Undergraduate STEM Learning Assistant Personas

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LA personas characterize common assets that LAs bring to the practice of teaching – these include ideas about STEM teaching and learning as well as LAs' goals for teaching. Personas are realistic, though fictionalized, characters that are based on potential or real users' personal goals and experiences when interacting with a program or product. Our LA personas address the design questions: *How can we recruit diverse students to become LAs? How can LA pedagogy courses support LAs to engage in student-centered teaching?* We use interviews with STEM LAs at three universities in the Pacific Northwest to construct a set of four Learning Assistant personas – each with distinct goals, perspectives, and experiences with teaching, and challenges they might encounter – that collectively represent the participant LAs. This set of personas can guide pedagogy course instructors to consider LAs' assets and experiences while designing courses that promote excellent, engaging, and equitable teaching.

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I. INTRODUCTION

At the university level, fulfilling a vision for high-quality, active, student-centered learning is particularly important and challenging in large introductory STEM courses. Some of the most effective university science learning environments are those in which small teams of students work together to conduct investigations, gather evidence, and discuss and debate what conclusions they can draw from the evidence [1–3]. In such contexts, instructors must balance specific content learning goals with the goal of engaging students' emergent scientific questions. Doing so is a substantial task that a single instructor has little hope of doing well. Undergraduate instructional assistants can provide the necessary support to accomplish this vision if they are prepared to leverage students' science ideas.

A particularly effective model for undergraduate peer instruction is the Learning Assistant (LA) model, in which peer instructors participate in both a weekly meeting to prepare for the content they will teach and a pedagogy course to prepare them to facilitate discussion and small-group problem solving [4–6]. Typical pedagogy courses prepare LAs to support active learning by teaching learning theory, strategies for responding to common ideas, and group management skills.

Prior research on Learning Assistants demonstrates that LA programs promote active learning and student success in a variety of ways [4–7]. The literature also suggests that LAs may become more sophisticated implementers of active learning strategies as a result of the pedagogy course, and documents some activities that may be helpful for LAs' development [5,8–10]. However, the body of research on Learning Assistants provides little evidence relevant to designing an effective pedagogy course that leverages LAs own intellectual and experiential assets for student-centered teaching. Our goal is to support the development and evaluation of effective pedagogical preparation for STEM LAs, so that they are well-equipped to notice and leverage students' science ideas for high-quality active learning.

To do so, our team developed a set of *Learning Assistant Personas*. Personas are fictionalized but realistic characters that are based on potential or real users' goals and experiences when interacting with a program or product (our users are Learning Assistants interacting with the components of the LA program: teaching, prep meetings, and pedagogy courses). Originating from human-interface design, a persona is a user-centered design tool that has been adopted to support user-centered design of an educational program or product [11–13]. LA personas characterize common intellectual assets that LAs bring to bear on their teaching – these include cognitive resources (i.e, potentially fruitful pieces of knowledge [14,15]) about teaching, learning, and physics content as well as LAs' needs, goals, and experiences for teaching preparation and practice. This set of personas allows us to investigate, characterize, and communicate LAs' assets for teaching in a way that directly informs the design of a pedagogy course or LA program.

We used a six-step process to build the LA personas: (1) articulate design problem, (2) collect user information, (3) assemble phenomenographic categories, (4) build personas, (5) check personas, and (6) solve design problems [16]. The first five steps are directly involved in persona development and validation and are discussed in this manuscript, while step six is a subject of future research. The design problems we address with these LA personas are: *How can we recruit diverse students to become LAs? How can LA pedagogy courses support LAs to engage in student-centered teaching?*

II. STUDY CONTEXT

Study participants were recruited from STEM LA programs at three universities in the Pacific Northwest.

University A is a small, private university with approximately 2000 undergraduate students. 42% are the first in their family to earn a college degree, 69% identify as women, and 61% are from a historically underrepresented group. University A has a long-established LA program in the physics department. LAs are typically second-fourth year undergraduate students who are physics, engineering, and/or elementary/secondary education majors. LAs facilitate small group work in regular class sessions and may host study center hours. On average, 7-15 undergraduate students serve as LAs each academic year.

University B is a regional public institution with an overall undergraduate student population of about 6000. 40% are the first in their family to earn a college degree, 67% identify as nonwhite, and 30% are eligible for Pell grants. The LA program at University B is relatively new, and serves physics, computer science, and math courses. LAs at University B are usually second-fourth year undergraduate students who are physics, computer science, or engineering majors. LA responsibilities depend on the course: some LAs facilitate small group work in regular class sessions, while others facilitate optional out-of-class study sessions. Five to ten undergraduate students serve as LAs each academic year.

University C is a public institution with an undergraduate population of about 14,000 undergraduates. 70% identify as white, and 22.8% are the first in their family to earn a college degree. The LA program at University C is relatively new, though undergraduates have served as TAs in physics labs for many years. LAs at university C are typically second-fourth year undergraduate students from a variety of STEM majors. LAs supervise physics labs only and are the sole instructors in the room during labs. On average 35 undergraduate students serve as physics LAs each academic year.

III. METHODS AND ANALYSIS

To collect user information, we interviewed a total of 15 Learning Assistants from three universities. This was a convenience sample: all Learning Assistants at the three participating institutions were invited to participate in a research interview, and all LAs who consented to participate were interviewed by a member of the research team. The research team developed an interview protocol to probe Learning Assistants' experiences, motivations, ideas about teaching and learning, and thoughts about the pedagogy course. Questions included: *What drew you to become an LA? What makes a good [physics/computer science/math] class? What do you find most challenging about teaching? What elements of the pedagogy course were most helpful for you in teaching?* Interviews were semi-structured, with interviewers using a protocol of pre-determined questions and using additional, in-the-moment questions to press further into the interviewee's perspectives and experiences. We initially interviewed two experienced LAs to validate the interview protocol. These interviews informed minor changes to improve the understandability of our interview questions. Then, we interviewed 13 more LAs over the course of about one year. All interviews took place in an online video conference and lasted 40-60 minutes. All interviews were recorded and transcribed.

We used a phenomenographic approach to analyze a subset of eight LA interviews to assemble categories that informed persona development [17,18]. These interviews were selected to represent a variety of LA experience levels, institutional and teaching contexts, and perspectives on teaching and learning. First, three researchers (co-authors LG, TH and KG) independently reviewed six of the eight interviews – each researcher reviewed a different set of six, so at least two researchers reviewed each interview. Researchers made detailed notes on LAs' motivations, ideas about teaching and learning, challenges faced, and experiences in the pedagogy course. Then, all three researchers met to discuss each interview and came to a consensus about the key ideas expressed in each category. We then collaboratively organized key ideas into themes within each category (e.g. "Goal: help students figure out answers for themselves," "Idea about teaching and learning: You get ideas from talking with peers"). We organized these themes into a table with rows containing categories such as motivation, big ideas about teaching and learning, challenges, and columns representing a unique persona. Through discussion, we arranged the themes in each category to form coherent descriptions of a hypothetical LA's motivations, goals, ideas about teaching and learning, teaching strategies, challenges, and perspectives on pedagogy course material. This process resulted in four distinct Learning Assistant personas. We added character stories to make each persona lifelike: a pseudonym, a character avatar (e.g., Fig. 1), description of major and/or career goals, motivation to be an LA and length of experience as an LA. The character stories are reflective of the themes from our interviews but are not meant to predict the background or gender, racial, or ethnic identity of LAs who are characterized by a given persona.

A set of personas is considered valid when a real user is primarily characterized by a single persona, with a few secondary characteristics that align with one or two other personas [13,16]. To validate our personas, the three co-authors independently reviewed the eight interviews used to develop the preliminary personas, checking that each real LA was predominantly described by one persona, with secondary characteristics resembling one or two other personas. We then checked the personas against three interviews we had not previously analyzed, noting when these interviews suggested nuances that we had not noticed earlier. The three co-authors met to discuss any nuances and needs for clarification they noticed with two other researchers and reached consensus on final revisions to the personas through discussion. All five researchers were involved in LA programs at their institutions - four were faculty who work extensively with LAs and one was an undergraduate researcher and experienced LA.

IV. LEARNING ASSISTANT PERSONAS

Our analysis produced four STEM LA personas – Luke, Logan, Leena, and Lucy – who embody a range of ideas about effective teaching and learning and accompanying teaching goals and challenges. These personas characterize Learning Assistants' perspectives about teaching and learning and can represent LAs across STEM disciplines.

Each persona combines the perspectives of several Learning Assistants who vary in experience, major/discipline, teaching context, background, and initial motivations to become a Learning Assistant.

A. Luke

Luke's goal as an LA is to help students deeply understand the course material. As an LA, Luke prefers to give students space to think problems through while he actively listens to get a sense of students' specific physics ideas. Luke pays careful attention to detect students' mental models. He'll intervene if needed by addressing misconceptions or missing pieces in a student's mental model or by affirming correct pieces. When interacting with a student, Luke is likely to ask Socratic questions to guide the student through a problem or concept. If a student can correctly apply concepts and explain why, he knows things are going well.

Fig. 1: Luke – The Fixer. Key phrase: Learn deeply!

Luke's big ideas about teaching and learning align with his focus on detecting and refining students' mental models. He believes that students should build accurate mental

models so they are able to explain their answers and see beyond surface-level steps and procedures. Luke sees incorrect ideas as obstacles that may need to be specifically addressed and asks questions to assess how robust student ideas are. For example, one LA said, *"If you have a misconception, you have to confront that before you can move on or you're never gonna commit that concept to memory correctly. That misconception will always be there. I think it's really important to draw out student thinking to help them build those bridges between where they're thinking and where they want to be."*

Luke has high self-efficacy as an LA and doesn't feel that he faces many significant challenges in this role. However, he is constantly looking for ways to improve his questioning skills to better elicit and address student ideas without giving away the answer. For Luke, videos of other LAs interacting with students (e.g. Periscope Lessons [19]) and articles on learning theory and discipline-based education research are the most helpful parts of the pedagogy course.

B. Logan

Logan's goal as an LA is to help students figure out how to approach problems and construct answers for themselves. As an LA, Logan works to draw out and understand students' ideas and to ask questions to guide students' thinking along a correct path. Logan tends to use open questions to probe students' thinking without guiding them toward his own reasoning and can use correct and incorrect ideas to guide his interactions with students. He has an intuitive sense of what to do next and when things are working.

Fig. 2. Logan – The Pathfinder. Key phrase: You can do it!

Logan's big ideas about learning highlight his growth mindset and goal of helping students build their own answers. He believes that it is important for students to be willing to be wrong and learn from their mistakes. Logan understands that there may be more than one correct way to approach a problem and learning how to solve problems is more important than getting the right answer. Logan tries to understand students' thinking processes or lines of reasoning and assess whether they are appropriate for the problem so he can help students develop solid logic and thinking processes. For example, one LA explained, *"I think one of the things I've learned to do, to understand students more, is taking a pause and really trying to process what they're thinking. Sometimes my mind moves really quickly, and I have this snap reaction of 'that's not how I would explain it.' Now, I'm trying to take a moment to process, really trying to see: is this a sound line of reasoning? Is it a valid way to think about this concept?"*

As this quote suggests, Logan is very aware of the distinction between his way of thinking and other students' ways of thinking and tries to support students toward accurate logic without forcing students to take up his way of thinking. Logan's biggest challenge is in understanding and building on students' ideas, especially when students approach a problem differently than Logan naturally would.

Logan finds the activities and assignments in the pedagogy course generally useful, but nothing is "mind-blowing." The prep meetings with faculty are helpful for talking about content-specific strategies and challenges.

C. Leena

Leena's goal as an LA is to attend to the affective aspects of learning and to promote students' sense of belonging. She had a great experience in her introductory physics class, and being an LA means she can still be part of and give back to her learning community. As an LA, Leena focuses on establishing rapport with students and building a community where students find support and belonging. Leena pays close attention to students' affect in the classroom, because she finds that positive affect and belonging are needed for successful active learning.

Leena's big ideas about teaching and learning motivate her focus on building a supportive learning community and fostering students' sense of belonging. She believes that when students experience care and a safe environment, they are better able to learn, and that class content should be connected to students' other experiences (in other classes and outside of school).

Fig. 3. Leena – The Carer. Key phrase: "You belong!"

Leena's biggest challenge is finding confidence in her own content knowledge, and she has experienced interactions where students doubted her expertise. She feels a tension between performing as an expert and promoting and participating in a community where it's okay for students to be wrong. For example, one LA said, *"I think in general...I worry that I would accidentally say something incorrectly, and then everyone would know, and then after that, they would think everything I say is incorrect."*

Pedagogy course readings about identity, stereotypes, and belonging in the discipline have helped Leena understand her own position in the classroom and be better prepared for the classroom environment.

D. Lucy

Lucy's goal as a Learning Assistant is to support group work and collaborative learning. As an LA, Lucy leverages multiple students' perspectives and disagreements among students to help them learn, and she knows things are going well when students are talking with their group members. Lucy tries to fit into groups of students as a peer, rather than as an authority figure.

Fig. 4. Lucy – The Facilitator. Key phrase: "Work together!"

Lucy's big ideas about teaching and learning highlight her focus on learning from peers. She believes that we all learn from other people's ideas, and that students should try to make sense of concepts and problems as a group by sharing ideas. Thus, she finds that it is important for students to be motivated and invest in class activities and discussions. For example, one LA explained, *"When you talk to your friends, you get an idea that you're not the only one who's struggling, and it's not that you don't understand anything. The more you talk to your friends, the more ideas you get about how to solve a problem."*

Lucy's biggest challenge as an LA aligns with her beliefs about the value of collaboration. It can be challenging to encourage students to invest in class activities and share their ideas. She lacks strategies for supporting learning when students don't want to interact. She also finds navigating relationships with students who are peers difficult at times, since she does not want to position herself as an authority figure in the classroom.

Lucy has learned a lot from conversations with peer LAs in the pedagogy course. She has really appreciated readings and discussions about why students may not want to participate and encouraging student engagement and wishes the pedagogy class had more on this topic.

IV. DISCUSSION AND CONCLUSIONS

The four Learning Assistant personas we developed – Luke, Logan, Leena, and Lucy – highlight a range of intellectual assets for teaching. These intellectual assets align with literature on effective undergraduate STEM education and instructor preparation. For example, Luke is particularly attuned to students' mental models and specific science ideas and is constantly seeking better ways to ask questions that draw out and address students' ideas. Decades of disciplined-based education research have demonstrated the value of instructor attention to students' mental models and specific science ideas [2,20–22] and have informed curricula that specifically target and either address or leverage common student ideas (e.g., [5,6]). Logan, in contrast, is more attuned to students' problem-solving processes and focuses on understanding how students' lines of reasoning can be leveraged for further learning. Logan's goals align with literature that emphasizes the benefits of a growth mindset about learning [25], and with other literature suggesting learning benefits from discipline-specific formative assessment and responsive teaching practices [26–29]. Leena is aware of the impact that students' affect and instructors' encouragement can have on their science learning. Her primary focus is on fostering a learning community that facilitates students' sense of belonging and encourages students to feel like they can do science. Studies have shown that a student's sense of belonging, science identity, and recognition as a "science person" is complex, and is strongly linked persistence in STEM fields [30–34]. Like Leena, many LAs are themselves in the process of developing a confident STEM identity, which may support their own success in STEM courses [35]. Lastly, many STEM education research studies support Lucy's sense that students' "get ideas from other people" and that peer discussion promotes improved STEM learning [3,36]. To support students' learning, Lucy prioritizes facilitating effective small group discussions in which every student participates.

Our first design question was: *How can we recruit diverse students to become LAs*? The personas we present here enable us to take next steps toward addressing this still-open question with a shared understanding amongst all stakeholders of who LAs are. The four personas we developed highlight both the diversity of goals that LAs may bring to the classroom and the value of having multiple LAs (and faculty) who prioritize different goals in a single classroom. In our interviews, the question: "What does a good physics (or other STEM discipline) class look like?" elicited particularly rich and varied responses that reflected both lived experiences and ideas about teaching and learning. We hypothesize that using some form of question as part of the recruitment/hiring process may help departments recruit a more diverse set of LAs who embody a range of LA personas.

Our second design question was: *How can LA pedagogy courses support LAs to engage in student-centered teaching?* Our four personas demonstrate that LAs possess a diversity of intellectual "resources" for student-centered teaching and learning, such as: "we learn from other people's ideas" (Lucy) or "there is more than one correct way to approach a problem and learning how to solve problems is more important than getting the right answer" (Logan). Pedagogy courses can anticipate and leverage the big ideas about teaching and learning that the four personas highlight. Further, our four personas call out parts of pedagogy courses that have been most helpful for LAs and highlight key challenges that LAs face as they facilitate active learning. These include the challenge of choosing questions to probe and address student ideas without giving away the answer (Luke), and of finding confidence in one's own content knowledge in a leadership role (Leena). Pedagogy courses can take time to address these challenges with discussions that unpack and normalize them and with research-based strategies for addressing them.

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