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What I see of you in me: how do high school students position scientists in a science internship?

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ABSTRACT

Science internship has been suggested as an effective way of engaging high school students in science inquiry. Research has investigated the impacts of science internship on students' science knowledge, skills, attitudes, interests, identity, confidence, and career aspirations. However, little research has studied how high school students position scientists in an internship. Drawing on dialogic self-theory, this qualitative study investigated how students positioned their relationships with scientists in a science internship using students' journals and interviews. Our analysis identified nine different positions of high school students towards scientists. They viewed scientists as *busy faculty*, *expert*, *evaluator*, *feedback provider*, *effective instructor*, *patient listener*, *life-long learner*, *role model*, and *talent scout*. These findings can help scientists and programme designers to tailor and improve future science internship designs and activities, and can contribute to understanding the process of science identity development. Importantly, this study demonstrates an alternative approach to understanding students' views of scientists.

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Introduction

According to the recommendations of the National Science Education Standards, 'students must be given access to scientists … to gain access to their expertise and the laboratory settings in which they work' (National Research Council, 1995, p. 221). Students' visits to university laboratories are an important way to have contact with actual scientific work in order to understand how scientific knowledge is formed and used in society (Driver et al., 1996; National Academies of Sciences, Engineering, and Medicine, 2021). One effective way to engage students in university laboratories is the science internship. A science internship is a temporary work experience for high school students to participate in scientists' ongoing research in a scientific setting and is designed to give students hands-on exposure to the real world of science. When high school students are situated in scientific settings, two types of internships might occur: assisted internship and autonomous internship. Assisted internship is when high school students play a supplementary role by assisting with scientists' work, such helping with data collection, experiments, data analysis, or maintaining lab equipment. In an assisted internship,

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students can have a taste of scientists' work by participating in a segment of science inquiry. Autonomous internship allows high school students to act like a scientist and conduct a full cycle of science inquiry, which requires students' continuous efforts in asking scientific questions, conducting a literature review, designing experiments, collecting and analysing data, and communicating scientific results. In an autonomous internship, students engage in a more student-centered and self-directed learning practice than an assisted internship affords.

Both assisted and autonomous internships situate high school students in an authentic science learning environment and provide various benefits to students. Research shows that science internships can (a) help students develop accurate views on scientists and scientific practices through seeing real scientific work firsthand (e.g. Burgin & Sadler, 2016), (b) help students explore or discover whether their initial interest and attitude in a particular area of science aligns with the reality of daily tasks and research challenges (e.g. Gibson & Chase, 2002); (c) help students gain science knowledge and inquiry skills such as problem-solving, teamwork, and communication (e.g. Cramer et al., 2015); (d) boost students' confidence, sense of accomplishment, and self-efficacy through contributing to real scientific work (e.g. Hsu & Roth, 2010); and (e) help students learn about education pathways to science careers and even consider scientific career choices (e.g. Roberts & Wassersug, 2009). Science internships also benefit scientists in various ways. For example, students can assist with data collection, freeing up professionals for more complex tasks; students may ask unexpected questions that spark creativity and bring a new perspective and enthusiasm to research projects; and students may develop interests through the internship experience and apply to become a member of the scientist's research team. Thus, overall, science internships are a mutual-beneficiary mechanism. They ignite a passion for science in young minds while providing valuable support to the scientific community. Thus, science internship is a great way to connect high school students in a meaningful manner to the sciences and to scientists (Kabacoff et al., 2013).

Recently, a growing body of research has aimed to investigate identity development in the context of science internships and to illustrate how science internships may (a) help students develop science identities through interactions with scientists and (b) understand the norms and behaviours associated with the scientific community (e.g. Carsten Conner et al., 2021; Edry et al., 2023; Hernandez-Matias et al., 2020; Milton et al., 2023; Perin et al., 2020). However, little research has investigated how high school students view scientists in a science internship. Before one can develop a science identity or consider becoming a scientist, one must have certain perceptions about scientists. Thus, it is important to understand how high school students perceive scientists in a science internship, a unique, authentic science learning environment where students get to work directly with scientists. This qualitative study aims to understand how high school students positioned scientists in a science internship and how that might reflect how they position themselves. Thus, our research question is: How do high school students position their relationship with scientists in a science internship?

Theoretical framework: dialogical self-theory

To investigate high school students' positioning with scientists in a science internship, we draw on dialogical self-theory (DST) as our theoretical framework. DST, informed mainly by Russian dialogism and the American pragmatism, explains how people position themselves and others in the world. DST has been influential in psychology, and recently it has made its way into other fields such as social work, anthropology, and education (Hong et al., 2017). Instead of envisioning a static and core 'I' who is responsible for one's thinking, DST sees the self as 'a dynamic multiplicity of relatively autonomous *I* positions in an imaginal landscape' (Hermans et al., 1992, p. 28). To highlight the social nature of the self, DST created the concept of the *dialogical self*, which has the unique capacity of conducting dialogues among many I positions within oneself. Thus, the dialogical self is social, not in the sense of dialoguing with others outside oneself, but in dialoguing with others inside oneself. Instead of viewing the self as something internal and dialogue as something external with others, the concept of the dialogical self integrates self and other into one entity. That is, instead of viewing self and dialogue as a dichotomy, DST combines self and dialogues, connects individuals and society, and views the self as a 'mini-society' (Meijers & Hermans, 2018). The self has multi-voices and can be dialogically extended to an independent other, and even to a broader societal and historical context (Hermans, 2013). Self is therefore not static but decentralised, polyphonic, and constantly evolving; it is viewed as a multifaceted structure containing a diversity of I-positions (Konopka et al., 2018).

An I-position is the role we take as members of society, and these might change depending on the place and time at which we are experiencing life (Hermans & Gieser, 2012). People have more than one role in life, which means that we have multiple I-positions. Each I-position is constituted by an internal and an external I-position. The internal I-positions appear once we recognise that the I-positions have their own narrative, voice, history, and way of facing reality (Hermans & Gieser, 2012; Konopka et al., 2018). The external I-position is the extended domain of the self – 'an-other-in-the-self' – and is the label we give to others (Hermans & Gieser, 2012, p. 39). For instance, an external I-position might be an inspirational figure that guides one's actions (Hermans & Hermans-Konopka, 2010). The internal and external I-positions are connected, and they engage in a dynamic interplay where the self is influenced by society (Hermans & Gieser, 2012). For example, a high school student might see themselves as having different roles in life, and each role can be defined as an I-position. For the internal I-position of being a daughter, there is an external I-position: a parent; for the internal I-position of being a sister, it implies the existence of their siblings; for the internal I-position of being a student, there is an external I-position of a teacher in one's mind.

Dialogues may happen between different I-positions in the self. For example, a teenager might have this internal dialogue: 'I didn't receive good grades in science, but I love outdoor activities, so I still signed up for the science field trip.' Here, we notice a conflict of two positions: 'I as a low-achieving science student' and 'I as a person who enjoys outdoor activities.' After a dialogic negotiation between the two positions, the teenager rejects the former position and appropriates the latter. A dialogue may also happen within one I-position (i.e. between an internal and an external I-position). For instance, 'In my mind, I see my elementary science teacher as my role model because she often provided interesting hands-on activities to engage students. Thus, I did not feel bored in classroom and was inspired to become a science teacher like her.' In this case, there is a dialogue between the internal I-position (i.e. an elementary student) and the external

I-position (i.e. an inspiring teacher). This 'other-in-the-self' (external I-position of a teacher) in this teenager's mind plays an important role in guiding her career aspirations.

The unique viewpoint of the dialogical self can reveal a complex, dynamic system of identity development and positioning. Researchers in the field of education have started to use DST to investigate both preservice and in-service teachers' identity development. For example, Henry (2016), Hong et al. (2017), and Xu et al. (2024) have used DST to reveal preservice teachers' I-positions when becoming a teacher and the tensions between I-positions. To advance understanding of teacher identity, Akkerman and Meijer (2011) drew on DST to conceptualise teacher identity with a dialogic perspective. Moreover, a research instrument has been created based on DST to gain insights into university professors' positionality in teaching (Bakker & ter Avest, 2019). These findings can help educators make sense of teacher identity transformation and can be valuably used in mentoring processes to support teacher education and new teachers' teaching practices.

Researchers have drawn on DST to investigate teacher identity development, but little research has used DST to study students' science identity and positionality. This study used DST as a theoretical framework to help us better understand how high school students position scientists and explain their relationships with scientists in a science internship.

Research context and method

Science internship context

This study was approved by the Institutional Review Board office at the University of Texas at El Paso and approval number is 496306-16. Both written consent forms and assent forms were collected from participants and pseudonyms are used throughout the paper to protect participants' privacy. This study emerged from the Work With A Scientist Program, which invited 11th graders to work with scientists in a science internship at a university in the southwestern United States. Thirty-six high school students from three Title I schools (the majority of students are from low-income families) participated in this internship (31 Hispanic, 2 Asian, 2 White, 1 Black; 11 males, 25 females). These 36 high school students worked with 4 scientists and their laboratory teams. Dr. Vaca was a biologist, a female in her forties, and White; Dr. Racki was an engineer, a female in her thirties and Asian; Dr. Naff was a chemist, a male in his forties, and Hispanic; and Dr. Macbeth was an immunologist, a male in his forties, and White. The students worked with the scientists and their laboratory teams for seven months (10 Saturdays from January to May and 30 business days in June and July). This internship programme incorporated educational pedagogies of project-based learning and cogenerative dialogues (see more details about cogenerative dialogues in Hsu, 2018, 2019, 2021, 2022; Hsu & Liao, 2018, 2022). That is, students conducted open-inquiry scientific projects with the support of scientists and conducted cogenerative dialogues with scientists to debrief and improve the quality of the internship teaching and learning. Each student who completed the programme also received a stipend of $450 and a school course credit on 'scientific research and design.' Details of the programme design can be found in Hsu (2020), Hsu and Espinoza (2018), and Hsu and Venegas

(2018). This study was approved by the school district and the university's institutional review board. Written consent forms (and assent forms required) were collected from the participants. We have used pseudonyms in this paper to protect the participants' privacy.

Data collection and analysis

Data for this study mainly came from two data sources: the high school students' journals and interviews with the students. Journal data include students' reflections every 1–2 weeks on the following questions: How was your learning experience this week? How was your experience in cogenerative dialogues this week? What was the most interesting observation this week? Throughout the internship, each student wrote about 15 journal entries of approximately 360 words each. Interview data include individual interviews with available high school students at three points in time. The first interview, which occurred before the internship, asked questions about students' views on the nature of science and their perceptions of student-scientist partnerships before starting the internship. The second interview took place immediately after students finished the programme and asked questions about their overall experience of the internship. The last interview, which occurred six months after students graduated from the internship, asked what they remembered about the internship and the impact of the internship on their career choices. In total, 31 students completed the programme and our data includes 446 student journal entries and 93 student interviews. We reviewed all the data and identified 330 scientist-related descriptions, which serve as the database for us to analyse how students positioned scientists in the internship.

Informed by DST, two researchers analysed these 330 scientist-related descriptions to understand and compare the nature of each description and categorise the positions involved in them. To establish credibility of the data analysis, two researchers worked together to examine intercoder reliability (Campbell et al., 2013; MacPhail et al., 2016). A coding scheme of 'high school students' perceived external positions for scientists' was created and improved iteratively within the study. The two researchers coded independently for 13 rounds and calculated the Cohen's kappa value for each round (Gisev et al., 2013; McHugh, 2012). During the data analysis process, the Cohen's kappa values increased with continuous discussion and revision of the coding scheme (from 25%, 13.99%, 31.82%, 58.94%, 62.92%, 43.71%, 33.85%, 77.30%, 60.53%, 60.01%, 78.34%, 79.08%, to 84.82%). In each round, the two researchers coded independently, compared coding results, calculated the Cohen's kappa value, discussed coding disagreements, and improved the most updated coding scheme. An agreement above 80% can be considered perfect agreement (Gisev et al., 2013; McHugh, 2012). Thus, our final 84.82% agreement level can be deemed as valid agreement between two researchers. This rigorous process of iteratively improving the coding established the validity of our data analysis and contributes to the credibility of the research findings.

High school students' perceived external positions for scientists

The purpose of the study was to investigate how high school students position scientists in a science internship and how this is reflected in how they position themselves. Drawing on DST, we analysed 446 journal entries and 93 interviews with high school students, identified 330 scientist-related descriptions, and categorised various internal and external I-positions involved in these descriptions. Our analysis suggests that the students saw the scientists in nine major external I-positions: (a) scientists as busy faculty, (b) scientists as expert, (c) scientists as evaluator, (d) scientists as feedback provider, (e) scientists as effective instructor, (f) scientists as patient listener, (g) scientists as life-long learner, (h) scientists as role model, and (i) scientists as talent scout. Each external I-position of the scientists corresponds to an internal I-position of the high school students, including (a) students as unattended learners, (b) students as novices, (c) students as being evaluated, (d) students as feedback receivers, (e) students as engaged learners, (f) students as comfortable questioners, (g) students as helpers, (h) students as followers, and (i) students recognised as being talented. These internal I-positions reflect how the high school students in the science internship saw themselves. An overview of these external and internal I-positions is illustrated in Table 1.

Scientists as busy faculty

Scientists were positioned by some students ($N = 5$, 1.51%) as having a busy schedule in academia and being unable to be fully involved in students' learning activities. Academia is a demanding environment where scientists and faculty often face numerous tasks (e.g. research, grant applications, administrative roles) that sometimes require their full attention, which might lead to neglect of their teaching responsibilities in the science

Table 1. Definitions of high school students' perceived external positions for scientists.

No	External I-Position	Internal I-Position	Definitions	Frequency *N* (%)
1	Busy faculty	Unattended learner	Scientists are positioned as having busy schedules in academia and being unable to be fully involved in students' learning activities.	5 (1.51%)
2	Expert	Novice	Scientists are positioned as someone who has higher social status, demonstrates professional knowledge, and demands students' respect and attention but does not necessarily foster students' engagement.	36 (10.90%)
3	Evaluator	Evaluated	Scientists are positioned as authorities who provide summative evaluations of students' overall performance.	15 (4.54%)
4	Feedback provider	Feedback receiver	Scientists are positioned as helpers who address students' issues and provide specific and supportive feedback on students' individual and collaborative work/practice.	41 (12.42%)
5	Effective instructor	Engaged learner	Scientists are positioned as effective instructors who can use a variety of teaching methods, materials, and resources to help students learn or supervise teaching assistants effectively.	109 (33.03%)
6	Patient listener	Comfortable questioner	Scientists are positioned as patient listeners who welcome students' questions/ideas and make students feel comfortable.	51 (15.45%)
7	Life-long learner	Helper	Scientists are positioned as life-long learners who do not know everything, need to do more research, and benefit from insights and help from other people, including students.	21 (6.36%)
8	Role model	Follower	Scientists are positioned as role models who excite or inspire students by demonstrating charismatic characteristics and sharing their professional trajectories and contributions.	37 (11.21%)
9	Talent scout	Recognised talent	Scientists are positioned as talent scouts who recognise and encourage students' aptitudes towards new challenges and learning experiences.	15 (4.54%)
			Total	330 (100%)

internship. For example, students pointed out that the scientist was not able to be there at all times for the entire science internship, including when students needed their advice.

> Due to an unexpected situation in which Dr. Vaca couldn't make it, the instructors were a little unprepared, so we did the cogenerative dialogues earlier than usual. (Danielle)

> And then, like how Dr. Macbeth has class. Yeah, I bet it was overwhelming. And I think it was good that he wanted to work with us, but at the same time, not saying anything bad, but, like, at the same time, I feel like he should've—like, you know how they say, "Don't take a bite bigger than you can chew"? I feel like maybe he should've said, "You know, I have to teach and dedicate my time to my students, the, you know, my actual students. So I feel like it'd be hard for me to be able to do this program in the summer." (Violet)

> While Dr. Macbeth wasn't there … and she (RA) tried to help us by starting us on experiments, Dr. Macbeth wouldn't let us because he wasn't there. That goes back to me wishing he was there a little more. (Yasmin)

The examples above illustrate that high school students positioned scientists as busy faculty with numerous tasks in their daily life, and they positioned themselves as unattended learners who need scientists' advice and attention. When students articulated this positioning, they often revealed their disappointment and deemed it as an area for improvement in the science internship. However, this positioning occupied only 1.51% of the scientist-related descriptions, which shows that only a few students positioned scientists as busy faculty.

Scientists as experts

Scientists were also sometimes ($N = 36$, 10.90%) positioned by students as an expert who has higher social status, demonstrates professional knowledge, and demands students' respect and attention but does not necessarily foster students' engagement. Students respected when scientists were talking, teaching, or sharing an experience. They also acknowledged that scientists possess a higher level of knowledge and that they still need to work on themselves in order to understand advanced science knowledge.

> It was weird actually calling him Dr. Naff, because we're so used to, like, calling, like, our teachers like Mr. or Ms. So, it was like, kind of, awkward like, "Doctor." [chuckles] Like, you're talking to an actual doctor [laughter], but he's like a doctor so that was, that was nice. I've never experienced that. (Madison)

> There was discussion between the other scientists beside Dr. Naff which might have made me less contributive since I didn't want to break their train of thought. I still had the same opportunity to talk, but I just felt like I didn't have much to say. (Neil)

> Well, I guess the only challenge I could think of would be, like, being able to talk with them on a very scientific level. 'Cause if I try to talk to, uh, Dr. Naff, uh, I guess, like, the conversation would eventually go somewhere where I wouldn't be able to understand it as much as he would. (Neil)

The examples above illustrate that high school students position scientists as experts who have in-depth knowledge and advanced skills; they position themselves as novices who only have basic science knowledge and they recognise the need for further learning in order to grasp what the scientists were teaching. When students articulated this positioning, they often revealed their admiration and deemed scientists as authority figures who deserve respect. Viewing scientists as experts is a typical public image. Surprisingly, this positioning only occupied 10.9% of the scientist-related descriptions, which shows that students do not necessarily position scientists as experts in a science internship.

Scientists as evaluators

In the science internship, scientists were sometimes (15, 4.54%) positioned as an evaluator who makes summative evaluations of students' overall performance. In the internship, scientists often provided key instructions to students at the beginning and let research assistants (RAs) guide students' practices step by step. Thus, it became a routine that when the scientist showed up, the scientist would provide an overall evaluation of students' performance and sometimes would even ask students to redo their scientific practices.

> The most interesting thing that I observed along with the rest of the lab was the way that Dr. Racki turned down our ideas and proposal posters again and again. (Ernest)

> The most interesting observation this week is seeing how we got all the tools, putting everything in the SketchUp program together, how the building is looking. I like to ponder on the building mainly because Dr. Racki will definitely have some problems with it and have us make changes to the building. I am most curious to hear what she will have us make changes to, because the building looks aesthetically pleasing and is similar to several office buildings in the El Paso area. (Ernest)

> We did go around what we are planning to do with our projects, just so Dr. Macbeth and the mentors can get a feel as to what we want to do and how to move on from our broad topic. (Sally)

The examples above illustrate that some high school students positioned scientists as an evaluator who would carefully examine students' work progress, and they positioned themselves as someone waiting to be evaluated. When students articulated this positioning, they expressed appreciation and anxiety simultaneously for this evaluation from scientists because they could gain insights and objective evaluations from the scientists. Sometimes, students mentioned they would contemplate the scientist's possible evaluations and use them as a motivation to improve their projects. This positioning occupied only 4.54% of the scientist-related descriptions, which shows that only a relatively few students positioned the scientists as evaluators.

Scientists as feedback providers

Scientists were also positioned as feedback providers (41, 12.42%) who would monitor students' work and provide specific and supportive feedback on students' individual and collaborative work/practice. Students were usually receptive to the scientists' feedback and would wait for it in order to be guided in their work. They also expressed the importance of the scientists' feedback in directing their work properly and making their scientific practice more effective.

> I haven't even mentioned what a huge help it is having Dr. Vaca to help steer my partner and I in the proper direction when we truly need assistance, or a useful tip or two. I really appreciate her willingness and patience when it comes to all the questions me or my partner might have. (Danielle)

> Dr. Vaca made a new suggestion this week, pointing out the difficulties some of us have when it comes to speaking up during cogen [cogenerative dialogues]. She made it clear that the system we have been working with simply won't yield the same results as a different approach. We now go to see her privately on Thursdays to have a more personal discussion, instead of leaving it to the outspoken members of the group to control each cogenerative dialogue session. My partner and I both agree that this has worked exceptionally well so far, since we actually got to interject our own points, bringing them more to her attention than we would normally be able to. It's helped us feel a lot more comfortable, and we may be able to speak more of our minds in the future, hopefully. (Danielle)

> We researched under main supervision of Jane, Dr. Racki's assistant teacher. Every once in a while, usually twice an hour Dr. Racki would come in to see how the team's research was going, see what we found, if we were on the right path and if we were making progress along with helping each group and each student. (Ernest)

The examples above illustrate that some high school students positioned scientists as feedback providers who would provide timely and helpful feedback, and they positioned themselves as feedback receivers who benefit from the feedback. When students articulated this positioning, they often expressed their appreciation and excitement about receiving friendly and constructive feedback because they could use it to improve their projects. This positioning occupied 12.42% of the scientist-related descriptions, which shows that quite a few students positioned the scientists as feedback providers.

Scientists as effective instructors

Scientists were also positioned as effective instructors (109, 33.03%) who can use a variety of teaching methods, materials, and resources. Some students expressed having an overall positive experience in regard to the instruction they received from scientists in the internship.

> High school doesn't come close to the work you do here at UTEP. [Interviewer: Did they train you?] Yes, yes, yes. They did. They gave us a training at first, and, like, they made sure we were doing it right, our lab instructors. The RAs, they were a lot of help when it comes to that. It was, like, two RAs per, per lab. Plus the instructor, Dr. Vaca. Yeah, they were helpful, a lot. (Jordan)

> One of the topics that was addressed was by Dr. Vaca in where she discussed that much of the reason as to why she tries to not give us an answer for many of the things that she is showing us is because of the fact that she wants to teach us to be independent in the sense that she wants us to come up with our new ideas, which is something that I totally agree with. (Jabir)

> My learning experience this week was very good, even though Dr. Racki stated that the lecture would be rather boring. The group interacted very much, asking questions during the presentation and as a group. The ideas in the PowerPoint were discussed at length. (Ernest)

The examples above illustrate that some high school students positioned scientists as effective instructors who would draw on different teaching strategies, and they positioned themselves as engaged learners who enjoy receiving instructions from scientists. When students articulated this positioning, they displayed an awareness of the nuanced features of lectures at the college level and resonated with scientists' intention of supporting them to become autonomous learners. This positioning occupied the highest portion (33.03%) of the scientist-related descriptions, showing that many students positioned the scientists as effective instructors.

Scientists as patient listeners

Scientists were positioned as patient listeners (51, 15.45%) who welcome students' questions/ideas, make students feel comfortable, and create an environment that encourages students to participate. Students recognised scientists' openness towards their ideas and described moments where students' voices were attentively heard.

> [Dr. Racki is] Open minded. I know I keep saying that a lot, but open minded. Um, understanding and respect for one each other, like not just like respect for the doctor because he or she's an adult, but also respect from the doctor to the student … to also listen. (Sophia)

> The most interesting observation this week was during cogen when we were running out of things to talk about and there was still plenty of time left. To avoid an extended period of silence, I would ask Dr. Naff about some seemingly random topic, and he would be able to mold that conversation and come up with some way to connect it to what we are learning about in the program. For example, just talking about a haircut got Dr. Naff to think about how to filter water by using the sulfur in hair to purify the water of contaminants. These times when our scientist just goes off on a tangent is always interesting to see what he will talk about next. (Jeremiah)

> My experience in cogenerative dialogues this week was very good. I feel that we had a very successful discussion where everyone's voice was heard and we all contributed to the conversation. We asked Dr. Naff some questions and they were very informative and useful. (Ryan)

The examples above illustrate that some high school students position scientists as patient listeners who persist in hearing students' ideas, and they position themselves as comfortable questioners who are not afraid of asking questions or articulating ideas. When students articulated this positioning, they often appreciated that their voices were heard, which motivated them to want to engage more in the internship. Interestingly, this positioning represents the second-highest portion (15.45%) of the scientist-related descriptions, which shows that many students positioned scientists as patient listeners.

Scientists as life-long learners

Scientists were also positioned as life-long learners (21, 6.36%) who do not know everything, need to do more research, and can benefit from insights and help from other people, including students. Some students mentioned that scientists acknowledged that their knowledge is limited and that they need to continuously learn more about their field. For example, some students shared that the scientists did not always have all the answers, and they unceasingly experienced new outcomes from their academic research. Students also expressed an awareness that the knowledge held by scientists is not exclusively empirical but includes opinions and subjective perspectives.

> Even though the experiment will take a long time to complete since this chemical reaction takes a long time to complete, it was fun setting it in motion. Besides, we also did a new

> experiment that not even Dr. Naff knew the answer to, and we will wait and see what happens the next time we go. (Ryan)

> It just shows how like, because the plant takes care of the clownfish, which is kind of like Dr. Vaca taking care of us, showing us all of this information. But at the same time, we're also helping everyone, because obviously the clownfish is also helping out the plant. So we're also helping Doctor Vaca even though she's still taking care of us, but we're also helping her out. (George)

> Dr. Macbeth [chuckles]. Like, so not necessarily a guy in a lab suit or in a lab coat like doing stuff, but more like a person who does that, but also it is just like a normal person. Like an everyday person who has their own opinions, their own things that they like. Um, just like being human, right? Um, they have their own opinions about life, their own opinions about science, their own views about science, and maybe the sorts of things that they do. And it's someone who does a lot of research. A lot of research. (Brian)

The examples above illustrate that some high school students positioned scientists as life-long learners who engage in continuous learning, and they positioned themselves as helpers who can contribute to scientists' learning. When students articulated this positioning, they often revealed their pride and a sense of accomplishment in being able to help scientists. Importantly, this positioning occupied 6.36% of the scientist-related descriptions, which shows that quite a few students positioned scientists as life-long learners.

Scientists as role models

Scientists were also positioned as role models (37, 11.21%) who can excite or inspire students by demonstrating charismatic characteristics and sharing their professional trajectories and contributions. Students expressed that scientists' words, emotions, and actions enriched students' perspectives on what being a scientist entails and how they might consider pursuing a similar educational trajectory to scientists. For example, some students in this internship expressed positive opinions about how scientists are passionate about their work and how they were motivated to pursue a similar professional journey.

> But working with Dr. Vaca definitely was so interesting. It just—it did make me question like, maybe I could look into other fields of science to see what [I] might want to major in. So maybe go to what Dr. Vaca was working on, or continue what I was also already interested in. (George)

> Dr. Vaca, they just have a drive for helping people. … Like, just the love of being in the lab, it's a pro, being able to help people in the end if you do have a good result. I mean, if I were a scientist, I would like to go and pursue around immunology, the area where Dr. Vaca is, and Dr. Macbeth, because obviously there's more areas and fields out there that I probably don't even know about. (Leslie)

> Oh, I remember Dr. Vaca really inspired me to, like—I wanna run my own lab eventually [laughter]. Yeah, I don't think it'll be until, like, a very, very long time, so five years, I don't know, I don't know, graduating, uh, applying to med school maybe. Maybe I'll be back in UTEP, uh, maybe, I don't know. (Veronica)

> Um, of course I'm not going to have a science career after [chuckles] this, no. But they helped me understand what it means to be passionate about what you enjoy doing, um, getting what's done. Um, for example, Dr. Racki, you know, she earned it all, you know?

> She has a PhD, master's, everything. She has her own office. She's happily married, she has a family, she has a nice home and everything. (Noa)

The examples above illustrate that some high school students positioned scientists as role models who had achieved a great work-life balance in their careers, and they positioned themselves as followers who were inspired to follow similar professional paths as these scientists. When students articulated this positioning, they often revealed their admiration towards scientists and aspirations towards STEM careers. This positioning occupied 11.21% of the scientist-related descriptions, which shows that quite a few students positioned scientists as role models.

Scientists as talent scouts

Scientists were sometimes positioned as talent scouts (15, 4.54%) who recognise and encourage students to embrace new challenges and learning experiences. Some students described that scientists actively expressed their support and provided advice and information to create a possible plan for the student's future educational trajectory. For example, some students mentioned being invited to learn more and participate in scientists' ongoing projects.

> Dr. Vaca encourages us and builds up our ego, when we feel like there is no ego to build upon, because we are so young and have not accomplished as much as we hope to. Dr. Vaca reminds us that we are so far ahead already, and we are going to accomplish a lot, so I want to live up to her pep talks and give her some useful information to work with. It would be so neat to work with Dr. Vaca in the future or at least credit her for my work. (Valentine)

> This week in the cogenerative dialogues I experienced with my group, the lab group scientist, Dr. Macbeth, explained to us how proud he was to see how we were all doing, and how we had all slowly improved on our behavior, outlook, and understanding of the scientific practices. We go through as well as how we handle the Work with a Scientist Program, and how we handle any stressful times that may come from it. I think it is reassuring for all of us for Dr. Macbeth to tell us that. I myself have felt like I have improved and I am very glad to be in Dr. Macbeth's lab. (Brian)

> I think networking is probably a big one, just because like of all the people I met and even now, like Dr. Naff said we're free to come back any time and like work for him. So networking was probably a huge one in itself. Just me meeting new people and I guess having those connections out there if we were to come to UTEP and if we were to study science, like, we're going to have like a homie up in the lab. (Reese)

The examples above illustrate that some high school students positioned scientists as talent scouts who identified students' strengths and uniqueness, and they positioned themselves as being recognised as talented individuals who realised their potential and possibilities in STEM. When students articulated this positioning, they often revealed their excitement about learning about their own potential in STEM. This positioning occupied only 4.54% of the scientist-related descriptions, which shows that only a few students positioned scientists as talent scouts.

Female and male students' perceived external positions for scientists

Based on the 330 scientist-related descriptions, we further differentiate female and male students' responses (See details in Table 2). For the female students, the three most frequent external I-positions for scientists are (a) effective instructor (30.16%, 57 positions from 15 students), (b) patient listener (17.46%, 33 positions from 12 students), and (c) role model (13.76%, 26 positions from 10 students). For the male students, the three most frequent external I-positions for scientists are (a) effective instructor (36.88%, 52 positions from 13 students), (b) expert (13.48%, 19 positions from 8 students), and (c) patient listener (12.77%, 18 positions from 8 students). That is, both female and male students perceived scientists quite frequently as 'effective instructor' and 'patient listener.' However, female students tended to also perceive scientists as 'role model' while male students tended to perceive scientists as 'expert.'

Discussion

The purpose of this study was to analyse how high school students positioned their relationship with scientists in a science internship. Our analysis of 330 scientist-related descriptions suggests that the students saw the scientists in nine major external I-positions: (a) busy faculty, (b) expert, (c) evaluator, (d) feedback provider, (e) effective instructor, (f) patient listener, (g) life-long learner, (h) role model, and (i) talent scout. Among the nine external I-positions, 'scientist as effective instructor' occurred the most (33.03%, it is the 1st ranking position for both males and females), indicating that most students acknowledged these scientists' teaching practices in the internship. The second-most frequent external I-position was 'scientist as patient listener' (15.45%, it is the 2nd ranking position for females and the 3rd ranking position for males). These two most frequent external I-positions could be the effect of incorporating cogenerative dialogues in the science internship programme, because both scientists and students were invited to share their ideas equitably and respectfully in cogenerative dialogues and address challenges as a team to improve their internship teaching and learning. More details about how the programme implemented cogenerative dialogues can be found in Hsu (2020). Moreover, our findings also show that female students tended to perceive scientists as 'role model' (3rd ranking position for females) whereas male

Table 2. Frequencies of high school students' perceived external positions for scientists.

No	External I-Position	Female (17 students)	Number of Positions (%) Male (14 students)	Total (31 students)
1	Busy faculty	3 (1.59%) From 3 students	2 (1.42%) From 2 students	5 (1.51%) From 5 students
2	Expert	17 (8.99%) From 10 students	**19 (13.48%)** **From 8 students**	36 (10.90%) From 18 students
3	Evaluator	7 (3.70%) From 6 students	8 (5.67%) From 3 students	15 (4.54%) From 9 students
4	Feedback provider	25 (13.23%) From 13 students	16 (11.35%) From 8 students	41 (12.42%) From 21 students
5	Effective instructor	**57 (30.16%)** **From 15 students**	**52 (36.88%)** **From 13 students**	109 (33.03%) From 28 students
6	Patient listener	**33 (17.46%)** **From 12 students**	**18 (12.77%)** **From 8 students**	51 (15.45%) From 20 students
7	Life-long learner	11 (5.82%) From 9 students	10 (7.09%) From 7 students	21 (6.36%) From 16 students
8	Role model	**26 (13.76%)** **From 10 students**	11 (7.80%) From 7 students	37 (11.21%) From 17 students
9	Talent scout	10 (5.29%) From 5 students	5 (3.55%) From 3 students	15 (4.54%) From 8 students
	Total	189 (100%)	141 (100%)	330 (100%)

students tended to perceive scientists as 'expert.' (2nd ranking position for males). One possible explanation is that the current culture in general may tend to encourage boys (not girls) to pursue science because of some educational and societal biases (e.g. boys are more logical and rational than girls), which may contribute to women's progressive underrepresentation along their professional trajectory (Avolio et al., 2020). Thus, female students might have less opportunities and exposures to hear people talking about science career paths or stories about scientists in schools or families. Thus, when female students encountered scientists in this internship, they were easily inspired by these scientists and quickly deemed them as role models to follow. But for male students, since they might have been encouraged more frequently in their daily life to pursue science, they might have heard about stories about scientists or science career paths already. Thus, when they encountered scientists in this internship, they might be not as inspired as female students and simply deemed them as experts, who have more advanced knowledge and social status.

Three major implications can be derived from the findings regarding these high school students' external I-positions in relation to scientists. First, understanding how high school students view scientists in a science internship can help scientists and programme designers to tailor and improve future science internship designs and activities. As illustrated in the data analysis, high school students also expressed certain emotions associated with certain external I-positions. For example, 'scientists as busy faculty,' 'scientists as experts,' and 'scientists as evaluators' are three positions where students expressed negative emotions, such as disappointment, frustration, or anxiety. Future science internship designers and scientists may pay attention to these categories and adopt strategies to address these specific possible positions. For example, to address the possible position of 'scientists as busy faculty,' scientists may explain to students in the internship their plan to continue overseeing students' work progress while they are away; to address the possible position of 'scientists as experts,' scientists may remind students more frequently that scientists do not hold the truth but that their knowledge is continuously updated; to address 'scientists as evaluators,' scientists may explain their rationale for evaluation (e.g. keeping students' work on track) or be careful to give friendlier and less-harsh evaluations. These adaptive strategies might make high school students feel more welcome and receptive in a new learning environment, such as a science internship.

Second, this study's findings about how high school students position their relationships with scientists in an internship can help educators and researchers understand how high school students might develop science identities. Science identity development is a complex process (Avraamidou, 2020). A rich learning environment, such as a science internship, has great potential in helping researchers understand the process of science identity development because of internships' contextualised nature of authentic science, including hands-on activities, state-of-the-art equipment, and exposure to the culture of the scientific community. That is, an internship environment can serve as a unique 'figured world' (Holland et al., 1998) where students get to 'figure out' who they are or whom they want to become by engaging in the social practice with scientists and scientific artefacts; where certain characters, actors, acts, outcomes are valued over others. These encounters may transform students' identities as they adapt to author themselves in the moment of interactions (Holland & Lave, 2009). Importantly, science internships provide a relatively long-term collaboration with scientists. Students might encounter setbacks, face criticism, or struggle with complex concepts. Researchers can investigate how students might overcome these challenges, possibly leading to a stronger sense of identity built on resilience and perseverance. All these unique features of authentic science may serve as valuable resources to understand how students may develop science identity in the figured world of science internship. Comparing to schooling environments, the internship setting provides students with a different and holistic science learning environment and provides researchers with peculiar opportunities to better understand science identity development. This study serves as a springboard to understand science identity development by illustrating students' internal I-positions and external I-positions that occurred in the internship. Future researchers may consider using these positions to track and understand students' identity development longitudinally. For example, are there any of these positions associated with science identity development? If so, which ones? When students just start to develop science identities, do they position themselves more as novice, feedback receiver, or helper, like students' internal I-positions identified in this study? When students build stronger science identities, do they position themselves more as expert, feedback provider, or life-long learners, like students' external I-positions identified in this study?

Third, this study demonstrates an alternative way to understand how students perceive scientists. In science education, understanding students' images of scientists is an important and popular research topic because students' stereotypical views of scientists might affect their interest in pursuing science careers. Thus, researchers have created many research instruments, such as the Draw-a-Scientist Test (DAST, Chambers, 1983) and its checklist (DAST-C, Finson et al., 1995), to understand how students think of scientists. However, one recent study (Toma et al., 2022) questions the assumption that if students hold more stereotyped images of science, they might have less interest in science careers. These researchers conducted a quantitative analysis to investigate whether the stereotyped images of scientists identified by the DAST and DAST-C can predict students' career interests. Their results show that students' stereotyped images cannot predict their science career interests and even found that those students who presented more stereotyped images of scientists actually have more interest in science careers. One possible reason to explain this result is that students might just try to draw a scientist that is plausible to everyone, thus they chose to use known-public stereotypes to make their drawing recognisable as a scientist to the public (Toma et al., 2022). This result therefore invites researchers to question the validity of the DAST and DAST-C and call for alternative approaches to understanding students' images of scientists. As our data analysis indicates, students in the Work with a Scientist Program seldom described stereotypical images of scientists, such as scientists as nerds or unemotional, dishevelled, old, bald, male, white, crazy geniuses in lab coats with no social life. This shows that science internships can help students develop more accurate images of scientists. As researchers, we did not ask students directly about their views on scientists in their journals or in interviews. That is, as researchers, we avoided the discursive effect that students might do their best to portray scientists in a way that researchers could understand (and therefore integrate all the stereotyped images of scientists). Instead, we simply invited students to share with us their observations and experiences in the science internship. Based on these observations and experiences in 446 journals and 93 interviews, we then identified 330 scientist-related descriptions as our database to understand how students viewed the scientists in the internship. Doing so we avoided having students attempt to convince researchers about what they described are socially constructed representations of scientists, and at the same time we obtained a high-quality database about how students viewed scientists. This indirect approach of obtaining students' views on scientists may serve as an alternative way to understand students' images of scientists. In other words, instead of asking students to draw a scientist directly, future researchers may ask students to envision an activity (e.g. internship) where students work with scientists and to describe what interactions could look like between students and scientists. After all, analysing students' positions towards scientists (instead of analysing students' drawings which mainly reveal physical features of scientists' images) may have stronger prediction potential to students' interests in science careers because positioning requires a deeper reflection about students' relationship with scientists. Based on the findings of this study, future researchers may consider exploring the relationship between students' positions towards scientists and their science career interests. For example, students may have higher science career interests if students position scientists more positively.

Conclusion

The purpose of this qualitative research is to understand how high school students position their relationship with scientists in a science internship setting. Drawing on dialogical self theory, we analysed students' scientists-related descriptions that occurred in their journals and interviews. Our analysis illustrated that these high school interns perceived scientists with nine major external and internal I-positions. These positions help us understand how high school students positioned their relationship with scientists while they work with scientists in a science internship. Specifically, these identified positions have potential in guiding educators to design better internship activities, helping researchers to understand science identity development, and serving as an alternative method to understand students' views on scientists and its relationship to students' science career interests.

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