Validation of an Interview Protocol to Explore Students' Beliefs about Intelligence

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Validation of an Interview Protocol to Explore Students' Beliefs about Intelligence

Abstract

The overarching research goal driving this project is to characterize and better understand the beliefs that undergraduate students hold about their own intelligence. The research team utilized the work of Carol Dweck as a theoretical framework. Dweck's framework posited two mindsets: fixed and growth. Fixed mindset individuals believe that their intelligence is unchanging, while people with a growth mindset believe that effort can grow and develop greater intelligence. Prior researchers have shown that individuals with a growth mindset respond to challenges with higher levels of persistence, are more interested in improving upon past failures, and value effort more than those of a fixed mindset.

Guided by Mindset as a theoretical framework, the research team drafted an interview protocol. This protocol was used to conduct one-on-one, semi-structured interviews with students in both their first and fourth years of studying engineering at the university level. The purpose of these interviews was to gain insight into the students' goals, beliefs about effort, and responses to challenges with a focus on the students' views of their intelligence, particularly in the context of their experience at school in and out of the classroom. Not only will their beliefs be examined, but also the experiences that they perceive as influencing the formation of their beliefs. This preliminary study consisted of eight interviews, resulting in the refinement and validation of the interview protocol as well as some preliminary data with respect to students' beliefs about the nature of intelligence. The research team utilized NVivo for open and exploratory qualitative analysis of the preliminary data. Findings include both the revised interview protocol as well as preliminary themes for student beliefs about the nature of intelligence.

This work is important because it will pave the way for further research that seeks to understand deeply held beliefs through data collection in the form of interviews, especially related to intelligence in engineering education. The products of this research will provide a template for interviews that can provide access to fundamental, underlying student beliefs.

Scope

The validation of the pilot is part of our National Science Foundation Research Initiation in Engineering Formation grant to study engineering students' beliefs about their own intelligence. The purpose of this project is to both study students' beliefs about intelligence as well as train new researchers in the field, including a professor and graduate student with no prior experience or training in conducting engineering education research.
Using a cross-sectional qualitative study, we are trying to answer the following research question and subquestions:
How do undergraduate engineering students characterize their beliefs about the nature of intelligence?

- How do students perceive the nature of their own intelligence?

- How do student perceptions change over time during undergraduate formation?

For the full project, we plan to interview at least 40 first-year and senior engineering students. This paper describes our initial step of validating our interview protocol through a set of pilot interviews. We have done another round of interviews to validate and/or revise the protocol further. We included senior students in the second round of pilot interviews to ensure that this protocol is valid for the proposed cross-sectional study involving students at both the beginning and end of their undergraduate engineering education.

Theoretical Framework

A person's beliefs about intelligence can be implicit, strong, and deeply-held. Mindset is a framework developed by Carol Dweck (Dweck, 2006)that categorizes beliefs about intelligence. Someone who holds a fixed mindset believes that intelligence is static and does not change (i.e., a person has a fixed amount intelligence). Whereas, someone with a growth mindset believes that intelligence can increase over time with effort. These beliefs are not all-or nothing, but rather they are contextual. For example, a person may have a fixed mindset about their mathematical ability while maintaining a growth mindset about their artistic ability, or vice-a-versa.

These beliefs can manifest different behaviors, particularly in academics (Dweck, 1990). Previous research has shown that beliefs about intelligence can be tied to: 1) Goals and motivation, 2) Beliefs about effort, and 3) Responses to challenges, as shown in Figure 1(Blackwell, Trzesniewski, & Dweck, 2007). These distinct aspects were a starting point for the development of our initial interview protocol.

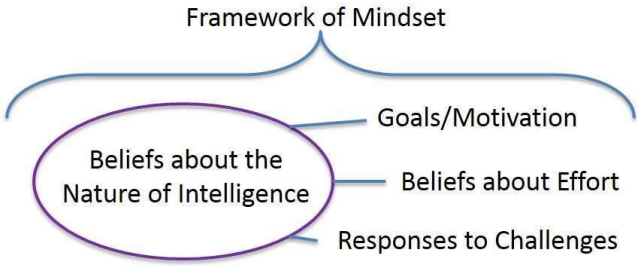

Figure 1. Distinct aspects of the Mindset framework

Background and Motivation

Our motivation to develop and validate a protocol to access the beliefs that students hold about the nature of intelligence is to ultimately understand how to better include and retain all students who seek to become an engineer. To meet the needs of the 21st century, we need more engineers that are well-prepared to take on the changes in our society (National Academy of Engineering, 2004). Relatedly, retention of engineering students is becoming more important both to meet the demands for engineers and as a metric for university program quality (American Academy of Arts & Sciences, 2017). Figure 2 shows how the Mindset framework directly relates to the goal of improving the pathways of engineering students who meet challenges during their time in undergraduate education. Specifically, there are two hypothetical paths students in engineering can take as a function of their underlying beliefs about the nature of intelligence.

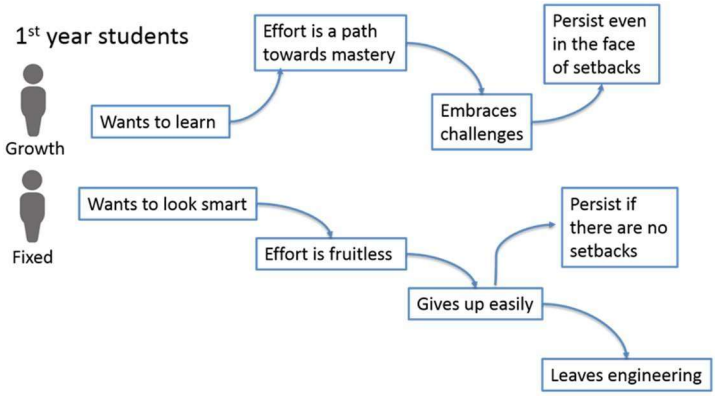

Figure 2. Hypothetical student pathways driven by beliefs about intelligence

How and when students develop their beliefs about intelligence that influence their ability to thrive in an engineering program is complex. Previous studies have utilized the Mindset Framework within the context of engineering education. For example, researchers have used quantitative measures to provide evidence that students who maintain a growth mindset are more likely to utilize active learning strategies (Stump, Husman, & Corby, 2014). Another study that utilized quantitative measures of students' beliefs about intelligence supports the use of first-year design tasks to mitigate the formation of a fixed mindset in engineering students (Blackwell et al., 2007). However, a gap exists when it comes to a qualitative understanding of students' beliefs about intelligence, and the formation of such beliefs. This current project is a first step in our contribution to this gap. Figure 3 shows some of the potential experiences and sources of belief formation that could influence students' beliefs about intelligence, and by extension, their sense of belonging in engineering.

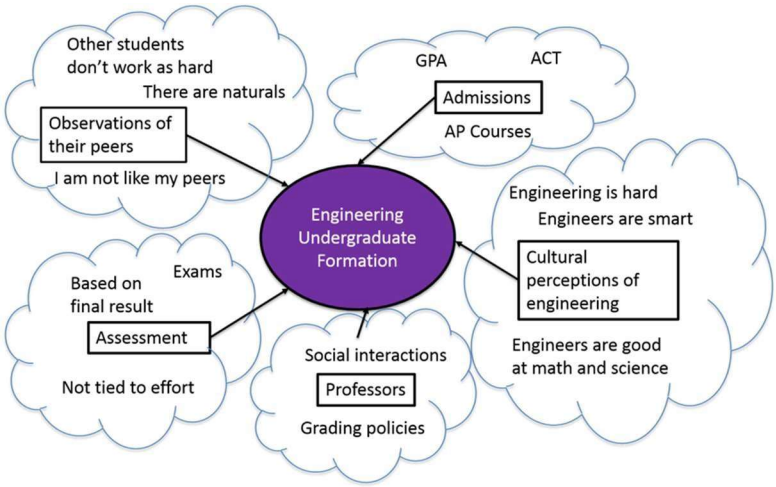

Figure 3. Possible ways that engineering students' experiences might influence beliefs about intelligence

The goal of this work is to develop an effective protocol that allows us, as researchers, to collect qualitative data that can be used to characterize engineering students' beliefs about their own intelligence. Learning and asking about others' beliefs can be sensitive and difficult. Often,

beliefs about subjects like intelligence can be held very deeply and may even subconsciously differ from espoused beliefs. The sensitivity of the topic of intelligence provides an additional challenge to collecting meaningful data about related beliefs. However, we have made progress in this area through the development and validation of an interview protocol to access engineering students' underlying beliefs about the nature of intelligence.

Process

To begin the study, we drafted a protocol for pilot interviews based on the theoretical framework of Mindset described in the Theoretical Framework section. This included a brief description of the goals of the interviews and what the participants should expect, a list of questions to ask, some notes for the interviewer to remember, and concluded with requesting the participants' feedback on the interview process. The questions intended to serve as data collection were grouped into the three categories of the framework: Goals/Motivation, Beliefs about Effort and Responses to Challenges. The initial protocol can be found in Appendix 1. Once a satisfactory initial protocol was established, students were recruited to participate in the pilot via a survey created in Qualtrics that asked demographic information, means of contact, year of education, consent to participate, and the four items with previously established validity and reliability to quantitatively measure an individual's mindset, which are listed below (Dweck, 2006; Dweck, 1990).

- You have a certain amount of intelligence, and you can't really do much to change it.
- Your intelligence is something about you that you can't change very much.
- To be honest, you can't really change how intelligent you are.
- You can learn new things, but you can't really change your basic intelligence.

These questions were asked as a Likert scale, ranging from "strongly agree" to "strongly disagree."

Afterward, Graduate researcher Adams contacted the instructor for the Introduction to Mechanical Engineering class and gained permission to solicit the students in the course for participation in the interviews. The researcher described the project to the class and a QR code that granted access to the survey was distributed to the students. The students were told about the twenty-five dollar compensation for participation in an interview.

Twenty students responded to the survey with an interest in participating. Four were selected using maximum variation sampling. The primary motivation for our sampling strategy was to interview individuals with a variety of responses to the Mindset items on the survey. Additional criteria were making sure to include students who did not identify themselves as male or white. Finally, previous college experience and whether or not they identified as a first-generation college student were considered as factors.

After the students were selected, the researcher contacted them via email to request they sign up for a time to interview. While waiting for responses, the researcher experimented with the room, the recording device, and having a conversation between two people with voices at higher and lower pitches. It was found that higher pitched voices register better with the recording device, but lower pitches are also audible. All four initially selected participants signed up via poll for an interview time.

As the researcher interviewed the subjects, new questions were thought of and added to the protocol. After each interview, the recording was listened to by all members of the research team to refine the first author's interviewing skills. After the first round of pilot interviews, the interviews were transcribed and carefully reviewed to determine the effectiveness of our

protocol. We identified the inadequacy of our initial protocol and recognized the challenge of collecting data that would enable us to characterize students' beliefs about intelligence and therefore answer our research questions. While we used a framework linking specific behavior with beliefs, the exact way that these beliefs manifest is still molded by personality and circumstance. Therefore, we needed to ensure that each question, with the aid of follow-up, resulted in both a detailed description of behavior as well as the perspectives or beliefs that guided said behavior. While reviewing the transcripts, we also were conscientious of the language students used. Previous research has shown that certain phases and word are indicative of beliefs, such as "I guess we all have…" and "Obviously, it's…", which guided our revisions to the protocol (McNeill, Douglas, Koro-Ljungberg, Therriault, & Krause, 2016).

Findings and Resulting Revisions to the Protocol

After reviewing the initial four interviews, we determined the initial interview protocol did not provide rich data for answering our research question. The protocol did not always elicit a specific example of behavior, students were reluctant to provide details that would help to characterize their motivation for their beliefs, and/or the students all gave the same answers regardless of mindset and thus provided no useful information.

For example, the question, "On a scale of 1-10 (10 being the smartest), how would you rate your intelligence as an engineering student?" elicited no information that would help us to answer our research question. All of the research subjects answered this question with the same response of 6-7 and were reluctant to provide more follow up details. This agrees with prior research that showed most people tend to rate themselves as slightly above average intelligence (Kruger & Dunning, 1999). When asked why, one student even provided the rationale that they know people both less and more intelligent than themselves. This question has been removed since it provided very little information and may have put students on the defensive. In its place we have added the question, "Tell me about yourself as a student."

We added this question and put it first in the protocol to learn more about our research subjects and build rapport with the students. We added targeted follow-up questions for clarification to more deeply probe participants for ways they make meaning related to beliefs about intelligence. For example, if the student says that they are a good student. We will follow with, "What does it mean to be a good student?" Just as students were reluctant to discuss how smart they were, they also did not want to discuss or talk about specific times that they felt smart. Therefore, we also removed the question, "Tell me about a specific time you felt smart." After reviewing the interviews, students were also reluctant to provide information for this question. They had not yet settled into the conversation and seemed more likely to give cautious rather than genuine answers. Building rapport over course of interview seems to help with this. It appears regardless of students' beliefs about intelligence, they have reservations about discussing their own intelligence.

The questions regarding exam performance worked very well. For example, "If you scored low on an exam, how would you react? Why?" elicited strong reactions from all students. This was clearly an experience that all the students shared. However, they all had different responses to how they reacted and why. For example, one student would pull out their calculator and check the effect on their final grade before they would even look at what they did wrong on the exam. More probing questions are needed to deeply understand how these reactions are tied to their beliefs about intelligence. Some examples include, "How do you feel when someone else, who you do not think is as smart as you, does better on an exam?" and "How do you feel when you did better than someone you know on an exam, who you think of as considerably smarter than

you are?" In addition, we will continue to probe the students to clarify what specific words and/or terms that they use mean to them. For example, we could clarify what does "low" mean to each student. Is it below the class average? Failing? Getting a 'B'?
We also found that more follow-up was needed on the breakdown of motivation based on grades versus learning. While students did provide different percentage breakdowns for their motivation, they were all still strongly motivated by grades. While the information provided is interesting, it does not help to answer our research question. Being motivated by grades does not necessarily indicate a fixed mindset. However, if the motivation for getting good grades is for validation of your intelligence or to look smart, it could be used as evidence towards a fixed mindset. This question also does not help to clarify whether their belief is local or global. Follow-up questions include, "Is this the same for all classes? Engineering vs humanities? Or even different engineering courses?"

Another interesting observation from the first round of interviews is that only students who tended toward growth mindset had suggestions about how their professor could improve to help with their motivation/learning. In our first pilot interviews, we asked students, "After you did well/poorly on a test, what could a professor could do to motivate you to continue to do well/do better next time?" Even after follow-up students who tended towards fixed mindset would only mention small things such as more examples in class. One student even said that it was their responsibility to do well, not the professor's. Whereas, the students that tended towards growth mindset had detailed, well-thought answers. More follow-up needs to be done to understand the effect/role that professors have. Follow-up questions include, "Does it matter to you if your peers or professor thinks you are smart?" and "Do you think your peers or professors judge you when you do poorly?"

The original protocol and the most current protocol develop through this pilot are provided for review in the appendix. In all, there have been three incarnations of the protocol so far.

Conclusions

The preliminary protocol, developed from theory, was useful. It allowed the research team to collect data and learn how to conduct interviews. The protocol provided useful and interesting information about how important grades are to students and shed light on shared engineering experiences, such as receiving a low score on an exam. There were also some clear differences between students who tended towards fixed or growth mindset in the survey. However, the depth of information obtained was not as strong as needed to answer our research question. After reviewing the transcripts of our interviews, we determined that we needed to modify some of our questions, and more importantly, we need to ask more follow-up and probing questions. This demonstrates the importance of protocol development and validations for studies aimed at collecting quality data about the beliefs that students hold.

Next steps

Because our first round of interviews prompted significant change to our interview protocol, we conducted another round of pilot interviews to further refine our protocol. To achieve this, we secured four more participants. First, we updated our Qualtrics survey. Previously, some of the students did not leave any means to contact them. The new survey rephrased the request for contact information by requiring the students to fill out information but allowing them to select "yes" or "no" to indicate whether they would like to participate. We also made it clear that their

email address will not be used for any other purposes. Following this, more participants were selected. Two first-year participants were chosen to test the updated interview protocol, and two senior participants were also chosen to look for any ways that the questions in the protocol may affect or be affected by the age of the participants and how far they have progressed in their programs. Interviewing both first-year and senior students is necessary for the cross-sectional study.

Two of the research team members are new to qualitative research and are still training to ensure proper collection methods. They will continue to review the recording of each interview in teams to ensure that they are not leading the participants and are probing to obtain rich data that will answer the research question. In particular, the interviewer will try not to respond to particular responses as good but rather interesting, or neutral affirmations of continued participation in the conversation. Also, while building some rapport with students can be helpful, providing information about your own experience may lead them to share or disclose information they may not have, potentially leading the interview process. The process of developing and validating an interview protocol has proved to be an excellent opportunity to introduce engineering researchers to qualitative, educational research.

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Appendix 1: Initial Protocol

Interview Number:

Pseudonym:

Date:

Logistics

Hello! Thank you for volunteering to participate in this interview. First I want to let you know what to expect.

- Our conversation will be **recorded** and then transcribed verbatim. This allows me to revisit what was said accurately and eliminates the need to take notes frantically. Any **identifying information will be removed** from the transcript and the audio will be kept in a secured location.
- Your name will be replaced with a pseudonym--do you have a preferred **pseudonym** (for next letter)?
- I may take some notes along the way, so that I can keep track of things to follow up on without interrupting you.
- The interview should be about an hour and is completely voluntary—you can stop at anytime.
- You will receive the $25 at the end of our discussion.
- Do you have any questions for me before we begin? [Answer, start recorder]

Purpose

- Our goal today is for us to have a detailed discussion about your **beliefs about or perceptions of the nature of your intelligence**.
- The discussion will inform my understanding of the perceptions of engineering students and will help future decisions about the undergraduate engineering experience and how it can be improved for all students.
- I want to hear your own beliefs— I am expecting that they will be different from the beliefs of others—there is **no right or wrong answer**.
- I aim to understand your perspective, so I will ask questions like "what do you mean by that?" These types of questions can be a bit awkward and may require you to reflect on what you've experienced, so I will purposefully leave long pauses after my questions. Take your time--if you need clarification, please let me know.

Throughout interview, remember:

- *Respond with "that's interesting" rather than "that's good"*
- *Use "tell me more about that," "you used the word X, what do you mean by that?"*
- *Make connections, "why do you think that's important in terms of intelligence?"*

Interview Questions

Goals/Motivation

1) Tell me about a specific time in engineering school when you felt smart.
   a) What about that experience made you feel smart?
2) What are your favorite things to work on in engineering school?
   a) Things that come easily?
   b) Things that are challenging?
3) If you scored high on an exam, how would you react? Why?
   a) What could a professor do to motivate you to continue to do well?
4) If you scored low on an exam, how would you react? Why?
   a) What could a professor do to motivation you if you had done poorly?
   b) What if other students did much better that you?
5) Tell me about a specific part of engineering school that made/makes you feel motivated to keep pursuing an engineering degree.
   a) Why do you think it was motivating to you?

Beliefs about Effort

6) On a scale of 1-10 (10 being the smartest), how would you rate your intelligence as an engineering student?
7) Tell me about an experience that convinced you of this…
   a) Why was that experience important to you?
   b) What would you have to do to move up on the scale?
8) Tell me about your strategies to be a good engineering student
   a) Where do you think these strategies come from?
   b) How have these strategies developed since you started engineering school?
   c) How will these strategies prepare you for your future career?

Responses to Challenges

9) Tell me about a specific part of engineering school that has been difficult for you.
   a) Why do you think it is/was difficult for you?
   b) What did you do when you realized it is/was difficult for you? What was the outcome of that action?
   c) What advice would you give to an engineering student who is struggling with something similar?

[Turn off recorder]

Conclusion

1. What questions do you have for me?
2. Are you interested in being contacted for further participation in this study sometime in the next year?
3. Do you have any feedback for me that would improve the experience of the next participant?
4. Thank you! [pay $25, sign human subjects log]

Appendix 2: Current Interview Protocol

Interview Number:

Pseudonym:

Date:

Logistics

Hello! Thank you for volunteering to participate in this interview. First I want to let you know what to expect.

- Our conversation will be **recorded** and then transcribed verbatim. This allows me to revisit what was said accurately and eliminates the need to take notes frantically. Any **identifying information will be removed** from the transcript and the audio will be kept in a secured location.
- Your name will be replaced with a pseudonym--do you have a preferred **pseudonym** (for next letter)?

- I may take some notes along the way, so that I can keep track of things to follow up on without interrupting you.
- The interview should be about an hour and is completely voluntary—you can stop at anytime.
- You will receive the $25 at the end of our discussion.
- Do you have any questions for me before we begin? [Answer, start recorder]

Purpose

- Our goal today is for us to have a detailed discussion about your **beliefs about or perceptions of the nature of your intelligence**.
- The discussion will inform my understanding of the perceptions of engineering students and will help future decisions about the undergraduate engineering experience and how it can be improved for all students.
- I want to hear your own thoughts and perceptions— I am expecting that they will be different from the thoughts of others—there is **no right or wrong answer**.
- I aim to understand your perspective, so I will ask questions like "what do you mean by that?" These types of questions can be a bit awkward and may require you to reflect on what you've experienced, so I will purposefully leave long pauses after my questions. Take your time--if you need clarification, please let me know.

Throughout interview, remember:

- *Respond with "that's interesting" rather than "that's good"*
- *Use "tell me more about that," "you used the word X, what do you mean by that?"*
- *Make connections, "why do you think that's important in terms of…?"*
- *Ask for examples, "can you give me an example of when that happened?"*

Interview Questions

Goals/Motivation

10) Tell me about yourself as a student.
    a) What does it mean to be a 'good' student?
    b) Why do you say you are a "xxx" student?
11) If you scored high on an exam, how would you react? Why?
    a) What would you consider a good score on an exam? Medium? Low? (for interviewer: consider grade curves in the answers)
    b) What if you did better than someone you consider smarter than you are?
    c) Follow up questions on how you are perceived and how that affects their identity?
12) If you scored low on an exam, how would you react? Why?
    a) What if other students did much better that you?
    b) What if someone you don't consider as smart as you are did better than you?
    c) Do you care if (peers or professors) judge you when you do poorly? Why or Why not?
13) How can (peers or professors) motivate you to give more effort to class?
14) Does it matter to you if (peers or professors) think you are smart? Why?
15) Tell me about what motivates you to keep pursuing an engineering degree.
    a) Why do you think it is motivating to you?
16) If you were to make a pie chart of your study motivations, what percent would you say you are motivated by your grades versus your desire to learn?

a) Why?
b) Is that the same for all of your classes?
c) In what ways are grades important to you?
d) In what ways is learning important to you?

Beliefs about Effort

17) Tell me about your learning and studying strategies as a student. (for researcher: push!)
    a) Where do you think these strategies come from? School, peers, family, teachers influence?
    b) How have these strategies developed since you started college? (for researcher: Details How did it feel when you had to study more in college? Talk about it, examples)
18) How much effort do you put into classes?
    a) How do you feel when a class requires you to put a lot of effort into it?
    b) Do you know students who do well without trying?
        i) How does that make you feel?
    c) In your day to day life, do you think you'll need to put in more or less work per day in your job than you do in school?

Responses to Challenges

19) Tell me about a specific part of college that has been difficult for you.
    a) Why do you think it is/was difficult for you?
    b) What did you do when you realized it is/was difficult for you? What was the outcome of that action?
    c) What advice would you give to a student who is struggling with something similar?
20) Tell me about a specific part of college that is easy for you.
    a) Why do you think it is/was easy?
    b) What do you think it means for something to be easy or difficult?

[Turn off recorder]

Conclusion

1. What questions do you have for me?
2. Are you interested in being contacted for further participation in this study sometime in the next year?
3. Do you have any feedback for me that would improve the experience of the next participant?
4. Thank you! [pay $25, sign human subjects log]