that progression. Beginning with a positionality of unknowledgeable or unskilled, students then were able to position themselves as gaining knowledge through listening to their peers and professors, articulating their ideas and questions, and collaborating to solve problems. Being in a supported environment promoted risk taking and, by discovering what real scientists do, students could see themselves doing similar work in the future. Some students even saw themselves as scientists at that moment.

4.2. Acknowledgement of Student Positions by Others

Although the focus of the study was on the self-positioning of students, part of the adoption of identity includes the acknowledgement or recognition of that identity [32]. Several instances of that acknowledgement by research assistants and scientists were identified throughout the cogen dialogues. For example, in the engineering lab 4 cogen, Katia mentioned that her aunt wanted her to design a studio and a greenhouse now that she had the "knowledge to make it efficient and cost effective". Research assistant Andy responded, saying:

> So that's great. I can see that you guys are now thinking as engineers, okay. Engineers, where you have the knowledge and you know how to apply the knowledge, and now you have different solutions in your mind in order to solve the problem.

By identifying the students as potential engineers, Andy is providing a recognition of that positioning, a crucial dimension of identity development.

Another example of a scientist positioning a student can be seen in the following exchange:

> Samantha: It was cool seeing, like, all of us working and running around a little bit and... I don't know, I thought it was pretty neat. All of us were working and just like staying on track. And it looked like a lab and very scientific.
>
> Zach (research assistant): Like being in the lab, everyone's working—doing their own thing. It's just learning to kind of walk around each other, like, hold off in doing a step because you know someone's about to use like the—the water bath or something along the lines. You start learning to collaborate with other people, figure out what they're doing, how they're doing it.
>
> Dr. V: So in general, I think that you—you worked really good today and like Samantha said, I saw you guys, like, working together, like going to other tables—
>
> Samantha: You can add good teamwork.

In this exchange, both Dr. V and Zach responded to Samantha's comments of how well their team was working "running around . . . working, staying on track" by providing recognition of the student positioning of team collaborator, strengthening the team's view of themselves as collaborators. This is reflected in Samantha's comment when she agreed, saying "Good teamwork!" Acknowledgement of student positions by others in the cogenerative dialogues helped students identify and solidify their own understanding of their positioning, in this case the position of team collaborator. This is consistent with other findings that show working in professional science settings can strengthen students' confidence in working as part of a team [26].

4.3. Prevalence of Positions Reflected in Cogens and Observed Patterns

Each lab was working in a different discipline depending on the research focus of the scientist (i.e., biology, engineering, chemistry, immunology). Depending on the discipline and the interactions among the scientists, researchers, and students, different positions emerged during cogens as participants reflected on their internship teaching and learning. The frequencies of these positions across the four different laboratories are illustrated in Table 2.

Table 2. Frequencies of positions reflected in cogens across four different laboratories.

Position	Lab 1 Biology Number (%)	Lab 2 Engineering Number (%)	Lab 3 Chemistry Number (%)	Lab 4 Immunology Number (%)	Total Number (%)
1. A person lacking scientific competence or knowledge	2 (2.8%)	3 (3.7%)	1 (2.3%)	4 (7.5%)	10 (4.0%)
2. A person gaining confidence, scientific competence, or knowledge	17 (23.6%)	14 (17.1%)	11 (25.0%)	12 (22.6%)	**54 (21.5%)**
3. Listener	4 (6.0%)	5 (6.1%)	9 (20.5%)	7 (13.2%)	25 (10.0%)
4. Articulator	**24 (33.3%)**	18 (22.0%)	3 (6.8%)	9 (17.0%)	**54 (21.5%)**
5. Team collaborator	8 (11.1%)	**19 (23.2%)**	6 (13.6%)	4 (7.5%)	37 (14.7%)
6. Science presenter	6 (8.3%)	8 (9.8%)	4 (9.1%)	**9 (17.0%)**	27 (10.8%)
7. Problem solver	8 (11.1%)	5 (6.1%)	7 (15.9%)	3 (5.7%)	23 (9.2%)
8. Risk taker	0 (0.0%)	**10 (12.2%)**	0 (0.0%)	4 (7.5%)	14 (5.6%)
9. Potential scientist/engineer	2 (2.8%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	3 (1.2%)
10. Science contributor	1 (1.4%)	0 (0.0%)	**3 (6.8%)**	0 (0.0%)	4 (1.6%)
Total	72 (100.0%)	82 (100.0%)	44 (100.0%)	53 (100.0%)	251 (100%)

In general, seven out of the ten positions were mentioned and shared in each laboratory's cogens: a person lacking scientific competence or knowledge; a person gaining scientific confidence, competence, or knowledge; listener; articulator; team collaborator; science presenter; and problem solver. A person gaining scientific confidence, competence, or knowledge (21.5%) and articulator (21.5%) were the two most frequent positions reflected in cogens. These results indicate that the science internship greatly helped students to gain confidence, scientific competence or knowledge and supported students to speak up freely about their ideas in the internship. Incorporating cogens into the internship for each laboratory seemed to really support students' voices, help them speak up in front of scientists and their peers, and become "articulators".

As shown in Table 2, each laboratory made unique contributions to students' emergent positions. Lab 1 (biology) particularly helped students to become an "articulator" (33.3%) who was willing to speak up and make a statement when needed. This result may be attributed to the Lab 1 scientist's openness and commitment to respecting students' autonomy and interests. For example, our research teams observed that the Lab 1 scientist actually invited high school students to be coauthors of scientific publications if their creative ideas made a unique contribution to the scientific projects. Thus, students in Lab 1 were keen to ask questions to gain clarification and further understanding and express ideas to deepen conversations.

Lab 2 (engineering) greatly supported students to become a "team collaborator" (23.3%) and a "risk taker" (12.2%). This may be due to the collective solidarity developed in Lab 2 by supporting students as a team. As Gloria stated, "I think that I changed since the beginning mainly because I've become not just more comfortable, but I know that you guys will help me with things I don't understand... I knew when I mess up that you guys would help me with something I did wrong". This solidarity and team support then helped these high school students to be willing to take risks and take on new challenges in the internship and become risk takers—a rare position that did not occur in Lab 1 or Lab 3.

Lab 3 (chemistry) greatly supported students to become a "science contributor" (6.8%), which is a rare position that did not occur in Lab 2 and Lab 4 at all. This result may be due to the fact that the scientist teamed high school students with current scientists' teams on their ongoing projects. That is, high school students and "current scientists" were addressing the same level of scientific problems and trying to find solutions together "with" scientists.

As Leah stated, "We're still in high school, but doing some big stuff!" That is, students saw themselves as someone who could solve important scientific problems.

Lab 4 (immunology) greatly supported students to become "science presenters" (17.0%). This finding may be due to the scientist's instructional emphasis on science communication. Often, high school students were afraid of presenting science and public speaking. For example, Marcos said: "I'm just like, "Oh my God, this presentation has to be good. It's gonna be with real scientists. It's gonna be this and this, not just for high school teachers". So I'm kind of nervous. I want to make an impression on the scientist that's gonna be judging and everything". Thus, the scientist in Lab 4 spent extra efforts and time in preparing students' presentation skills in the internship.

4.4. Comparison of Prevalence between Cogens and Follow-Up Interviews

Eight months after their internship experience, students participated in semi-structured interviews. The interview questions were designed to encourage reflection on how the internship experience affected their understanding of science and their future academic and professional goals, and whether cogens had influenced their success in the internship. Thirty-one students participated in the follow-up interviews, which were transcribed and coded using the same coding schema as above. Results are shown in Table 3. Students were included in the identified position if they posited themselves at least once in that position during the interview. Across the interviews, students generally positioned themselves in multiple roles, and the type of question asked elicited similar positionalities from the students.

Table 3. Percentage of student positions in cogens and interviews.

Position	% of Students Positioning in Cogens	% of Students Positioning in Follow-up Interviews
1. A person lacking scientific competence or knowledge	22.6%	0%
2. A person gaining confidence, scientific competence, or knowledge	**67.7%**	**58%**
3. Listener	**54.8%**	38.7%
4. Articulator	**58.1%**	**58%**
5. Team collaborator	**61.3%**	**64.5%**
6. Science presenter	**58.1%**	35.5%
7. Problem solver	41.9%	45.2%
8. Risk taker	25.8%	6.5%
9. Potential scientist/engineer	6.5%	**67.7%**
10. Science contributor	9.7%	9.7%

The greatest discrepancy between positioning in cogens and positioning in the follow-up interviews was related to the potential scientist/engineer position (6.5% vs. 67.7%). When reflecting back on their time in the internship, students were able to identify themselves as a person who could be a scientist or work in a science laboratory. This result may relate to the questioning in the interviews connected to future career goals and potential areas of study in college as opposed to cogens where the discussions were more reflective of what was currently going on in the laboratories and not focused as much on future goals. In both the cogens and the follow-up interviews, the majority of the students positioned themselves as team collaborator, articulator, and a person gaining confidence, scientific competence, or knowledge. That is, both during and after the internship, students saw themselves as people who were able to ask questions, gain skills and knowledge, and collaborate with their peers, all characteristics of science identity. There was also a higher instance of science presenter positioning and listener positioning in the cogens and less so in the follow-up interviews. This finding may be due to the fact that during the internship, students were frequently presenting research and this was a common topic for discussion in cogens. Similarly, students also frequently reflected on their "listening to others" skills during cogens. Interestingly, 22.6% of the students positioned themselves during cogens as someone who was lacking scientific competence or knowledge, but no students held this position anymore during the follow-up interviews.

Overall, more than 50% of the students posited five positions (i.e., a person gaining confidence, scientific competence, or knowledge; team collaborator; articulator; science presenter; listener) in the cogens and four positions (i.e., potential scientist/engineer; team collaborator; articulator; a person gaining confidence, scientific competence, or knowledge) in the follow-up interviews. The fact that most of the students saw themselves as potential scientists and engineers during the follow-up interviews demonstrates their strong association with science identity.

5. Discussion

This study offers three major contributions for the teaching and learning of science. *First, this ethnographic study identified ten major student positions that emerged from science internships where high school students worked with scientists for seven months.* Internships with scientists provide an authentic place of learning that demystifies what occurs in professional science workspaces. By understanding that science is the search for knowledge and not a static enterprise, students can begin to ask their own questions and seek their own answers. Students became members of a community of practice in the science laboratory. Although they may have initially been lacking knowledge, and on the periphery, as they worked in the community, learning from scientists and each other, they became participants. Creating authentic science learning environments for students can have an important impact on how students position themselves as science learners and as part of the science community. Knowledge of the ten positions that emerged from the science internships can help researchers and educators understand how an authentic science learning experience may make unique contributions to student positions and science identity development.

Second, this study may help educators create a more authentic science learning environment that can enable the emergence of different student positions. Science education is moving away from traditional memorization of facts and vocabulary and more towards providing more inquiry-based, collaborative learning experiences. Furnishing those experiences is critical to engaging students in work that helps to confront societal challenges and exposes students to careers in science and engineering fields. Even if professional science laboratories are not available, science educators can model the environment within classrooms to promote and support the positions identified in this study, as students learn how to research and experiment to answer questions. This study can serve as a model for other educators to create an environment that provides students with authentic science experiences that support diverse positions.

Third, this study shows that students retain the positions they took in the science internship over time. Students who participated in the Work with a Scientist Program continued to see themselves as future scientists months after the internship was completed. Students also acquired and retained skills including team collaboration and problem solving that are crucial to membership in science communities. The building of a science identity was not limited to the time that students were working in the internship. Students continued to hold positions that were consistent with characteristics of a science identity in follow-up interviews after the internship was over. Being part of a community of practice, the science laboratory, and working with professional scientists can give students an inside look into how science is done and help them become a member of that community. Developing a science identity offers benefits beyond just learning science. Students with strong science identities are more likely to pursue careers in science and STEM fields [49–51]. Students with strong identities in a particular field are more likely to contribute to the field with which they identify [52].

Previous research on science internships focused mostly on students' knowledge, skills, attitudes, and interests, while little research focused on students' positionalities. Using positioning as an analytic lens can help researchers identify the dynamic situations in which learners can or cannot gain access to learning opportunities that are crucial for learning to happen [29]. Moreover, these moments of positive micro-identities, if encouraged, might result in more learning and ultimately a more positive academic macro-identity [53]. In fact, more and more researchers are using positioning theory to study the moment-to-moment dynamics of diverse positioning in educational settings [54]. This study makes an important contribution to the field by analyzing students' positionalities while working with scientists in authentic science environments, which opens a new way to understand the complex dynamics of learning involved in science internships. Future research may use the analytic lens of positioning to study the relationship between micro-identities and macro-identities, including what factors might be involved in the *thickening* [55] of a micro-identity into a macro-identity. Additionally, this study serves as an example of utilizing cogens as a new method to collect data and investigate student positions that emerged from their science internship. Cogen provides a reflective space for students to speak freely and take responsibility for their own learning [56]. The accountability to group members involved in cogens helps students express more accurate descriptions about their learning experiences, compared to self-reported data (e.g., surveys, interviews) that does not involve accountability to group members.

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