HOW DO STUDENTS WITH LOW INTEREST IN MATHEMATICS REACT TO TASKS? AN INVESTIGATION OF TRIGGERING INTEREST

by

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ABSTRACT

The purpose of this study is to investigate the reactions students with low interest in mathematics have to multiple mathematics tasks. Interest has been shown to influence students' engagement, motivation, and achievement (Renninger & Bachrach, 2015; Hidi & Harackiewicz, 2000; Kang & Keinonen, 2018). Therefore, understanding what triggers the interest of students with low interest in a particular subject has been, and remains to be, an important goal for educators so students' experiences and achievement are improved.

My study focused on triggered situational interest, which is the first of the four phases of Hidi and Renninger's (2006) four-phase model of interest. One of the ways that may be used to initiate or trigger student interest in math is through the tasks students encounter in the classroom. To this end, I elicited students' in-the-moment reactions to math tasks that included three task features: realistic context, the opportunity to justify an answer, and a visual representation of data. Their responses informed my answers to the following research questions:

Research Question 1: *Among high school students who reported having low situational interest in mathematics, to which aspects of mathematical tasks did these students react? In what ways did the students react to the aspects and what explanations did they provide for their reactions? Which, if any, of the aspects were intended features of the focus tasks?*

Research Question 2: *What are the different cases that emerge when considering students who reported having low situational interest in mathematics that*

frequently and consistently reacted to a particular task aspect across most, or all, of the five different mathematical tasks? Within each case, how were the students' explanations for their reactions to that particular task aspect similar and different across the mathematical tasks? How do their explanations for their reactions support the concluding stances for that particular task aspect?

I used a Two Cycle coding process (Miles et al., 2018) to analyze the transcript data. Through this process, I developed codes to capture students' reactions to each of the three task features as well as their reactions to two task aspects that emerged from the data: mathematical topic, and perceived difficulty. I used the frequency of the assigned codes to answer research question one. I then used the assigned codes along with analytic memos (Miles et al., 2018) to select three student cases to answer my second research question.

Students generally reacted in ways that aligned with previous research for the task features, but their explanations were not always the same as those found in the research. For the emergent task aspects, students generally reacted positively to topics they had previous success with and reported having a general preference for ease. However, there were exceptions to these trends.

This study highlights the benefit of eliciting the students' voices to learn about their experiences. My results illustrate a range of ways that interest can be triggered by concurrent aspects of mathematics tasks among students who report having low interest in mathematics. My results suggest the importance of task selection and task launching in a classroom setting. I suggest future research that expands on the current study to include students with higher levels of interest in mathematics, or by using tasks that are included in current classroom curricula.

Chapter 1

INTRODUCTION

Students' experiences and outcomes in their academic classrooms are influenced by many factors, one of which is their interest in the subject. Interest has been defined as, "a psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time" (Hidi & Renninger, 2006, p.112). According to Renninger and Bachrach (2015), interest supports students' engagement and encourages behavior that increases opportunities to learn. Many previous studies have linked higher student interest to an increase in student learning in general (e.g., Harackiewicz et al., 2008; Jansen et al., 2016; Wade & Adams, 1990). Researchers have found this to be the case specifically for mathematics as a subject (e.g., Mitchell, 1993; Singh et al. 2002; Boaler & Staples, 2008).

Researchers have made distinctions between individual interest and situational interest (Hidi & Renninger, 2006; Ainley et al., 2002; Mitchell, 1993; Hidi & Baird, 1988). Ainley, Hidi, and Berndorff (2002) define situational interest as being "elicited by certain aspects of the environment" (p. 545) and individual interest as "an individual's predisposition to attend to certain stimuli, events, and objects" (p. 545). Situational interest must be present before students can develop individual interest in a subject, and it can be triggered by intentional external efforts by others (Hidi & Renninger, 2006).

Understanding why some high school students report having low situational interest in math is important because students with lower situational interest have been found to be less likely to pursue future courses in mathematics (Bong et al., 2015; Sansone et al. 2015; Köller et al., 2001), which may limit their prospects in higher education or STEM related career fields. Empirical evidence demonstrates that students' situational interest in mathematics tends to drop noticeably as students enter high school (Fredericks & Eccles, 2002; Gottfried et al., 2001; Kim et al., 2015). Furthermore, students in high school who express having low levels of interest in mathematics are likely to have begun to incorporate their low interest as part of their personal identities, and therefore may be less likely to seek out opportunities on their own to increase their interest (Cobb & Hodge, 2011). Students with lower reported levels of interest in mathematics than their classmates are a worthy demographic to study because those are the students who could most benefit by being impacted by external efforts to trigger situational interest (Hidi, 1990).

To disrupt trends of students' interest decreasing over time, educators can recognize that students' situational interest is not a fixed trait and can be externally influenced (Schiefele, 1991; Hidi & Renninger, 2006; Mitchell, 1993). It is important to find ways to positively influence these students' levels of interest. Renninger and Hidi (2015) note that educators can support students in "continued and meaningful engagement" (p.101) by drawing on knowledge, understandings, and experiences the students already have. They also say that educators can "incorporate design elements that explicitly support students to make connections to the content and develop their interest" (p. 101). Incorporating elements that connect to the students' existing interests may increase the students' willingness to engage or re-engage with the content in which they are less interested.

One way that teachers can design instruction to directly impact student interest is through the tasks they select for instruction (Hiebert & Wearne, 1993; Watson & Mason, 2007). Students with low situational interest in math may be more likely to be motivated to engage with selected tasks if it includes the presence of a feature that triggers their interest or attention, (Hidi & Harackiewicz, 2000). A single task can be composed of multiple features that may influence a student's interest. Some features that have been shown by research to positively influence student interest include the incorporation of a real-life context (e.g., Van den Heuval-Panhuizen, 2005), the opportunity to justify an answer (e.g., Boaler & Staples, 2008), and visual representations of quantitative data (e.g., Van Meter et al., 2020). There is a need to investigate how multiple features of a task concurrently influence student interest.

Given that interest is malleable, understanding the moments when it fluctuates can provide greater insight on how and when task features might impact interest. However, student interest is frequently studied through methods such as observation (e.g., Renninger & Bachrach, 2015), which requires external interpretation of another person's actions. Alternatively, we could investigate students' reports of their experience through questionnaires (e.g., Schukajlow et al., 2012, Frenzel et al., 2010) or interviews *after* the completion of an intervention (e.g., Ridlon, 2009). These retrospective measures have their strengths, but there is value in gaining insight into how student interest manifests and changes in-the-moment. Use of multiple measures would also strengthen the conclusions that can be made from the interpretation of collected data.

It is also valuable to listen to what students say about what aspects they report reacting to in the tasks they solve, instead of limiting investigations to the features that educators expect to trigger their interest. Listening to students use their voices to explain their reactions to tasks gives them the agency to be involved in the process of improving opportunities to learn and engage with math (Robinson & Taylor, 2006; Mitra, 2018) and avoids relying on assumptions made by adult educators that may not reflect the students' experience (Jenkins, 2006). This study aimed to emphasize voices of students to gain insight into how they react to tasks instead of relying on assumptions or expectations. One way this study achieved that aim was by having the students openly explore tasks that included features that educators presume positively affect students' situational interest and allowing the students to explain the reactions they had to those tasks. The students were not told that the tasks were intentionally selected with a focus on features intended to trigger their interest and additional triggers of situational interest emerged as a result.

I designed this exploratory study to increase our understanding of how high school students with low situational interest in math react to tasks that they encounter. I wanted to learn more about the ways in which these students reacted to features that are present in tasks, particularly when there were multiple features present. I also wanted to learn more about how these students reacted to other aspects of the task that were not intentionally included as features to trigger or increase interest. Finally, I wanted to explore the explanations the students provided for their reactions to the features and other aspects. To address my curiosities, I developed the following two research questions to guide my study:

Research Question 1: *Among high school students who reported having low situational interest in mathematics, to which aspects of mathematical tasks did these students react? In what ways did the students react to the aspects and what* *explanations did they provide for their reactions? Which, if any, of the aspects were intended features of the focus tasks?*

Research Question 2: *What are the different cases that emerge when considering students who reported having low situational interest in mathematics that frequently and consistently reacted to a particular task aspect across most, or all, of the five different mathematical tasks? Within each case, how were the students' explanations for their reactions to that particular task aspect similar and different across the mathematical tasks? How do their explanations for their reactions support the concluding stances for that particular task aspect?*

To answer these questions, I conducted a series of one-on-one interviews with 11 students who reported having a low level of situational interest in math. The students that I recruited to participate in the interviews all scored lower than a pre-determined cut-off score on a survey that measured their situational interest in mathematics as a subject. Each student completed a pre-interview, multiple task interviews and a final interview. The interview transcriptions were the data that I analyzed.

To investigate the aspects to which students reacted, and whether those aspects were intended features, I used five different multi-part mathematical tasks in my study. Four of the tasks were focus tasks that included three features that have been shown through research that they can positively influence student interest. The three features were the inclusion of a real-life context, the opportunity for the student to justify their answer, and the opportunity to interpret data from a graphical representation. I designed the comparison task to be devoid of those features.

To attain in-the-moment data, I provided the students with multiple opportunities throughout the interviews to tell me about the reactions they had to the tasks. During each task interview, the students completed one of the five math tasks. I asked them to explain any reactions they were having to the task before they solved any of the parts, after each part, and after completing the entire task. I also asked them to compare completed tasks to each other, providing them with another opportunity to reflect on the reasons for the reactions that they had to each task. The students were not aware of the specific features that I was investigating, so any mention they made of those features in their interview responses were unprompted and spontaneous reactions to the feature.

I answered the first research question by analyzing and tabulating the codes I developed and assigned to “monothematic chunks” (Miles et al, 2018, p. 74) of the interview transcripts. I coded the monothematic chunks using the “Two Cycle” coding process suggested in Miles et al. (2018, p. 64). The First Cycle codes that I used were three a priori codes related to the three featured task aspects of context, opportunity to justify, and interpretation of graphs and a fourth code to incorporate chunks that could not be assigned one of the other three codes. The Second Cycle codes I developed were a combination of revised subcodes for the three First Cycle codes that pertained to the featured aspects and two additional emergent aspect codes, mathematical topic, and perceived difficulty. This process informed the concluding stances I present for the three task features and two additional task aspects of the mathematical tasks to which the students explained having reactions.

I answered the second research question by selecting three representative cases when a single student had consistent and frequent reactions to a particular task feature or aspect. I selected these cases by analyzing the codes assigned to each student's transcripts and identifying the students that had consistent reactions to a particular feature or aspect during most of the tasks they had solved. After that, I wrote descriptive summaries and analytic memos for each of the selected students which led me to choose three cases to explore more deeply. These three cases were Diondre's preference for the inclusion of a real-life context, Arthur's positive reactions to the opportunity to justify his answers using his opinions and prior experiences, and Callie's preference for ease in mathematical tasks.

I designed this study to contribute to both research and practice in mathematics education. Regarding research, the methods I used made a contribution because they demonstrated a way in which data on students' situational interest in mathematics can be collected in-the-moment and in their own voices. My results also contributed a deeper understanding of how students react to multiple features of mathematical tasks when they are present concurrently. Regarding teaching practice, my study demonstrated how students' reactions to aspects in tasks can inform teachers' task selection. These findings also suggest the importance of launching a task in a way to increase the chances that all students are able to access the context of the task. Finally, my study highlighted the benefits of providing students with the opportunity to share their experiences in their own words and valuing their input when making decisions about the tasks they are provided.

Chapter 2

LITERATURE REVIEW

In 1913 John Dewey published his essay, *Interest and Effort in Education* which establishes that student interest has been a construct of significance to scholars of education for over a century. Dewey says that interests "mark an identification in action, and hence in desire, effort, and thought, of self with objects" (p.90) and that when interests are cultivated, students can meaningfully grapple with the subject at hand. Since Dewey's time, researchers in the field of student interest have shown the connections between interest and engagement (e.g., Renninger & Bachrach, 2015), motivation (e.g., Hidi & Harackiewicz, 2000), and achievement (e.g., Kang & Keinonen, 2018). These connections have also been shown specifically in math (e.g., Köller et al. 2001). Because of these connections, it is important to better understand the experiences of students with lower levels of interest and what they say influences their interest.

In a school setting, educators have influence over external factors that can affect student interest. Below I will describe the research that has been done into the effects of the external factors, or triggers, of interest that have been researched in educational settings. In math classrooms, one way in which interest can be triggered is through the intentional inclusion of elements that are designed to trigger interest in the tasks the students encounter (Renninger et al., 2019). In my study, I refer to these intentional elements as task *features*. There is less research available on the effects of how the presence of multiple features in the same task affects the students' experiences with tasks. There also is limited research on students' reactions to aspects of tasks that are not intentionally included in the task as features. My study aims to explore and provide insight into these gaps.

Interest

Interest is defined by Hidi and Renninger (2006) as "a psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time" (p. 112). This definition is applicable both within and beyond school settings. Renninger and Hidi (2015) refined the previous definition to account for interest as both a psychological state as well as a motivational variable, encompassing more factors that could influence a person's interest. Their refined definition, "the psychological state of a person while engaging with some type of content… and also to the cognitive and affective motivational predisposition to reengage with that content over time" (Renninger & Hidi, 2015, p. 8), accounts for the person's affect as they interact with the content, as well as the motivation someone would have to seek out the opportunity to engage with the content.

Renninger & Hidi (2015) further clarify the construct of interest in research, distinguishing it from our colloquial utilization of the term of "liking" something as the requirement for someone to have interest. They clarify "liking may indicate that interest has been triggered. However…it is insufficient to measure interest solely on the basis of positive feelings…negative affect may be associated with the experience of interest, especially in the early phases of development" (p. 60). A person's heightened emotional response, whether that response is positive or negative, can trigger interest and encourage further engagement with the content (Renninger and Hidi, 2015).

Renninger and Hidi (2015) also explain how a person's interest is influenced by internal factors, "characteristics of the person," and external factors, "characteristics of the environment" (p.9). The dependence on the internal factors influencing interest can explain why individual people who have had similar environmental experiences as other can have different levels of interest in the same content. Furthermore, both the original and refined definitions rely on the proposition that "Interest is a content-specific concept. It is always related to specific topics, tasks, or activities" (Schiefele, 1991, p.301). This means that a person's interest will vary depending on the specific content with which the person is engaging. When conducting research on student interest, the content in question is frequently the course or subject matter. For this study, the content with which the participants interacted and for which I collected data about their interest was mathematical tasks.

Student Interest and Academic Outcomes

Student interest became and continues to be of importance to researchers in part because of its connection to students' academic outcomes. Specifically, higher levels of interest have been connected to higher levels of student motivation and engagement, both of which increase students' opportunities to learn (Renninger & Hidi, 2015). Furthermore, many studies, spanning multiple decades, have demonstrated a direct connection between levels of interest and student achievement in different subject areas (e.g., Harackiewicz et al., 2008; Wade & Adams, 1990; Hidi & Baird, 1988; Kang & Keinonen, 2018). Other studies have shown this connection as it related specifically to math achievement (e.g., Singh et al., 2002; Jansen et al., 2016; Heinze et al., 2005; Boaler & Staples, 2008).

Studies have shown connections between student interest and student achievement in several academic subjects. In a 2008 study, Harackiewicz and colleagues found that, of students who took an introductory psychology course, students who started the course with higher levels of interest, or whose interest was triggered early on in the course, received higher grades than their less interested peers. Wade and Adams (1990) found that college students were better able to recall details from texts that they found interesting. Younger students, those in the fourth and sixth grade, were able to recall details in informative texts that were written in ways that were intended to be interesting to students that age (Hidi & Baird, 1988). In science education, Kang and Keinonen (2018) found that Finnish 15-year-olds who reported higher interest in their science instruction achieved higher scientific literacy scores on the PISA.

Jansen, Ludtke, and Schroeders' (2016) conducted a large-scale study with 39,129 German ninth grade students comparing the students' interest levels and achievement in math, German (their native language), biology, chemistry, and physics. For all subject areas, interest was a predictor of achievement, meaning that the more interested students achieved higher than the less interested students. They also found that interest had the highest effect on predicting math achievement, and the lowest effect on predicting German achievement. They also investigated the levels of the individuals' interest in each of the five subject and compared those to their achievement levels in each subject. This comparison found that within the individual, the more interest a student had in a subject, the higher their achievement was for that subject. This supports, not only a connection between interest and achievement, but also that a person's interest is not static, rather it is dependent on the content at hand.

In addition to Jansen, Ludtke, and Schroeders' (2016) study, many other studies have linked student interest in math to achievement in math. Singh, Granville, and Dika (2002) found that eighth grade students' motivation and attitude, which combined are an indicator of interest, varied directly with their achievement levels. In Boaler and Staples' (2008) three-year study of high school students participating in different styles of mathematics instruction, they found that the students at the Railside school, a school with non-traditional teaching methods, enjoyed math class more and performed higher on most of the achievement measures given to the students in all schools. In another study out of Germany by Heinze, Reiss, and Franziska (2005) of 500 students in seventh and eighth grade, significant differences were found in the levels of interest between the three performance achievement groups, with the lowest performing group having the lowest levels of interest and vice versa.

Student Interest in Math in High School

There is an abundance of research that shows students' interest in math decreases as they progress through school. Gottfried, Fleming, and Gottfried (2001) found through a longitudinal study that students' intrinsic motivation for school mathematics decreases more than it does for other school subjects throughout their schooling career. Their measure of motivation included curiosity and persistence, both of which are key factors in interest as well, making their conclusion valid for student interest as well as motivation. Fredricks and Eccles (2002) cite multiple studies (Eccles et al., 1984; Eccles et al., 1989; Wigfield et al., 1991) which indicated that students' value of and interest in math declines between middle school and high school. Additional studies that have demonstrated a drop in interest as students progress through school. These studies include Köller et al. (2001) which showed a drop in interest in math across groups of German students from grades 7 to 10, even those who were higher academic achievers than their peers, and Kim et al. (2015) which demonstrated a similar result for students from Korea in grades 6 to 10.

In addition to studies demonstrating that student interest in math decreases over time, there are also studies that connect lower student interest to a decreased desire to take higher courses in math or pursue professions in STEM fields. Bong et al. (2015) explored the connections between the gap between Korean students' genders and their participation in STEM fields and suggested that the decision to pursue STEM fields required high interest and self-efficacy in math, and the boys consistently rated higher on those scales. A study I mentioned earlier, conducted by Köller and colleagues (2001), found that students with higher levels on interest in math were more likely to select an advanced math course after they completed tenth grade whereas students with less interest were more likely to choose a more basic course. Also, in another previously mentioned study (Boaler & Staples, 2008), more Railside students were more likely to pursue additional math courses than their less interested peers who had received a more traditional method of instruction. Additionally, students' levels of interest in math affects their identities as learners of math, such that students with low levels of interest may be less likely to seek out math opportunities beyond high school (Cobb & Hodge, 2011).

Measuring Interest

Researchers have measured interest using a variety of instruments and methods. The choice of instrument that is used in a study "requires clarity about what needs to be measured (i.e., indicators of interest)" (Renninger & Hidi, 2019, p. 272.). Some of the ways that interest has been measured include surveys or questionnaires (e.g., Schukajlow et al., 2012; Frenzel et al., 2010), interviews (e.g., Ridlon, 2009), and observations (e.g., Renninger & Bachrach, 2015). Each method has its strengths and weaknesses in their ability to detect or measure both the cognitive and affective components of interest. The choice of which method or methods to use depends on what the researcher aims to measure, as well as the constraints of the study.

Surveys can be an efficient method when collecting data on interest for a large number of participants. For example, Schukajlow and colleagues (2012) had 224 participants to whom they gave a pre- and post-unit survey with 52 Likert scale questions relating to their enjoyment, interest, value, and self-efficacy expectation for 12 different math problems. Frenzel and colleagues (2010) gave 3,123 students a survey with 20 Likert scale questions, 6 of which evaluated interest, multiple times over a five-year period. These studies were able to uncover trends in the population of students they evaluated, but the instruments did not provide participants the opportunity to explain the reasons for their response selections.

Interviews can provide participants with the opportunity to share more details about their experiences or thoughts than they can in a survey or questionnaire, but it can limit the number of participants since interviews are typically more time-consuming to conduct and analyze than surveys. In Ridlon's (2009) two-year study, she had 52 sixth grade participants, but only interviewed 3 students (and their parents) in the first year, and 5 students (and their parents) in the second year. These interviews served to triangulate the data she collected, and the interview results did support the survey results, even though there were a limited number of students interviewed.

Two weaknesses that apply to both surveys and interviews are that they both rely upon self-reported data and that they are typically administered after the completion of, or in a different setting from, the experience they are evaluating. Self-reported data is limited by the participant's ability to self-reflect and their comfort level with their honest responses. With regards to interest, especially people with low levels of interest, may not be aware that their interest has been triggered, or, if it had been triggered, exactly what triggered it (Renninger & Su, 2012). Participants may also be hesitant to provide honest answers based on their comfort levels with the how the data is collected or who is collecting the data. This is especially a concern when the participants are unable to remain anonymous to the data collector. This may be, in part, attributed to social desirability bias which is when "subjects change their [responses] for impression management (to look better to others), self-deception (to feel good about themselves), or identity definition" (Larson, 2019, p. 534). On the other hand, self-report can provide insights when investigating the reasons behind actions or reactions that may or may not be external indicators of interest.

Most studies that utilize surveys or interviews, including those I discuss in this section, administer the instrument to the participants at the end of the experience they are being used to evaluate. This timing means that the participants are able to use the entirety of the experience to inform their responses, but they may have forgotten specific events that may have been meaningful in-the-moment. In many cases, it may not be reasonable to interrupt the experience to obtain in-the-moment data, especially if it means frequent interruption of students' classroom instruction, which would have been the case for all of the studies I have mentioned.

Another method of measuring interest is through observation. Renninger and Bachrach (2015) opted to use observational methods to collect data about an out of school science workshop. The researchers were able to observe the students' reactions and actions while they engaged with the available activities, which provided insight into some of the potential triggers that the students reacted to. This was able to be done un-obtrusively, without interrupting the students' experiences. On the other hand, using observational methods alone does not provide insight from the participants into the reasons for why they exhibited observable external behaviors. Furthermore, observational data may not be generalizable to wider populations than that which is being observed (Renninger & Bachrach, 2015). Because interest is multi-faceted with affective and cognitive components, the use of multiple data collection tools can triangulate collected data to create more convincing results. (Renninger & Hidi, 2019).

Four-Phase Model of Interest

Interest as a construct in the research is separated into two distinct categories, individual interest and situational interest (e.g., Hidi & Renninger, 2006; Ainley et al., 2002; Mitchell, 1993; Hidi & Baird, 1988; Tsai et al. 2008). Situational interest is interest that is influenced by factors outside of the individual, or "elicited by certain aspects of the environment" (Ainley et al., 2002, p. 545). Individual interest as defined by Ainley, Hidi, and Berndorff (2002) is "an individual's predisposition to attend to certain stimuli, events, and objects" (p. 545), meaning that individual interest leads people to seek out opportunities to engage with the content in which they are interested.

Hidi and Renninger created the "Four-Phase Model of Interest Development" (2006) which refines situational and individual interest each into two more specific classifications representing gradations of a person's interest in a specific content. The first two phases encompass situational interest, and the second two phases encompass individual interest, 1. Triggered Situational Interest, 2. Maintained Situational Interest,

3. Emerging Individual Interest, and 4. Well-Developed Individual Interest. Hidi and Renninger (2006) explain how the phases are connected to each other in this way:

> The four phases are considered to be sequential and distinct, and represent a form of cumulative, progressive development in cases where interest is supported and sustained, either through the efforts of others or because of challenges or opportunity that a person sees in a task. However, without support from others, any phase of interest development can become dormant, regress to a previous phase, or disappear altogether. (p. 112)

This explanation emphasizes that the development of a person's interest progresses through the phases occurs in order, and that the development and maintenance of interest at any given phase relies on sustained support by others. It then follows that for a student to progress through the levels of interest for a given subject or topic, they must start in the first phase, Triggered Situational Interest, which is the phase I focus on in my study.

Triggered Situational Interest

Triggered situational interest is the earliest phase of interest in the Four-Phase Model and is defined as "a psychological state of interest that results from short-term changes in affective and cognitive processing" (Hidi & Renninger, 2006, p. 115). People enter this phase of interest through triggering, which is when something about the topic, subject, or activity they did not already have interest in catches their attention (Renninger et al., 2019). The triggers that people with lower levels of interest encounter are generally provided externally. One way in which triggers can be provided to students is in the way in which an activity is written or structured (Renninger et al., 2019).

Renninger and Su (2012) developed a profile of learners who are in the Triggered Situational Interest phase. Renninger and Hidi (2015) revised and expanded on the list of learners' characteristics given in Renninger and Su (2012). Their list of characteristics include that a student in the Triggered Situational Phase:

- Attends to content, if only fleetingly
- May or may not be reflectively aware of the experience
- May need support to engage from others and through instructional design
- May experience either positive or negative feelings
- May not persevere when confronted with difficulty
- May simply want to be told what to do (p. 13)

Characteristics such as "fleeting" attention, lacking perseverance, and a lack of self-directed action demonstrate the likely necessity of external support for the student to maintain or increase their interest in the content.

Fittingly, the factors that catch a person's attention, enabling them to enter, or remain, in the Triggered Situational Interest phase are referred to as *triggers* (Renninger & Hidi, 2015). In school settings, triggers can be included as part of the instructional design of the tasks the teacher provides to their students. Specifically, teachers can "incorporate design elements that explicitly support students to make connections to the content and develop their interest" (Renninger & Hidi, 2015, p. 101). Renninger et al. (2019) provide "novelty, challenge, and meaningfulness" (p. 5) as examples of design elements, or features, that research has shown to be triggers in school settings regardless of the specific academic subject. It is important to note that not all students will respond to features the same way, meaning that a particular feature may trigger interest for some students but not others (Renninger et al., 2019).

Triggering Interest Through Features in Math Tasks

In math classes, one way in which teachers can expose students to features intended to trigger their interest is through the tasks they select for instruction (Hiebert & Wearne, 1993; Watson & Mason, 2007). The definition of math tasks that I use for this study is Stein and colleagues' (1996):

> A mathematical task is defined as a classroom activity, the purpose of which is to focus students' attention on a particular mathematical idea. An activity is not classified as a different or new task unless the underlying mathematical idea toward which the activity is oriented changes. (p. 460)

Math tasks can include features that research has shown to trigger students' interest while they engage with the task. I selected three of these features to focus on for my study: the inclusion of a realistic context (e.g., Van den Heuval-Panhuizen, 2005), the opportunity to justify an answer (e.g., Boaler & Staples, 2008), and visual representations of quantitative data (e.g., Van Meter et al., 2020). While these features can be intentionally included in the task, not all students will respond to the features in the same way, meaning that they will not be triggers for all students, and may, in fact, suppress some students' interest (Renninger et al., 2019). Furthermore, there may be other aspects or characteristics of the task that triggers or suppresses a student's interest that were not intentionally included as features.

Inclusion of a Realistic Context

The term *context* in educational research can refer to (emphasis by the author) "*the learning environment*…[including] both the different situations in which learning takes place…and the interpersonal dimension of learning" (Van den Heuval-Panhuizen, 2005, p. 2), or to "*a characteristic of a task presented to the students"* (Van den Heuval-Panhuizen, 2005, p. 2). For my study, I refer to the second definition operationalizing context as a characteristic. The complete definition for this perspective is that context is “*a characteristic of a task presented to the students:* referring either to the words and pictures that help the students to understand the task, or concerning the situation or event in which the task is situated” (Van den Heuval-Panhuizen, 2005, p. 2). In other words, for the purposes of my study, I interpret context to be the intentionally included addition of information that situates the information provided in the task prompt in a non-classroom setting.

The above definition of context could include tasks that Rellensmann and Schukajlow (2016) call “dressed up word problems” which are “reality-related” but the student only needs to “undress” the problem and apply a mathematical process to find an answer (p.368). They go on to explain that these types of problems “do not require the process of transferring information between mathematics and reality” (p. 369). However, since the inclusion of a context in these problems does not assist the student with understanding the purpose of the task, which is to apply a mathematical process, I did not consider these problems as containing a context for my study.

The term *realistic* can also be interpreted in multiple ways. The definition that I use for my study is the interpretation used in Realistic Mathematics Education, an approach to math education that was developed in the Netherlands (Van den Heuval-Panhuizen & Drijvers, 2020). This definition does not limit the task’s context to those that exist in the real world with verifiable quantities and instead expands the definitions of “realistic” to include “problem situations which they can imagine” (p. 521). This means that realistic contexts may be real-world, but may also be based on fictional stories or imagined scenarios (Van den Heuval-Panhuizen & Drijvers, 2020).

The inclusion of a realistic context in math tasks has been shown to trigger student interest by appealing to students' preferences and activities outside of the school setting (e.g., López & Sullivan, 1992; Walkington, 2013) as well as the meaningfulness or relevance of the context to the student (e.g., Gutstein, 2003; Gutstein & Peterson, 2013). Included contexts that draw on students' preferences and activities outside of school to leverage the positive affect they have towards those preferences and activities to trigger interest in the task (Renninger & Hidi, 2015). Contexts that are aimed to be relevant or meaningful to the students' lived experiences leverage students' existing value schemas to trigger interest in the task (Renninger & Hidi, 2015). Both types of contexts leverage existing student interest in non-math topics to trigger interest in math tasks.

Including Contexts Based on Student Preferences. Two examples of studies demonstrating that the inclusion of contexts that appeal to students' preferences and activities outside of a school setting can increase students' interest in a math classroom setting include Walkington (2013) and López and Sullivan (1992). Walkington's (2013) study involved high school algebra students enrolled in a computer-based algebra course. López and Sullivan's (1992) study involved 123 seventh grade Hispanic students who were provided tasks with different types of included contexts during a short instructional unit on solving one- and two- step equations. Both of these studies demonstrated increases in both performance and positive affect towards mathematics.

Walkington's (2013) study showed that high school students enrolled in a computer-based algebra course performed better when provided with tasks that were designed on the results of an interest survey that the students completed. The interest survey asked the students to rate the following nine topics: “sports, music, movies, TV, games, art, computers, food, and stores” (p. 937). The results of the survey were used to inform the contexts of the computer-based tasks the students in the treatment groups were provided. After completion of the units, the groups that were assigned to the re-designed problems with contexts based on the results of the interest surveys performed significantly better than the control group which was provided with an earlier version of the tasks. Walkington (2013) concluded that “the impact of personalization was significantly greater for students identified as struggling in algebra” (p. 938) which is noteworthy because of the connection between low performance and low interest. This conclusion could indicate that the inclusion of the personalized context triggered interest in the lower performing students.

López and Sullivan’s (1992) study showed that Hispanic seventh grade students performed better and reacted more positively to tasks that included personalized contexts. The study participants were 123 Hispanic seventh grade students who experienced parallel instructional units with a focus on solving one- and two-step equations. After all students completed a “Biographical inventory” which “asked questions about such matters as the names of friends and of favorite places, foods, objects, activities, and events” (p. 7). The students were then randomly assigned to three groups, one that included personalized information gathered from the inventory, one that included general contexts like those found in typical math textbooks, and one where the problems did not include any reference to a realistic context. The groups that were assigned to the personalized and general context groups performed better on the posttest, which was made of items that did not include a context. The authors suggest that “Personalization that incorporates more familiar elements in the problem situation may reduce [the cognitive processing] demand by enabling the learner to understand and process the elements more readily" (p. 11). Furthermore, the group that had been assigned to the group that included the personalized contexts reported "significantly more positive overall attitudes than those under the other two treatments" (p. 12). Since both performance and affect was increased in the group with personalized contexts, it follows that the inclusion of contexts likely triggered the students' interest.

Including Contexts Based on Meaningfulness. Several examples of how contexts that are relevant or meaningful can support or increase students' interest come from Eric Gutstein's and others' work on incorporating lessons that include elements of social justice into the math curriculum. In Gutstein's 2003 article, he describes his experience teaching seventh and eighth grade students in a low-income Latino community using real-world projects with social justice themes. Several chapters in the book, *Rethinking Mathematics: Teaching Social Justice by the Numbers* (Gutstein & Peterson, 2013) are descriptions of teachers' and researchers' experiences using social justice lessons or projects in classrooms. In all cases, the authors provide several examples indicating that the experience with the real-world task increased the students' interest in the tasks or in math in general.

Gutstein (2003) spent two years teaching at the middle school level where he supplemented the required curriculum with 17 projects with contexts that he believed to be, "related to and built on [his] students' lived experiences as urban youth from immigrant, Latino, working-class families" (p. 47). One project that Gutstein described was to demonstrate the wealth and population distribution by continent using cookies. For example, two students represented the population of North America each got 14 cookies while the four students representing Africa each got a piece of one cookie shared between them. After this project, Gutstein reported that "all but 3 of the 26 [students] expressed that they learned a lot and gave specific examples" (p. 50). He also shared that 23 students indicated that they had experienced feelings that included "'shock,' a strong sense of 'unfairness'…'anger,'…'bad and disturbed,' [and] 'disappointed'" (p. 51). These feelings, in colloquial terms, would not be considered to be positive emotions, but they do indicate heightened emotions in a way that indicates that the project triggered or increased their interest in the topic. At the conclusion of the two years, when provided the open-ended prompt, "How have your views about mathematics changed from being in my class the past 2 years?" (p. 60), Gutstein said that "16 [students] wrote about using mathematics to understand the world" (p. 61). The students' reported emotions immediately after the project, as well as their responses after completing all of the real-world projects with contexts that were intended to be relevant and meaningful to their experiences, indicate that the tasks supported development of their interest.

Some other examples of students' reactions to relevant or meaningful tasks come from descriptions of classroom experiences in *Rethinking Mathematics: Teaching Social Justice by the Numbers (Second Edition)* (Gutstein & Peterson, 2013). In response to a unit that eighth grade students worked on, where they compared the earnings they would earn using the actual wages earned by service-sector workers in their community, one student said, "'It was interesting to learn algebra that way because we learn more than just one thing… It unshields us from the safety of our home to be ready for the outside world'" (Dean, 2013, p. 74). The term "unshields" is a strong description that indicates they experienced something deeper than they had expected to in math.

Turner and Strawhun (2013, p. 130) describe a linearity and proportionality unit taught to sixth grade students in a small middle school "in a predominantly working class African American, Dominican, and Puerto Rican community in New York City" (p. 130). In this unit, the students investigated overcrowding at their school when compared to another small middle school in the same building, which happened to be a technology magnet school that "attracted affluent, predominantly white families from across the district" (p. 130). The students discovered that their classrooms were smaller than those of their peers at the other school and that, in the hallways, each student at the other school had more than four times as much space than they did. At the conclusion of this unit, several students made comments indicating that the activity supported or increased their interest since the context was of particular concern to them. One student said, "we would actually, like, really get into it, and that made it easier…. Like the facts [about the school], they made you want to find out the answer. Like we wanted to know" (p. 132) The phrase "made you want to find out the answer" indicated that the student had a desire to achieve a solution to find out more about a particular problem (overcrowding) that she faced as a student. Another student was motivated to take the results the class found and presented a speech to the local school board comparing the two schools, and also did extra research that showed the school board that their school was not up to the building codes that the board of education had set forth. This action clearly indicated that her interest in the topic was supported.

The inclusion of a realistic context that is enjoyable, meaningful, or both, can trigger or support student interest in a math task by providing access to the task. If the contexts include something that the student enjoys or is involved with outside of math class such as in Walkington's (2013) study or López and Sullivan's (1992) study, they can draw on their knowledge of that activity or appreciate being reminded of something they enjoy. For contexts that are personally meaningful to students, like those included in Gutstein and Peterson's book (2013), the contexts can motivate the students to remain engaged and seek out more information as they use what they learn to address a problem they face in their lived experiences.

Opportunity to Justify a Solution

The second feature I focus on in my study is providing students with the opportunity to justify solutions in ways that allow them to draw on their previous experiences and currently held opinions. Simon and Blume's (1996) and Hanna's (2000) articles explore the purpose and role of proof as justification in math education. Hanna (2000) said that "in the classroom, the fundamental question that proof must address is surely 'why?' In the educational domain, then, it is only natural to view proof first and foremost as explanation" (p. 8). By creating and presenting proofs, or justifications, that are explanatory in nature, connections can be made between ideas, both mathematical and experiential, to make better sense of the math. Simon and Blume (1996) agree that students benefit most from proofs that are explanatory. They suggest that mathematical arguments must:

> [P]roceed from knowledge that is taken-as-shared in the community, must be seen by the community as logical (i.e., each assertion following reasonably from the previous one), and the idea must fit

> with knowledge that has previously been accepted by that community. (p. 6)

These requirements situate the arguments among specific communities, which means that mathematical arguments or proofs that are appropriate in a community of mathematicians would not necessarily be appropriate in a mathematics classroom, creating versatility in the approach of constructing arguments in different environments. From these specific requirements for a mathematical argument, they developed a definition for mathematical justification:

> Establishing a mathematical justification involves developing an argument that builds from the community's taken-as-shared knowledge. What is taken-as-shared requires no justification. Knowledge may be taken-as-shared as the result of prior justification in the community or assumed to be part of the knowledge community members possess prior to their involvement in the community. (Simon & Blume, 1996, p. 28)

This definition allows students to draw on prior mathematical knowledge, as well as prior experiences and held beliefs, to produce an explanation for their solutions that is logical and reasonable to themselves and the audience for the justification.

Staples et al. (2012) frames mathematical justification as "a means by which students enhance their understanding of mathematics and their proficiency at doing mathematics; it is a means to learn and do mathematics" (p. 447). This framing aligns with the definition for "justification" in the Cambridge Dictionary: "a good reason or explanation for something," since to provide an explanation, the student must first reflect on their reasoning, thus enhancing their understanding. This definition allows for the inclusion of arguments that are based on previous experiences and knowledge and does not exclude arguments that are based on mathematical processes. Specifically, for my study, I am focusing on opportunities for the students to draw on their previous experiences, understandings, and beliefs about the math as well as about the world around them. The opportunity to justify mathematical conclusions in this manner has been shown to increase equity in heterogeneous groups of students (Boaler & Staples, 2008), and improve students' dispositions towards math (Staples et al., 2012).

Boaler and Staples (2008) compared the experiences of students at Railside High School which utilized a project-based math curriculum to other local schools that used other curricula. The questions the teachers asked in the project-based classrooms were 32% conceptual or probing questions while the students at the other schools asked 97-99% procedural questions (Boaler & Staples, 2008). This showed that the teachers were encouraging students to think more deeply about the problems they were working on. Similarly, the Railside students spent 81% of their instructional time either working in groups, or presenting their work, meaning that the majority of the time was spent in peer-to-peer interactions requiring the students to draw on their own knowledge to construct and present their solutions. The result of this experience was that the students' enjoyment of and interest to pursue future math experiences were increased. The trend of students' experiences with and recognition of the importance of justifying their answers in their classes can be encapsulated with the following student's quote,

> 'With math you have to interact with everybody and talk to them and answer their questions…It's not just one way to do it (…) It's more interpretive. It's not just one answer. There's more than one way to get it. And then it's like: 'why does it work'? (p. 630)

The student's recognition that they were being asked "why" something worked connects to the emphasis on explanatory proofs or justifications in the classroom (Simon & Blume, 1996; Hanna, 2000). By saying that math is "interpretive" and that "there's more than one way to get it," the student is showing that she recognized the expectation that the students use their own thought processes and approaches, and that those approaches were valued by others.

Staples et al. (2012) describe several ways in which educators recognized the power of justification for their students after participating in a summer professional learning opportunity. Staples et al. said, “teachers noted that justification allowed students to build on prior knowledge, connect two ideas in a new way, and review other course material” (p. 454). Making connections to prior knowledge deepens the students’ understanding of the math. In the same study, the teachers also recognized that giving the students the chance to justify their answers gave them more opportunities to demonstrate their understanding, even if they may not have been able to accurately calculate a numerical or quantitative result. Arguably the most important connection that Staples et al. (2012) indicates is that “engaging students in justification fostered student perseverance, independence, critical thinking skills, general communication skills…. And the habit of mind to support one’s ideas or request that of another” (p. 455). In particular, of that above list, perseverance and independence are likely indicators of triggered or supported student interest.

The process of justifying an answer or a solution process provides students with multiple ways to deepen their understanding through reflection and communication of their ideas (Staples et al., 2012). The opportunity students have to draw on their prior knowledge in their justifications provides access to the tasks allowing students to engage with the content that they may not otherwise have engaged with. As a feature, the opportunity to justify responses in ways that allow them to draw on their opinions and previous experiences can trigger or support student interest by supporting engagement through access that draws on connections to prior experiences and ideas.

Visual Representations of Quantitative Data

The third feature that I focus on in my study is the inclusion of visual representations of the quantitative data in a task. Visual representations of quantitative data can include tables, scale drawings, arrays, diagrams, or graphs that display relationships between quantities without reliance on textual descriptions of the connections or representation with alphanumeric symbols (i.e., y = mx + b) (Ioannidis, 2018; Cartiff & Greene, 2020). Ioannidis (2018) states that "for a visual representation to be useful … it must be *expressive* as well as *effective*." Expressiveness is related to the accuracy with which the visual representation captures the underlying items… Effectiveness is related to the quality of the interpretation of the visual representation by a human" (p. 4543). In other words, for the visual representation to be beneficial, it needs to display the connections between the quantities accurately and in a way that those connections can be understood by the person making use of the representation.

The inclusion of visual representations of quantitative data has been shown to support the development of students' conceptual understanding and can support their problem-solving process by creating access to the task at hand (Stylianou, 2020). Krawec (2014) states the "visual representation is critical to effective problem solving as it demonstrates comprehension of the problem and sets students up to develop an accurate solution path" (p. 111).

Visual representations can serve as either a "process" tool with which to make sense of data, or as a "product," through which a solution is communicated (van Garderen et al., 2021). As a process tool, students are given more opportunities to access a given task because the visual representation serves "as a means to understand the information provided in the problem situation and set goals – one uses representation as a tool that helps one combine different aspects of the problem so as to see all the constraints and affordances of the problem and how these interact with one another" (Stylianou, 2020, p. 110). Additionally, the inclusion of a visual representation provides students with an additional means through which to make sense of the data, making the students' understanding of the data deeper (Tripathi, 2008). Once the student has made sense of the data given in different forms, they are more likely to be able to self-regulate and successfully perform the problem-solving task (van Garderen et al., 2021).

While there is not a significant body of research linking visual representations of quantitative data directly to student interest, the aforementioned influences of the representations likely peripherally influence interest. Specifically, greater accessibility to problem-solving tasks increases students' success in problem solving task (Krawec, 2014). In a previous section I provided evidence that achievement and interest are linked with increased achievement positively influencing interest, therefore it follows that the inclusion of a visual representation may trigger or support student interest.

Student Voice

High school students can be directly impacted by teachers' instructional choices made in their classroom. For this reason, it is valuable to elicit and respond to what students say about their experiences. Giving students the opportunity to share how they are influenced by the tasks with which they are provided, as well as the types of tasks they would want to experience gives them agency over their own experiences (Robinson & Taylor, 2006). In the school setting, the decisions about what the students will be exposed to in the classrooms are decided by adults, adults whose assumptions may not align with the students' lived experiences (Jenkins, 2006). These misaligned assumptions can be addressed if the students are provided the opportunity to share their ideas, and if those ideas are valued and acted upon in meaningful ways (Cook-Sather, 2009).

One way that student voice can be elicited is through a process called *consultation*. Mitra (2018) defines consultation as, "teachers partnering with students to discuss teaching and learning, including inviting students to provide feedback on instructional styles, curriculum content, assessment opportunities and other issues in the classroom." When this feedback is acted on by the teachers, the curriculum can encourage more self-efficacy among the students along with increasing the relevance of the curriculum, and "can also increase student interest in schoolwork and learning" (p. 476). Because students are the ones that are impacted by the instructional choices made in the school setting, their insight and contributions can be invaluable to inform decisions that will improve the experience for the high school students and adult educators alike.

Summary of the Ways in Which the Literature Informed the Study Design

In order to investigate how aspects of mathematical tasks influence students' reactions in ways that can indicate triggered or suppressed interest, I first had to define the construct of interest as it is used in my study. My study focused on the first phase of the Four Phase Model of Interest, Triggered Situational Interest (Hidi & Renninger, 2006). My participants were ninth grade students who reported low levels of interest in math, therefore it is unlikely that those students were in subsequent phases of interest with regards to math. This group is of particular importance because of the connection between interest and other academic outcomes.

I selected four math tasks that included the three focus task features: the inclusion of a realistic context, the opportunity to justify an answer with previous experiences, and visual representations, specifically graphical representations, of quantitative data. Each task was embedded in a single context, contexts which were intended to be enjoyable, relevant, and/or meaningful to the students. Each task included at least one prompt representing each of the other two features. I also created an additional comparison task that was devoid of these intentional features to be used as a contrasting task to the focus tasks.

I chose to recruit participants by using a Likert scale survey of situational interest that I administered to three classes. I used the results of those surveys to invite students scoring below a pre-determined threshold to participate in semi-structured interviews. As an effort to combat the weakness of post-experiential interviews, I facilitated the task-based interviews while the students completed each task in a way that obtained in-the-moment responses with minimal disruptions to the students' work. Each participant also completed a reflective interview that took place after all of the task-based interviews that allowed them to compare all of the tasks they completed during the interview process.

Finally, my data is comprised entirely of student voice. I provided my participants with abundant opportunities to share what they were thinking. Their reactions and explanations provided me with the insight to answer the following research questions:

Research Question 1: *Among high school students who reported having low situational interest in mathematics, to which aspects of mathematical tasks did these students react? In what ways did the students react to the aspects and what explanations did they provide for their reactions? Which, if any, of the aspects were intended features of the focus tasks?*

Research Question 2: *What are the different cases that emerge when considering students who reported having low situational interest in mathematics that frequently and consistently reacted to a particular task aspect across most, or all, of the five different mathematical tasks? Within each case, how were the students' explanations for their reactions to that particular task aspect similar and different across the mathematical tasks? How do their explanations for their reactions support the concluding stances for that particular task aspect?*

Chapter 3

METHODS

In this chapter, I will describe the data collection and data analysis process that I used when conducting this study. Regarding data collection, first I will describe the context in which my study took place. This includes how I chose the school in which to situate my study, details about the school, and a description of the classes from which the student participants were recruited. I will then detail the process I used to identify and select students who reported having low situational interest in math from the classes, culminating with a description of the recruited students that agreed to participate in my study. From there, I will discuss the interview procedures used to collect the data as well as how the five mathematical tasks were selected or designed.

Also, I will describe how I analyzed the data to explore how students discussed their experiences with the mathematical tasks. This analysis occurred in two different ways, to answer the two different research questions. The goal of the first research question, and the associated analysis, was to examine which aspects of the mathematical tasks elicited positive and/or negative responses from the students. The goal of the second research question, and the associated analysis, was to describe representative student cases that can further our understanding about how students with low situational interest in mathematics experience a variety of mathematical tasks.

Context of the Study

The research questions I sought to answer in this study centered on understanding the experiences of high school students who reported low situational interest in math. I specifically wanted to recruit student participants who came from a school with a high population of Black and Hispanic students and significant economic need who also reported low situational interest in math. This population of students represents the intersection of two populations that generally underachieve when compared to their counterparts. With regards to interest, students with low interest in a subject do not tend to achieve at the same levels as their more interested peers (Mitchell, 1993; Singh et al. 2002; Boaler & Staples, 2008). With regards to ethnicity and socioeconomic status, students from schools with a higher percentage of Black and Hispanic students, and students from schools with a higher percentage of significant economic need, tend to underperform and underachieve when compared to students at schools with lower percentages of both (Ladson-Billings, 2006; Chen & Nunnery 2019; de Brey et al., 2019). By focusing on this intersectional population, insights can be gained about specific barriers to interest for this population which may inform new ways to increase student interest and improve prospects of higher achievement.

Selecting the School and Teacher

To gain access to high school student participants like those described above, I had two main considerations, I needed to find a school that fit my requirements, and I needed to find a teacher at that school willing to let me come into their classroom to recruit and work with their students. To find a willing teacher, I asked a student teaching specialist who works with local area high schools to send me a list of teachers that she thought would be interested in supporting my research. The list she sent me had six teachers' names, representing five local area high schools. Four of the five high schools had a Black and Hispanic student population between 62% and 90% and between 30% and 49% of their student population are classified as low-income. The other school had a Black and Hispanic student population of 31% and 6% of their student population were classified as low-income (Delaware Department of Education, 2022). Because the four schools better fit my preferred student population, I decided to begin by reaching out first to the teachers at those schools.

Three of the four teachers I contacted indicated initial willingness to let me interview their students, but only one, Ms. Harper (all names used are pseudonyms), agreed after I fully explained my requests. The specific requests that I outlined in the e-mail were 25 minutes of classroom time with the whole class, as well as multiple opportunities to conduct interviews with individual students, which added up to approximately four hours of one-on-one time with each participating student. I explained that the interviews would involve the students interacting with math tasks, but I did not specify that I was seeking student participants who indicated low student interest in math. After Ms. Harper agreed to participate, I acquired permission from the school's administration to conduct my study in the building during school hours.

School, Teacher, Grade Level, and Course Selection

The school in which I conducted my study was a suburban Title I Mid-Atlantic public neighborhood high school that serves grades 9-12. The schools' student population at the time data was collected consisted of 999 students enrolled in grades 9-12. Of the 999 students, 47% identified as African American or Black, 25% identified as white, 15% identified as Hispanic, 8% identified as Asian, 3% identified as multi-racial, and the rest of the student population did not report their race. Furthermore, 39% of the student population was classified as low-income (Delaware Department of Education, 2022).

The participants in this study were in ninth grade. Being in ninth grade, their perspectives on school, classes, and their futures are different from their counterparts in higher grades. Ninth grade students are new to the high school experience, where they are typically expected to take on more responsibility and ownership of their own achievements, especially with regards to graduation requirements (Fulk, 2003). Furthermore, McCallumore and Sparapani (2010) write that “Ninth graders have the lowest grade point average, the most missed classes, the majority of failing grades, and more misbehavior referrals than any other high school grade level.” These concerns, especially since my target participants were students indicating a low situational interest in math, a core academic subject, makes this population’s perspective unique and important as it relates to my research focus. Ms. Harper taught only ninth grade students at the time of my study, so my participants would all be ninth graders.

Ms. Harper taught two different ninth grade courses, an on-level course, and an honors-level course, which was an accelerated version of the ninth grade on-level math course. Ms. Harper described the topics covered in the on-level course, titled “Integrated Math 1” as “Modified content, mostly Algebra 1” and the honors course, titled “Integrated Math 2, honors” as “Mostly Geometry & more Algebra 1” (personal communication, February 21, 2019). She taught three sections of the ninth grade on-level math course, which included two days a week for additional academic support with curriculum-based instruction on the other three days. She taught one section of the ninth grade honors-level math course, which had five days a week of curriculum-based instruction.

The decision to recruit from the ninth grade on-level math course was a three-part decision that I made in collaboration with Ms. Harper. First, neither myself nor Ms. Harper were comfortable with removing any students from the classroom during curriculum-based instruction. However, during the academic support days, students worked on self-paced mathematics activities designed to support their curricular instruction, and she would excuse the students from those activities while they were interviewing with me. In other words, I had permission to use class time during the two academic support days, providing me with time to meet with students during the school day.

Second, because Ms. Harper taught three sections of the on-level course, I had a larger population of students from which to recruit. There was a total of 88 students in the on-level course to recruit from, and there were only 23 students in her honors-level course My goal was to recruit students who indicated low situational interest in math on an evaluation tool (which is explained in the participant selection section) and the lower number enrolled in the honors course would likely reduce the number of students that would meet my criteria for recruitment.

Third, the student population of the on-level course, for several reasons, more closely reflected the demographics of the students I wanted to have represented in my study. First, the on-level course closely reflected the school's total population with most of the students being non-white, whereas more than 50% of the students in the honors course identified as white. Furthermore, because interest can influence achievement, the students in the honors-level course (generally expected to be higher-achieving than their peers in on-level courses) were more likely to have higher interest (either situational or sustained) in the subject than their peers in the on-level course. All of these reasons informed my decision to recruit from the students in the on-level course.

Participant Selection

In this section, I will explain how I recruited students who reported low situational interest in math for participation in the interviews I conducted for data collection. First, I will describe the survey that I used as an evaluation tool to assess students' level of situational interest in math. Then I will explain how I administered the tool in Ms. Harper's classes and used it to recruit the 11 students that participated in the data collection interviews.

Situational Interest Evaluation Tool

To recruit students who reported low situational interest (SI) in math, I needed a tool that would evaluate the level of student SI. This tool needed to be accessible to ninth grade students and not infringe too long on the students' math classroom time. I was able to meet these requirements by version of a survey of student SI found in Linnenbrink-Garcia et al. (2010). This modified survey became my recruitment tool. Both the original survey questions from the Linnenbrink-Garcia et al. survey and the modifications I made are in Table 3.1. I explain the survey selection and the specific modifications below. The student-facing version of the modified survey I made is in Appendix A.

Table 3.1 *Original Survey Questions from Linnenbrink-Garcia et al. (2010) Study 1 and Modified Survey Used for Recruitment Tool*

Original	Modified
1. I think the field of psychology is very interesting	1. I think mathematics is very interesting
2. Psychology fascinates me	2. Mathematics fascinates me
3. I'm excited about psychology	3. I'm excited about mathematics
4. I think what we are learning in this course is important	4. I think what we are learning in this class is important
5. I think what we are studying in Introductory Psychology is useful for me to know	5. I think what we are studying in mathematics is useful for me to know
6. I think the field of psychology is an important discipline	6. I think mathematics is an important subject
7. To be honest, I just don't find psychology interesting	7. To be honest, I just don't find mathematics interesting
8. I find the content of this course personally meaningful	8. I find the content of this class to be personally meaningful
9. I see how I can apply what we are learning in Introductory Psychology to real life	9. I see how I can apply what we are learning in mathematics to real life.

To explain why I chose to use the specific survey that I did, I will summarize the work that Linnenbrink-Garcia and colleagues (2010) reported in their validity study article, "Measuring Situational Interest in Academic Domains". In the first of three studies explained in the article, Linnenbrink-Garcia and colleagues explored the SI of a cohort of undergraduate students who were enrolled in an introductory psychology course. To do this, they gave the students a survey that had eleven items intended to measure maintained-SI, and six items intended to measure triggered-SI. The students rated each item on a scale of 1 (Strongly disagree) to 7 (Strongly agree). In the process of analyzing the results, the researchers dropped three items from the analysis due to their ambiguous wording, two in the maintained-SI category and one in the triggered-SI category. The results of the study indicated that the responses to the questions asked could be used to predict the amount of SI the psychology students had in both their specific course and the subject of psychology as a field.

There were two additional studies presented in the Linnenbrink-Garcia et al. (2010) article that were studies of surveys given to students in middle and high school math regarding interest, but those surveys did not suit the needs of my study. These two included surveys specifically designed to give to students in middle and high school math classes to evaluate their interest in math, and their original survey questions were adjusted for those purposes. However, even though I was exploring SI in high school math classes, the questions used in the initial survey given to the psychology students was more relevant for my purposes. This is because the authors adjusted the first survey "to more cleanly tap situational interest that emerged specifically from a given course" (p. 658) instead of a general subject matter (in their case the field of psychology), which did not align with my own purpose of finding students with low SI in math as a general subject matter. For that reason, I instead adapted the psychology survey from the first study to use for my recruitment tool.

There were three adaptations that I made to my survey from the one used in Linnenbrink-Garcia et al.'s (2010) Study 1 so that it met the needs for my study. First, the Triggered-SI items were intended to find out students' affective responses to the specific *ways* in which course content was presented in class, as opposed to the *topics* in the content itself. Because I did not want students to consider their specific teacher or class routines in their survey responses, I excluded all of the Triggered-SI items from my survey. Furthermore, in the original study, the authors separated the Maintained-SI items into Feeling and Value categories, which was not necessary for my research purposes because I was only evaluating overall SI, not categorized SI. For this reason, I combined all nine items into a single Maintained-SI category.

Second, I slightly altered the wording of the survey items to suit the needs of my study. This was because my participants were high school math students and not college psychology students. In particular, I changed the language mentioning psychology to refer to math and used slightly different terms to make the questions more relevant to high school students (e.g., replacing "course" with "class"). As mentioned at the beginning of this section, Table 3.1 shows a side-by-side comparison of the original and modified versions of each survey item.

Lastly, I needed to create the survey in a way that would facilitate a clear distinction between students I classified as having low-SI in math from the rest of the students. To do this, I altered the number of answer choices for each item from seven to six. By doing this, I eliminated the option students had of picking a "neutral" sentiment for any given item. In the modified survey the students were given the following options: 0-Strongly Disagree, 1-Disagree, 2-Slightly Disagree, 3-Slightly Agree, 4-Agree, and 5-Strongly Agree. Because there was no place for a student to mark a "neutral" or "non-response," the students had to choose an option that leaned more towards "Agree" or more towards "Disagree", making a clearer distinction between students with low SI and their classmates. A student's score was calculated by adding the value of each of their nine item responses as it related to level of SI. For all items excepting item seven, the value was the response the student indicated. Item seven, which was “To be honest, I just don’t find mathematics interesting,” was the only question where an “agree” response indicated that the student was not interested in math. For this reason, I reverse scored that item, so that if a student responded with 0 (Strongly Disagree), the value of that item was 5, if they responded with 1 (Strongly Agree), the value was 4, etc. This meant that a possible score range was 0-45 with 0 meaning lower SI and 45 meaning higher SI.

Prior to administering the survey, I determined a cut-off score to use to distinguish students with low SI from their classmates. I decided that using a cut-off score, as opposed to a threshold percentile within each class period, would be more useful to identify the individual students having low SI in math. Using a threshold percentile would compare the students to their classmates, and it is possible that within a particular class that many, or all, of the students would have higher SI in math than students in a different class. If I recruited students using a threshold percentile, it would be possible that I would be recruiting students in one class for interviews that had a higher SI in math than students who were not recruited in another class. By using a cut-off score, this possibility was avoided.

I decided that the cut-off score should represent students who, on average across the nine items, responded in ways that indicated lower than neutral interest responses to the questions. To make the distinction, I opted to use 22.5 as the cut off score. This score represents the median possible score for the survey, so students falling below this score would be on the lower half of the spectrum of responses, which I interpreted as students more likely to have low SI in math. Because all survey scores were whole numbers, it would not be possible to fall exactly on the cut-off score, making it a clear delineation of students I defined as having low SI from their classmates.

Survey Administration and Participant Selection

Prior to administering the survey to students, I made a short presentation to each of the three on-level ninth grade math course classes to explain my study and hand out student assent and parent consent forms. (Human subjects recruitment processes were followed aligned with IRB approvals from the University of Delaware.) During this time, I explained that I was conducting a research question about how high school students felt about math and asking them to complete a short survey about their feelings towards math. I encouraged them to be honest with their responses and assured them that no one at their school, including Ms. Harper, would see their surveys or the results. I also let them know that I would be selecting some students based on their survey results for one-on-one interviews on future days. I did not indicate to the students, or to Ms. Harper, how their responses would inform my selection of students I would be selecting, only that I would be selecting students based on the survey responses.

At this point, I handed out the IRB student assent and parental consent to participate forms. I explained what each form was, and that their parents and themselves had the option of letting them participate. I also highlighted that if they were selected to participate in the one-on-one interviews that they would be given a $40 Visa gift card after the last interview to compensate for their time and effort. Ms. Harper told the students that she would be using the survey completion as the students' daily participation points for the day that I administered the survey, so all students would have to complete the survey even if their parents did not sign the form.

All students who were present during the day that I explained my study signed the assent forms and immediately gave them back to me. Ms. Harper told the students to make sure their parents reviewed the consent form and to bring it back signed if they agreed to the student's participation. I provided Ms. Harper one large envelopes for each class in which she could place the signed consent forms. I collected the envelopes from her on the days that I administered the survey.

Of the 88 students enrolled in the course, 72 students were present for survey administration and both assented and obtained parental consent to participate. After I handed out the surveys, I reminded the students that their honesty was important, and that Ms. Harper would not see their responses. I also answered any questions about the rating scale, and I informed them that the two demographic questions (gender and ethnic identities) were optional. I told the students they had 10 minutes to complete the survey and started a timer. At that time, I collected the surveys. Students who completed the survey for class participation points, but were not study participants, were allowed to keep their surveys after showing completion. To avoid seeing student results, but still grant them participation points, Ms. Harper checked off students' names as they handed me their surveys or showed me that they were complete (I only analyzed survey data from students that assented and if their parents gave consent.)

Of the 72 participants, 15 students qualified to be recruited for the one-on-one interviews, and 11 participated in the study. I invited the 15 qualifying students to participate in the interview process. I met with each student in person individually so they could ask me any questions they had about the interview process. I explained that Ms. Harper had given me permission to use the academic support class time to conduct the interviews and that they would not be responsible for work missed in math class on those days. I told them that each interview would be 30-45 minutes long and that there would be at least five interviews. After this explanation, three students immediately withdrew their assent and one student completed two interviews but was unable to complete any more. This left me with eleven students participating in the interview process, five students in one class, and three in each of the other two classes. I assigned pseudonyms to the students that reflected their given names by keeping the first letter and the number of syllables. The demographics of the eleven interview participants are included in Table 3.2. Four of the students were female and seven were male. Six of the students identified as Black, two identified as white, one as multi-racial, one as Black/Pacific Islander, and one as Hispanic. All eleven participants had chosen to answer the demographic questions about their gender and ethnic identities on the survey, so their identities are student-declared responses.

Table 3.2 *Student Participants for Interviews*

Pseudonym	Gender	Ethnicity
Arthur	Male	Black
Andrew	Male	White
Callie	Female	White
Coleman	Male	Multi-racial
Diondre	Male	Black
Francis	Male	Black
Janelle	Female	Black/Pacific Islander
Jorge	Male	Hispanic
Khalil	Male	Black
Kimberly	Female	Black
Shantel	Female	Black

Data Collection

The data for my study came from multiple one-on-one interviews with the eleven student participants. Each student participated in a series of six or seven interviews beginning with a pre-interview, four or five mathematical task interviews, and a culminating post-interview. I spent, on average, just over three hours engaged in interviews with each student. In this section, I will begin by explaining how I selected the mathematical tasks that the students completed during the math task interviews and describe each task. I will then detail the interview process that each student completed with me. The series of interviews began with a pre-interview to familiarize the students with my study and so I could get the students' general stance towards math and their initial reactions to the tasks. The students then completed task interviews, during which I prompted the students in multiple ways to encourage them the explain their reactions. The final interview gave the students additional opportunities do share their reactions to tasks or tasks parts by comparing their experiences across all completed tasks.

Task Selection

I used five different multi-part mathematical tasks ("tasks") during the interview process (see Appendices B-F for the student-facing tasks). The target of these tasks was to provide the students with exposure to tasks that either included or excluded intended features that research has shown affects students' experiences with mathematical tasks. These intended features are the following: having a *realistic context (context),* being given *the opportunity to explain or justify an answer using opinion or experience (opportunity to justify)* and being asked to *interpret data represented in a visual representation (graph interpretation).* Four of the tasks, the focus tasks, were selected to *include* intentional features that researchers have shown can affect students' experiences with mathematical tasks in general. I designed the fifth task, the comparison task, to *exclude* the intentional features that were included in the focus tasks. In all cases, it was possible that each task could have potential, unanticipated aspects that could impact students' experiences as well.

The first step that I used to determine which tasks I would use was deciding what mathematical topics and rigor would be appropriate for the students being interviewed. For this reason, before selecting or constructing the tasks, I talked to Ms. Harper about the topics she had covered up to the point that data collection would begin. The goal of the interviews was not to be instructional in nature, so I wanted to choose tasks with math topics that the students had been exposed to in math class. I also did not want variations in mathematical topics to be the focus of the students' responses during the interviews, so I wanted all five tasks to have similar mathematical topics.

All five tasks that I selected or created (i.e., the four focus tasks and the one comparison task) had mathematical topics familiar to the students that were related to linear functions. Because the interviews were conducted near the end of the school year, Ms. Harper had been their teacher for several months and said she had spent the most time covering linear equations and systems of linear equations. Using this information, I decided to select tasks that centered these topics, or topics that were closely related, such as linear inequalities. I showed her the five tasks prior to interviewing the first student, and she confirmed that the mathematical topics involved in the tasks were aligned with what the students had seen in her class previously. She also confirmed that she had not used tasks that looked like the focus tasks during her instruction, so the task appearance would likely not look familiar to the students. She also said that she had used tasks with a similar structure as the comparison task that I designed. Table 3.3 provides a summary of the tasks' titles, contexts, and included mathematical topic(s).

Table 3.3 *Titles, Context Descriptions, and Mathematical Topics Included for Focus Tasks and Comparison Task*

Task Title	Context	Mathematical Topic(s)
"Datelines" (DL)	Half-plus-seven dating age rule	Linear inequalities Linear inverses
"Financial Aid" (FA)	Comparing educational paths after high school	Systems of linear equations
"Pic Me!" (PM)	Instagram interactions	Scatterplots and their best-fit linear models
"Wage War" (WW)	Supply and demand of workers based on wages offered	Systems of linear equations
Comparison Task (CT)	None	Systems of linear equations Scatterplots and their best-fit linear models Linear inequalities Linear inverses

Four Focus Tasks

I selected these four focus tasks because they incorporated the three intended features described above, and the tasks came from the educational resource site "Mathalicious" found at mathalicious.com. Mathalicious, (which has since been re-organized and re-named "Citizen Math" at citizenmath.com) was a site that provided access to a multitude of pre-structured mathematical lessons with rich problem-solving tasks covering topics intended for grades 6-12. I chose to use this resource to select my tasks because all the lessons provided on the site intentionally include both *context* and *opportunity to justify.* Specifically, each of the lessons are developed around a familiar real-world context that is intended to be socially relevant to the target student audience. According to the description of Mathalicious on edshelf.com by the lesson creators, “We create lessons that explore the math behind real-world topics, from sports to shopping to the odds of finding life on other planets.” Furthermore, each lesson on Mathalicious also includes the *opportunity to justify* which is supported by the same edshelf.com description by the authors that each lesson, “challenges students to construct arguments, justify their reasoning, and use mathematics to think more critically about the world.”

Because I was not using the Mathalicious lessons for instructional purposes, I repurposed the included lesson activities to be used as my tasks. Mathalicious lessons are intended to be facilitated by a teacher in a classroom setting, potentially over multiple days. Each lesson has a launch that is either a video or an interactive applet, followed by multiple lesson activities that may or may not have a digital component. As a component of my task decision process, I chose lessons on Mathalicious that had solely paper-based lesson activities that were accessible to students who had not seen the launch. I also made sure that the lesson activities I selected maintained the inclusion of context and opportunity to justify for that lesson (every activity may not have contained both, but when all activities were examined, at least one part contained context or opportunity to justify). The paper-based lesson activities were what I used for my tasks. To make the distinction between the Mathalicious lessons and lesson activities being used as intended, and the way in which I used the lesson activities combined as a single multi-part task, I will refer to each lesson activity as a task part.

To select the specific four tasks from Mathalicious, I used the filter options provided on the Mathalicious website and selected tasks that fit my criteria from the results. These filters allowed users to search for lessons by grade level or math course, by math topic, and by context. Using these filters, I searched for tasks where the topic was “solving linear equations” or “solving linear systems”, and limited the results to Algebra 1, the closest equivalent to the students’ current course. Because all of the lessons in the search results already contained *context* and *opportunity to justify*, I had to make sure to select lessons that also contained *graph interpretation*. By the nature of the math topics I searched for, and the intent of Mathalicious lessons as stated by the authors, it was not surprising that all the tasks that appeared in the search result required the students to reference a graph in order to fully answer at least one task part. However, there was variation in how the graphs were presented to the students. In some tasks, the graph was provided, and in others the student had to construct the graph before using it as a resource.

Because I was using Mathalicious as the source for my tasks, I was unable to select four tasks with the exact same mathematical topic. Mathalicious is designed as a resource to find supplementary lessons for topics to use alongside an external comprehensive curriculum. As such, there are not many specific mathematical topics that are covered in multiple Mathalicious lessons. All four selected math tasks do have a specific mathematical topic that is directly related to linear equations or systems of linear equations. Once I completed the task selection process, the four focus tasks that I selected from Mathalicious were titled “Datelines,” “Financial Aid,” “Pic Me!” and

“Wage War” (see Table 3.3 for the task, context, and topic) These four tasks will be described in detail with emphasis on how the three intended features are present in each, and the student-facing versions of these tasks are included in Appendices B-F.

“Datelines” Task. The “Datelines” (DL) task is a six-part task that focuses on linear inequalities and linear inverses as its mathematical topics and includes the three intended features. The first intended feature, *context,* as described in the task subtitle is “What’s an acceptable dating range?” The first part of the task begins with the statement, “To determine the age of the youngest person you can date, some people recommend using the formula **half-plus-seven**: *start with your own age, take half of it, and add seven years* [emphasis theirs]” and each subsequent task part relies on the half-plus-seven rule in this introductory statement. The second intended feature, *opportunity to justify,* occurs in task parts 1, 4, and 6. The third intended feature, *graph interpretation,* occurs in task parts 4-6.

All task parts in the DL task rely on the “half-plus-seven” *context* given in the prompt. Part 1 uses this rule to prompt students to complete a table where either the older person’s age or the younger person’s age is provided, and the student has to provide the missing age. Parts 2 and 3 prompt the student to use the rule and the table to develop two separate linear equalities with variable “a” representing one person’s age, and variable “d” representing the other person’s age. In the first linear equality, the input, “a” represents the older person’s age, and the output, “d” represents the younger person’s age; in the second linear equality, “a” is the younger person’s age and “d” is the older person’s age. The students then construct a graph of these two linear equalities on the same given axes, and then in part 4, transform the graphs into one representing a system of linear inequalities, by considering that the lines are the boundaries of an age, not inclusive of all ages that fit the rule's criteria. In part 5, the task shows images of four celebrity couples and provides the actual ages at which they started dating and asks the students to classify whether the age gap followed the dating rule. Finally, in part 6, the students are asked to consider the age gap between the two people as time passes and how it affects their adherence to the rule.

Three DL task parts give students the *opportunity to justify*. In part 1, after completing the table, the students are given the prompt, "Does half-plus-seven make sense for all ages? Explain." The students can then use the results from their table, as well as their own experience about the reasonableness of dating ages, to respond as to whether the rule makes sense. For example, the age of 10 years is given on the table, both as the older and the younger person, and a student may respond that 10 is too young to be a part of a couple. This response would not be based strictly on the accuracy of their calculations, but rather their personal experiences. In part 4 the students are prompted with "what does [the shape of the shaded region] suggest about your dating prospects as you get older? Explain." This prompt allows the students to answer in a variety of ways but asks them to filter their answers through the interpretation of their experience with the context, not limiting it to a quantitative response. Finally, in task part 6, the students are given the prompt, "once someone is inside your RoCo, will (s)he ever be outside of it again? Explain your reasoning." RoCo is short for "romance cone," which is what the authors called the shape of the shaded region created by the two linear inequalities. For this part, the students' answers would rely on their knowledge and understanding that people age at the same rate, without being given any mathematical models or prompts to guide them to that answer. Although there is only one correct answer for this task part there are multiple ways to explain or justify this answer that relies on the lived experience of aging one year at a time, or by using a mathematical justification they had previously learned but was not included in the task (e.g., a slope of "one" representing both people aging one year every year, is bigger than the slope of one of the inequalities, but smaller than the slope of the other.)

The students are prompted to use *graph interpretation* in DL task parts 4, 5, and 6. In part 4, the students are prompted to describe the shape that was created from their constructed system of linear inequalities and interpret it as it relates to the half-plus-seven context. In part 5, the students are prompted to use their constructed graphs to determine whether the ages provided for the real-life celebrity couples obey the dating rule by plotting the points and interpreting the meaning of the location of each point. In Part 6, the students are prompted to refer to their constructed graphs and interpret the "RoCo" representation for a general situation, rather than the specific instances referred to in part 5.

"Financial Aid" Task. The "Financial Aid" (FA) task is a five-part task that focuses on systems of linear equations as its mathematical topic and includes the three intended features. The first intended feature, *context*, as described by the task's subtitle is, "Is college worth the cost?" The task gives the average earnings for people with various levels of education, as well as the cost for various educational paths and the students use this information throughout the task to compare and contrast the cost and benefits of choosing different paths after high school. The second intended feature, *opportunity to justify,* occurs in task parts 2 and 5. The third intended feature, *graph interpretation,* occurs in task parts 3 and 4.

All task parts in the FA task have their basis in the task's *context* of comparing different educational paths. The task part 1 prompt provides the median incomes for a high school graduate and someone with a bachelor's degree, as well as the average yearly tuition and expenses for a four-year college according to the National Center for Educational Statistics (the year the data was take from was not provided). The students use this information to complete a table and a graph for the net income for each educational path for every year 0 through 6.

Task part 2 prompts the students to consider how many years it would take for both options (high school diploma and bachelor's degree) to yield the same net income and how that might affect someone's decision after high school. Part 3 provided the students with a single graph that had four separate functions on it. Two of the functions represented the data from the previous two parts, the other two functions represented a student acquiring a two-year associate's degree and receiving a master's degree after six years of schooling. The students were prompted to determine the yearly cost for schooling for each, as well as the yearly income post-graduation from the graph.

The students were prompted in part 4 to find the age someone would be when the net incomes were equal for pairs of educational paths that are similar, associate's vs. high school diploma, bachelor's vs. associate's, and master's vs. bachelor's, and then had students determine lifetime net income for each path assuming someone retired at age 65. Finally, in part 6, the students are asked to consider factors, such as the subject areas someone studies for their degrees, that are not included when using the median values for comparisons.

Two FA task parts give the students the *opportunity to justify*. In part 2, the students are prompted to determine when a high school diploma and a bachelor's degree would yield the same net income and then use that information to respond to the question, "Based on this, do you think it would be a smart decision for her to attend college? Explain." The wording of this prompt invites students to defend one choice over the other, likely incorporating their own experiences into the answer. Part 5 has students considering additional details that might influence a person's decision about educational paths which had not been considered in the previous task parts. In previous parts, the students only considered the median yearly income for each educational choice, whereas in part 5, the student are told "the average starting salary…in petroleum engineering is $98,000 and $33,100 for someone…in social work" after both received a bachelor's degree. The prompt then asks the students, "When deciding what to study (and for how long), how important do you think average income is, and do you think it's the most important factor? Explain." The students once again are invited to use their own experiences and opinions to justify their answer to the prompt.

The students are prompted to use *graph interpretation* in parts 3 and 4, whereas they are given the option to use a graph or quantitative calculation in part 2. The task, as provided to the students, included two reference graphs, each containing the data representing the information for all four educational paths given in the task parts. One of the graphs went from 0 to approximately 43 years post-graduation and the other from 0 to 20 years post-graduation. The students had access to these graphs for all task parts, in addition to the graph they constructed for part 1, and the graph included in task part 3 (0 to 10 years post-graduation). Task part 2 prompted the students to determine how old someone would be at the point where a bachelor's degree and a high school diploma would yield the same net income. A student could determine the answer using either a reference graph, or by calculating numerically when the net incomes would match. In part 3, students were provided a graph with the data for an associate's degree and a master's degree plotted on it and prompted to use the graph to "determine the annual tuition and expenses, as well as the median annual income." In part 4, the students were given a reference graph with the input range of 0-20 years to find the age when pairs of different paths yield the same net income, and a reference graph with the input range of 0-43 years to find the total net income at retirement for each of the four options.

"Pic Me!" Task. The "Pic Me!" (PM) task is a four-part task that focuses on scatterplots and their best-fit linear models as its mathematical topic and includes the three intended features. The first intended feature, *context*, as described in the task subtitle is "How can you become popular on Instagram?" Throughout the task, the students are prompted to explore the relationship between various details about different Instagram accounts including followers and interactions, among others. The second intended feature, *opportunity to justify*, occurs in task parts 3 and 4. The third intended feature, *graph interpretation*, occurs in task parts 1-3.

All task parts in the PM task are developed around the *context* of Instagram interactions. Task part 1 includes a scatterplot showing the relationship between the number of followers and interactions for several different Instagram accounts and prompts the students to respond to the question, "do you think having more followers will make a picture more popular?" Part 2 includes two scatterplots; one shows the relationship between the number of Followers versus the number an account is following and the other scatterplot shows the relationship between the interactions with a post versus the number of hashtags used. The task prompts the students to use the two scatterplots to explain whether it makes sense to follow more accounts or add more hashtags to get people to interact with an image. In part 3, the students are given data from Union Metrics, which is described as “a company that analyzes Instagram data for major brands such as Nike and Urban Outfitters.” This part has two graphs, one is a non-linear graph that shows the relationship between the number of hours because a post was added to an account and the percentage of interactions, whereas the other is another scatterplot showing the relationship between the number of total monthly interactions and the average posts per day. The students use the given data to answer the prompts “Does it appear that brands who post more frequently receive more comments and likes?” and “How often would you suggest that a brand post a new image to Instagram and why?” Finally, in part 4, the students are given a quote from a *Business Insider* article, “Teens are spending thousands on prom so they can look cool on Instagram,” and prompted to reflect on the value of Instagram interactions.

Two PM task parts give students the *opportunity to justify* when they are giving their answers. The prompts the students answer in part 3 both require the students to consider possible explanations for the trends demonstrated by the graphs, not just describe what those trends are. The first prompt includes the question, “Why do you think this is the case?” and the second prompt asks the students to answer the question, “How often would you suggest that a brand post a new image to Instagram and why?” Both of these questions encourage students to consider their own experiences when interpreting the information provided in the graphs. Part 4 of the

PM task does not incorporate quantitative information, but does tell students to consider the described experiences of other teenagers on Instagram, as reported by *Business Insider*, and asks students to give their own personal opinions in their answer to the prompt, “How valuable do you think interactions are on Instagram, and what might be some consequences of trying to build a ‘personal brand?’”

The students are prompted to use *graph interpretation* in PM task parts 1-3. The prompt for students in task 1 begins with “According to the line of best fit, how do additional followers affect the number of interactions,” which requires the students to use and interpret the given scatterplot and line of best fit. In part 2, the students use the information given in two different scatterplots and are prompted to interpret both scatter plots in their answers to the question, “Based on the scatterplots below, which seems like a more effective strategy… and why?” Finally in PM task part 3, one of the questions the students are asked in the prompt, “Does it appear that brands who post more frequently receive more comments and likes?” is directly related to the two graphs provided in the part.

“Wage War” Task. The “Wage war (WW)” task is a four-part task that focuses on systems of linear equations as its mathematical topic and includes the three intended features. The first intended feature, *context*, as described in the task’s subtitle, is “How much should companies pay their employees?” Throughout the task, the students are prompted to explore the implications of offering and providing various wages for their workers. The first part of the task has students construct an employee supply and demand graph for an hourly job being offered to unskilled workers. The next two parts use the implications of the data in the graph to consider what the graph would mean in a real-life scenario and the last part expands on those considerations to explore wider implications of changing or keeping the current federal minimum wage. The second intended feature, *opportunity to justify,* occurs in task parts 3 and 4. The third intended feature, *graph interpretation,* occurs in task parts 2 and 3.

All task parts in the WW task are based on the supporting *context* of exploring hourly wages. Task part 1 provides three supply and demand pairs where the supply is the number of workers willing to work at each hourly rate for wages, and the demand is how many workers the company would want to hire at each rate. The students create a single graph plotting both the supply and demand lines using the information. This graph is used in task part 2 where the students are provided with $7.25 per hour as the federal minimum wage (this wage was accurate for the year in which I collected the data) and then are asked with the following question to interpret the meaning of that wage as it relates to the scenario their graph represents: “If the company only pays minimum wage, can it hire as many workers as it wants?” WW task part 3 prompts the students to determine the meaning of the solution of the linear system of equations as it relates to the wage the company is willing to offer (i.e., “Find the lowest wage at which the restaurant will be able to attract as many employees as it wants”). Task part 4 does not use the previous data or graph the students created, and instead asks the students to reflect on the implications of the federal minimum wage as it affects societal constructs. The prompt starts by briefly explaining struggles of low-income working American families and goes on to ask the students, “Some people think the government should raise the minimum wage…If this happened, how do you expect it would impact workers at the business?”

Two WW task parts, parts 3 and 4, give students the *opportunity to justify*. In task part 3, the students are first prompted to find “the lowest wage at which the restaurant will be able to attract as many employees as it wants,” or the solution to the system of equations, but proceeds to prompt the students to reflect on what this solution means in terms of the scenario by asking, “Do you think this is the amount the company should pay its employees? Why or why not?” Mathematically, based on the model the intersection of the supply and demand lines is the lowest wage, but by asking the students to defend whether that amount is actually the best wage to offer in a real-life context, the students are able to incorporate outside experiences or a sense of how workers seek jobs and how companies hire them. In part 4, the students are not prompted to complete any calculations, and their response is based entirely on their opinions and experiences. The prompt mentions common struggles of Americans working minimum wage jobs and their “struggle to afford rent, childcare, and other expenses,” and asks students to consider the implications for the workers if the minimum wage was raised. The prompt does not ask students to decide if they believe it should be raised, so the students are not defending one choice over the other, rather just considering any possible implications for the workers at businesses if the minimum wage was increased.

WW task parts 2 and 3 ask the students to use their constructed *graph interpretation* to answer the questions in the prompts. Task part 2 prompts the students to interpret the meaning of the minimum wage or $7.25 as it relates to both the supply and demand of workers available to work at that wage. Task part 3 prompts the students to find the solution of the system of equations they constructed and interpret the meaning of the coordinate pair as it relates to the number of workers available/desired, and the hourly wage the company is offering.

The above explanations show how all four focus tasks include the three intended features of *context*, *opportunity to justify,* and *graph interpretation.* Each task was consistently supported by its context throughout all parts of the task, and each expected student answer was prompted to be interpreted through the lens of the context and its implications. Each task also had at least two parts that gave the students the opportunity to justify by incorporating their personal experiences and opinions to formulate a complete answer. Finally, each task also had at least two parts where the students had to use either a provided graph, or a graph that the students constructed, to show they could use as a resource to answer a question as it related to the interpretation of the meaning of the graph, not just find a quantitative amount on the graph. To contrast tasks that included the intended features of the focus tasks, I created a fifth task (i.e., the comparison task) that was devoid of the intended features, which I describe next.

Comparison Task. I designed the five-part comparison task (CT) to provide students with the chance to respond to how the absence of the intended features affects their experience when interacting with the tasks. The CT task was designed to include similar mathematical topics to the ones that were in the four focus tasks so that the primary difference between the CT task and the focus tasks would be the lack of intended features. Each of the task parts in the CT task prompt students to answer with equations, graphs, and/or quantitative values. The variables provided are always “x” and “y,” and are designed to represent an unknown quantity devoid of measurement units or additional interpretation. The graphs and equations the students are prompted to find are also designed as representations of relationships between unknown quantities of unknown units.

All parts of the CT task are questions from generated worksheets of different Algebra 1 topics on Kuta Software Infinite Algebra 1 free worksheets (Kuta Software, 2019). I chose this resource for the task parts because it is a free and easy to use resource that teachers can use to acquire worksheets to be used as a supplement to the classroom curriculum. Ms. Harper acknowledged using Kuta software worksheets in her classes earlier in the year, so I knew that the student participants for my study had seen Kuta worksheet style questions before.

Parts 1 and 2 of the CT task have the same mathematical topic as both the FA and WW tasks, which is systems of linear equations. CT task part 1 gives a system of two linear equations written in slope-intercept form, and the students are asked to graph both equations on the axes provided. The prompt is “Solve by graphing” with the expectation that students find the coordinate pair where the two lines intersect. CT task part 2 is also a system of linear equations, but instead of providing the lines in slope intercept form, the students are given two complete tables with three pairs of x and y coordinates in each. The prompt for that task part is “Find the equation for both lines then graph to find the solution.” A student’s answer should include a linear equation for each table, a graph that includes both lines plotted on the same axes, and the solution to the system as a coordinate pair.

The mathematical topic for CT task part 3 is scatterplots with a line of best fit, which is the same as the PM task. This task part has four included component prompts. The first prompt asks the students to make a scatterplot given a table of six complete coordinates on a given set of axes that are pre-labeled with the values for each grid line. The axes themselves are not labeled with units. The second and third prompts ask the students to draw a line of best fit from their scatterplots and find the equation (in any form) of the line they drew. The last prompt asks the students to find the y-coordinate for a given x-coordinate based on the students' line of best fit.

Task parts 4 and 5 in the CT task, are the same the mathematical topics in DL, namely linear inequalities and inverses respectively. Task part 4 gives the students a linear inequality and pre-marked axes and the students are asked to graph the linear inequality. Task part 5 prompts the students to "Graph the function, then find and graph the inverse" and they are given a linear equation in slope-intercept form and pre-marked axes on which to do so. Since there were two distinct mathematical topics in the DL task, I chose to represent the DL task mathematical topic in two task parts of the CT task.

The CT task has at least one part that represents each of the four focus tasks' mathematical topics, yet is devoid of all three intended features that are included in the focus tasks. First, a realistic *context* is absent from the task because none of the task parts provide units for the quantitative values, nor are any variables defined to represent anything other than an unknown quantity of unknown units. The graphs do not have a title for the relationship between the variables, and the axes are labeled by their variable letters, not a unit-based quantity. Secondly, the students are not prompted in the CT task parts to explain their answers, nor are they asked what their answers mean once they have found the quantitative results, therefore students are not provided with an *opportunity to justify* in the CT task. Thirdly, although there are graphs present in all of the CT task parts, and a student's answer is intended to be found on the graph, or the answer is itself a constructed graph, they are not using the *graph interpretation* because the values or solutions they find from the graphs cannot answer any questions outside of what the quantitative value is. In order to represent the interpretation of a graph, the students would need to use the information from the graph to interpret the meaning of a solution as it relates to a situation external to the graph or the graph's defining functions.

Interview Process

The data from my study were collected during multiple one-on-one interviews with each of the 11 student participants. The interview process included an initial interview that lasted an average of 15 minutes, multiple task interviews, each lasting an average of 32 minutes, and a final post-interview, after the tasks had been completed, that lasted an average of 15 minutes. The protocols for the interviews can be found in Appendices G-I. A diagram summarizing the interview process can be found in Figure 3.1. Because all task interviews were completed during their academic support period, the students did not miss instructional time for their participation in the process, nor did they have to use any personal time outside of their scheduled math class to complete the process. All interviews were video-recorded on an iPad, and also audio-recorded using a Tascam microphone recorder. I used two separate devices simultaneously in the case of a technical issue with one of them.

To reduce the likelihood that students would make assumptions about what I wanted them to say in their responses, and feel more comfortable during the interview process, I did not share all my research premises with them. I told them that that I recruited them because of their survey results, but they did not know that I was using the results to specifically recruit students with low situational interest in math.

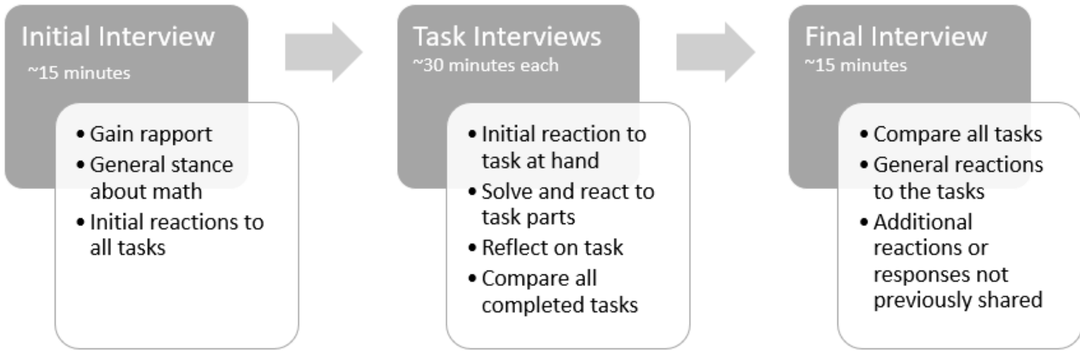

Figure 3.1 *Summary of Interview Process*

Disclosing this to students, besides potentially affecting their responses to focus on their interest (or lack thereof), may also have caused them to be concerned that I had a negative impression of them as students. If they believed this to be true, they may not have been as willing to be honest in their responses, or they may not have felt comfortable participating in my study at all. I also did not disclose that a goal of the interviews was to find out what aspects of math tasks elicited positive or negative reactions from them. If they knew that was my goal, they may have been more likely to focus their attention on the task aspects more than they would have if they were not aware of my goal. I wanted their responses to authentically represent what they were reacting to, what was catching their attention, and what their focus was on.

Initial Interview

My two goals for the initial interview were, first, to gain rapport with them and familiarize them to my study and my expectations for them throughout the interview process, and second, to expose them to the tasks they would be solving and assess their initial reactions to the tasks. The initial interview protocol is in Appendix G. I began the interview with an introduction about myself and explained that I was collecting data to learn how to make math classes better for students in the future. To encourage the students to be honest in their responses to me, I told them, “It is really important that you tell me what you think and feel, not try to guess what I want to hear.” I also told them that, “I’m not here to judge or grade your performance on the math tasks, and nothing you say will be told to any of your teachers or administrators.” I felt that if the students knew that what they told me throughout the process would not be shared, they would be more likely to be honest in their responses, and less likely to worry that there would be negative consequences for what they said.

The first set of questions I asked were general questions about their math class. I began by asking questions about the specific math class they were currently enrolled in, such as which class it was, whether it was optional, and what a typical class period was like. These questions were included to build rapport and ease the students into the feel of the interview so they would likely be more comfortable with responding to my questions that directly related to my research interests.

The next set of questions I asked required more reflection by the students because they asked about their personal feelings about math as a subject and their ideas about what it means and takes for them to learn math. The goal for this set of questions was to learn about the students’ general stance toward math as a subject, which informed my second research question. These interview questions included, “What are some things that would make math class or math as a subject more interesting?” “What makes some math topics more interesting to you than others?” and “What math activities are more interesting to you than others?” Each of these questions was responded to with a follow-up question to clarify why they responded in the ways they did. These questions gave the students the opportunity to share and reflect on what they felt would make math more interesting to them before seeing the tasks that they would be completing in subsequent interviews. This insight helped me see the lens through which the students may be viewing the tasks while they interacted with them, and they could refer to their responses to these initial questions if they noticed something in any of the five tasks that supported or contradicted their initial inclinations.

After I asked the students the general questions, I shifted the focus of the initial interview to their reactions to the five tasks that they would be solving during the task interviews. The goal for this set of questions was to have the students share what they noticed about the tasks, especially what elicited a positive or negative reaction from them. I gave the student all five tasks at the same time and gave them three minutes to sort the tasks in order based on their interest in solving them. The time limit was put in place to discourage the students from attempting to solve any parts of the task, but still gave them plenty of time to read through each part and sort them. None of the students used the entire three minutes to complete their task sort. After the sorting was done, I asked the students to explain their task order, focusing particular attention on why they put the first and last tasks in those placements because they were most likely going to be able to give explanations that included specific reasons for a reaction.

Task Interviews

The task interviews comprised the majority of the data I collected for my study. The task interview protocol can be found in Appendix H. In all, I conducted 54 task interviews (i.e., 11 students each completed five tasks, but one student only completed four of the five tasks), ranging from 19-62 minutes, for an average of 32 minutes for each interview. During each interview, the students were asked about their initial reactions to the entire task, their reactions during each task part as they solved them, their reactions to the entire task after it was completed, and their reactions to the task as it relates to other tasks they completed.

To reduce the effect of task order on student responses, each student completed the tasks in a different order during the task interviews. I assigned each task a number, 1 through 5, and used a random number sequencer to assign a task sequence to each student. By chance, two students were assigned the same task sequence, but the other nine students had unique orders. I decided to use this method of random assignment for the order of tasks so if students had similar responses to a task or task part, it would be less likely attributable to task order. Furthermore, by having the students complete the tasks in different orders, they were less likely to discuss the tasks with other participants being interviewed in the same time frame between interview sessions because they were not doing the same tasks at the same time.

Indicator Tool. I designed an interest indicator tool (see Figure 3.2) for use during the task interviews that served two purposes. The first purpose was to elicit relevant student responses, and the second was to facilitate more precise data analysis. The indicator tool consists of two scales, *Enjoyment* and *Desire to Solve*, which represent two facets of interest, with Enjoyment representing the "feeling-related component" enjoyment and Desire to Solve representing the "value-related component" (Schiefele, 1991, p. 303). The scales are numbered 1 through 5, where 1 indicates (and is labeled with) "none" and 5 indicates (and is labeled with) "a lot" with reference to how much enjoyment and desire to solve that students felt. I designed the indicator tool to allow students to change their ratings during the task interviews, so each time they were prompted to rate their feelings on the scale, they used colored squares placed on their number ratings, and I recorded their responses on a separate sheet of paper.

The first purpose of the indicator tool was to elicit student responses that explained the reactions that were relevant to my study during the interview process. By asking the students to explain their ratings for both enjoyment and desire to solve, I got responses that were directly relevant to the purpose of my study. I asked the students to consider their ratings multiple times throughout the task interviews, so the tool was a way to keep their responses explaining their reactions to the tasks aligned with my research purpose. Specific details about how I used the indicator tool for data collection during the task interviews is provided below in the section describing the task interview procedure.

The second purpose of the indicator tool was to facilitate more precise data analysis. Specifically, the ratings helped me classify their responses as explanations for positive or negative reactions, even when the words or phrases they used were ambiguous. I was able to do this by assuming that the response a student gave when they placed the markers low for either scale would be indicative of a negative reaction for that facet of interest. Similarly, if a student moved the marker on the scale up after solving a task part, I assumed their response explaining why they moved the marker would be indicative of a positive reaction for that facet of interest. I did not use the numerical ratings as quantitative data, instead I used the placement (low or high) and the movement (down or up) to interpret the student's response as being supported by either a positive or negative reaction. Specific details for how I used the indicator tool during the analysis process is provided below in the data analysis section.

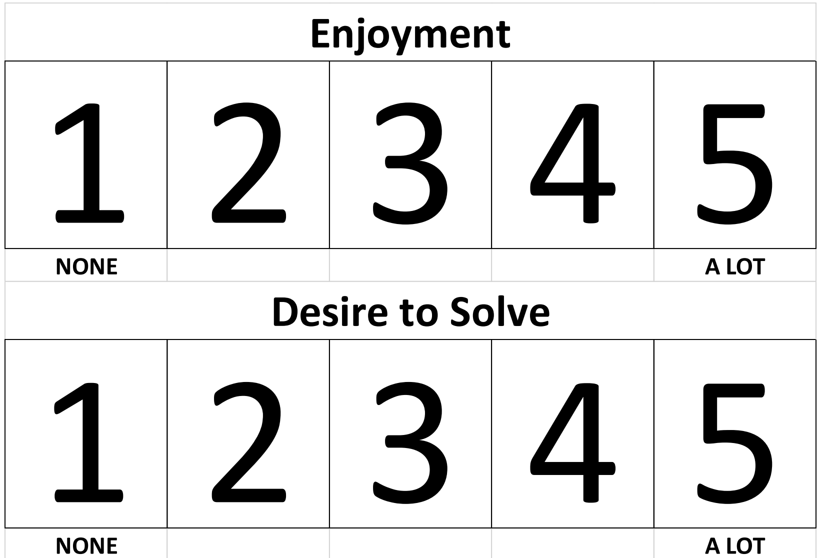

Figure 3.2 *Indicator Tool*

Task Interview Procedure. Each task interview consisted of four phases for the student, (a) their initial reaction, (b) solving and reacting to each task part, (c) final reactions, and (d) sorting all completed tasks by their preferences. I followed the same protocol for each task interview, regardless of which task the student was solving, although the first task interview included an explanation of the indicator tool along with the procedure each task interview would follow. I began each task interview by asking questions about the student's initial reactions to the task as a whole and to the task's parts. After the students responded to the questions about their initial reactions, I asked them to solve the task's parts, stopping after each one to solicit their reactions to that task part. After all task parts were complete, I asked the students to share their reactions to the entire task, especially as compared to their initial reactions to the task. Once the final reactions were shared, the task was considered complete. At that time, I asked the students to sort all completed tasks in order of preference (if it was their first task interview, this phase was omitted).

The purpose of the first phase of the task interview was to obtain students' responses about their initial feelings based on their first impressions of the task. At the beginning of each task interview, I gave the students the task in its entirety and said, "Please read through the entire task first and let me know when you are done." I monitored them while they looked at the task to make sure they had seen all task parts and did not skip a page or miss the back of a page. After they told me that they were done reading through the task, I asked them, "What is this task about?" I intentionally did not use "context" or "scenario" because I did not want to influence what drew their attention to a focus task feature. This meant students' responses reflected their interpretation of the word "about," which could mean context to them, but also could mean mathematical topic, or a different construct. I then asked, "Which task part are you *most* looking forward to solving," and the opposite, "Which task part are you *least* looking forward to solving." After they selected the task part that fit the description, I prompted them to provide an explanation for choosing each part. I designed these questions to elicit explanations that indicated positive or negative reactions to parts of the task that may serve as triggers or detractors of interest in parts of the task. I gave the students the opportunity to mention anything else they noticed or wanted to tell me about the task that I may not have thought to ask about. It also reinforced to the students that I wanted to hear what they had to say, even if it was in response to a question I asked. During the last portion of the first phase of the task interview, I had the students place the markers on the indicator tool and asked them to explain their rating selections. By having the students consider their rating and explain it to me, I elicited responses that were directly relevant to my research goals.

During the second phase of the task interview, the students were given the opportunity to solve each part of the task. While the students were solving a task part, I encouraged them to voice what they were thinking, or describe what actions they were taking to make progress on their answers. By listening to the students' thought processes as they solved the task parts, I could learn what details of the task they were focused on, and how they interpreted the prompts. Because I was not looking at the students' ability to solve the tasks on their own, I let every student know that I was willing to help them if they wanted me to, after they attempted to begin solving a task part on their own. If a student appeared to be unable to make progress in a task part, I asked what they were struggling with, and offered help. If they wanted help, I gave them scaffolded support, but avoided providing them with direct procedures or solutions. If they did not want help, I asked them to continue voicing what their thought processes were. Similarly, if a student did not directly ask me if their answer was correct, I did not let them know whether the answer they had put down was correct or not. If they did ask me directly if an answer was correct, if it was correct, I would say "yes" and if it was not correct, I would say "no, would you like to try again?" and let them decide if they wanted me to help them correct their answer or move on. I designed the task interview process to be non-evaluative, and if the student did not directly ask me for feedback on their answers, evaluating their answers for correctness may have influenced their responses about their reactions towards the task. This is especially relevant for students' responses that indicated that they were confident that their answer to a task part was correct, or stated that a problem was easy, when their answer was not mathematically correct.

After the student indicated that they completed a task part, I asked them to share their answers, and gave them the opportunity to tell me about their reactions to the task part. If the answer they provided was incomplete, or undeveloped, I asked them for clarification or to explain it further. These prompts were to encourage the student to think deeply about each task part and discourage them from rushing through. If a student rushed through a task part, their reactions to that part would likely not reflect their reactions had they spent more time on the task part. After they explained their answer, I asked them if they wanted to move the markers on the indicator scale from where they had placed them for the previous task part (or if it was the first task part, where they had placed them as the indication of their initial reactions to the task.) I then followed up by asking the students to explain why they moved the markers or why they chose to leave them where they were. The follow-up questions about the marker placement were my opportunity to elicit student responses about their reactions to the task part that was more likely to be relevant to my research goals.

The purpose of the third phase of the task interview was to elicit students' responses that explained their reactions to the task and task parts after they had the opportunity to solve each part. After phase two was complete for all of the task's parts, I asked the students questions that prompted them to reflect on and compare the task's parts. The first question I asked was, "Have you seen a task like this one before?" which the students could respond to with reference to the mathematical topic, or the types of activities they were prompted to do. The responses to this question, along with the next, “what part(s) of this task caught your attention the most?,” revealed where the students were focusing their attention on the task, regardless of whether that led to a positive or negative reaction. This question gave me insight into what students prioritized as they worked through solving and experiencing the task. This was especially important in the analysis for research question two, which was about examining cases of the ways in which different students experience tasks. Next, I asked the students to think about what task parts they liked the least and the most, and prompted them to explain their choices. By asking them to evaluate the task parts in that way, I elicited explanations that described specific reasons for their positive and negative reactions to the task. Having the students make comparisons between the different task parts also helped focus their responses to the task aspects that were similar or different in the task parts. I finished up phase three of the task interviews by asking, “If you could change the task at all, what changes would you make? How would those changes make the task better for you?” This prompted the students to think carefully about why they reacted a certain way to the task or task part. If they reacted negatively to a task part, they could share what they thought would make if better. Alternatively, if they reacted positively, they would likely respond that they would not want to make any changes.

The final phase of the task interviews, phase four, was a task sort of all completed tasks. After phase three of the task interview was done, I considered the task to be complete. At this point, I gave the students all the tasks that they had completed during previous task interviews, and asked them to consider those tasks, along with the one they just completed, and “put them in the order that you most enjoyed or appreciated solving them.” I intentionally used language that mirrored the indicator tool instead of the term “interest” because I did not want the students to use a colloquial interpretation of interest as enjoyment only without the facet of desire or appreciation. After they sorted the tasks, I asked them to explain in detail why they put the tasks in the order they chose. In most cases, the students left the previous tasks in the same order they had been after the last task interview. Therefore, I focused my prompts on asking them why they placed the newest task in the place they did relative to the other tasks. This avoided having students repeat similar explanations for task placements and made the interviews more efficient.

Final Interview

I designed the first questions of the final interview to elicit student responses about their reactions to all the completed tasks. The final interview protocol can be found in Appendix I. The first prompt for the final interview was the same as the prompt for phase four of the task interviews, “Can you please put [the tasks] in the order that you most enjoyed or appreciated solving them?” The difference was that for the final interview, the students had completed all tasks, whereas for the task interviews their phase four sorts were missing one or more task. After the final task sort, I asked the students to explain the placement of all tasks, even if that meant they would be repeating reasons for the placement of some of the tasks. To prompt them to explain their reasoning, I asked the following questions, “What helped you make the decision to put the tasks in this order?” “Did you have difficulty making decisions about where to place any of the tasks? What made that decision difficult to make?” These questions helped the students provide explanations that included specific reasons to support their choice for the order of the tasks. Furthermore, the answers to these questions gave me insight into what they prioritized in their recollection of the experiences they had with the tasks. The next questions I asked were "What are the reasons that made you put these two tasks in the top two positions?" and "What about these two in the bottom two positions?" I asked these questions to elicit explanations for positive reactions (for the top two) and negative reactions (for the bottom two) that were more general (i.e., not tied to a specific task).

After the students had explained their task order decisions, I asked them questions about their experience with the process and how it may have affected their general stance to math as a class and as a subject. The first question in this part of the final interview was "Now that you have seen a variety of different types of math tasks…what types of tasks would you prefer to see in your math classroom? Why?" My purpose for this question was to elicit responses that informed my second research question, which was about clarifying students' priorities when interacting with math tasks. Although it encouraged the students to consider the completed tasks as a reference, the question was designed so they could generalize which (if any) task aspects they reacted to in a positive way, and with regards to their experiences as a math learner. The last question I asked was, "Is there anything else you would like me to understand about your experience with the tasks you solved?" which invited students to share additional reactions or comments about the tasks or the process that did not fit as a response to the questions I had already asked.

Transcriptions and Recordings

The transcriptions that I used for data analysis were created jointly through an electronic service and my manual efforts. The mp3 audio files from the Tascam voice recorders were sent to Temi.com for preliminary transcribing. I cleaned up the files that were returned by Temi by adding the pseudonyms for the students and making corrections to parts of the transcriptions that had been improperly transcribed. While editing the 54 transcripts, I added descriptions of students' actions to clarify their responses. For example, if a student said, "this part," I added a bracketed comment indicating to which part the student was referring. Once I completed editing each transcript, I added line numbers to facilitate data analysis.

Data Analysis

In this section, I will explain how I analyzed the data I collected during the interview process to answer my two research questions. I began by preparing the interview transcripts for code assignment followed by two rounds of data analysis. The first round of analysis addressed research question one by focusing on the task aspects that students mentioned in their responses during all task occurrences. The second round of analysis addressed research question two, which examined cases of students who explained consistent reactions to specific task aspects across most of their task occurrences. To accomplish these goals, I developed codes to assign to the task aspects students mentioned during the interviews using both a priori and inductive methods (Miles et al, 2018). For the first round of analysis, I applied these codes to each task occurrence. For the second round, I looked for trends in the codes that were assigned to each student across their five task occurrences in combination with descriptive summaries of each student's interview process to select representative cases. In this section I will first describe how I prepared transcripts for coding then developed and assigned codes to excerpts of the transcripts. Then I will explain how I used the coded excerpts to assign codes to each task occurrence. Finally, I will explain the process I used to select representative cases to answer my second research question.

Preparing Transcripts for Code Assignment

To identify the units of analysis, before assigning specific codes, I determined the portions of the transcripts that had the potential to be assigned a code. Because my research questions rely on students' explanations of positive and negative reactions they experienced while interacting with tasks, I found and digitally highlighted portions where these reports were made. The portions can be described as "monothematic chunks" of varying lengths from a phrase or sentence to multiple questions and responses between the interviewer and the student (Miles et al, 2018, p. 74). Each chunk of data included a student's explanation for a reaction that they had to the task they were currently working on or recalled a task that they had previously completed.

As the monothematic chunks were being highlighted, I determined whether the student was explaining a positive or negative reaction. After I made the determination, I changed the color of the digital highlighting so one color indicated positive, and the other indicated negative. Many of these determinations were made based on the interview question to which they were responding, or as an explanation for their placement of the markers on the indicator tool, rather than the statements as they stood alone. An example of this is in Coleman's Pic Me! task interview when he made this response, "'Cause I'm like, I'm not really doing anything besides answering questions. Like there's no work like problem solving." In this statement, he is explaining a reaction he had to a task part, but without taking into account what was happening during the interview, it is not possible to determine whether this was an explanation for a positive or a negative reaction. In this instance, Coleman had decided to leave the markers on the indicator tool high for both his desire to solve and his enjoyment, so this chunk was labeled as a positive reaction. Similarly, during the Datelines task interview, Francis responded to an interview question with, “these equations.” While this response was marked as an explanation for a student’s reaction, it is not possible to discern whether it was a positive or negative reaction. To determine that, I looked at the interview question to which he was responding, which was, “What’s your least favorite part.” By taking the question into account, this response was marked as a negative reaction to the task.

For chunks that included both an explanation for a positive reaction, and a negative reaction, the chunk was assigned to both categories. This occurred most often when students were explaining the order in which they placed tasks during the intermediate and final task sorts. An example of this occurring is when Kimberly is explaining the order of tasks during the intermediate task sort after completing the comparison task:

> Um, ‘cause I like doing problems that have more of like a story to them uh it kind of just helps me figure it out more. And then with this one [comparison task], it was like, it was just right into the work. So, with but with these, it was read a problem and it kind of makes you like kind of put you in like real life situations a little bit. And it, it makes me think more and think better.

In this explanation, Kimberly is reacting positively to the focus tasks that she placed in front of the comparison task, but negatively directly to the comparison task. This can be determined because she used the phrase “I like” with regards to the former, and then compared it to the comparison task then reverted back to positive language like “think better” again at the end of the statement. For this reason, this chunk was assigned to be both positive and negative for later coding purposes.

This transcript preparation simplified my code development process and code assignments. By highlighting the monothematic chunks that included the students’ explanations, my attention was consistently kept on the excerpts of the transcripts that could be relevant to answering my research questions. By categorizing the positive and negative reactions, code assignment was further simplified, and I could focus my attention on which aspect codes the explanation was assigned, without having to simultaneously attend to whether it was explaining a positive or negative reaction.

Code Development and Assignment

To code the prepared transcripts, I followed the "Two Cycle" coding process suggested in Miles et al. (2018), "First Cycle coding methods are codes initially assigned to the data units. Second Cycle coding methods generally work with the resulting First Cycle codes themselves." (p. 64). The First Cycle codes I used were three a priori codes related to the three featured task aspects of context, opportunity to justify, and interpretation of graphs and a fourth code to incorporate chunks that could not be assigned one of the other three codes. The descriptions for the First Cycle codes can be found in Table 3.4. The Second Cycle codes I developed were a combination of revised subcodes for the three First Cycle codes that pertained to the featured aspects and two additional emergent aspect codes, mathematical topic, and perceived difficulty, along with their subcodes. The Second Cycle codes can be found in Table 3.5. In this section I will explain the First Cycle coding, followed by how the Second Cycle codes were developed, and end with how the Second Cycle codes were assigned to inform the results for my first research question.

Table 3.4 *First Cycle Codes and Definitions*

Code	Description
Context	The student mentions the specific real-life context included, or the general presence or lack of a real-life context in the explanation for their reaction.
Opportunity to Justify	The student mentions or describes the opportunity to answer a task prompt with their personal opinions or experiences in the explanation for their reaction.
Graph Interpretation	The student mentions requiring the interpretation of a graphical representation of data in the real-life context of the task to answer a task prompt in the explanation for their reaction.
Other Aspect	The student mentions something other than a featured aspect as an explanation for their reaction.

First Cycle Coding

My goal for the First Cycle coding was to organize the identified chunks of the transcripts into broad categories. With this goal in mind, the descriptions I wrote for the First Cycle codes were broad and lacked specific details. There were four a priori codes that I used for the First Cycle of coding, one code for each of the featured aspects, which I assigned at any mention of the featured aspect, and a code for those that did not include a mention of any of the featured aspects. As I previously mentioned, the First Cycle code descriptions can be found in Table 3.4. Throughout both coding cycles, I allowed for "simultaneous coding," where I could assign a single chunk more than one code (Miles et al, 2018, p. 72). Throughout the interviews, it was common for the students to provide multiple reasons for their reactions in their explanations.

Table 3.5 *Second Cycle Codes and Definitions*

Subcode	Positive	Negative
Relevant (CR)	The relevance of the context was appreciated.	The context was not relevant to their lived experiences, or its relevance was not appreciated.
Value (CV)	The context was appreciated for reasons other than its relevance or presence.	The context was not appreciated for reasons other than its relevance or presence.
Presence (CP)	The presence of a real-world context was appreciated and/or there was a preference for tasks that included real-world contexts.	The lack of a real-world context was appreciated and/or there was a preference for tasks that did not include real-world contexts.
Opinion and experience (OO)	The requirement to state an opinion and/or use experiences from outside of math class in their answer was appreciated.	The requirement to state an opinion and/or use experiences from outside of math class in their answer was not appreciated.
Writing (OW)	The requirement of an answer written in words instead of computations was appreciated.	The requirement of an answer written in words instead of computations was not appreciated.
Graph Interpretation (GI)	The requirement to interpret data from provided or student constructed graphs to answer a prompt was appreciated.	The requirement to interpret data from provided or student constructed graphs to answer a prompt was not appreciated.
Familiar (MF)	A specific mathematical topic that was previously studied was appreciated.	A specific mathematical topic that was previously studied was not appreciated.
Unfamiliar (MU)	A specific mathematical topic that was unfamiliar was appreciated.	A specific mathematical topic that was unfamiliar was not appreciated.
Easy (DE)	The ease of a task or task part was appreciated and/or indicated a general preference for ease.	The ease of a task or task part was not appreciated and/or indicated a general aversion to ease.
Hard (DH)	The challenge of a task or task part was appreciated and/or indicated a general preference for challenge.	The challenge of a task or task part was appreciated and/or indicated a general aversion to challenge.

An example of an excerpt that I coded with two First Cycle codes occurred in Arthur's Financial Aid task interview, "I kinda like enjoy it 'cause like I was saying, you can think about like like a real-life thing and then put it on a paper like answer like what you think about it." The phrase "real-life thing" is a mention of the real-world context, so I assigned the context code and "answer…what you think about it" is a mention of the opportunity to justify an answer using personal experiences, so I assigned the opportunity to justify code to the excerpt as well. If I separated the chunk into multiple parts based on the code assigned, the coherence of the student's response would be lost or reduced, so I decided to assign multiple codes to a single chunk.

For data organization and further analysis, I created a workbook in Microsoft Excel. I made four sheets within the workbook, one for each of the First Cycle codes. Each sheet had five labeled columns to place information about each coded chunk. One column was the coded chunk, three columns referenced the location of the excerpt, and two columns specified details relevant to the codes. More specifically, the three reference columns were the student's name, the specific interview from which the excerpt came, and the line number where the excerpt began. The specific interview was labeled with the task name if it came from that task's task interview, and "final" if it came from the student's final interview. The last column indicated to which task the student's explanation was referring. As I assigned one of the First Cycle codes to the previously highlighted chunks of the transcripts, I added the excerpt to the appropriate sheet (or sheets) in the workbook.

At the end of the First Cycle of coding, I had assigned all identified transcript excerpts at least one of the four codes. The organization of all coded chunks into broad categories made it easier for me to look for themes in each category to refine and develop new codes. In the next section I will explain how I revised the First Cycle codes by creating multiple subcodes for the three featured aspect codes and the new codes that emerged inductively from the fourth code.

Revision of First Cycle Codes and Creation of New Codes

The process I used to create my final list of codes for the Second Cycle coding involved revising the First Cycle codes and creating new codes that emerged while exploring the data. Finding common themes was facilitated by the Excel Workbook I created for data organization given that all of the coded chunks of interview transcripts related to the same code were on their own pages, allowing me to easily make comparisons and find similarities. In the following sections, I will describe the themes I found in each of four First Cycle codes and how those themes informed the revisions I made and the new codes I developed. I will conclude each section with a table containing the definitions for each code I developed during the process. As a reminder, Table 3.5 shows the codes for all aspects.

When developing the definition for each code, I used language that would reduce ambiguity and maintain consistency. Each code needed a definition to describe both a positive and negative reaction, and I intentionally used language where the description for a negative reaction directly mirrored the description for the positive reaction. In most of my code definitions, I chose to use “appreciated” for a positive reaction and “not appreciated” for a negative reaction. The term “appreciate” can encompass other, more specific concepts including “like,” “value,” and “find importance in,” among others. As a reminder, all of my code definitions are in Table 3.5. In the following sections, I will summarize how each code was developed with more detail and clarifying examples for each code being provided in my description of my Second Cycle coding.

Both of my research questions place an emphasis on the featured aspects, so it was important to me that all data identified with a featured aspect First Cycle code was captured by the revised definitions. With this goal in mind, as I found common themes within each aspect and used those themes to revise the code and create subcodes, I made sure that all identified chunks could accurately be assigned at least one code or subcode with their definitions. In this phase my focus was on defining each of my codes for my codebook, so while I ensured that each could be assigned a code, I did not assign the codes to at this time.

For the excerpts that mentioned something other than a featured aspect, it was important for me to find the most common themes among the responses. With this goal in mind, when I developed codes to capture the emergent themes, I did not find it necessary to ensure that all of the identified chunks were able to be assigned one of the developed codes. After I developed the definitions for codes that did capture the common themes, almost all of the identified chunks were able to be accurately coded with one of my developed codes. Exploring the identified transcript chunks that could not be assigned a code, I did not find consistent or coherent themes that could inform the answers to my research questions.

Revision of Context Code. While exploring the data that I coded with the First Cycle context code, which I will refer to as the context aspect code, I found three common themes in what students mentioned as specific reasons why they reacted to a real-world context. The three themes were student enjoyment, relevance to the student's experience, and the presence of a context. Using these three themes, I created three thematic subcodes for the context code, “relevant (CR)” “value (CV)” and “presence (CP).” I defined each of the subcodes in two ways, one to indicate a positive reaction, and one to indicate a negative reaction to the aspect as defined by each thematic subcode, which resulted in six possible code assignments. The definition of the subcodes allowed for simultaneous coding with multiple context subcodes. For example, the codes allowed the student to find a context relevant, but not personally valuable. The three thematic subcodes with their positive and negative definitions are in Table 3.6.

Table 3.6 *Code Definitions for Context*

Subcode	Positive	Negative
Relevant (CR)	The relevance of the context was appreciated.	The context was not relevant to their lived experiences, or its relevance was not appreciated.
Value (CV)	The context was appreciated for reasons other than its relevance or presence.	The context was not appreciated for reasons other than its relevance or presence.
Presence (CP)	The presence of a real-world context was appreciated and/or there was a preference for tasks that included real-world contexts.	The lack of a real-world context was appreciated and/or there was a preference for tasks that did not include real-world contexts.

Revision of Opportunity to Justify Code. While exploring the data that I coded with the First Cycle opportunity to justify code, which I will refer to as the opportunity to justify aspect code, I found two common themes in what students mentioned as specific reasons why they reacted to prompts asking them to justify their answers with their own experiences. The two themes were the opportunity or expectation for the students to provide their opinions or use their experiences in their answers to prompts, and the prompt requiring an answer in written words as opposed to performing calculations with a quantitative answer. These two themes led to two thematic subcodes for the opportunity to justify code, “opinion and experience (OO),” and “writing (OW).” I defined each of the thematic subcodes in two ways, one to indicate a positive reaction, and one to indicate a negative reaction to the aspect which resulted in four possible code assignments. The definition of the subcodes allowed for simultaneous coding with multiple opportunity to justify subcodes. For example, the codes allowed the student to explain that they appreciated being given the chance to share their opinion, and also that they preferred written answers to computational answers. The two thematic subcodes with their positive and negative definitions are in Table 3.7.

Table 3.7 *Code Definitions for Opportunity to Justify*

Subcode	Positive	Negative
Opinion and experience (OO)	The requirement to state an opinion and/or use experiences from outside of math class in their answer was appreciated.	The requirement to state an opinion and/or use experiences from outside of math class in their answer was not appreciated.
Writing (OW)	The requirement of an answer written in words instead of computations was appreciated.	The requirement of an answer written in words instead of computations was not appreciated.

Revision of Interpretation of Graphs Code. Unlike the previous two featured aspect codes, there was only a single common theme in what students mentioned as specific reasons why they reacted to prompts requiring them to interpret the meaning of data presented in a graphical representation. The common theme was appreciation of the requirement. Even though the identified chunks were already coded with the First Cycle code for graph interpretation, which I will refer to as the graph interpretation aspect code, I revised the definition of the aspect code to create a thematic code with the same name, graph interpretation (GI). I defined the thematic code in two ways, one to indicate a positive reaction, and one to indicate a negative reaction which resulted in two possible code assignments. Simultaneous coding with two graph interpretation codes was not possible because the codes were not compatible within a single transcript chunk. The revised thematic code with its positive and negative definitions are in Table 3.8.

Table 3.8 *Code Definitions for Graph Interpretation*

Subcode	Positive	Negative
Graph Interpretation (GI)	The requirement to interpret data from provided or student constructed graphs to answer a prompt was appreciated.	The requirement to interpret data from provided or student constructed graphs to answer a prompt was not appreciated.

Development of Codes from Fourth First Cycle Code. The fourth First Cycle code did not mention any specific characteristics or aspects, so the aspect codes that were to be assigned to the excerpts emerged from the data itself. While exploring the data assigned this code, there were two major aspects that emerged that encompassed nearly every excerpt. These two major emergent aspects were the student's reactions based on their familiarity with the particular mathematical topic that was included in the task or a task part, and the student's reactions based on the level of difficulty they perceived or preferred while working on tasks.

I developed one emergent aspect code for “mathematical topic” which I defined as “The student mentions a specific mathematical topic in the explanation for their reaction.” I decided to use the phrase “specific mathematical topic” to emphasize that the student had to name or describe a specific mathematical procedure or concept to be assigned this code. Some ways that the students mentioned a specific mathematical topic were by name (i.e., “graph,” “table,” “multiplication”), by describing a process (i.e., “putting dots on the graph”) or by referring to their written work through gestures like pointing (i.e., “we’ve done ones like this before” while pointing at a table of values.)

I further developed this aspect code into two thematic subcodes, “familiar (MF),” and “unfamiliar (MU).” I defined the thematic codes in two ways, one to indicate a positive reaction, and one to indicate a negative reaction which resulted in four possible code assignments for this task aspect. The definition of the subcodes allowed for simultaneous coding with multiple mathematical topic subcodes. For example, a student may mention multiple mathematical topics and find them both familiar but mention appreciation of one and not the other. The definitions of the thematic subcodes for the emergent aspect code “mathematical topic” are in Table 3.9.

Table 3.9 *Code Definitions for Mathematical Topic*

Subcode	Positive	Negative
Familiar (MF)	A specific mathematical topic that was previously studied was appreciated.	A specific mathematical topic that was previously studied was not appreciated.
Unfamiliar (MU)	A specific mathematical topic that was unfamiliar was appreciated.	A specific mathematical topic that was unfamiliar was not appreciated.

The second emergent aspect code that I developed was for “perceived difficulty” which I defined as “The student mentions a level of difficulty in general, or with regards to a specific task or task part.” I further developed this aspect code into two thematic subcodes, “easy (DE)” and “hard (DH).” I defined the thematic codes in two ways, one to indicate a positive reaction, and one to indicate a negative reaction which resulted in four possible code assignments for this task aspect. The definition of the subcodes allowed for simultaneous coding with multiple mathematical topic subcodes. For example, a student may respond that they both preferred for something to be easy while also saying that they did not prefer challenge in the same response. the definitions of the thematic subcodes for the emergent aspect code “perceived difficulty” are in Table 3.10.

Table 3.10 *Code Definitions for Perceived Difficulty*

Subcode	Positive	Negative
Easy (DE)	The ease of a task or task part was appreciated and/or indicated a general preference for ease.	The ease of a task or task part was not appreciated and/or indicated a general aversion to ease.
Hard (DH)	The challenge of a task or task part was appreciated and/or indicated a general preference for challenge.	The challenge of a task or task part was appreciated and/or indicated a general aversion to challenge.

The codes I summarized above are the compilation of codes I used during my Second Cycle of coding. All together I defined five aspect codes and ten thematic codes, which resulted in twenty distinct code definitions. Once I had definitions for all twenty codes, I was able to begin the process of assigning codes to the transcript chunks.

Second Cycle Coding

In this section, I will explain the process I used to code the transcript chunks that I identified in the First Cycle coding. I will begin by explaining how I organized the transcript chunks to facilitate coding and compiling the transcript chunks and their assigned codes. Then I will provide examples for each code and explain why I assigned the code to the chunk to clarify and illustrate the definitions for each of my codes.

Organization of Coded Chunks. To organize the transcript chunks as I assigned codes, I expanded the Excel Workbook that I set up for my First Cycle codes. The workbook was already set up with a sheet for each of the three featured aspects, and I added two new sheets for the two emergent aspects and one sheet for chunks that could not be assigned any of my defined codes. I also added two columns to each of the five aspect sheets to indicate the Second Cycle code along with whether it was defined by the positive or negative definition of the code that I assigned to the transcript chunk, making a total of seven columns for each sheet. The organization of the workbook sheets allowed me to sort and filter the excerpts by the student's name, the task to which the student was referring, whether it was defined by the positive or negative definition, and by the assigned code.

The sheets for the three featured aspects already contained all of the identified transcript chunks that would be assigned a revised code, but the ones for the emergent codes needed to be added to the appropriate sheets. To do this, I followed a process similar to the process I used when assigning the First Cycle codes pertaining to the featured aspects. I went through each of the chunks and identified the ones that mentioned the emergent aspects of mathematical topic and perceived difficulty. As I determined whether the emergent aspects were mentioned or not, I copied the chunk to the appropriate sheet. After this process was done, all of the identified chunks had been sorted and I could start assigning codes.

I mentioned during my explanation for the First Cycle coding that I allowed for Simultaneous Coding throughout all of my coding. When an identified chunk of data was identified as mentioning two or more aspects, the chunk was added to the sheet for all appropriate aspects. While assigning the Second Cycle codes to the transcript chunks, I did not need to attend to whether a chunk mentioned multiple aspects because it would be present on all appropriate sheets and receive each code as I coded for each aspect. Furthermore, a transcript chunk could be assigned codes for two different task occurrences, in which case it also added to all appropriate aspect code sheets with different values in the column for the code assignment, the column for the task to which the student was referring, or both.

In the next sections, I will provide examples of transcript chunks that I coded with each of my Second Cycle codes. I will begin each section with an overview of what was required to be mentioned in the responses to be assigned each code. After that I will provide two examples of each code, along with the specific phrases in the responses that fulfilled the requirements I defined for the code.

Real-Life Context. All transcript chunks that I coded with the context aspect code were assigned one of the three thematic subcodes I defined for this featured aspect. The three subcodes I defined for context were relevant, value, and presence. I defined each of these subcodes to include for both a positive and a negative reaction, so there were six total codes that could be assigned to each of the chunks identified as mentioning context. The six codes were relevant-positive, relevant-negative, value-positive, value-negative, presence-positive, and presence-negative.

Context: Relevant-Positive. My definition for the relevant-positive (CRP) code was "The relevance of the context was appreciated." I assigned this code to transcript chunks where the student mentioned that the specific context of a task was relevant to their personal experiences and that it was a reason for their positive reaction. The CRP code was also assigned when the student said that they recognized the importance of the context with regards to their peers' experiences, or stated a different positive value for the context's relevance.

Two of the responses that illustrate the CRP code are Andrew referring to the Pic Me! task, and Janelle referring to the Financial Aid task. During one of Andrew's intermediate task sorts, he placed Pic Me! first. When he was explaining why he placed it first, he said, "I mean it was about Instagram, which I use on the daily." By placing Pic Me! first, his explanation was for a positive reaction. In his response, he mentions Instagram as something he "[uses] on the daily," which means that he personally uses it every day. The combination of the positive reaction, mentioning the context, and saying that it is something he frequently uses is why I assigned it the CRP code in reference to the Pic Me! task.

During Janelle's final interview, she placed the Financial Aid task first in her final task sort and her explanation for her decision included the context of the task and its relevance to her experience:

> I really liked this one 'cause it, it talked about college and it I feel like it was giving the right amount of information, um, like slightly, some of it, it can be taken out but it was still about around the same information so it can help you on how to plot it and how to table it and things like that. And I feel like kids definitely need to know about this.

Janelle's response begins with "I really liked this one," which is a clear indication that she is explaining a positive reaction to the task. She then immediately mentions that "it talked about college," referencing the task's context. At the end of her response she says, "I feel like kids definitely need to know about this," indicating that she felt that the context was relevant to her peer group, which includes herself. For these reasons, I coded this response with the CRP code in reference to the Financial Aid task. In her explanation, Janelle mentioned reasons other than the relevance of the context for her positive reaction to the task which were captured by other codes.

Context: Relevant-Negative. The definition for the relevant-negative (CRN) code was "The context was not relevant to their lived experiences, or its relevance was not appreciated." I assigned this code to transcript chunks where the student mentioned the specific context of the task in their explanation and that their interpretation of the relevance was a reason for their negative response. The CRN code was assigned when the student either mentioned that the context was not relevant to their experiences, or they acknowledged that the context was relevant, while also explaining how that relevance was a reason for a negative reaction.

One example that illustrates the CRN code is when Coleman is reflecting on the Datelines task immediately after finishing the last task part. He is responding to the interview prompt that asked him to identify the task part that he liked least:

> Maybe like the celebrities...I just don't think it was really necessary for them..., it was good for information, but just, I don't think we needed them for a problem. Like we could have did something else for it..., Coulda done, did like uh your parents Maybe...Yeah. Just like maybe your family members and stuff like that.

I determined this response was explaining a negative reaction because it was the task part that he liked least. Coleman opens his response by mentioning "the celebrities," referring to the fifth task part that included the ages of several celebrity couples. By saying he did not think the inclusion of the celebrity couples was necessary, and that he did not “think we needed them for a problem,” and concluding with the suggestion to use family members instead, he is indicating that the specific context was not relevant to him or his experiences. For these reasons, I assigned this excerpt the CRN code in reference to the Datelines task.

Another example that illustrates the CRN code is Diondre explaining why he placed the Financial Aid task low in his final task sort, “I'm a freshman, so thinking, looking at things as into college, uh, makes me think that it makes me think I'm getting so old and time's getting so faster. And like, I wanna like stay young.” I determined that this response was an explanation for a negative reaction because it was an explanation for a low placement in the task sort. By saying “I’m a freshman” and later that “it makes me think I’m getting old,” he is explaining that he recognizes the relevance of the college context to his current experience as a high school student, and that the connection explains his negative reaction. For these reasons, I assigned this excerpt the CRN code in reference to the Financial Aid task.

Context: Value-Positive. The definition for the value-positive (CVP) code was “The context was appreciated for reasons other than its relevance or presence.” This code captured the transcript chunks that I coded with the context task aspect code that explained a positive reaction that did not fit the definition of the other positive context subcodes. I assigned this code to transcript chunks where the student mentioned the specific context of the task as a reason for their positive reactions and provided an explanation that did not explicitly mention their perception of the relevance or presence of the context in the explanation for their reaction.

One example that illustrates the CVP code is when Janelle explains why she placed the markers high on the indicator tool after reading through the Pic Me! task, but before solving it:

> You know, not to be weird, but I guess because it's talking about clothes and like Instagram and things, it's like automatically like something that I would want to talk about rather than like the last one, which is like the company and things like, um, that made it interesting.

I determined that this was a response to a positive reaction because Janelle was explaining why she placed the markers high. She mentions the specific task context when she says, “it’s talking about clothes and like Instagram,” which describes the context of the Pic Me! task. Finally, Janelle used the phrase, “something I would want to talk about,” but does not further explain why it was something she wanted to talk about. Because she did not provide further details in her explanation, I assigned the CVP code to this transcript chunk in reference to the Pic Me! task. In this case, the CRP code could not be applied because she never explicitly mentions the relevance of the context, only that she liked the elements of the context. She may have been thinking about the context relevance, but I did not want to make assumptions about her explanation and misrepresent her experience. I will repeat this transcript chunk as an example for the value-negative code as well but in reference to a different task.

Another example that illustrates the CVP code is when Kimberly is explaining her choice for the task part that she most wanted to solve before starting to solve the task, “Probably the second [page]...Because it's talking about, um, raising the minimum wage from 7 dollars and 25 cents to 15 dollars and I want to see like how much it changes.” I determined that this response was describing a positive reaction because she was responding to the interview prompt asking her which part she wanted to solve most. Kimberly explains that the context of the minimum wage changing was the reason for her reaction, and says, “I want to see…how much it changes.” This explanation does not mention the relevance of the context, nor just the presence of a context in the task, so I assigned this transcript chunk the CVP code in reference to the Wage War task.

Context: Value-Negative. The definition for the value-negative (CVN) code was “The context was not appreciated for reasons other than its relevance or presence.” This code captured the transcript chunks that I coded with the context task aspect code that explained a negative reaction but did not specifically mention the relevance or presence of a context. I assigned this code to transcript chunks where the student mentioned the specific context of the task as a reason for their negative reactions and provided an explanation that did not explicitly mention their perception of the relevance or presence of the context as the reason for their reaction.

One example that illustrates the CVN code is the same transcript chunk that I used as an example for the CVP code, but in this case, Janelle is reacting to the context in the Wage War task in comparison to the context in the Pic Me! task. As a reminder, in this explanation, Janelle is explaining why she placed the markers high on the indicator tool prior to solving any task parts for Pic Me!:

> You know, not to be weird, but I guess because it's talking about clothes and like Instagram and things, it's like automatically like something that I would want to talk about rather than like the last one, which is like the company and things like, um, that made it interesting.

I determined that she was explaining a negative reaction by the way she used the phrase “rather than.” She is comparing something that she “would want to talk about,” in this case the context in the Pic Me! task, with the context of the “last one, which is like the company and things” which is a reference to the context of the Wage War task. This comparison makes it clear that she did not like the context of the Wage War task, and did not want to talk about it. Since she does not provide further details for why she does not like the Wage War context in this chunk, I assigned the CVN code in reference to the Wage War task.

Another example that illustrates the CVN code is also referring to the context of the Wage War task when Shantel is explaining why she put Wage War last in one of the intermediate task sorts:

> This one was hard. It was about money. I like money but I that was too much. Like definitely if the company wants to hire somebody and the people that want the job that's like you have to really think about it like how much they all going to get paid and how much hours they all going to work and what time they come in and what time they leave and break time. That's a lot to think about. I don't want to run no company...And then you gotta like definitely if you're like working at a fast-food restaurant and you're giving them all the same pay. You might not have as much money as you need to get the food and pay for all the food that you need and grease and oil and all that just for it, it's, that's a lot to think about. Dang. I don't even want to think about it.

I determined that this response was to a negative reaction because it was an explanation for placing a task last in one of the task sorts, but the general tone of the chunk also indicates a negative reaction. Some specific phrases indicating a negative reaction are "that was too much," "that's a lot to think about," and "Dang. I don't even want to think about it." The Wage War context of the cost to hire employees and run a business is also mentioned throughout this response. Finally, I did not interpret any of the phrases she said as directly implying a recognition of relevance or lack of relevance as the reason for her reaction. She does say that she doesn't want to run a company, but I interpreted that phrase as her summarization of what someone who would run a company would have to think about, not meaning that it was not relevant because she did not run a company. For these reasons, I assigned this chunk the CVN code in reference to the Wage War task.

Context: Presence-Positive. The definition for the presence-positive (CPP) code was "The presence of a real-world context was appreciated and/or there was a preference for tasks that included real-world contexts." I assigned this code to transcript chunks where the student mentioned the presence of a specific context or the general presence of a context in a task in their explanation as a reason for their positive reaction. I also assigned the CPP code when the student mentioned that they did not appreciate the lack of a context within a task, usually referring to the comparison task.

One example that illustrates the CPP code is when Coleman explains why he changed his mind and put the comparison task after the Financial Aid task in his final task sort:

> I flipped them cause like this one was pretty bland and only asked to like solve and stuff. while this one had like a story and stuff behind it and you had to find, find like, the uh, like the uh, average high school diploma.

I determined that this was an explanation for a positive reaction to the presence of a context with regards to the Financial Aid task because of Coleman's decision to put the Financial Aid task ahead of the comparison task. He mentions the specific context of the Financial Aid task when he says, "average high school diploma" (likely referring to the net income after graduating from high school) and that his positive reaction to the task was because "this one had…a story." For these reasons, I assigned this chunk the CPP code with reference to the Financial Aid task.

For similar reasons, I also assigned the CPP code to Coleman's response with reference to the comparison task. The definition of the CPP code includes a general preference for the presence of a context in a task, which Coleman indicates with the phrase, "…this one was pretty bland and only asked to like solve and stuff." He clarifies what he meant by “solve and stuff” when he goes on the say he preferred the other (Financial Aid) task because it “had a story.” Assigning the CPP code in reference to both tasks was necessary since he clearly mentioned both tasks in his response.

An example that illustrates the CPP code with reference to a single task is when Kimberly is explaining why she put the comparison task last in one of her task sorts:

> ‘Cause I like doing problems that have more of like a story to them uh it kind of just helps me figure it out more. And then with this one, it was like, it was just right into the work. So with but with these, it was read a problem and it kind of makes you like kind of put you in like real life situations a little bit. And it, it makes me think more and think better.

I determined that this response was to a negative reaction with regards to the comparison task because she placed it last in the task sort. She indicated a preference for tasks that include a context by saying “I like doing problems that have...a story to them” and further emphasized her point by saying with the comparison task that “it was just right into the work.” For these reasons, I assigned this chunk the CPP code with reference to the comparison task. She does not mention any specific focus tasks or their contexts in this response, only referring to the focus tasks in general when she says “with these” and then generally referring to their collective inclusion of context. This is why the CPP code was only assigned to the comparison task.

Context: Presence-Negative. The definition for the presence -negative (CPN) code was “The lack of a real-world context was appreciated and/or there was a preference for tasks that did not include real-world contexts.” I assigned this code to transcript chunks where the student mentioned the presence of a specific context or the general presence of a context in a task as a reason for their negative reaction. I also assigned the CPN code when the student mentioned that they appreciated the lack of a context within a task, usually referring to the comparison task.

One example that illustrates the CPN code comes from a transcript chunk where Andrew is explaining placing the comparison task high in one of the task sorts:

> Yeah, because it's more with math. It's not like a different scenario that has to like apply with real life. I mean that sounds kind of like, I mean it means I don't have a problem with having to do real life but like I like to like, I don't know, do it more with math then ‘cause like this, it makes you think not also about the math but It makes you think about the real life scenarios. So you're doing like two things at once. This you're only thinking about the math.

In this response, while Andrew is describing a positive reaction to and preference for the comparison task, the explanation he provides is the *absence* of a context, which fits the definition of the CPN code which includes a preference for tasks that do not have a context. His preference for tasks that lack contexts is indicated when he says “it’s more with math. It’s not like a different scenario that has to like apply with real life.” It’s also indicated when he explains that he does not like having to do “two things at once” referring to the math and attending to the real-life context. For these reasons, I assigned this chunk the CPN code in reference to the comparison task.

Another example that illustrates the CPN code is when Jenelle is explaining why she put the comparison task first in her final task sort, “I don't like word problems too, so this one was just like right there easy, and it was like cool to like figure it out pretty easily. Like it's just right there.” Similar to Andrew’s response, she is explaining a positive reaction to the comparison task, indicated by placing it first in the task sort, but her explanation was the preference for tasks *lacking* a context, which fits the definition for the CPN code. Janelle does not mention the term context, or a specific context in her response, but she does use the phrase, “word problems” which she consistently used as a description for the focus tasks and their inclusion of prompts that required the context to be taken into account. She also says “it’s right there” by which she meant that she did not have to read as much to figure out what the prompt was asking her to solve. For these reasons, I assigned this chunk the CPN code in reference to the comparison task.

Opportunity to Justify. All transcript chunks to which I assigned the opportunity to justify aspect code were assigned one of the two thematic subcodes I defined for this featured aspect. The two subcodes I defined for the opportunity to justify were opinion and experience, and writing. I defined both of these subcodes for both a positive and a negative reaction, so there were four total codes that could be assigned to each of the chunks identified as mentioning the opportunity to justify. These four codes were Opinion and Experience-Positive, Opinion and Experience-Negative, Writing-Positive, and Writing-Negative.

Opportunity to Justify: Opinion and Experience-Postive. The definition for the Opinion and Experience-Positive (OOP) code was “The requirement to state an opinion and/or use experiences from outside of math class in their answer was appreciated.” I assigned this code to transcript chunks where the student mentioned that they appreciated task prompts that required them to use their own opinions and/or previous experiences to construct their answers. I also assigned the OOP code to chunks where the student mentioned a general preference for prompts that required them to draw on their opinions or experiences to construct their answers over prompts that did not include the same requirement.

One example that illustrates the OOP code is when Khalil was explaining why he most wanted to solve task part 4 of the Wage War task, “Because it basically said if this, if, if it happened, like what would you think? Would it be a good idea or not? Like, I want to share my opinion.” I determined it was a positive reaction because he was responding to a question asking for which part he most wanted to solve. In his response he directly states, “I want to share my opinion,” so it is clear that he appreciated the opportunity to share his opinion in his answer. For these reasons, I assigned this transcript chunk the OOP code with reference to the Wage War task.

Another example that illustrates the OOP code is when Arthur moved the markers on the indicator tool up after task part 4 of the Pic Me! task:

> Like I said, it's like a real like real life question. The question that people could relate to like how does, like, uh, like building personal brand can like affect you or not. So like I could use my opinion and use like experiences and stuff to help answer the question. Like most of these questions.

I determined that this response was for a positive reaction because it was said after moving the indicator tool markers up. He also directly states in his explanation for moving the markers up that “I could use my opinion and … experiences” which clearly fits the definition of the OOP code. For these reasons, I assigned this transcript chunk the OOP code with reference to the Pic Me! task.

Opportunity to Justify: Opinion and Experience- Negative. The definition for the Opinion and Experience-Negative (OON) code was “The requirement to state an opinion and/or use experiences from outside of math class in their answer was not appreciated.” I assigned this code to transcript chunks where the student mentioned that they did not appreciate task prompts that required them to use their own opinions and/or previous experiences to construct their answers. I also assigned the OON code to chunks where the student mentioned a general preference for prompts that did not require them to draw on their opinions or experiences to construct their answers over prompts that did include the same requirement.

The only transcript chunk to which I assigned the OON code was when Diondre was explaining why he put the Financial Aid task last in one of the task sorts:

> This was more of a like how you say more of a, like a talkative type of question as to where like the math doesn't really pull in. It's just asking you like, what's your general opinion about what the subject is talking about to where, um, I like graphing more than like answering these types of questions.

I determined that Diondre had a negative reaction since he was explaining why the task was last in the task sort. By saying, “It’s just asking you…what’s your general opinion,” he is indicating that he does not appreciate the requirement to use his opinion to answer the task prompts. For these reasons, I assigned this transcript chunk the OON code with reference to the Financial Aid task. In his explanation, Diondre also mentions other reasons why he had a negative reaction to the task, but the negative reaction in conjunction with specifically referencing the need to use his opinion is why I assigned the OON code.

Opportunity to Justify: Writing-Positive. The definition for the Writing-Positive (OWP) code was “The requirement of an answer written in words was appreciated and/or there was a preference for an answer requiring words instead of computations.” I assigned this code to transcript chunks where the student mentioned that the requirement to provide an answer in words but not necessarily because those words were their opinions or experiences was a reason for their positive reaction. I also assigned the OWP code to chunks where a student mentioned a preference for prompts that required a written answer over prompts that required quantitative computations to obtain an answer.

One example that illustrates the OWP code is Coleman's explanation for why he did not have a Wage War task part that he liked the most, "Well, I think I like, like all of them since they're pretty all pretty much all just questions and I didn't really have to solve anything." I determined this was a positive reaction because he used the phrase, "I like all of them" and because he was responding to an interview prompt asking which task part was his favorite. I determined that he preferred prompts that required a written response over calculations when he said that he "didn't really have to solve anything." I interpreted this phrase as meaning not having to solve computational problems to get to his answer. This also makes sense when interpreting his use of "just questions" as meaning questions in words that were not asking for a quantitative answer. For these reasons, I assigned this transcript chunk the OWP code with reference to the Wage War task.

Another example that illustrates the OWP code is when Kimberly moved the markers up on the indicator tool after task part 5 of the Financial Aid task, "'Cause it was just me explaining instead of me solving." I determined this was indicating a positive response because she was explaining why she moved the markers up. I interpreted her use of "explaining" to mean that she was using words, and "solving" to mean computations, so she was expressing a preference for writing an answer in words rather than needing to perform computations. For these reasons, I assigned this transcript chunk the OWP code with reference to the Financial Aid task.

Opportunity to Justify: Writing - Negative. The definition for the Writing - Negative (OWN) code was "The requirement of an answer written in words was not appreciated and/or there was a preference for an answer requiring computations instead of words." I assigned this code to transcript chunks where the student mentioned that the requirement to answer a task prompt using words, but not specifically because the words were their opinions or experiences was a reason for their negative reaction. I also assigned the OWN code when a student mentioned a preference for task prompts that required quantitative computations to obtain an answer over prompts that required a response in written words.

For the first example that illustrates the OWN code, I will revisit Diondre's explanation for placing the Wage War task low in a task sort:

> This was more of a like how you say more of a, like a talkative type of question as to where like the math doesn't really pull in. It's just asking you like, what's your general opinion about what the subject is talking about to where, um, I like graphing more than like answering these types of questions.

Since he is explaining why he placed a task last in a task sort, I determined this was explaining a negative reaction. The phrases that indicate Diondre preferred computations over a written response were, "the math doesn't really pull in," and "I like graphing more than…like answering these types of questions." For these reasons I assigned this transcript chunk the OWN code in addition to the OON code I previously explained in reference to the Financial Aid task.

Another example that illustrates the OWN code is when Jorge moved the markers on the indicator tool down after task part 3 of the Pic Me! task, a part that asks the students to provide an answer in written words instead of quantitative computations, "I don't like doing questions like these...Like I don't even know. I just, I like, I'm like I'd rather be doing graphs like doing the plotting and all that than answering the questions." I determined this was explaining a negative reaction because he was explaining why he moved the markers down. In his response, Jorge says, “I don’t like doing questions like these,” which on its own is ambiguous, but goes on to clarify that he prefers computations to written answers by saying that he would “rather be doing graphs…than answering the questions.” In this phrase, I interpreted “questions” to mean task prompts that required a written response. For these reasons, I assigned this transcript chunk the OWN code with reference to the Pic Me! task.

Graph Interpretation. All transcript chunks to which I assigned the graph interpretation aspect code were assigned the single thematic code that I defined for this featured aspect. I defined the thematic code for Graph Interpretation for both a positive and a negative reaction, which resulted in two codes that I could assign to each of the chunks identified as mentioning Graph Interpretation. The two codes were Graph Interpretation-Positive, and Graph Interpretation-Negative.

Graph Interpretation-Positive. The definition for the Graph Interpretation-Positive (GIP) code was “The requirement to interpret data from provided or student constructed graphs to answer a prompt was appreciated.” I assigned this code to transcript chunks where the student mentioned that prompts requiring them to use a graphical representation of the data to provide a meaningful contextual answer were a reason for their positive reaction. I did not assign the GIP code if the student mentioned something about a graph other than specifically using the data from the graph to inform their answer. When a graph was mentioned in another way as a reason for their reaction, I assigned one of the mathematical topic codes.

One example that illustrates the GIP code is when Jorge was explaining why he most liked solving task part 4 of the Wage War task, “Because in order to understood it, I had to look at the graph and find out where exactly they had the same amount of people...I understood it. I had to find where on the graph I'd put it." Jorge was explaining why he most liked solving that task part, so I determined that he was explaining a positive reaction. In his response, Jorge specifically mentions using the graph to find data relevant to the context to inform his response when he said "look at the graph and find where exactly they had the same amount of people." For these reasons, I assigned this interview chunk the GIP code in reference to the Wage War task.

Another example that illustrates the GIP code is when Andrew is reflecting on what he noticed about the Pic Me! task after he had completed all the task parts:

> The graphs, the graphs, definitely...and their plots because that's the information you need to pretty much do it because that's, I mean that's what varies and that's what like you can't really do this without knowing the graph because that's the information you need. I mean it has a lot of information on here.

I determined that he was describing a positive reaction to the requirement to use a graph because of the language he used in his response. Specifically, I interpreted his phrase, "it has a lot of information on here" being used after he explained that the data from the graphs were essential to construct an answer as recognition of the importance of the graphical representation, and further interpreted that recognition as appreciation. My determination of a positive reaction was also supported by the high placement of the markers on the indicator tool. For these reasons, I assigned this transcript chunk the GIP code with reference to the Pic Me! task.

Graph Interpretation-Negative. The definition for the Graph Interpretation-Negative (GIN) code was "The requirement to interpret data from provided or student constructed graphs to answer a prompt was not appreciated." I assigned this code to transcript chunks where the student mentioned that prompts requiring them to use a graphical representation of the data to provide a meaningful contextual answer were a reason for their negative reaction. I did not assign the GIN code if the student mentioned something about a graph other than specifically using the data from the graph to inform their answer. When a graph was mentioned in a different way as a reason for their reaction, I assigned one of the mathematical topic codes.

One example that illustrates the GIN code is Arthur's explanation for why he moved the markers down on the indicator tool after part 2 of the Financial Aid task, "I didn't really enjoy this because of how many sources I needed to use." The phrase, "I didn't really enjoy" is why I determined that he was explaining a negative reaction. Arthur's use of the term "sources" is why I determined that he was referring to the need to interpret the data from the graphical representations, since he was using the graphs as his sources when constructing his answers. For these reasons, I assigned this transcript chunk the GIN code with reference to the Financial Aid task.

Another example that illustrates the GIN code is Kimberly stating her concern about the Wage War task after she had answered all the task parts:

> Because when like finding the slope and stuff, it was like, it was a little hard because like the way the lines and the graph is set up and everything, it makes you think, Oh, it's only going like one space. But you gotta, look at the numbers and realize like it's going more than that. So if you don't, you don't really, if you're not really like paying attention and you're trying to, like you're just looking at it, it's kinda hard to get like you're not going to get the right answer.

I determined that this was an explanation for a negative response with the language Kimberly used. The phrase, "it was a little hard" to read the graph along with her thought process that "if you're not…paying attention…you're not going to get the right answer" indicates her concern over the clarity of the representation is what informed my determination that she was explaining a negative response. Since she was referring to the details of the graph’s axes and recognized the importance of understanding the meaning of the quantities represented by the axes, I determined she was indicating using the graph as a source of data that needed interpretation. In this case, she recognized and appreciated the importance, but had a negative reaction because she did not feel confident that she was able to accurately use the representation to construct her answer. For these reasons, I assigned this transcript chunk the GIN code with reference to the Wage War.

Mathematical Topic. All transcript chunks to which I assigned the mathematical topic aspect code were assigned one of the two thematic subcodes I defined for this emergent aspect. The two thematic subcodes I defined for mathematical topic were familiarity and unfamiliarity. I defined these subcodes for both a positive and a negative reaction, so there were four total codes that could be assigned to each of the chunks identified as mentioning a specific mathematical topic. These four codes were Familiar-Positive, Familiar-Negative, Unfamiliar-Positive, Unfamiliar-Negative.

Mathematical Topic: Familiar-Positive. The definition for the Familiar-Positive (MFP) code was “A specific mathematical topic that was previously studied was appreciated.” I assigned this code to transcript chunks where the students clearly indicated that they recognized a specific mathematical topic, and that it was a reason for their positive reaction. I assigned the MFP code whenever students indicated a positive reaction in any way of the familiar Mathematical topic. For example, a student may have mentioned that they liked the topic in the past when they had seen it, or they mentioned that they found the topic to be easy for them. In the latter case, the chunk would also have been assigned a subcode for difficulty. When assigning the MFP code, I was only looking for the students saying that a familiar mathematical topic was a reason for their positive reaction.

One example that illustrates the MFP code is Francis responding to the interview prompt, “Why did you like it?” which he was asked after he moved the markers on the indicator tool up after task part 3 of the comparison task, “That I could remember it. Like I could remember the line the best [of best fit] ‘cause once I remember it, that you got to put the these things down and you draw the line like in between.” I determined this was an explanation for a positive reaction because he had moved the markers up. The specific mathematical topic Francis mentioned is the line of best fit, which he does not refer to by its proper name in his response, but he says, “line the best” and accurately describes the method to create the line of best fit. He indicated that the line of best fit was a familiar topic by saying that he “could remember it.” For these reasons, I assigned this transcript chunk the MFP code with reference to the comparison task.

Another example that illustrates the MFP code is when Callie explains why she liked task part 4 of the Datelines task the most, “Because I knew that the graph was like linear and everything and I knew how to explain it.” I determined this was an explanation for a positive reaction because she was referring to the task part that she liked the most. The specific mathematical topic that she mentioned were linear functions by saying “the graph was…linear.” She indicated that she was familiar with the topic of linear functions by saying “I knew” in her response. For these reasons, I assigned this transcript chunk the MFP code with reference to the Datelines task.

Mathematical Topic: Familiar-Negative. The definition for the Familiar-Negative (MFN) code was "A specific mathematical topic that was previously studied was not appreciated." I assigned this code to transcript chunks where the students clearly indicated that they recognized a specific mathematical topic, and that it was a reason for their negative reaction. I assigned the MFN code whenever students indicated a negative reaction in any way of the familiar Mathematical topic. For example, a student may have mentioned that they had not liked the topic in the past when they had seen it, or they mentioned that they found the topic to be difficult for them. In the latter case, the chunk would also have been assigned a subcode for difficulty. When assigning the MFN code, I was only looking for the students saying that a familiar mathematical topic was a reason for their negative reaction.

One example that illustrates the MFN code is when Diondre explained why he moved the markers down on the indicator tool after answering task part 1 of the comparison task, "I think I did it wrong just because fractions with graphing is very confusing. Definitely something I struggled with uh, earlier this year. So I think I'm done, but I don't think it's right." I determined that he was explaining a negative reaction because he was explaining why he moved the markers down. The specific mathematical topic that he mentioned is "fractions with graphing." I determined that it was a familiar topic for Diondre because he used the phrase, "earlier this year." For these reasons, I assigned this transcript chunk the MFN code with reference to the comparison task.

Another example that illustrates the MFN code is Khalil explaining why he lowered the markers on the indicator tool after task part 1 of the Datelines task, "'Cause I, I don't have no interest in this...'Cause it's boring. like No like fun to it...’Cause all you're doing is subtracting and adding numbers.” I determined he was explaining a negative reaction because he was explaining why he lowered the markers. The specific mathematical topics that he mentioned were “subtracting and adding numbers.” In this response, Khalil does not explicitly mention that he has was familiar with the topic, but it is reasonable to assume that he was familiar with subtracting and adding, especially since he said it was “boring” and introduced the topics by saying “all you’re doing is,” both indicating that he was familiar with subtracting and adding numbers. For these reasons, I assigned this transcript chunk the MFN code with reference to the Datelines task.

Mathematical Topic: Unfamiliar-Positive. The definition for the Unfamiliar-Positive (MUP) code was “A specific mathematical topic that was unfamiliar was appreciated.” I assigned this code to transcript chunks where the students clearly indicated that they did not recognize a specific mathematical topic, and that it was a reason for their positive reaction. I assigned the MUP code whenever students indicated a positive reaction in any way of the unfamiliar Mathematical topic. For example, a student may have mentioned that they liked learning something new or that they liked the challenge that a new topic provided to them. In the latter case, the chunk would also have been assigned a subcode for difficulty. When assigning the MUP code, I was only looking for the students saying that an unfamiliar mathematical topic was a reason for their positive reaction.

One example that illustrates the MUP code is when Janelle moved the markers on the indicator tool up after task part 3 of the Datelines task, “It went up because, um, I'm actually like, this is like something new to learn. So I'm actually like interested in learning it. So yeah.” I determined that she was explaining a positive reaction because she was explaining why she moved the markers up. Janelle did not mention a specific mathematical topic by name, but she was referring to the task part where she was introduced to the topic of linear inequalities. She also mentioned that she was "interested in learning it" which also indicates that it was an unfamiliar topic that she wanted to learn. For these reasons, I assigned this transcript chunk the MUP code with reference to the comparison task.

Another example that illustrates the MUP code is when Khalil gives his explanation for why he liked task part 5 of the comparison task the most, "Because I worked, I liked it. This one was 'cause I, I paid more attention to this one because I actually got the new got to know something new. And that was like you said, the inverse." I determined that this response was explaining a positive reaction because he was explaining why he liked that task part the most. Also by saying "I actually got…to know something new," he was indicating a positive reaction. The specific mathematical topic that he mentioned was "the inverse," meaning finding the inverse of a linear equation. For these reasons, I assigned this transcript chunk the MUP code with reference to the comparison task.

Mathematical Topic: Unfamiliar- Negative. The definition for the Unfamiliar-Negative (MUN) code was "A specific mathematical topic that was unfamiliar was not appreciated." I assigned this code to transcript chunks where the students clearly indicated that they did not recognize a specific mathematical topic, and that it was a reason for their negative reaction. I assigned the MUN code whenever students indicated a negative reaction in any way of the unfamiliar Mathematical topic. For example, a student may have mentioned that they did not like having to learn something new or that they did not like the challenge that a new topic presented to them. In the latter case, the chunk would also have been assigned a subcode for difficulty. When assigning the MUN code, I was only looking for the students saying that an unfamiliar mathematical topic was a reason for their negative reaction.

One example that illustrates the MUN code is when Janelle is explaining why task part 1 of the comparison task is the part she was least wanting to solve:

> This one [pointing to task part 1]…'cause I don't know what that is. I don't know how to plot um fractions or how to convert that to decimals and stuff to put it. I think I know, but I'm not exactly sure.

I determined this was an explanation for a negative reaction because she was responding to the interview prompt for which task part she was least wanting to solve. The specific mathematical topic that she mentioned is "plot[ting] fractions or…convert[ing] that to decimals." She indicates that she is unfamiliar with this topic by saying "I don't know how" without an indication that she had seen the topic before. She also says, "I think I know, but I'm not exactly sure" which could be interpretated as her seeing the topic before, but that she was still unfamiliar with the topic. For these reasons, I assigned this transcript chunk the MUN code with reference to the comparison task.

Another example that illustrates the MUN code is Khalil's explanation for his low placement of the markers on the indicator tool before solving any parts of the Pic Me! task, "I put them there because it don't excite me...Because, um, I'm not used to this...Um, I'm not used to like doing this stuff, like having these problems [pointing to the scatterplots]." I determined this was an explanation for a negative reaction because he was explaining a low placement of the markers as well as him saying, "it don't excite me." The specific mathematical topic was not verbally mentioned, but he indicated that he was referring to scatterplots because he pointed to multiple scatterplot depictions when he was saying “these problems.” I determined that he was unfamiliar with the topic because of the phrases, “I’m not used to this,” and “I’m not used to…having these problems.” For these reasons, I assigned this transcript chunk the MUN code with reference to the Pic Me! task.

Perceived Difficulty. All transcript chunks to which I assigned the perceived difficulty aspect code were assigned one of the two thematic subcodes I defined for this emergent aspect. The two thematic subcodes I defined for perceived difficulty were easy and hard. I defined these subcodes for both a positive and a negative reaction, so there were four total codes that could be assigned to each of the chunks identified as mentioning a specific mathematical topic. These four codes were Easy-Positive, Easy-Negative, Hard-Positive, Hard-Negative.

Perceived Difficulty: Easy-Positive. The definition for the Easy-Positive (DEP) code was “The ease of a task or task part was appreciated and/or indicated a general preference for ease.” I assigned this code to transcript chunks where the student mentioned that the perceived ease was a reason for their positive reaction, or they indicated a preference for ease over challenge. I assigned the DEP code anytime that ease was mentioned as a reason for a positive reaction, even if the student mentioned another aspect in the same transcript chunk. It was common for students to have positive reactions to other task aspects and explain the reason they reacted positively to the other task aspect was because of how that aspect influenced their perceived difficulty. In these cases, the transcript chunk would be coded with multiple aspect codes, including the DEP code. If the student only mentioned the perceived ease as their reason for a positive reaction, then those chunks would only be coded with the DEP code.

One example that illustrates the DEP code is Francis explaining why he placed the Wage War task high in the final task sort, “Waging war, it was pretty easy to do. I got through it fast and of course Imma like something that's easy and fast that I can get done. So yeah.” I determined this was an explanation for a positive reaction because the Wage War task was placed high in his task sort. In this response, Francis said “of course Imma like something that’s easy,” which clearly indicates both that he thought the Wage War task was easy, and that he generally preferred ease. For these reasons, I assigned this transcript chunk the DEP code with reference to the Wage War task.

Another example that illustrates the DEP code is Coleman explaining why he moved the markers on the indicator tool up after task part 3 of the Pic Me! task. I used this transcript chunk as an example of the Opportunity to Justify Writing-Positive (OWP) code as well, “’Cause I'm like, I'm not really doing anything besides answering questions. Like there's no work like problem solving. So it's pretty easy and fun to answer the questions.” Coleman’s phrase, “it’s pretty easy and fun” completely fits the definition for the DEP code. In that single phrase he is indicating that he had a positive reaction (“fun”) because it was “easy.” For these reasons, I assigned this transcript chunk the DEP code with reference to the Pic Me! task. To assign the DEP code, I did not need to attend to the rest of his response, which I attended to when assigning the OWP code.

Perceived Difficulty: Easy-Negative. The definition for the Easy-Negative (DEN) code was “The ease of a task or task part was not appreciated and/or indicated a general aversion to ease.” I assigned this code to transcript chunks where the student mentioned in their explanation that the perceived ease was a reason for their negative reaction, or they indicated a general aversion to ease. I assigned the DEN code anytime that ease was mentioned as a reason for a negative reaction, even if the student mentioned another aspect in the same transcript chunk. It was common for students to have negative reactions to other task aspects and explain that the reason they reacted negatively to the other task aspect was because of how that aspect influenced their perceived difficulty. In these cases, the transcript chunk would be coded with multiple aspect codes, including the DEN code. If the student only mentioned the perceived ease as their reason for a negative reaction, then those chunks would only be coded with the DEN code.

One example that illustrates the DEN code is Khalil explaining why he liked task part 4 of the Financial Aid task the least, “Probably this, ‘cause I ain't really do nothing but see, try to plot the point. But it was, it wasn't challenging enough for me.” I determined Khalil was describing a negative reaction because he was explaining why he liked a task part the least. His use of the phrase, “wasn’t challenging enough” is what indicated that his negative reaction was due to his perception that the task part was too easy. For these reasons, I assigned this transcript chunk the DEN code with reference to the Financial Aid task.

Another example that illustrates the DEN code is Jorge explaining why he placed the comparison task fourth in his final task sort, “It just wasn't all, it was just kind of easy once I got used to it to it, it wasn't really nothing interesting about it.” I determined this was describing a negative reaction because he was explaining why he placed the task fourth out of five in the task sort, and because of the phrase, “wasn’t really…interesting.” He also indicated that the reason for his negative reaction was his perceived ease of the task by saying, “it was just kind of easy.” For these reasons, I assigned this transcript chunk the DEN code with reference to the comparison task.

Perceived Difficulty: Hard-Positive. The definition for the Hard-Positive (DHP) code was "The challenge of a task or task part was appreciated and/or indicated a general preference for challenge." I assigned this code to transcript chunks where the student mentioned that the perceived challenge was a reason for their positive reaction, or they indicated a preference for challenge over ease. I assigned the DHP code anytime that challenge was mentioned as a reason for a positive reaction, even if the student mentioned another aspect in the same transcript chunk. It was common for students to have positive reactions to other task aspects and explain the reason they reacted positively to the other task aspect was because of how that aspect influenced their perceived difficulty. In these cases, the transcript chunk would be coded with multiple aspect codes, including the DHP code. If the student only mentioned the perceived challenge as their reason for a positive reaction, then those chunks would only be coded with the DHP code.

One example that illustrates the DHP code is Andrew explaining why he decided to keep the markers on the indicator tool high after task part 2 of the Financial Aid task, "It made me think a little bit and like I got a little confused so it wasn't just like they're super easy and just nothing. It made me think a little bit." I determined this to be describing a positive reaction because the markers remained high after he completed the task part. Andrew indicated his preference for challenge over ease when he said, "It made me think a little bit…so it wasn't just like they're super easy." Since I already determined that he was describing a positive reaction, I interpreted this phrase to mean that he preferred having to "think a little bit" over it being "super easy." For these reasons, I assigned this transcript chunk the DHP code with reference to the Financial Aid task.

Another example that illustrates the DHP code is Diondre discussing the Financial Aid task during his final task sort, “Um, I appreciate this one because I did not know all of it. I didn't know not, I did not know the right answers, but I still gave, I still gave it a shot and it just, I appreciate it for just being here.” Although Diondre did not place the Financial Aid as one of the top two tasks in his task sort, I determined that this response was describing a positive reaction because he used the phrase, “I appreciate this one.” Diondre indicated that he appreciated the challenge of the task when he said, “I still gave it a shot and…I appreciate it for…being here.” For these reasons, I assigned this transcript chunk the DHP code with reference to the Financial Aid task.

Perceived Difficulty: Hard-Negative. The definition for the Hard-Negative (DHN) code was “The challenge of a task or task part was appreciated and/or indicated a general aversion to challenge.” I assigned this code to transcript chunks where the student mentioned that the perceived challenge was a reason for their negative reaction, or they indicated general aversion to challenge. Some terms that I interpreted as a negative reaction to difficulty were “frustrated,” and “confused,” when the student did not mention that those feelings had been resolved. I assigned the DHN code anytime that challenge was mentioned as a reason for a negative reaction, even if the student mentioned another aspect in the same transcript chunk. It was common for students to have negative reactions to other task aspects and explain the reason they reacted negatively to the other task aspect was because of how that aspect influenced their perceived difficulty. In these cases, the transcript chunk would be coded with multiple aspect codes, including the DHN code. If the student only mentioned the perceived challenge as their reason for a negative reaction, then those chunks would only be coded with the DHN code.

One example that illustrates the DHN code is the same transcript chunk that I used as an example for the CVN code, when Shantel is explaining why she put the Wage War task last in one of the task sorts:

> This one was hard. It was about money. I like money but I that was too much. Like definitely if the company wants to hire somebody and the people that want the job that's like you have to really think about it like how much they all going to get paid and how much hours they all going to work and what time they come in and what time they leave and break time. That's a lot to think about. I don't want to run no company...And then you gotta like definitely if you're like working at a fast-food restaurant and you're giving them all the same pay. You might not have as much money as you need to get the food and pay for all the food that you need and grease and oil and all that just for it, it's, that's a lot to think about. Dang. I don't even want to think about it.

I once again determined that this was describing a negative reaction because she was explaining why it was the last task in the task sort. For the DHN code, I only needed to look at the first sentence of the response, "This one was hard." Since it was a negative response, and clearly stated that she thought it was hard, this chunk was assigned the DHN code with reference to the Wage War task. In her response, Shantel also says the phrases, "that was too much," and "that's a lot to think about" which are indicators of a negative reaction, but since she was not clear about why it was "too much," or why it was "a lot," I did not want to make the assumption that she was referring to difficulty and misrepresent her experience.

Another example that illustrates the DHN code is Arthur explaining why he kept the markers on the indicator tool low after task part 3 of the Financial Aid task, " All these lines for the graph confused me because, and the numbers confused me too, because it was like harder for me to look at it and figure out which ones were which.

Like what numbers to find." I determined this was a description of a negative response because he used the term "confused" multiple times, and because he was explaining why he kept the markers low. Arthur's use of "confused" along with "harder for me to…figure out" indicated that he was referring to his perceived difficulty of the task part in his response. For these reasons, I assigned this transcript chunk the DHN code with reference to the Financial Aid task.

I used the compiled identified transcript chunks and their assigned codes to organize the data in ways that would facilitate the answers to my two research questions. For research question 1, I used the coded transcript chunks to assign codes to the 54 task occurrences. For research question 2, I used the codes that were assigned to each student's task occurrences as my initial filter to select cases of students' experiences with the tasks that exemplified focus to specific task aspects. In the next section, I will explain how I used the coded transcript chunks to assign codes to task occurrences.

Assigning Codes to Task Occurrences

I decided to use a task occurrence as the final unit to which I would assign and tally the codes. I defined a task occurrence to be the compilation of one student's mentions of a single task. This definition allowed me to account for times when students mentioned a task they had previously completed in a different task interview and the final interview. I assigned the task occurrence all codes that were assigned to transcript chunks that referred to that task. When one code was assigned multiple times in the task occurrence, I still assigned the code a single time. By assigning single codes to task occurrences instead of accounting for each coded chunk, I was able to account for each student's experiences with all tasks equally, and not have the code tallies influenced by a single student's experience. This was important for my first research question which asks what all students explained were reasons for their reactions in all tasks. For that research question, I was not attending to how frequently an individual student mentioned the same reason for their reaction during a single task occurrence. By creating tallies for all codes by task occurrences, I could see patterns across the students and across tasks for what the students explained were the specific reasons for their reactions. I also used the coded task occurrences as my first step in selecting cases for my second research question, which I explain in a later section.

To assign codes to the task occurrences, I used the Excel workbook where I recorded all coded transcript chunks. I added another sheet to the workbook to record the codes each task occurrence was assigned. This sheet had seven columns, the student's name, the name of the task, and a column for each of the five task aspects. To assign the codes, I filtered the five aspect sheets in the workbook for each student and each task and recorded the codes on the sheet for the task occurrences. I did this for all 11 students and all tasks they completed resulting in 54 coded task occurrence units (Shantel only completed four of the five tasks). After this was completed, I obtained reliability for my codes.

Reliability

Reliability for my coding was obtained with the assistance of another math education graduate student in the doctoral program. Reliability coding entire task occurrences was not feasible because students could mention a task in any of their six interviews (five task interviews and final interview), so I decided to use the task interviews and compare codes that were assigned to the transcript chunks within that interview. To obtain reliability, I wanted to make sure at least 10% of the task interview transcripts were selected to be coded by the other coder, so I selected 6 of the 54 transcripts. To ensure that at least one of each task type was represented in the sample of 6 transcripts, I assigned each student participant a number from 1-11 and used a random number generator to determine which student's transcript would be selected for each task type. Because there were only five tasks, the sixth transcript was obtained by assigning each remaining transcript a number from 1-49 and used the random number generator to select the remaining task. The six tasks selected in this process represented five student participants and included two Datelines tasks.

After I determined the six tasks, I trained the other doctoral student on how I coded the interview transcripts. I provided her with my written code book, verbally explained what each code represented, and gave examples of each code from transcripts that were not included in the six selected for reliability. We then coded a complete interview transcript together, not included in the six selected for reliability, which helped familiarize the other coder with the interview process including the prompts to move the markers on the indicator tool, and how the process influenced whether a response was to a negative or positive reaction. For instance, if the student was asked "Why did the markers go up?" that would indicate that the student's response would be coded as a "positive" even if the words themselves did not indicate a positive or negative response.

After the other graduate student coded the six transcripts, I compared the codes that I had assigned to each transcript to the codes that they found. To determine a percent for reliability, I added the number of codes that I assigned to the number of codes that they assigned and divided that sum by double the number of codes that matched. Across all six transcripts, they marked 33 codes, I marked 32 codes, and we had 26 that matched. Therefore, the percent reliability across all six transcripts, calculated as described above, was 80%. Because I wanted to achieve at least 85% reliability, as suggested by Miles, Huberman, and Saldaña (2018, p. 79), I determined the percent reliability for each individual transcript using the same calculations and found that three of the six transcripts had between a 91% and 100% reliability rate. The remaining three transcripts had 83%, 66%, and 36% reliability. Table 3.11 has the reliability rates for all of the transcripts we both coded.

Table 3.11 *Interrater Reliability Percentages by Transcript*

	Number of Codes Assigned to Transcript			
Transcript	Rater 1	Rater 2	Match	Reliability
Khalil Datelines	7	7	7	100%
Shantel Pic Me!	5	6	5	91%
Khalil comparison task	6	5	5	91%
Andrew Wage War	6	6	5	83%
Callie Financial Aid	4	2	2	67%
Francis Datelines	5	6	2	36%

To determine the conflicts between our codes for the three transcripts that did not reach the 85% threshold, I examined the transcript chunks from the three transcripts to which one of us had assigned a code and the other had not, or to which we assigned different codes. This combined for a total of seven excerpts. For each of these conflicts, we explained to the other how we determined our code and compared it to the code book. Five of the conflicts were resolved by examining the broader context of the response, either by looking at a larger portion of the transcript with direct attention to the specific coded chunk and how the larger portion informed that excerpt, or by referring to the video for gestures the student made to identify what task part specifically they were referring to. For example, in one case the student mentioned “maybe explain more” which the other coder interpreted as wanting the opportunity to justify their answer. However, the video showed she was pointing to the prompt, which indicated that she wanted the prompt to explain more about what she should do for that part of the task, a task part that did not request students to write a written explanation. By examining this expanded context, we both agreed that codes as they already appeared in the code book appropriately applied to the five conflicts.

The other two conflicts required a clarifying revision to the code definitions for the thematic subcodes for the Mathematical Topic aspect. In both cases, the other coder assigned an excerpt with the Mathematical Topic Unfamiliar-Negative and Perceived Difficulty Hard-Negative (DHN) codes, and I only assigned the DHN code. One of the transcript chunks was an explanation Callie gave for moving the markers down on the indicator tool after a task part in the Financial Aid task, “Because I didn’t know how to do any of it, and I was very frustrated.” The other coder interpreted her phrase “I didn’t know how to do any of it” as her attending to an unfamiliar mathematical topic and “frustrated” indicating difficulty. When I assigned codes, I found it was unclear what Callie meant by “any of it” since it could be interpreted to mean the math procedures or the language for the prompt, so to prevent misinterpretation of the student’s experience, I did not assign a Mathematical Topic code. Recognizing this discrepancy, I added the term “specific” to each of the four subcodes for mathematical topic which is reflected in the definitions I provided earlier in this section. I had already coded the transcripts with this concern for ambiguity in mind, so although the definitions needed to be revised in the codebook for clarity, the revisions to the definitions for the Mathematical Topic codes did not affect codes that I had previously assigned.

Selecting Student Cases

To answer my second research question, I determined cases where the students mentioned consistent reactions to a single task aspect across the tasks. To determine the cases, I used a combination of the coded task occurrences, descriptive summaries I wrote for the task interviews, and analytic memos I wrote reflecting on each student's experience. I verified that the cases were supported by the data by comparing the cases I selected to the coded transcript chunks that supported the case. At the end of this process, I had three cases, "Context," represented by Diondre and Coleman, "Opportunity to Justify," represented by Arthur, and "Difficulty" represented by Callie.

Coded Task Occurrences to Determine Cases

I used the coded task occurrences to find students that expressed consistency in their reactions to aspects across the tasks. For the featured aspects, if a student was assigned two positive subcodes for the same aspect I would record a single positive reaction for that aspect. For example, if a student's task occurrence was assigned both Context Presence Positive and Context Relevance Positive, I would record a positive reaction to context for that task occurrence. For the emergent features, it did not make sense to separate by positive and negative based on the definitions of the subcodes, so I had to combine codes differently. For the Mathematical Topic, I combined the

Familiar Positive and unfamiliar negative codes since it made sense to pair a positive reaction to a familiar topic with a negative reaction to an unfamiliar topic, but I did not pair the Familiar Negative and Unfamiliar Positive codes since they could represent different ideas. For Perceived Difficulty, I combined the Easy Positive and Hard Negative codes and the Easy Negative and Hard Positive codes. These pairings make sense because if a student liked something that was easy, it is comparable to a student not liking something that was hard. Similarly, it is natural to pair a negative reaction to something easy with a positive reaction to something that was hard.

After I recorded the reactions to the aspects for the task occurrences, I made an array to show me how often and in what ways each student reacted to each aspect. The array had rows for each of the ten students I was considering for cases (I excluded Shantel because she did not complete all five tasks) and had columns for each reaction type for each aspect. I included a column for each aspect that indicated that the student had a mixed reaction, meaning that they were assigned codes that I had not combined. For example, if a student had both a positive and a negative reaction coded for the Opportunity to Justify, then I accounted for that in the mixed reaction column. The number in the array indicates in how many task occurrences the student had a particular reaction. This display can be found in Figure 3.3.

Using the array, I decided that the three potential aspects I would select cases for were Context, Opportunity to Justify, and Perceived Difficulty. I decided that I would not select cases for Graph Interpretation and Mathematical Topic because there were not more than three task occurrences for any student for any of the specific reaction descriptions. Using the same logic, I decided not to select students for cases where they had three or fewer task occurrences representing a specific reaction. This left one reaction type for each aspect I selected to present representative cases, a positive reaction to Context, a positive reaction to Opportunity to Justify, and a preference for ease for Perceived Difficulty.

	Context			Opportunity to Explain			Graph Interpretation			Mathematical Topic				Perceived Difficulty		
	Pos	Mix	Neg	Pos	Mix	Neg	Pos	Mix	Neg	MFP/MUN	Mix	MFN	MUP	DEP/DHN	Mix	DEN/DHP
Arthur	4			4			3	1		1	2	2		5		
Andrew	2		1	1		3	3			3	1			2	3	
Callie	2									1				4	1	
Coleman	4	1		3						3	1			4	1	
Diondre	4			1	1	2				1	1	2		2	1	
Francis	4			3		1				1	1	1		3	2	
Janelle	3		2	2			1			1	2	1	1	5		
Jorge	2	1	1			1	1			3	1			3	2	
Khalil	4			2	1					1			2	1	4	
Kimberly	4	1		3			1	1		1	2	1		4	1	

Figure 3.3 *Array with Totals for Each Student for Each Aspect*

For Context and Perceived difficulty, there were multiple students that had at least four task occurrences representing the reaction type I was going to present, but only one student, Arthur, with four task occurrences for opportunity to justify. Even though Arthur was the only possibility for opportunity to justify, I did not automatically select him to be the representative case. I followed the same process to confirm that Arthur would be an appropriate representative that I used for the other aspects. If I had not come to the conclusion that he would be an appropriate representative, then I would not have been able to present a case for the Opportunity to Justify. Figure 3.4 shows my array with the cells highlighted from which I would select the representative cases.

	Context			Opportunity			Graph			Mathematical Topic				Perceived Difficulty		
	Pos	Mix	Neg	Pos	Mix	Neg	Pos	Mix	Neg	MFP/MUN	Mix	MFN	MUP	DEP/DHN	Mix	DEN/DHP
Arthur	4			4			3	1		1	2	2		5		
Andrew	2		1	1		3	3			3	1			2	3	
Callie	2									1				4	1	
Coleman	4	1		3						3	1			4	1	
Diondre	4			1	1	2				1	1	2		2	1	
Francis	4			3		1				1	1	1		3	2	
Janelle	3		2	2			1			1	2	1	1	5		
Jorge	2	1	1			1	1			3	1			3	2	
Khalil	4			2	1					1			2	1	4	
Kimberly	4	1		3			1	1		1	2	1		4	1	

Figure 3.4 *Array Highlighting Possible Student Representatives for Cases*

Once I identified all possible representatives, I had to select the students that best illustrated each case. For my purposes, the best representatives were students that frequently mentioned the specific reaction to the aspect throughout the entire process, not students who only mentioned it once. For this reason, I had to use something other than the coded task occurrences for my selection since the coded task occurrences did not account for repeated codes within a single task occurrence.

Selecting Student Representatives for Cases

I decided to use a combination of descriptive summaries of task interviews and analytic memos of the student's responses throughout the process to select the students to represent each of the three cases. I started by reviewing all the transcripts for the eight students that could be representatives for one of the cases (Andrew and Jorge were the two students that could not be representatives for any case). I re-read each transcript in the order in which the interviews took place. After reading each transcript, I drafted a descriptive chronological summary of the student's responses. The summaries for the task interviews described the students' reactions before the task, after each task part, including whether or not they moved the markers on the indicator tool and why, and after the task. The summaries for the final interview described the reasons the students gave in their explanations for the order of the tasks in their final task sort.

After writing the summaries for each of the interviews, I wrote an analytic memo about the student's experience. An analytic memo is defined as "a brief…narrative that documents the researcher's reflections and thinking processes about the data" (Miles et al, 2018, p. 88). In each memo, I wrote the commonalities I noticed in each of the descriptive summaries as well as anything that stood out to me while I was reading the transcripts themselves. I also used my memory of interviewing the students to recall their tone of voice, their body language, and other factors that could not be captured in the transcripts when writing the memos.

Using the summaries and memos, I made the initial decision to select Diondre to represent "Context," Arthur to represent the "Opportunity to Justify," and Callie to represent "Difficulty." Each of these students consistently emphasized the aspect I chose for them to represent over the other aspects. They also made frequent mentions of the specific reaction they had to the aspect throughout each task as well as through the entire task interview process.

Once I made the decisions for each case based on the summaries and memos, I ensured that the coded data also supported each selection. To ensure the data supported my decisions, I checked for repetition of the codes that were applicable to the reaction type and aspect that I selected them to represent. For each of the three selected students, the data supported my decisions that they were convincing representatives for each reaction type.

The last step I took was to determine contrasting examples for each of the three cases. To find the contrasting examples, I looked for transcript chunks that were coded with opposing codes to those that the case represented. For the context and the opportunity to justify cases, Diondre and Arthur represented positive reactions, so I found chunks coded for negative reactions. For perceived difficulty, Callie represented a preference for perceived ease, so I found chunks coded with a preference for challenge. After finding the appropriately coded chunks, I decided that for contrasting examples to the context case, I would use examples from Janelle's transcripts, and for contrasting examples to the perceived difficulty case, I would use examples from Khalil's transcripts. For opportunity to justify case, I decided to provide examples from multiple students because there was not enough supporting data to select an individual student's transcript to fully represent a contrasting example.

After I selected my three cases and contrasting examples for each, I was prepared to present the results for both of my research questions. In the next chapter, I will present the results for my first research question which came from the coded task occurrences. In the following chapter, I will present the results for my second research question that come from the three representative student cases and their contrasting examples.

Chapter 4

RESULTS: ASPECTS OF MATHEMATICAL TASKS THAT ELICIT POSITIVE OR NEGATIVE REACTIONS

In this chapter, I will address my first research question:

> *Among high school students who reported having low situational interest in mathematics, to which aspects of mathematical tasks did these students react? In what ways did the students react to the aspects and what explanations did they provide for their reactions? Which, if any, of the aspects were intended features of the focus tasks?*

There were five task aspects mentioned by these students that elicited a positive and/or negative reaction for them and the three intended features of the focus tasks were included among these aspects. The three intended features of the focus tasks were (a) *the inclusion of a real-world context (context), (b) providing the opportunity to explain or justify an answer using opinions or experiences (opportunity to justify),* and (c) *interpretation of data from a visual representation (graph interpretation).* Two additional task aspects emerged from students' voices during data analysis that elicited positive and/or negative reactions from the students, and these aspects were not intended features of the focus tasks. These additional task aspects were *the specific mathematical topic (mathematical topic)* and *perceived difficulty*.

The results came from 54 task occurrences with at least one aspect mentioned in every task occurrence. The aspect mentioned most frequently was the emergent aspect perceived difficulty which was mentioned in 52 task occurrences. Context was the second most mentioned task aspect, and the most mentioned task feature, and was mentioned in 43 task occurrences. Mathematical topic was next mentioned in 39 task occurrences followed by the opportunity to justify mentioned in 30 task occurrences. The least mentioned aspect was the feature aspect graph interpretation which was only mentioned in 11 task occurrences. It is noteworthy that the emergent aspects were mentioned more than two of the featured aspects. These frequencies can be found in Table 4.1.

Table 4.1 *Number of Task Occurrences in Which Each Aspect was Mentioned*

Aspect	Number of Task Occurrences (54 Total)
Perceived Difficulty[b]	52
Context[a]	43
Mathematical Topic[b]	39
Opportunity to Justify[a]	30
Graph Interpretation[a]	11

[a]Featured Aspect
[b]Emergent Aspect

Because the students' reactions to perceived difficulty influenced their reactions to the other four task aspects, I will present those results first, followed by the three task features and ending with mathematical topic. For the featured aspects, I begin by presenting an initial conjecture informed by research. After presenting the results for each of the five aspects, I will end with a concluding stance informed by the results. My concluding stances represent my revised thinking about students' reactions to aspects of tasks, and this concluding stance was informed by data analysis. A table with my initial conjectures about students' reactions to aspects of tasks prior to data collection (for feature aspects) and my concluding stances (for all task aspects) can be found in Table 4.2.

Table 4.2 *Initial Conjectures and Concluding Stances for Student's Reactions to Task Aspects*

Task Aspect	Initial Conjecture	Concluding Stance
Context	Students reporting low situational interest in math would express an appreciation of or preference for tasks with contexts that were relevant to their experiences or enjoyable to interact with.	Students reporting low situational interest in math typically expressed an appreciation of or preference for tasks with contexts that were relevant to their experiences or enjoyable to interact with. These students recognize that some contexts that may not be relevant are enjoyable, or vice versa. Infrequently, these students may express negative reactions to specific contexts, or they may prefer tasks that do not include a real-life context.
Opportunity to Justify	Students reporting low situational interest in math would express an appreciation of or preference for parts of tasks that provided students with the opportunity to justify their responses with their opinions and/or lived experiences outside of math class.	Students reporting low situational interest in math typically expressed an appreciation of, or preference for, parts of tasks that provide them with the opportunity to justify their responses with their opinions and/or lived experiences outside of math class. This is because they either wanted the chance to share their opinions or experiences, or because they preferred prompts that did not require them to perform mathematical processes. Infrequently, students preferred task prompts that required mathematical processes over explanations based on opinions or experiences.

Table 4.2 Cont.

Task Aspect	Initial Conjecture	Concluding Stance
Graph Interpretation	Students reporting low situational interest in math would recognize and appreciate the utility of the graphical representations as a resource for constructing their responses.	Students reporting low situational interest in math typically recognized and appreciated the utility of the graphical representation as a resource for constructing their answers. Furthermore, students who mentioned this reaction recognized changes or improvements that could be made to the representation to improve its utility.
Mathematical Topic	N/A	Students reporting low situational interest in math frequently reacted to the presence of a specific mathematical topic that they recognize as either familiar or unfamiliar. These students typically reacted to familiar topics positively when they had success with or enjoyed them in the past, and negatively to ones they had difficulty with in the past. Less often, students reacted negatively to familiar topics because they bored them indicating a preference for novelty. These students typically reacted to unfamiliar topics negatively due to perceived inaccessibility. Less often, students reacted positively to unfamiliar topics due to a desire to learn or a perceived feeling of accomplishment.
Perceived Difficulty	N/A	Students reporting low situational interest in math very frequently reacted to their perceived difficulty of the tasks or task parts. These students typically preferred less difficulty. When a student reacted to a featured aspect of a task and gave a rationale of their perceived ease, the students always said that their preference for less difficulty influenced their reaction to the aspect. Occasionally, students preferred more challenge in some tasks or task parts and preferred less difficulty in other tasks or task parts.

Student Reactions to Perceived Difficulty

There were more task occurrences in which students mentioned a reaction to perceived difficulty more often, and with more consistent results, than any other aspect. While students very frequently attended to perceived difficulty, they typically mentioned it in conjunction with an additional task aspect. Perceived difficulty as an aspect could be mentioned by the students with regards to all tasks and all task parts, which meant there were multiple opportunities in all of the tasks for the students to attend to perceived difficulty. Furthermore, students could, and did, explain their reactions to concurrent task aspects by mentioning how that aspect affected their perceived difficulty. When a student mentioned both difficulty and another aspect, it was impossible in many cases to separate the reactions to each individual aspect, so perceived difficulty influenced the students' reactions to, and therefore the results for, each of the other four aspects, which is reflected in the themes that emerged. In this way, perceived difficulty influenced the themes I present for the explanations for students' reactions to the four other task aspects. In this section, I will present perceived difficulty by showing how it influenced students' reactions to other aspects as well as in isolation when students mentioned perceived difficulty without also mentioning a concurrent aspect.

Perceived difficulty was mentioned in 52 of the 54 task occurrences, with all 52 including at least one mention of the student's preference for less difficulty, and 15 also including at least one mention of a student preference for more challenge. Similar to the mathematical topic aspect, I considered the two ways students explained their reactions separately for each task occurrence and will present the results separately.

There were four ways that students ascribed their reaction to perceived difficulty, two that indicated a preference for less difficulty, and two that indicated a preference for more challenge. The two ways in which students indicated that they preferred less difficulty was by explaining a *positive* reaction to perceived *ease* or a *negative* reaction to perceived *difficulty*. Conversely, the two ways in which students indicated that they preferred more challenge was by explaining a *negative* reaction to perceived *ease* or a *positive* reaction to perceived *difficulty*. I will present the results in two sections, students' preference for less difficulty, and students' preference for more challenge.

Preference for Less Difficulty

In all 52 task occurrences where a perceived difficulty was mentioned, the students made at least one statement that indicated a preference for less difficulty. The students indicated this preference by either explaining that their positive reaction was for perceived ease, that their negative reaction was for perceived difficulty. In the task occurrences, when students mentioned perceived difficulty, they either mentioned it in isolation as an explanation for their reaction, or in conjunction with another aspect as an explanation for their reaction. In their responses, students generally did not explain the reason why they preferred less difficulty. When a student's response included explanations for reactions both to perceived difficulty and a featured aspect, the students only described a preference for less difficulty. Students also mentioned explanations for reactions that only included a preference for less difficulty without mentioning an additional aspect or feature.

Preference for Less Difficulty and a Reaction to a Featured Aspect

When a task occurrence mentioned a student's perceived difficulty along with an explanation for a reaction to a featured aspect in a task occurrence, the students only made statements indicating a preference for less difficulty. In task occurrences that perceived difficulty and a featured aspect were mentioned, the students provided their perceived difficulty as a rationale for their reaction to the featured aspect. Students provided this rationale for all three featured aspects.

Context and a Preference for Less Difficulty. There were only three task occurrences that mentioned context and perceived difficulty, and all three indicated that their reaction to context was due in part to their preference for ease. All three task occurrences mentioned the general presence of a context, not a specific context, and therefore are a subset of the results I presented for students' reactions to the presence of a context. Furthermore, all three task occurrences represented the comparison task, the only task that did not have a real-life context, so students used it for comparing and contrasting their reactions to the focus tasks. In two of the task occurrences, students said that the context increased their perceived difficulty, resulting in a negative reaction. In the other task occurrence, the student said that having a context reduced their perceived difficulty, resulting in a positive reaction.

Both Andrew and Janelle said that having a context present increased their perceived difficulty which induced a negative reaction towards context. Andrew indicated that he thought context increased difficulty when he explained his preference for the comparison task over the focus tasks and said, "you're doing…two things at once. This you're only thinking about the math." In this response, Andrew explained that the context was an additional layer to what he needed to consider when answering prompts. Janelle indicated that she thought context increased difficulty multiple times when she explained her preference for the comparison task and said, “I'm pretty sure it would throw me off somewhere. Like there would be some type of…little, tiny word…that maybe a person might not know and it would just throw them off.” In this response, Janelle indicated that the words used to couch the task in the context could make it more difficult, especially if it was an unfamiliar word or context.

Kimberly was the only student who mentioned that the presence of a context decreased the perceived difficulty of a task. When Kimberly explained why she put the comparison task last in a task sort she said:

> I like doing problems that have more of like a story to them…it kind of just helps me figure it out more…So with…these, it was read a problem and it kind of makes you…put you in like real-life situations a little bit. And it, it makes me think more and think better.

In her response she indicated the presence of the context when she said “problems that have…a story to them,” and “put you in…real-life situations.” She indicated that this presence reduced her perceived difficulty of the task when she said, “it…helps me figure it out more,” and “makes me think more and think better.” All three students who mentioned context and perceived difficulty indicated a preference for ease, and the presence of the context influenced their perceptions.

Graph Interpretation and a Preference for Less Difficulty. In the task occurrences that mentioned graph interpretation and perceived difficulty, students said that the graphical representation of the data facilitated their efforts to obtain the information they needed to form their answer. An example of this is when Arthur explained why he liked task part 4 of the Financial Aid task. In this task part, the prompt asks the students to determine the year in which two educational paths’ net gains intersect (emphasis mine):

> *I could use the graph and like it was way easier* ‘cause like they coming together at one point. So like it *was easy*, like *I could just* look at the paper and literally *look at the numbers*, put it down.

Arthur explained in his response that his positive reaction to the task part was because of both the graph interpretation (“use the graph”) and a preference for less difficulty (“it was way easier”). He repeated both reasons when he said “it was easy” (preference for less difficulty) and “I could just…look at the numbers,” (graph interpretation). Arthur’s response is an example of how graph interpretation influenced a positive reaction in part because it increased the student’s perceived ease or reduced their perceived difficulty.

There were some task occurrences where students mentioned that the lack of clarity of a representation led to a negative reaction. I discussed this result in the graph interpretation section, and it also applies to perceived difficulty since in all four occurrences, the student desired more clarity to make the task part easier. Kimberly’s response where she explained why she liked task part 1 of the Wage War task the least exemplified this circumstance:

> I dunno if it was just me or whatever that got like kind of stumped on it on the graph, ‘cause the way it, … how it's like jumping from one space instead of like the 20s and everything. So I would probably change the way it looks that way it's more easier to tell what you're counting by.

Kimberly, like the other students who desired more clarity in the graphical representation, recognized that the graph would be able to make it easier for her to obtain her answer, if there were changes made. This nuance shows that the students recognized that graph interpretation generally makes tasks easier, but specific graphs may increase perceived difficulty, therefore causing a negative reaction to the requirement for interpret data from those specific graphs.

Opportunity to Justify and a Preference for Less Difficulty. In the task occurrences that mentioned the opportunity to justify and perceived difficulty, students explained that the opportunity to justify was a reason that they perceived less difficulty. An example of this is when Coleman explained why he increased the markers on the indicator tool after task part 3 of the Pic Me! task (emphasis mine), "'Cause I'm like, I'm not really doing anything besides answering questions. Like *there's no work like problem solving.* So *it's pretty easy* and fun to answer the questions." When Coleman said, "no work like problem solving," he indicated that his positive reaction was because he was not expected to perform a calculation, one of the themes I presented for the opportunity to justify aspect. When he said "it's pretty easy," he is indicating a preference for less difficulty. Another example is when Kimberly explained why she liked task part 4 of the Wage War task, "'Cause I like explaining things *rather than doing the math* work, it's *easier to me* and I like, *it's easier for me to like …voice my opinion* about stuff like that." In Kimberly's response she explains her positive reaction to the opportunity to justify both because she did not have to perform calculations, "rather than doing the math," and because she wanted to share her opinion, "voice my opinion." Her preference for less difficulty is indicated when she said, "it's easier." Both Coleman's and Kimberly's responses are examples of how the opportunity to justify influenced a positive reaction in part because it increased the student's perceived ease or reduced their perceived difficulty.

Preference for Less Difficulty and Reaction to Mathematical Topic

When preferences for less difficulty were provided by students as rationales for reactions to specific mathematical topics in task occurrences, some responses indicated a positive reaction to perceived ease and some indicated a negative reaction to perceived difficulty. When this combination occurred, the students were indicating that the reason for their reaction was their perception of the level of accessibility of the topic. This result completely overlaps with the results I presented for the mathematical topic that included accessibility. These results encompass some of the task occurrences where students indicated a positive reaction to a familiar topic (high accessibility), and some where they indicated a negative reaction to familiar or unfamiliar topics (low accessibility).

Table 4.3 combines some of the examples I previously presented as students' perceived level of accessibility of a mathematical task because they also represent examples of students' preference for less difficulty as it relates to the mathematical topic. I maintained the same emphasis that I added when I presented these examples previously.

In these examples, the high accessibility examples demonstrated students' positive reactions because of perceived ease and the low accessibility examples demonstrated students' negative reactions to perceived difficulty. The students' reactions are indicated by the same emphasized phrases that I presented when describing the students' perceived level of accessibility.

Preference for Less Difficulty in Isolation

There were task occurrences that indicated a student's preferences for less difficulty that did not include a reference to another aspect. These preferences were indicated by a positive reaction to perceived ease or a negative reaction to perceived difficulty. Table 4.4 includes examples of each type of response of with emphasis added to the phrases that indicated a preference for less difficulty.

Table 4.3 *Examples of Explanations Indicating a Preference for Less Difficulty as Related to Accessibility of a Mathematical Topic (Emphasis Mine)*

Level of Accessibility	Examples
High Accessibility	Andrew placing Wage War high in a task sort: "I like this one more because like *I'm good with* like this type of stuff, this type of math, like tables and stuff."
	Kimberly placing indicator markers high after Datelines task part 1: "I get the tables and stuff *more easy* 'cause it's like, I don't know, I just feel like some, some things just *come more naturally* to me and the tables probably, 'cause I've been doing them longer comes like *a little bit easier* to me. So it's not that hard for me to find rules and stuff."
Low Accessibility	Diondre sharing thoughts he had before solving the FA task: "The graph doesn't look like something I've seen before. So *it looks like I'll be stuck on it*.
	Kimberly putting Pic Me! low in a task sort: "Like I keep saying, *I don't really know how to* do scatterplots I haven't really learned that."
	Arthur explaining why he liked Pic Me! task part 2 the least: "These two scatterplots because *I didn't really know how to*, there was the equation up here and *I didn't know* if I should use it or not. And this like, they were asking me to like to compare them or make them different and like *I didn't really know how to* like look at the scatterplot and like really like make sure how to like make them like really different from each other or comparable.

Table 4.4 *Examples of Student Statements Indicating a Preference for Less Difficulty in Isolation*

Reaction	Examples
Positive perceived ease	Francis placing Wage War high in a task sort: "Waging war*, it was pretty easy* to do. I got through it fast and of course Imma like something *that's easy and fast* that I can get done." Andrew placing Wage War high in a task sort: "I thought back to which one I thought *I remembered was easiest* I'm pretty sure it was this one." Callie leaving markers high after task part 6 of Datelines: "Because *the question was just easy* and I knew what to do and the *finding the answer was easy*."
Negative perceived difficulty	Kimberly lowering markers after task part 1 of Pic Me!: "'Cause I didn't like it. Like I*, it was hard* for me to come to a solution for the problem." Callie lowering markers after task part 2 of Financial Aid: "Because I *didn't know how* to do any of it. and I was *very frustrated*." Janelle explaining placement lowest two tasks in final task sort: "I guess in my opinion that's like obvious of course. Like if you *cannot figure it out*, it would be like less likable."

The language students used to describe a positive reaction to perceived ease was distinctly different from the language they used to describe a negative reaction to perceived difficulty, although the reactions are complementary to each other. There were fewer ways in which students referred to ease, usually it was using a variation of the word "easy," although some students indicated the speed at which they could arrive at an answer to imply their perceived ease. This language is seen in these examples when Francis said, "it was pretty easy" and "that's easy and fast," Andrew said, "I remembered was easiest" and Callie said, "the question was just easy," and "finding the answer was easy." The language the students used to refer to perceived difficulty was more varied and included feelings of confusion or frustration along with labeling something as hard or difficult. This language is seen in these examples when Kimberly said, “it was hard,” Callie said, “didn’t know how,” and “very frustrated,” and Janelle said “cannot figure it out.” While the students mentioned opposite reactions, the explanations they gave for those reactions were similar and indicated a preference for ease.

Preference for More Challenge

While all 52 task occurrences included statements indicating a preference for less difficulty, 15 of those task occurrences also included statements indicating a preference for more challenge. Students indicated their preferences in one of two ways, either by explaining a negative reaction to perceived ease or a positive reaction to perceived difficulty. Most of the student responses that indicated a preference for more challenge were provided as the immediate reason for their reaction, not as an explanation for a reaction to a different aspect. Mathematical topic was the only aspect for which a preference for more challenge was attributed as an explanation for a reaction. None of the occurrences indicated a preference for more challenge as an explanation for a reaction to a featured aspect.

There were two distinct ways in which students indicated a preference for more challenge and the explanations they gave for their preference were similar for both. When a student explained a negative reaction to perceived ease, they usually said they wanted more challenge. Similarly, when a student explained a positive reaction to perceived difficulty, they said they appreciated the difficulty, or liked that it was not easy.

Most of the students’ responses in task occurrences that indicated a preference for more difficulty explained reactions to a specific task or task part. Table 4.5

includes student's responses to a specific task or task part with emphasis added to the phrases that indicated whether they were explaining a negative reaction to perceived ease or a positive reaction to perceived difficulty.

Table 4.5 *Examples of Student Statements Indicating a Preference for More Challenge*

Reaction	Examples
Negative perceived ease	Jorge placing the comparison task low in a task sort: "It was *just kind of easy* once I got used to it to it, It wasn't really nothing interesting about it."
	Francis moving markers down after part 2 of Pic Me!: "Because the questions are *pretty obvious*. I mean the answers to the questions are *pretty obvious*."
	Khalil leaving markers low after part 1 of Pic Me!: "Still don't like it...'Cause *I don't get to think hard enough*."
Positive perceived difficulty	Khalil placing Financial Aid first in a task sort: "I did the first one because it was *challenging* and I didn't know it. I didn't never try it and then I randomly, well, I ain't randomly, but *I worked hard* to get that to know it."
	Andrew discussing Wage War after completing the task: "I thought it would just be like, like write a sentence out, write a sentence out for each one. But there was more to each question than I thought … it was a good thing. Definitely, 'cause it *made me think more*."
	Callie moving markers up after part 2 of comparison task: "I kind of liked it 'cause I like a *challenge* and I like, yeah, *challenge my mind*. So yeah, that's why,"

The language students used to describe a negative reaction to perceived ease was distinctly different from the language they used to describe a positive reaction to perceived difficulty, although the reactions are complementary to each other. There were a variety of ways in which students explained their negative reaction to perceived ease, either by labeling something as being easy, or by indicating a desire to work harder than they had to. This language is shown in these examples when Jorge said, "just kind of easy," Francis said, "pretty obvious," and Khalil said, "I don't get to think hard enough." The language students used to explain their positive reaction to perceived difficulty mirrors the language they used for perceived ease, by either labeling something as challenging, or by indicating appreciation for having to work hard. This language is shown in these examples when Khalil said, "challenging," and "I worked hard," Andrew said, "it made me think more," and Callie said, "challenge," and "challenge my mind." While the students mentioned opposite reactions, the explanations they gave for those reactions were similar and indicated a preference for more challenge.

In some task occurrences that mentioned a preference for more challenge, students compared the perceived difficulty of multiple tasks or tasks parts. In these responses, the students explained their preference using language that one thing as too easy, or the other one being better because it was more challenging. One example is when Jorge explained why he placed the Wage War task above two other tasks in the final task sort, "I think this one just because it's a little more harder to do so I kinda had to think more. Those [lower two tasks] were a little too easy once I got used to it." In this response, Jorge labels one task as "harder" and two other tasks as "too easy," and indicated his preference for the harder task both by placing it higher in the task sort while saying, "I…had to think more." Another example of a direct comparison is when Khalil explains why he put the Financial Aid task ahead of the comparison task in a task sort, "I like this one [Financial Aid] because it was actually challenging a little bit rather than this one [comparison task], this one's just easy." When he was asked to clarify whether he placed it ahead of the comparison task because of the difficulty, he said, “Yes, because I want to, I want to not saying I want to waste time, but I want to focus, and, not get through so quickly.” In the first part of his response, he labels Financial Aid as being “challenging,” and the comparison task as being “easy” and clarified that these perceptions were why he preferred Financial Aid.

Concluding Stance

These results demonstrated that students frequently have reactions to their perceived difficulty of tasks or tasks parts. Their reactions to perceived difficulty could be isolated to the task or task parts, or given as a rationale for reactions to other aspects of the tasks. Generally, and not unexpectedly, students stated a preference for less difficulty. This was always the case when students provided perceived difficulty as a rationale for a featured aspect. Less frequently, students indicated a preference for more challenge, or preferred a more challenging task over an easier task. Based on the results, my concluding stance for student’s reactions to perceived difficulty is, *Students reporting low situational interest in math very frequently reacted to their perceived difficulty of the tasks or task parts. These students typically preferred less difficulty. When a student reacted to a featured aspect of a task and gave a rationale of their perceived ease, the students always said that their preference for less difficulty influenced their reaction to the aspect. Occasionally, students preferred more challenge in some tasks or task parts and preferred less difficulty in other tasks or task parts.*

Task Aspects Included as Features of the Focus Tasks

For each of the featured aspects, I developed an initial conjecture informed by prior research, and a concluding stance informed by both prior research and the results of this study. Both the initial conjecture and the concluding stances are statements about how each task aspect could affect students' reported reactions. When presenting the results for the featured aspects, I will first share my initial conjecture, present the results that supported, enhanced, or opposed that conjecture, and end with my revised concluding stance on how the featured aspect affected students' reported reactions. For each featured aspect, there was evidence that directly supported my initial conjecture, as well as evidence that provided a more nuanced perspective than I had in my initial conjecture. For all but one aspect, graph interpretation, there was evidence that directly contradicted my initial conjecture. The number of task occurrences in which each featured aspect was mentioned, along with how many supported, clarified, or contradicted my initial conjectures are in Table 4.6.

Inclusion of a Real-World Context as an Intended Feature

When task occurrences indicated that students had explained a reaction to the inclusion of a real-world context, the students' responses generally supported my initial conjecture that the inclusion of a real-world context would elicit a positive reaction: "*Students reporting low situational interest in math would express an appreciation of or preference for tasks with contexts that were relevant to their experiences or enjoyable to interact with.*" Of the 43 task occurrences for which context was mentioned, 34 of them had responses directly supporting my initial conjecture with the student saying that they liked the context, thought the context was relevant, or both. Of the nine task occurrences for which students responded with a reaction about context that did not directly support my initial conjecture, in five of them, students said that they liked the context, but did not find it relevant, which still supports my conjecture, but provides a more nuanced insight into how students perceive context as a feature. There were four task occurrences that directly contradicted my initial conjecture (see Table 4.6). In two of the contradicting task occurrences, the students mentioned in their responses that it was the specific context of the task that they did not like, and in the other two, students mentioned a general preference for tasks without a context.

Table 4.6 *Number of Task Occurrences in Which Each Featured Aspect was Mentioned*

Aspect	Number of Task Occurrences (54 Total)
Real-life context	43
Supported conjecture	34
Additional nuance emerged	5
Contradicted conjecture	4
Opportunity to justify	30
Supported conjecture	21
Additional nuance emerged	2
Contradicted conjecture	7
Interpretation of graphs	11
Supported conjecture	7
Additional nuance emerged	4
Contradicted conjecture	0

Evidence Supporting and Providing Nuance to Initial Conjecture

When students mentioned context in a task occurrence, most of the time their responses supported my initial conjecture by saying they liked or enjoyed the context, found it relevant, or both. Even though I did not prompt the students to respond directly to the context, some students recognized that the context helped them engage more with the task, or improved their learning opportunities. The first example of this is when Shantel explained her reaction to the Datelines task during the task interview, "And it was easy since everybody loves celebrities and like if they have more like this, it would be so much easier and I would actually pay attention." And then during the final task sort, she reinforces this idea when explaining why she put Datelines high in her final task sort:

> Because I pay, like, it's because I pay attention to this types [sic] of like if it's like if it's interesting towards me, I pay attention to it. But if it's not, I just will give up. And I would like to try and stay focused and pay attention to it.

At two different times during a single task occurrence, during the task interview, and during the final interview, Shantel reported that having a context that appealed to her helped her to stay engaged with the task longer than she thought she may have otherwise.

Kimberly also recognized how a real-life context can benefit students' learning in a classroom setting when she explained why she placed the comparison task last in her final task sort:

> I like doing problems that have more of like a story to them. It kind of just helps me figure it out more. And then with this one [the comparison task], it was like, it was just right into the work. So with but with these [the focus tasks], it was read a problem, and it kind of makes you like kind of put you in like real life situations a little bit. And it, it makes me think more and think better.

Both Shantel's and Kimberly's statements about the benefits they experienced during tasks that had a real-life context reinforce the idea that students recognized the learning benefits on their own.

Students reacted positively to the context both by saying they liked or appreciated it, and by saying it was relevant to them. Some students mentioned that the context was enjoyable, for example when Kimberly was explaining what she noticed in the Datelines task before she started solving any of the task parts, she mentioned that the context of a particular task part, part 5, where there were celebrity pictures and the ages at which they started dating, drew her attention:

> Because um it was talking about like celebrities and stuff. And one, I didn't really know that about them. Like I didn't know the age difference was so big and that was kinda like, like, Whoa. Like, ‘cause some of it's like really big, like the Jay-Z and Beyonce one, he was 30 like that's crazy. I wasn't expecting that. So that was kind of like, Whoa.

Other students mentioned that they reacted positively to the relevance of the context of a task but did not mention that they liked it for a reason other than its relevance. An example of what this sounded like is Jorge’s response when I asked why he placed Wage War and Financial Aid as his top two tasks in his final task sort:

> Then it's these two. It’s something that I could relate to, you know, ‘cause once I get out of school, I have to find out how much money I'll be making and all that an hour and all that and how much, how long I'm going to have to work for or go to college for.

Both Kimberly and Jorge’s responses indicate a positive reaction to the context, and both gave their specific reason for the positive reaction as either liking the context (i.e., Kimberly), or finding the context relevant (i.e., Jorge).

Shantel also mentioned the relevance of context when she was explaining why she put Pic Me! first in her final task sort:

> And in this one it was about Instagram, and everybody got Instagram… It's about the followers and stuff. Like, if you ask somebody to see how many followers they got with Instagram and how many comments and likes it will get, they will literally tell you.

In this statement Shantel focused on the shared experience of Instagram without explicitly sharing that she liked that the task was about Instagram, just that it was a common experience that she believed most kids could relate to. This statement shows that she recognized that tasks are typically shared experiences within a classroom and interpreted the relevance of the context in that way, not just limiting it to her own experience or preferences.

While my initial conjecture included that students may appreciate a context, or find it relevant, as I accounted for above, it did not account for students that agreed with one of those statements but not the other. In five task occurrences, students mentioned that they liked or appreciated a context, but also acknowledged that they did not find it relevant to their experiences. This happened in two Datelines, two Financial Aid, and one Pic Me! occurrence. Janelle's explanation of how she reacted to the context of the Datelines task for why she placed Datelines high (second) in her final task sort demonstrates this nuance:

> This one I like because, um, it like kind of gets you into it and you know, at least for me at least, that was like funny to me. Like, oh wow. Like you wouldn't know that. So it was like something that, um, a kid will probably like, like I guess not exactly relate to, but like know about.

Janelle is clear that the context is appreciated, and appropriate for the audience of high school aged students, but that those same students may not find it relevant. In a different task occurrence Janelle said that she liked the context of the Pic Me! task, "…and definitely the topic of Instagram and things, you can relate to it too (Pic Me! Task interview)." Kimberly provides further insight into the nuances of the specific contexts and how she feels the relevance would affect students' reactions to the task:

> It [Datelines] kind of puts things into like a real-life perspective. That one did too. But this one was like kind of more like relatable 'cause like, you know, 'cause I'm a teenager and it's kind of like dating ages and stuff. And so it was, it was more relatable than this one [Financial Aid]. 'Cause I haven't graduated yet and I'm not really that close to graduating.

When she made this statement, Kimberly had already stated that she preferred tasks with contexts when explaining why she put the comparison task last in her final task sort. This statement emphasizes that the relevance she felt of the context also affected how she reacted to the tasks. With these student responses in mind, it is reasonable and expected that students will respond differently to different contexts, and it is important to recognize that a particular combination of relevance and enjoyment of the context that could be what increases students' interest in a task.

Evidence Contradicting Initial Conjecture

While most of the statements students made in task occurrences where context was mentioned supported my initial conjecture, there were four incidences that directly contradicted it. In two of these cases, students were responding to a specific context of a task, in one case it was Datelines and the other case it was Wage War. The other two cases were instances where students said that they preferred tasks that did not have a context.

The task occurrences where only negative reactions were mentioned by students were Jorge's Datelines occurrence and Janelle's Wage War occurrence. Jorge explained his negative reaction to the context for Datelines by saying, "It wasn't really to me that's something I needed or something that important either." This statement was made as an explanation for why he placed it lower than other tasks in his final task sort. Janelle had multiple responses regarding her negative reaction to the context in Wage War during the task occurrence.

Since Janelle made multiple statements about her negative reaction to the Wage War context, her task occurrence provides detail on why students may react negatively to a specific context. During the task interview, the context was one of the first things she noticed before solving any of the task parts, “Why do, why do like these equations always have to be about, about like unnecessary things? Like, I don't know…Like companies and things like, I don't know.” Wage War was the first task that Janelle completed, and even after solving the next four tasks, during the final task sort she mentioned her negative reaction towards the Wage War context again saying, “This one I just do not care for it. Um, because I, I like it's about companies and stuff…I didn't like doing it at all.” Janelle made it clear that she did not think the context of a company hiring workers was relevant to her experience, and because of that lack of relevance, did not find enjoyment in the task’s context. Overall, among the four different contexts included in the focus tasks, students rarely had negative reactions to the specific contexts.

Finally, there were two task occurrences in which students voiced a specific preference for tasks that did not include any context. These were both during comparison task occurrences when students were comparing the task that did not have a real-life context to the four focus tasks that did include one. In both cases, the students mention their concern that the context in which the math is embedded convolutes and complicates their ability to solve the mathematical problems. Andrew explains his reaction to the comparison task and its lack of context this way when saying he would not make changes to it:

> Because it's more with math. It's not like a different scenario that has to like apply with real life. I mean that sounds kind of like, I mean it means. I don't have a problem with having to do real life, but like I like to like, I don't know, do it more with math then ‘cause like this, it makes you think not also about the math but It makes you think about the real life scenarios. *So you're doing like two things at once. This you're only thinking about the math* [emphasis mine]. You're not doing like, oh how much would this person want to make or you're not thinking about a real-life scenario. You think also thinking about the

> math and that same time. So because the answer can vary whether or not this per like it's whether or not the real life scenario works. Your answer can't work off that this your answer works off you. All you gotta do is solve the problem. You don't have to really put as much thought into that. You can put it more into the problem.

Andrew says that the context makes him have to think about multiple things at once, whereas when solving a problem that does not reside in a real-life context he only has to focus on the math. Janelle has a similar explanation for her preference for tasks without context when she is explaining what she liked about the comparison task. In Janelle's case, she is concerned about comprehension of the scenario or being misled by the language used:

> Janelle: Like, if it was like with the word problems, I would just be like, I don't want to do this, you know? But like with this one, I was like actually really like trying to get this…
>
> Interviewer: So, you said you wouldn't want to do it if it was in a word problem, why would that make a difference?
>
> Janelle: Um, because I'm pretty sure it would throw me off somewhere. Like there would be some type of like little tiny word or some something like some other word that maybe a person might not know and it would just throw them off. 'Cause you're just like, Whoa. Like I don't know what to do, whether if it's just like this and and done, it would just be easier. Yeah.

Both Janelle and Andrew reacted negatively to tasks with a real-life context out of concern that the context convolutes (Andrew's occurrence) or makes it difficult to understand what was being asked of the students (Janelle's occurrence). Overall, the task occurrences indicate that most students preferred tasks that included a context, with a small number maintaining a preference for tasks that were not situated in a context.

Concluding Stance

After considering the evidence both in support of, and contradicting my initial conjecture, my revised, concluding stance is, *Students who indicated having low situational interest in math typically expressed an appreciation of or preference for tasks with contexts that were relevant to their experiences or enjoyable to interact with. These students recognize that some contexts that may not be relevant are enjoyable, or vice versa. Infrequently, students may express negative reactions to specific contexts, or they may prefer tasks that do not include a real-life context.* Most evidence generally supported my initial conjecture, that the context would elicit positive reactions, but my revised statement incorporates the nuances students mentioned in their rationales for why they had a positive reaction to tasks with a real-life context. My revised stance also acknowledges that some students said that they had a negative reaction to tasks with a context, although their explanations were not consistent and negative reactions occurred less often.

Providing Students with the Opportunity to Justify as an Intended Feature

When provided with the opportunity to justify, students' reported reactions generally supported my initial conjecture that this opportunity would elicit positive reactions: *"Students reporting low situational interest in math would express an appreciation of or preference for parts of tasks that provided students with the opportunity to justify their responses with their opinions and/or lived experiences outside of math class."* Of the 30 task occurrences for which the opportunity to justify was mentioned, 21 fully supported my initial conjecture with students voicing positive reactions to prompts designed to elicit justifications for answers that involved the students' opinion or experiences. Of the remaining nine occurrences, two included a distinction that I had not anticipated, that when some students expressed positive reactions to the prompts it was because they did not involve computations or data interpretation, not because they had the opportunity to share their opinions or experiences (see Table 4.3). In other words, they did not see this style of justification as a way of demonstrating their mathematical understanding and instead saw the explanation as being unrelated to the mathematical reasoning required for the task. In the remaining seven task occurrences, students said they preferred answering computational prompts rather than prompts asking for personal justifications of their answers, which directly contradicted my initial conjecture.

Evidence Supporting and Providing Nuance to Initial Conjecture

When task occurrences referred to whether a task provided the students with the opportunity to justify their answer with their opinion or experience, they generally supported my initial conjecture, as students expressed an appreciation for the opportunity to justify or explain. Some students responded to the opportunity to justify their answers by saying that they preferred prompts with that feature, because they had a desire to use and share their opinion or experiences. Arthur’s explanation for why he moved the markers up on the indicator tool after task part one of the Pic Me! task demonstrated his preference for prompts that allow him to use his opinions and experiences in his answer:

> And like that's part of opinions… Like I would like I've been on social media too. And then like you can use like what you already experienced to help solve like I said like my opinion and like your experience to solve this.

Khalil also attributed his preference to being given the chance to share his opinions when he explained why he was most looking forward to answering task prompt 4 of the Wage War task, “Because it basically said if this, if, if it happened, like what would you think? Would it be a good idea or not? Like, I want to share my opinion.” Janelle provided her speculation that prompts that allow for students to share their opinion would increase student engagement in class when she explained why she wanted to see more tasks like the Pic Me! task in her school math class, “I would say this is more of like, like, hey class, let's talk about this. ‘Cause this was like more, I guess opinionated. So it would get everyone into it.” Arthur and Khalil both supported my conjecture in these responses by sharing their personal appreciation of being given the opportunity to justify using their opinions or experiences. Janelle’s response expanded on her personal preference to include her recognition that it was likely her peers would also appreciate being given the opportunity to include their opinions because everyone would be able to contribute.

Although some task occurrences that supported my initial conjecture indicated that a student attributed a preference to wanting to share opinions or experiences, other occurrences indicated that a student attributed a preference to the lack of requiring computation or quantitative data interpretation to obtain an answer. In most of these instances, the students either said or alluded to their perception that a lack of computation made the problem easier or more fun. Coleman provided an example from the Pic Me! task where both ease and enjoyment are elicited as a result of the lack of “problem solving” (which I interpreted to mean computations), “’Cause I'm like, I'm not really doing anything besides answering questions. Like there's no work like problem solving. So it's pretty easy and fun to answer the questions.” Francis did not directly mention the lack of computation in his explanation for raising the markers on the indicator tool after solving the first task part of the Pic Me! task, but his response made it clear that perceived ease due to the lack of computations was the explanation for his preference of the prompt, “It was easy to solve. I just wrote down my thoughts.” Both Coleman’s and Francis’ responses demonstrated an appreciation for prompts that provided them with the opportunity to justify their answers, which supported my conjecture. In their responses, they attributed to their appreciation to the lack of mathematical processes, rather than to their desire to share their opinions or experiences in their answers.

In several cases, task occurrences that supported my initial conjecture contained a combination of students who mentioned both their desire to share their opinion and their preference for not having been required to perform a mathematical process for their answers. Diondre’s explanation for why he put Pic Me! (a task with multiple prompts providing an opportunity to justify) second in his final task sort showed this multi-faceted perspective:

> So for Pic Me, this is just the deal with how I'm looking at a problem isn't as what you think it is. Because with this problem, I thought I was going to do math I've never done before, but it was more of a, it was more of an opinion-based question … like communication type of problem where it just involves your words, not too much of math. It just shows the data and what your opinion is off the data. So I appreciate that. You know, just off the off the fact that I can't always judge a book by its cover, because I definitely did that in the sense where I thought I was going to be doing a lot of math.

In this response, Diondre expressed his preference for prompts that did not require mathematical processes when he explained that he thought he would be “doing a lot of math,” but after solving the task, he recognized that it instead “involves your words, not too much of math.” In this response he also said, “It just shows the data and what your opinion is off the data. So I appreciate that.” In these sentences he shared that he liked being given the opportunity to share his opinion. Combined, Diondre demonstrated that he reacted positively to the opportunity to justify using his opinion both because he could share his opinion, and because he did not have to, in his words, “do math.”

Shantel provided a more succinct example of this perspective when she explained why she most enjoyed answering task part 4 of the Wage War task, a prompt that provided the students the opportunity to justify their opinion, “I didn't have to write down or use the calculator or I just had to think about, like, literally my life. I didn't have to, like, think of nobody else's, I just had to think about my life.” In this response, Shantel expressed her appreciation of being given the chance to share her perspectives and experiences when she said “I just had to think about my life.” Shantel also said that she did not have to “use the calculator” which indicated she appreciated not having to perform mathematical processes to obtain her answer. Shantel’s response, like Diondre’s, supported my conjecture that students would appreciate being given the opportunity to justify, and appreciated it for the chance to share her opinion, while she also acknowledged that having to do mathematical processes would have detracted from her positive reaction.

Evidence Contradicting Initial Conjecture

There were seven task occurrences that directly contradicted my initial conjecture because they mentioned negative reactions to task prompts that required students to justify their answers with their opinion or experiences. In all but one of these cases, the students explicitly stated that they would have preferred a task prompt that included a mathematical process. An example of a student’s response that included a preference for mathematical processes is Jorge’s explanation of his negative reaction to task part 3 of the Pic Me! task. After he moved the markers on the indicator tool down, he said “I don't like doing questions like these...Like I don't even know. I just, I like, I'm like I'd rather be doing graphs like doing the plotting and all that than answering the questions.” Task part 3 of the task had two questions that provided the students with the opportunity to justify, and neither required a mathematical process for a complete answer. Both prompts did ask the student to interpret data from the graphs provided in the task in addition to bringing their own perspectives, opinions, and experiences to their answer, so by saying “I don’t like doing questions like these” and clarifying with “I’d rather be doing graphs,” he indicated a preference for prompts with mathematical processes over prompts asking for written justifications.

Another example where a student described a clear preference for mathematical processes is when Andrew explained his task placement in a task sort. During the task sort, Andrew explained his choice for placing the comparison task that did not have any prompts requiring justification higher than the Datelines task which did, “But this one [Datelines] also like you, you're explaining more stuff in it too. This one [comparison task], you're just like solving like problems the whole time and graphing the whole time.” Since Andrew placed the comparison task ahead of the Datelines task, this response indicated that he preferred, “solving problems the whole time” more than “explaining…stuff in it too.” He did not mention that he did not want to share his opinion or experiences, rather he focused on whether or not there were mathematical processes required.

The one task occurrence in which mathematical processes were not mentioned, still made it clear that the student, Khalil, had a negative reaction to prompts requiring justification. When Khalil was asked to identify which task part he like the least in the

Pic Me! task, he chose task part 3. The prompt in task part 3 did not require a mathematical process to inform his answer, which is what Khalil is reflecting on in his response, “I ain't really do nothing…I don't like how they asked the questions...Yeah. I don't like how they asked the question and make you, like make a whole statement about it.” In this response, Khalil made it clear that he did not appreciate prompts that required a written justification. When he said, “I ain’t really do nothing,” he could be referring to mathematical processes, but his emphasis was on having to “make a whole statement about it.” This response, along with Andrew’s and Jorge’s responses, demonstrated contradictions to my initial conjecture.

Concluding Stance

After considering evidence that supports, expands on, and contradicts my initial conjecture, my revised, concluding stance is that *Among students who report low interest in math, these students typically expressed an appreciation of, or preference for, parts of tasks that provide them with the opportunity to justify their responses with their opinions and/or lived experiences outside of math class. This is because they either wanted the chance to share their opinions or experiences, or because they preferred prompts that did not require them to perform mathematical processes. Infrequently, students preferred task prompts that required mathematical processes over explanations based on opinions or experiences.* Most of the evidence supported my conjecture that providing students with the opportunity to justify their answers elicited a positive reaction, but the students’ explanations provided clarification for the reasons for their preference. Specifically, while some students voiced a direct appreciation for the opportunity to share their opinions, other students preferred the task prompts because it did not require them to perform mathematical processes. Furthermore, some students expected, or preferred, to see prompts that engaged them in mathematical processes instead of prompts that required them to justify their answers with their own experiences, thus the opportunity to justify their answers elicited a negative reaction.

Requiring the Interpretation of Data Visually Represented in a Graph as an Intended Feature

When task occurrences indicated that students had a reaction to a prompt requiring the interpretation of data represented in a graph to inform their answers, the students' responses always aligned with my initial conjecture that they would have a positive reaction: *"Students reporting low situational interest in math would recognize and appreciate the utility of the graphical representations as a resource for constructing their responses."* However, students did not frequently react to this task aspect. There were only 11 task occurrences in which graph interpretation was mentioned as a reason for a positive or negative reaction, the least of the three aspects that were intended as task features. For this aspect, in all cases, when it was mentioned, the students responded that they recognized the utility of the presence of the graph to help them determine their answer to a prompt. Of the 11 occurrences, four of them included student responses that indicated their recognition of the utility of a graph to help them answer a task prompt, but also said the data could have been presented more clearly. There were not any task occurrences that directly contradicted my initial conjecture that students would find the data as presented in a graph useful (see Table 4.6).

Evidence Supporting and Providing Nuance to Initial Conjecture

As I mentioned above, in 11 task occurrences there was evidence that students had a reaction to graph interpretation, and in all cases their responses indicated support for my initial conjecture. In seven of the occurrences, the students recognized the utility of a representation in graph form that was either provided or they constructed as beneficial in their efforts to fully answer a task part. One example of this is when Andrew explained his positive reaction to task part 5 of the Datelines task. Andrew moved the markers up on the indicator tool after solving task part 5, which asked the students to use the system of linear inequalities graph they created through the previous task parts to determine whether multiple points were solutions to the systems. He explained why he moved them up, “When I looked at the graph, it helped a lot too when I put them on the graph because it showed like which ones were in the range and which ones were out of the range.” The statement, “When I looked at the graph, it helped a lot,” shows that he recognized the utility of the graphical representation, and it was a reason for his positive reaction, supporting my initial conjecture.

Another example directly supporting my conjecture is when Jorge explained why he liked task part 3 the most in the Wage War task, “Because in order to understand it, I had to look at the graph and find out where exactly they had the same amount of people...I understood it. I had to find where on the graph I'd put it.” In this response, Jorge shows recognition that he had to use the graph to answer the prompt when he said, “in order to understand it, I had to look at the graph.” When he said, “I understood it. I had to find where on the graph I’d put it,” he shows that the utility of the graph influenced his positive reaction.

One more example that demonstrated that students recognized the utility of using data represented in a graphical form to help formulate answers is Arthurs’ explanation for his positive reaction to the Financial Aid task. When he explained why he put the Financial Aid task high (second) in the final task sort, he said, “I had the graph…these were like clues, like it goes negative and then goes up and then go into, this one just goes up type of thing.” In this response, Arthur directly referenced the graph, “I had the graph,” and went on to say how the graph helped him formulate his answer, “these were like clues.” This response supports my conjecture that students would recognize, and appreciate, the utility of a graphical representation.

There were four task occurrences that indicated that students recognized the general utility of a graphical representation to inform their answer, but shared concern for the lack of clarity in a specific graphical representation. In each of these task occurrences, the students’ responses included suggestions on how to improve the clarity of the graphical representation. On example is when Andrew reflected on the Financial Aid task after he completed it, “I would definitely make this go up to at least 50 and everything. And that would make this go up to like 3 million...So that um, you could get a more accurate answer.” Andrew recognized that the representation was useful for obtaining an answer to the prompt, because he made multiple suggestions, “I would…make this go up to at least 50,” and “make this go up to like 3 million,” that he thought would lead to “a more accurate answer.” This response supports my conjecture that students would recognize and appreciate the utility of the graphical representation, and his negative reaction was due to the lack of clarity.

Arthur, also during the Financial Aid task said, “Probably if there were separate graphs it would make it easier.” He made this statement to explain why he least liked task part 4 of the task, which asks the students to determine the intersection of two functions on a graph that had four functions represented. His explanation for how he believed the representations could be changed so they would be more useful, indicated that he recognized the utility of graphical representations in general, which supported my initial conjecture, even though he had a negative reaction to the task prompt that required the use of the representation.

Two Wage War task occurrences also indicated a desire for more clarity in the representation to facilitate using the graph as a reference for the students' answers. One was Arthur who said that the graph he constructed as an answer to a task prompt lacked necessary details. After he completed the task, he was reflecting on what he noticed and suggested this change, "I'll make like put more numbers, like extend the graph, yeah, that pretty much that's to make it easier. Like extend the graph." In this response, he was referring to adding more than the three given coordinates from the prompt as points of reference on the supply and demand lines that he constructed. In the same task occurrence, Arthur again emphasized a desire for more clarity beyond the three provided coordinates, "It was only three numbers…which I felt like they didn't give me enough info." In both of these responses, Arthur again recognized the utility of the graph, supporting my conjecture, but said a clearer representation would make it even more useful.

The fourth example, also a Wage War task occurrence, is the commentary Kimberly provided for why she liked task part 1 the least, and what she would have changed. She began by explaining that the labeled axes on the graph that was provided made the graph difficult for her to interpret:

> When like finding the slope and stuff, it was like, it was a little hard because like the way the lines and the graph is set up and everything, it makes you think, Oh it's only going like one space. But you gotta, look at the numbers and realize like it's going more than that. So if you don't, you don't really, if you're not really like paying attention and

> you're trying to, like you're just looking at it, it's kinda hard to get like you're not going to get the right answer.

In this response, Kimberly explained that she had a hard time with determining the slope because of "how the graph was set up," and also said that, "if you're not…paying attention…you're not going to get the right answer. Both of these statements indicated that she recognized the importance of using the graph to inform her answer, which supported my conjecture. In a response later in the same task occurrence, she explained what would have made task part 1 better:

> I dunno if it was just me or whatever that got like kind of stumped on it on the graph, 'cause the way it, … how it's like jumping from one space instead of like the 20s and everything. So I would probably change the way it looks that way it's more easier to tell what you're counting by.

In this response, Kimberly does not suggest a specific change like the other responses did, but she did say that a change made to the representation would have made the representation clearer. These examples all supported my conjecture that the students appreciated and recognized the utility of the graphical representation, but also share how the representation needed to be clear for it to cause a positive reaction to the requirement.

Concluding Stance

While there were not many task occurrences that included students mentioning a reaction to the requirement to interpret data from a graph to inform their answers, when they were present, the evidence supported and clarified my initial conjecture. With this evidence provided, my revised, concluding stance is that *Students reporting low situational interest in math typically recognize and appreciate the utility of the graphical representation as a resource for constructing their answers. Furthermore,* *students who mention a reaction can recognize changes or improvements that could be made to the representation to improve its utility.*

In all of the task occurrences when this aspect was mentioned, the students reacted positively to the utility of the graph as a resource for their answers, supporting my initial conjecture. In some of these occurrences, the students mentioned that they wanted a clearer representation of the data for them to construct more accurate answers to the prompt. There were not any task occurrences when the students mentioned a negative reaction to the requirement to use their interpretation of a graphical representation as a resource for their answers.

Student Reactions to Mathematical Topic

The aspect of mathematical topic emerged during data analysis as a reason for students positive and/or negative reactions to the tasks. Students mentioned mathematical topic as a reason for their reactions in 39 of the task occurrences. By the nature of mathematical tasks, the aspect of mathematical topic is inherently present in every task and task part, unlike the features of opportunity to justify and graph interpretation which only occurred in some of the task parts or context which was not present in the comparison task. In this way, it is similar to perceived difficulty in that the students had more opportunities to react to it than the task features. While mathematical topic is present in every task part, I did not consider mathematical topic to be an intended feature designed to trigger or promote interest. For that reason, I am presenting the findings for mathematical topic after the findings for the intended features. Furthermore, since mathematical topic was an emergent aspect, I did not have an initial conjecture regarding its influence on student interest.

When a student explained a reaction to a specific mathematical topic appeared in a task occurrence, the theme around which it was typically mentioned was their familiarity with the topic. More specifically, their reasons could be classified in four different ways: the student (a) *liked* that it was a *familiar* topic, (b) *disliked* that it was a *familiar* topic, (c) *liked* that it was an *unfamiliar* topic, or (d) *disliked* that it was an *unfamiliar* topic. Of these four reasons, (a) and (d) are complementary to each other while (b) and (c) are distinct from the other reasons given.

Of the 39 task occurrences in which a specific mathematical topic was mentioned, 29 of them mentioned only one of the four ways described above. In the remaining 10 task occurrences, the students mentioned having reactions that were not consistent with a single way throughout the task occurrence. Having contradictory reactions during a task occurrence makes sense because each task had multiple task parts, with each task part containing different specific mathematical topics (i.e., none of the tasks included multiple task parts that prompted the students to complete identical processes to another task part). For this reason, it is more informative to make a conclusion regarding students' reactions to this aspect by considering each time a rationale was provided, even if a contradictory rationale occurred in the same task occurrence. As such, some task occurrences from which the illustrative examples included with the results come may be represented in more than one of the three categories. The three categories that I will present the results for this aspect are, first, occurrences with students liking the presence of a familiar topic or disliking the presence of an unfamiliar topic, then, occurrences with students disliking the presence of a familiar topic, and finally, occurrences with students liking the presence of an unfamiliar topic. The number of task occurrences in which each of these three categories occurred is in Table 4.7.

Table 4.7 *Number of Task Occurrences for Students' Reactions to a Specific Mathematical Topic*

Reason	Number (39 total)
Liking a familiar topic or disliking an unfamiliar topic	34
Liking a familiar topic	21
Disliking an unfamiliar topic	13
Disliking a familiar topic	10
Liking an unfamiliar topic	7

Liking the Presence of a Familiar Topic or Disliking the Presence of an Unfamiliar Topic

In most of the task occurrences in which a student explained their reaction to a specific mathematical topic, the student gave the reason for their reaction as either liking the presence of a familiar topic (21 of the 39 task occurrences) or disliking the presence of an unfamiliar topic (13 of 39 task occurrences). In most cases, when the student mentioned liking the presence of a mathematical topic that was familiar it was because they recognized it as a topic they reacted positively to previously, either because they found it enjoyable or highly accessible. In these cases, high accessibility was indicated with language that described their perceived difficulty, which is a separate emergent aspect, and I will revisit this connection in the next section. For this reason, I chose to use the term "accessible" to describe the students' explanations for their reaction to the mathematical topic aspect, so it is distinct from the results for the perceived difficulty aspect, but the students' perceived difficulty did influence this theme. Similar to the students' positive responses to familiar topics, in most cases when the students mentioned they disliked the presence of a mathematical topic that was unfamiliar, it was because they did not have previous experience and did not know what to expect. These two explanations are complementary to each other and support a conclusion that there are students that preferred familiarity over novelty in this setting.

Task occurrences that mentioned students liking the presence of familiar mathematical topics made statements that either indicated they perceive that the topic was accessible to them, or that they had previous positive experiences for other reasons with that topic in the past. Student responses that indicated the accessibility of the topic as the reason for their preference included phrases suggesting the student felt or would feel successful when constructing their answers to prompts including those topics. Student explanations that indicated a preference for a specific mathematical topic for a reason other than accessibility included phrases specifically indicating past enjoyment or a current sentiment. Table 4.8 provides examples for both of these types of responses with emphasis added to the phrases indicating whether the student was referring to accessibility or enjoyment.

Table 4.8 *Examples of Positive Reactions to the Presence of a Familiar Mathematical Topic (Emphasis Mine)*

Rationale	Examples
Accessibility	Andrew placing Wage War high in a task sort: "I like this one more because like I'm good with like this type of stuff, this type of math, like tables and stuff."
	Kimberly placing indicator markers high after Datelines task part 1: "I get the tables and stuff more easy 'cause it's like, I don't know, I just feel like some, some things just come more naturally to me and the tables probably, 'cause I've been doing them longer comes like a little bit easier to me. So it's not that hard for me to find rules and stuff."
	Arthur placing Datelines first in a task sort: "I like using like equations to find these questions. Like I like using equations, like especially like if I get the equation down pact in my head. I could. Actually just use the equation and just getting answers quickly type of thing."
Enjoyment	Diondre placing indicator markers high after Datelines task part 1: "This type of problem is very interesting because if I feel like I'm, see I've seen these types of problems before … where it's just one, two, one, two where it's filling in places for you, but also not giving you too much of a hint on how to calculate it. So these type of problems are definitely like interesting and intriguing to grab your attention towards."
	Kimberly placing markers high after comparison task part 2: "Because I like to find the equations for problems. I find it fun … it's more of like a, like a brain teaser than like a full on problem. …Like you have to think when you do it, but it's not like you was stressing yourself out. So I like those."
	Diondre placing markers high after comparison task part 2: I love graphing tables. It's probably like one of my favorite things to do for math period.

The language students used that indicated accessibility distinctly different from the language they used for enjoyment. For accessibility the students indicated ease or proficiency in their language. This appeared in these examples when Andrew said, "I'm good with," Kimberly said, "more easy," "come more naturally," and "a little bit easier," and Arthur said "getting answers quickly." For enjoyment, the students indicated positive emotions in their language. This appeared when Diondre said, “interesting” and “interesting and intriguing,” Kimberly said, “find it fun,” and Diondre (in a different task occurrence) said “favorite things.”

Complementing the task occurrences which included students mentioning that they liked the presence of a familiar specific mathematical topic because of its accessibility are task occurrences where students mentioned that they disliked the presence of a non-familiar specific mathematical topic because the students were concerned about it being accessible. These statements were most often made by students before they had attempted to solve any of the task parts, since they were basing their responses on their initial impressions and saw a mathematical topic that they did not recognize. Less often, students based their responses about disliking a specific mathematical topic after they attempted a task part or task with the topic and reported that they did not feel comfortable with it due to their lack of familiarity. Examples of each of these situations is provided in Table 4.9 with emphasis added to the phrases indicating the students’ perceived lack of accessibility for the mathematical topic.

All of the students’ responses include similar language indicating inaccessibility of the topic due to its unfamiliarity, regardless of whether the student made the statement before or after interacting with the topic. Most of the statements in the examples directly use a variant of the phrase “I don’t know” before solving or “I didn’t know” after solving. Other phrases that indicated the lack of accessibility in these examples were when Khalil said, “I'm not used to this,” and when Diondre said, “it looks like I'll be stuck on it.”

Table 4.9 *Examples of Negative Reactions to the Presence of an Unfamiliar Mathematical Topic*

Response Time	Examples (Emphasis Mine)
Initial impression	Kimberly placing initial markers low for the comparison task: "Because the other two like I can do this page [parts 1 and 2] while the other two pages [parts 3 and 5] are talking about, making a scatterplot and *I don't know* what a graph inverse is. So I feel like this page I would know how to do, but the other two. I'm not like, I don't really want to do them… '*Cause I don't know how*, I don't know what it's talking about.
	Khalil placing initial markers low for Pic Me!: "I put them there because it don't excite me...Because, *I'm not used to this*...I'm not used to like doing this stuff, like having these problems.
	Janelle explaining she least wanted to solve part 1 of the comparison task: "'Cause I don't know what that is. *I don't know how* to plot fractions or how to convert that to decimals and stuff to put it [on the graph].
	Arthur explaining he least wanted to solve part 3 of Pic Me!: "These ones, the ones that ask about the graph. Like this one the scatter plot that goes up to I think those are millions. And the scatter, and this graph, *I don't even know* what type of graph this is and it asks about them, that's what I really don't, I'm not interested."
	Diondre sharing thoughts he had before solving the FA task: "The graph doesn't look like something I've seen before. So *it looks like I'll be stuck on it*.
After completing a task or task part	Arthur keeping markers low after completing task part 5 of the comparison task: "I'll keep it there because I feel like this is the same thing as this like the inverse part, it confused me. I *don't really like know* what that means with this graph."
	Kimberly putting Pic Me! low in a task sort: "Like I keep saying, *I don't really know how to* do scatterplots I haven't really learned that."
	Arthur explaining why he liked Pic Me! task part 2 the least: "These two scatterplots because *I didn't really know how to*, there was the equation up here and *I didn't know* if I should use it or not. And this like, they were asking me to like to compare them or make them different and like *I didn't really know how to* like look at the scatterplot and like really like make sure how to like make them like really different from each other or comparable.

The explanations students gave for having a positive reaction to a familiar mathematical topic are complementary to the explanations they gave for a negative reaction to an unfamiliar mathematical topic. For both cases, the students indicated the accessibility as a reason for their reactions, with students finding familiar topics accessible, and unfamiliar topics not accessible. There were students who gave enjoyment as the reason in their explanations for their positive reaction to a familiar topic, but there were no students that indicated having a negative reaction to an unfamiliar topic that did not include a perceived lack of accessibility.

Disliking a Familiar Topic

In ten of the task occurrences that mentioned a specific mathematical topic eliciting a reaction from a student, students said that they disliked a topic that they were familiar with. In each of these occurrences, the students either saw a topic they recognized as one they did not enjoy in the past before solving, or they reacted after solving to a mathematical topic they did not enjoy working with in that moment, but recognized it as a topic they had experienced previously. The students did not always clearly explain the reason for their dislike, only using phrases such as, "I don't like…" or "I don't enjoy," without providing a rationale for their dislike or lack of enjoyment. In some cases, however, students did provide a rationale for their dislike or lack of enjoyment caused by the presence of a specific mathematical topic. Students' rationales for not liking the presence of a familiar mathematical topic were either that the topic bored them or because they had past struggles with a specific mathematical topic, indicating perceived low accessibility of the topic. Once again, I opted to use the phrase "past struggles" instead of "difficulty" to distinguish the results for mathematical topic from the results for perceived difficulty, although the students' perceived difficulty influenced the theme since it indicates the students' perceptions of accessibility. Examples of each rationale is in Table 4.10 with emphasis added to the phrases indicating whether the student ascribed their reactions to boredom to or to past struggles with a mathematical topic.

The language students used to describe boredom was distinctly different from the language they used to describe past struggles. The language students used to describe boredom indicated a lack of enthusiasm for the mathematical topic. This language is seen in these examples when Coleman said, “it's not new,” Janelle said, “just repetitive,” Kimberly said, “it's repetitive and like annoying,” Khalil said, “it's boring.” The language students used to describe past struggles indicated difficulty with or anxiety about the topic, both indications of the students' perceived low accessibility of previously encountered topics. This language is seen in these examples when Diondre said, “I struggled with,” Francis said, “kind of gets me confused,” and Janelle said, “make me stressed.” It is noteworthy that the two explanations that students gave for their negative reactions to familiar topics are in opposition to each other.

Liking an Unfamiliar Topic

The least mentioned reaction to a specific mathematical topic that was indicated in task occurrences was a positive reaction to an unfamiliar topic. Only seven task occurrences had statements where students explained this reaction. When students explained their reaction, they either mentioned a desire to learn something new, or described feeling accomplished after solving something unfamiliar. Examples of each rationale are in Table 4.11 with emphasis added to the phrases that indicated whether the student ascribed their reactions to a desire to learn to or to their perceived accomplishments.

Table 4.10 *Examples of Negative Reactions to the Presence of a Familiar Mathematical Topic*

Rationale	Examples (Emphasis Mine)
Boredom	Coleman placing markers low before starting Wage War: "Since I already done something like this before, it's not going to be as fun because it's, *it's not new*. Pretty much learning the same thing again."
	Janelle liking part 1 of Datelines the least: "The tabling 'cause just 'cause you had to like keep dividing. It was *just repetitive* I guess. Just keep doing that, keep doing that."
	Kimberly after solving the comparison task, "And then I feel like we've done too much of the graphing and stuff. It's just, *it's repetitive and like annoying*."
	Khalil lowering the markers after part 1 of Datelines: "'Cause I, I don't have no interest in this...'Cause *it's boring*. Like no like fun to it...'Cause all you're doing is subtracting and adding numbers"
Low Accessibility	Diondre moving the markers down after part 1 of the comparison task: "But I also think I did it wrong just because fractions with graphing is very confusing. Definitely something *I struggled with* uh, earlier this year."
	Francis placing markers low before the comparison task: "'Cause I don't really enjoy graphs and we're doing graphs and you know, equations and all that *kind of gets me confused*. Um, and my desire to solve really not there 'cause I won't enjoy it, you know, so I'll try to solve it, But if I don't get it…then I know I don't really have a desire to solve it."
	Janelle commenting after solving Wage War: "I personally like equations rather than word problems. Word problems, they *make me stressed*. It automatically turns my brain off."

The language students used to describe a desire to learn was distinctly different from the language they used to describe a feeling of accomplishment. The language students used to describe a desire to learn was direct and precise. This language is seen in these examples when Andrew said, "I learned that," Coleman said, "it taught me some stuff," Janelle said, "learn how to do that," and Khalil said, "know something new.” The language students used to describe a feeling of accomplishment described an increase in their perception of accessibility or difficulty. This language is seen in these examples when Khalil said, “I got the hang of it, so I started feeling it,” and when Andrew said, “at the end I really understood it.” Unlike the two explanations students gave for their negative reactions to familiar mathematical topics, the explanations students gave for their positive reactions to unfamiliar topics were similar and complementary to each other, both showing an appreciation for being exposed to a new topic.

Table 4.11 *Examples of Positive Reactions to the Presence of an Unfamiliar Mathematical Topic*

Rationale	Examples (Emphasis Mine)
Desire to Learn	Andrew liking task part 2 of Datelines the most: “*I learned that* instead of using the equal sign you can use that [inequality sign], I didn't even know you could do that.”
	Coleman explaining a high placement of Datelines on a task sort: “I had to do some like problem solving and stuff, which was different and *it taught me some stuff* I maybe forgot about or that I didn't know.”
	Janelle liking task parts 2 and 3 of Datelines the most: “The graphing...’cause like I wouldn't know how to do that. So it was like, it was like intriguing. So I was like, okay, let me try and like *learn how to do that* and then like putting it into the equation too. I kind of like that.”
	Khalil liking task part 5 of the comparison task the most: “Because I worked, I liked it…I paid more attention to this one because I actually got the new got to *know something new*. And that was like you said, the inverse.”
Accomplishment	Khalil moving markers up after task part 2 of Financial Aid: Because I like solving stuff like this because I really focused, and it helped me…Because I ain't even know how to do none of this stuff for real for real. But when I try, *I got the hang of it, so I started feeling it* and so I and like and how I can work things out.”
	Andrew liking part 5 of the comparison task the most: “I probably say this one...because like it made me think a lot and like *at the end I really understood it*.”

Concluding Stance

These results demonstrated that students frequently had positive or negative reactions to the presence of a specific mathematical topic in a task or task part. This means that the specific mathematical topic or topics included in tasks is an aspect that can affect students' experiences in ways that may influence their interest. Based on the results, *Students reporting low situational interest in math frequently reacted to the presence of a specific mathematical topic that they recognize as either familiar or unfamiliar. These students typically reacted to familiar topics positively when they had success with or enjoyed them in the past, and negatively to ones they had difficulty with in the past. Less often, students reacted negatively to familiar topics because they bored them, indicating a preference for novelty. These students typically reacted to unfamiliar topics negatively due to perceived inaccessibility. Less often, students reacted positively to unfamiliar topics due to a desire to learn or a perceived feeling of accomplishment.*

Summary

The results I presented in this chapter revealed to which task aspects, and in what ways, that students who reported having low situational interest in math reacted while solving five multi-part math tasks. In this chapter, I attended to the ways in which all 11 students reacted to each of the aspects, and I noted the frequency of task occurrences in which they were mentioned for the 54 total task occurrences. The purpose was to explore possible reactions different students would have when encountering the same tasks.

These results revealed students' specific reasons that explained their reactions to task aspects that were intentionally included as task features. The intended features, context, opportunity to justify, and graph interpretation, were suggested by research to positively influence student interest, and these results generally support this conclusion. The explanations students gave for their reactions provide more nuance and insight into their perceptions of, and interactions with, these features.

These results also revealed the aspects to which students attended and reacted that were not intended features of the task. These emergent aspects, mathematical topic and perceived difficulty, were mentioned with high frequency, and in various, and sometimes opposing, ways. The nature of these aspects is different from the nature of the featured aspects, but the students' explanations indicated they recognized and reacted to both in ways that could indicate the triggering or suppression of interest.

The tallies and descriptions I presented in this chapter did not capture the experience of students who consistently reacted to a certain aspect across the tasks, or repeated mentions of the same reaction within a single task. In the next chapter, I will present cases of students who consistently and frequently explained a reaction to a specific task aspect. Each of the three student cases that I will present represents one of the themes I presented in this chapter. The first is a case of a positive reaction to the inclusion of a real-life context, the second is a case of a positive reaction to being provided the opportunity to justify and answer using opinions or experiences, and the third is a case of a preference for less difficulty.

Chapter 5

RESULTS: CONSISTENT AND FREQUENT STUDENT REACTIONS TO TASK ASPECTS

In this chapter I will address my second research question:

> *What are the different cases that emerge when considering students who reported having low situational interest in mathematics that frequently and consistently reacted to a particular task aspect across most, or all, of the five different mathematical tasks? Within each case, how were the students' explanations for their reactions to that particular task aspect similar and different across the mathematical tasks? How do their explanations for their reactions support the concluding stances for that particular task aspect?*

I will present three cases in which students had a consistent and frequent reaction to a particular task aspect. I considered a reaction *consistent* if a student had the same reaction for the same reasons to the aspect in multiple tasks, and *frequent* if the student mentioned that reaction in at least four task occurrences, and multiple times during more than one of those task occurrences. The three cases represent consistent and frequent reactions to three of the five task aspects that I discussed in the previous chapter: context, opportunity to justify, and perceived difficulty. For all three cases, the student's case that I will present happens to be representative of the most common reaction type across all task occurrences: (a) a positive reaction to the inclusion of a context, (b) a positive reaction to being given the opportunity to justify, and (c) a preference for ease.

The first case I will present is Diondre’s positive reaction to the inclusion of a real-life context in the mathematical tasks. Diondre’s explanations for his reactions included the relevance of a context to his and his peers’ lives, as well as appreciation of the context. He also frequently talked about context throughout the interviews, not only as an explanation for his reaction, and he preferred the presence of a context in a task. I will also talk about Janelle as a contrasting example to Diondre’s case. Janelle did not mention context with frequency or consistency, but she did mention a strong preference for tasks that did not include a context, even though she acknowledged the relevance of, and enjoying, some of the contexts that were included.

The second case I will present is Arthur’s positive reaction to being given the opportunity to justify his answers with his opinions or experiences. Arthur’s explanations for his reactions included a primary and a secondary reason. The primary reason was being given the chance to share his opinion and use his experiences to inform his answers. The secondary reason was not being required to perform additional steps, such as doing computations or interpreting a graph, prior to forming an answer. I will also show examples of other student’s responses that explained their negative reactions to being given the opportunity to justify their answers with opinions or experiences.

The third case I will present is Callie’s preference for ease. Callie attended to her perceived difficulty of the tasks or task parts overwhelmingly more than the other aspects. In all but one instance, her explanation indicated a preference for ease. She indicated her preference for ease by explaining both positive reactions to things that were easy and negative reactions to things that were hard. I will also talk about Khalil as a contrasting example to Callie’s case. In contrast, Khalil did not primarily attend to his perceived difficulty of the task or task parts, but he did mention a preference for challenge as an explanation for a reaction at least once when interacting with each of the five tasks.

Case 1: Diondre's Reactions to Context

Diondre's case represented the most detailed evidence for a student's consistent and frequent reactions to context. Each focus task had an overarching context, and many task parts had a supporting sub-context around which that part was based. Diondre mentioned almost every context and sub-context across the tasks, frequently with lengthy responses about his thoughts and reactions. The comparison task enabled Diondre (and the other students) to differentiate between the focus tasks which contained a context with one that did not. Diondre leveraged this difference to explain his reactions to context in that task as a contrast to the focus tasks.

Throughout the interview process, Diondre frequently talked about the context of the tasks and how the context affected his reactions. Typically, when Diondre explained that context affected his reactions it was a reason that demonstrated that the context positively influenced his engagement with the task, most often with regards to personal relevance. Diondre's frequent reactions and detailed explanations provide a nuanced case of a student who generally reacted positively to the inclusion of context, but in different ways depending on the specific context, or the difficulty of the task.

There was consistency in Diondre's preference for tasks with context across all five tasks, but he reacted more positively towards some of the contexts than others. He appreciated the contexts in the Pic Me! and Wage War tasks more than the contexts in Datelines and Financial Aid. The dating context of the Datelines task did not engage Diondre's attention to the same extent as the contexts in the Pic Me! and Wage War tasks, so his responses involving context during the Datelines task were not as detailed as his responses in the other two tasks. For the Financial Aid task, Diondre demonstrated that he did not have a deep understanding of the context, so he was unable to use the context to inform his answers or help him overcome the difficulty he had with the math involved. These struggles combined and resulted in Diondre minimally mentioning context in his explanations for his reactions to the Financial Aid task.

In contrast to Diondre's case, Janelle generally preferred tasks that did not include a context. She felt that situating the math problems within a context complicated the solution process. She did, however, recognize and mention her thoughts about the inclusion of the specific contexts included in some of the focus tasks. She reacted particularly favorably to the two tasks that Diondre did not, Financial Aid and Datelines, and had a strong negative reaction to the context in Wage War, which was the one Diondre most enjoyed engaging with.

Diondre's Reactions to the "Pic Me!" and "Wage War" Tasks

Diondre mentioned context more frequently and engaged with it more deeply in the Pic Me! and Wage War tasks than he did with the other two focus tasks. For both tasks, when I asked what he noticed before solving the task parts, his response indicated that he had attended primarily to the context of the tasks. Also in both tasks, he mentioned specific details of the sub-contexts that were included in task parts, and his responses that included those sub-contexts were detailed, and, at times, lengthy, which indicated that he was engaged with the context of the tasks and task parts. He also highlighted the tasks' relevance to his own experiences, and his responses demonstrated appreciation of the specific contexts through his strong language and detailed explanations.

Diondre's Reactions to "Pic Me!"

Throughout the Pic Me! task, Diondre frequently mentioned the context both as an explanation for his reactions and to further verbally explain an answer that he wrote for a task part. He mentioned specific sub-contexts before solving any of the task parts, as well as after solving each task part. During this task, the primary reason he gave for his reaction to the context was its relevance and connected it to specific personal experiences he had with Instagram or with his peers. He had a particularly strong negative reaction to the sub-context of students' spending habits with regards to both Instagram and prom in task part 4, but the explanation for his negative reaction supported his perspective of the relevance of the task. I will present his experience with Pic Me! by starting with his initial impressions of the task which included both how he recognized the relevance of the task and how he initially attended to the specific sub-context in task part 4. After that, I will show the difference between how he reacted to task parts 1, 2, and 3 from how he reacted to task part 4.

Initial Impressions of the Task. When Diondre looked through the task before he solved any of the task's parts, Diondre attended primarily to the context. This was indicated by his responses to both the questions asking what the task was about, and what he noticed. Neither of these responses were explaining a reaction, but they both show that he had engaged with the task's context and its relevance to his own life. These responses are in Table 5.1.

Table 5.1 *Diondre's Responses Prior to Solving Pic Me! Task Parts*

Interview Prompt	Response
What is this task about?	It's basically about how to, how to find out what is the best strategy for Instagram likes and what can also be avoided. For the second part, it said what could also be like avoided for spending thousands of dollars on for a like prom when there's um, sites like the um, Buzzoid and that give out free Instagram likes. And basically seeing what the best way to get Instagram likes plus comments. Um, and how to make a picture popular basically.
What are some things you noticed?	I noticed that there's definitely, there's definitely things on here that actually happen on Instagram. So as in following other users in order to, uh, to uh, add an additional effect to the numbers of interactions and likes. So like main, like some of the stuff on here happens in actual real life and like use hashtags. People do that to spread, spread their like content and variety of pictures and videos.

Both responses demonstrated that Diondre recognized and understood the context. The first response provided detail of the context and some of the sub-contexts, and his second response connected the context with his personal experience, which highlighted that he thought that it was relevant. Together, especially since they do not mention any other task aspects, the responses showed that Diondre had deeply attended to the context while looking through the task.

In the first response, he started with a succinct overview of the entire task, "the best strategy for Instagram likes and what can also be avoided," and then provided more details. He included details of the sub-context of task part 4, mentioning kids "spending thousands of dollars on… prom," and the "Buzzoid" site. He also included details about the expectations for the first three task parts, explaining the task prompts' expectations in his own words. He said that it was asking, "the best way to get

Instagram likes plus comments," which was correct. The task prompts used the language "affect the number of interactions." He ended by saying that the purpose was, "how to make a picture popular," which paraphrased the same expectation, increasing or affecting interactions. These details showed he clearly understood the included context.

In his second response, instead of focusing on the details of the context within the task, he focused on its relevance to his own life and experiences. He used several phrases that showed he recognized situations depicted in the task had happened in his "real life." He started by saying, "there are things on here that actually happen on Instagram," and followed that up with the particular example to which he was referring, "following other users in order to… add an additional affect to the numbers of interactions." He provided another example that "some of the stuff on here happens in actual real life," and then explained how people use hashtags to "spread their … content." His recognition of the relevance to him of this specific context was consistent throughout the task.

Attention to Relevance in Task Parts 1, 2, and 3. Diondre attended to the relevance of the context and sub-contexts in a consistent way across task parts 1, 2, and 3. For task part 2, he mentioned the relevance of its context, but only briefly and generally when he said, "when you're looking at this problem, it kind of relates to … connecting to people and what you like compared to what they like." For task parts 1 and 3 he included personal anecdotes of experiences he had in the past that illustrated the scenario the task part depicted. These responses are in Table 5.2.

Table 5.2 *Diondre's Responses to Pic Me! Reactions to Task Parts 1 and 3*

Task Part	Response
Task Part 1	It shows a sign of real-life problems and how they can be easily solved because people like me, and like other kids in high school, any, any kids in this school, particularly, like you can definitely tell that these type of these type of questions are asked. Like why don't I get blah blah blah, but I have so and so…followers but I have this many pictures but I'm not getting this many likes.
Task Part 3	There'll be a big update that comes out one day and the update won't last, like, last as long, like maybe for like two or three days or so. And then it'll just get very stale and dry and then people will just get bored again and you won't be getting another big update till …another six months later. So that's kind of what drives people away. So, for... companies on Instagram to like post pictures, I think definitely two days is … definitely where you should have it at. You know, you have those days to prepare, then then you finally post it. People can see what you want. Just that way it's not in the middle of spamming and that way you're not going … away. Going ghost for a couple of days, you know, just, you know, you know, keep it nice and simple where companies are at.

In task part 1, the prompt asks the students if they think having more followers would make a picture more popular. Diondre started by saying that he moved the markers up after solving it because it was a real-life problem that he had encountered before. To clarify his perspective, Diondre added that he had heard "kids at this school" ask similar questions like, "why don't I get blah blah blah [i.e., likes or comments] but I have so and so [i.e., a lot of] followers?" and "I have this many pictures but I'm not getting this many likes?"

After task part 2, Diondre did not mention having a positive reaction, he left the markers where they were and said in his initial response, "I don't see this as a modern like everyday thing." He then realized that he did recognize the experience and provided the anecdote about an account for a game. He explained that the community will be active when a new update to the game comes out, but "then it'll just get very stale and dry [i.e., repetitive or slow] and then people will just get bored again." He used this anecdote to explain how he interpreted the scenario in the task part, which was asking how often companies should post to maintain activity on their accounts.

The rest of his response provided more detail to his written answer that companies should post every two days. His justification for his answer that companies should post every two days was completely based on his experience and opinion, not on the provided graph. One of the graphs was talking about hours since last post, and the other was companies' average posts per day. Diondre's explanation was given in days between posts, "Just that way it's not in the middle of spamming [i.e., posting too frequently] and that way you're not going … away. Going ghost [i.e., not posting at all] for a couple of days." Diondre's use of slang terminology around social media, "spamming," "going ghost," and "stale and dry," also indicated relevant personal experiences with the context.

Conflicting Reactions to Task Part 4. Diondre moved both markers up on the indicator tool after solving task part 4, which indicated a positive reaction, but then selected it as his least favorite part, which indicated a negative reaction. While the reactions were conflicting, the explanations for both were that he thought the context was relevant to his own experiences, consistent with his reactions across the rest of the task. His explanation for moving the enjoyment marker up provided more evidence for how relevant he thought the context was to his own experiences:

> So for the enjoyment is that…like I've said this so many times, it's just a real life problem …that actually happens. And it's so fun to solve because, you know, this correlates to what happens outside of school and even inside of school. People always talk about this and that about Instagram. Like they think it's like, not about, it's not about fame or

> anything because you have to do what you gotta do as an actual job, but to get, if you want that fame. So I don't think that Instagram should reflect on how kids should actually spend their money out in the real world.

Diondre recognized the consistency in his responses, “like I’ve said this so many times,” which supported my interpretation of what he attended to and chose to share. He emphasized again that it was a “real-life problem…that actually happens.” He clarified that sentiment even more when he said that it “happens outside of school and even inside of school,” meaning outside of the classroom context. The rest of his explanation for moving the enjoyment marker is the first time he mentioned his feelings about the sub-context of kids spending money to increase Instagram interactions. His opinion was that he “[did not] think that Instagram should reflect on how kids should actually spend their money out in the real world.” He further explained his thoughts and judgement about the sub-context when he gave his explanation for also moving the desire to solve marker up:

> And because the desire to solve this was basically just to like give my opinion, because I never really tell anybody about these type of things. Because, I mean, I just try to ignore ‘em because honestly, it's pointless trying to hear people say, ‘Oh, I want this with it. It's so much, but I'm still gonna get it anyway.’ Just for just for such a little cost as such a big price to get it, you know, you're paying so much for this little thing that like it's not gonna, it's not going to pay off. It's not going to help you in any way. Like, okay, sure. If you want fame, not to mention that if you're, if you do pay thousands for prom, right. And you don't get likes or comments, you're not, you're wasting thousands of money, thousands of dollars on something you just got ripped off on because it's not guaranteed that you're going to get your likes and your comments like you want it.

He said he wanted to solve it because he wanted to make sure his opinion was heard which meant he primarily reacted to the opportunity to justify, but the reason he wanted his opinion to be heard was because he had strong opinions about the matter.

The length of the response and the strong language indicated to me the intensity of his emotions towards the matter. He said that he wanted to share his opinion because he usually chose to avoid the conversation with his peers because he thought their choices were “pointless.” Other highly charged words and phrases he used that showed his intense emotions were, “it’s not going to pay off,” “it’s not going to help you in any way,” “wasting…money,” and “got ripped off.” He is clear and strong in his defense of his opinion against teenagers spending a lot of money for Instagram interactions, while also showing recognition that the scenario does happen in his peer group.

It was the same strong emotion towards the sub-context that led Diondre to select that task part as his least favorite. When he explained his choice, he continued to show his emotions and judgment towards the scenario:

> Just because of the scenario, because I don't like this scenario at all. Not saying like it was poorly given. I'm just saying like this shouldn't even be a problem because people shouldn't be spending thousands on prom and it's just like a waste of money. And like, just, you know, thinking about this, about how people, there's, there's plenty of ways to like get likes and at the end of the day doesn't really matter. But there's plenty of ways, like as in Buzzoid sells Instagram likes when people are paying thousands of dollars, which I don't think Buzzoid makes you pay thousands of dollars for Instagram Likes.

He started with the clarification that his selection was not because it had a context, but because he “[did not] like this scenario at all.” Using similar charged language from his previous response, he again explained why he did not like the scenario. The charged phrases he used in this response were, “this shouldn’t even be a problem,” “waste of money,” and “at the end of the day doesn’t really matter.” In this response he provided an alternative solution that he thought was more reasonable, buying likes from Buzzoid, that would not cost as much money.

His responses that explained reactions to task part 4 were different from, but still consistent with, his responses in the other task parts of the Pic Me! task. They attended primarily to the relevance of the context, and he engaged with it deeply, which showed by the inclusion of personal anecdotes throughout his responses. For Task part 4, however, he had strong negative emotions about the scenario that was depicted, which made him want to engage with the task, he wanted to share his opinion about it, even though he said he did not like the scenario. Because his strong reaction encouraged his engagement with the task prompt, I interpreted his responses as still maintaining a preference for the task including the context.

Diondre's Reactions to "Wage War"

The Wage War task was Diondre's favorite task, indicated by his comment after completing it, "Honestly, I liked this task a lot," and by the explanation for why he placed it first in his final task sort, after completing the last task, "The wage war was a very interesting, fun topic I liked talking about." Throughout the task Diondre shared lengthy personal anecdotes and included details that indicated a specific personal relevance of the context to his experiences or his presumed future. He connected to the task from the perspective of someone who would be in the workplace soon, so his answers reflected what he thought would be best for the workers, rather than what was best only for the company. Diondre explained that the context was at least part of the reason for all of his reactions throughout the task, and he also attended frequently to context in responses that were not explaining a reaction. This demonstrated the consistency with which Diondre attended to context throughout the task.

Initial Impressions of the Task. When Diondre looked through the task before he solved any of the task's parts, Diondre attended primarily to the context, which is consistent with his experience with the Pic Me! task. Like the Pic Me! task, this was indicated by his responses to both the questions asking what the task was about, and what he noticed. These responses are not explaining a reaction, but they both show that he had understood and engaged with the task's context and its relevance to his own life. These responses are in Table 5.3.

Table 5.3 *Diondre's Responses Prior to Solving Wage War Task Parts*

Interview Prompt	Response
What is this task about?	Basically about how, how um, people are getting paid and at the minimum wage or, at the cost of what it should be. And after reading, the last text the last text about how many, um, people like should get a raise or like how the minimum wage should be raised and how, um, how many workers can work at a place undergoing the pay that it has. .
What are some things you noticed?	It definitely looks like a real-life problem, which um, definitely looks interesting because it kind of looks like it uh has something to do with like politics. I'm not the biggest guy on politics, but it, I mean in this economy and especially as me turning into an adult and soon I definitely want to like see what my, the economy's going to be looking like when I'm out there in the real world, especially since like most, most people in the school actually get their jobs at like sophomore. So, um, it's definitely a real-life problem. It looks like.

In his first response he provided details that demonstrated he recognized and understood the main context and some of the sub-contexts included in the task. The overarching context was "how people are getting paid," which he mentioned at the beginning of his response. He then provided specific sub-contexts including "how the minimum wage should be raised," and "how many workers can work…undergoing the pay that it has."

His second response included his personal connection with the task. He recognized that it was a "real-life problem" that involved "politics." He explained how the scenario would affect him as he "[turned] into an adult" and was more closely affected by decisions about the economy. He then refined his answer as he realized that it would affect him sooner, since "most people in the school…get their jobs [as a] sophomore," and he was finishing up his freshman year of high school. He continued to make that connection throughout the responses to the task. Both responses together again indicated that his primary attention was on the task's context, and specifically its relevance to his own life and experiences.

There was one more time that Diondre mentioned context before solving any of the task parts, and that was in his explanation for the high placement of the markers on the indicator tool:

> This is another real world question and it definitely, it just like it informs you on how the real world you can, what type of job, what type of job you're going to be getting paid and how much you want and how people run their businesses and how workers are getting treated at the, at their pay. And if, you know, some jobs are really worth that much, pay. If not, you know, then just like try to find something new. And definitely, if people like prefer to go to college to pursue their dreams or just to work full time, you know, it definitely gives me a look at like, well what is the downfall and what is the uprise of working full time and then college, you know, so it definitely gives you a look at both sides.

Diondre's response focused on his recognition of the applicability of the context to his real life. This was indicated, not just by his words, but by the desire to solve marker being placed higher than the enjoyment marker. The phrases he said that indicated his focus on the applicability of the context are, "it informs you," and "it gives you a look at both sides." He also expanded the context to include possible actions of the companies, "how workers are treated," as well as possible actions of workers, "find something new." Neither the treatment of the workers by the company, nor individual worker's decisions were mentioned explicitly in the task, so their inclusion indicated that Diondre was considering the context's repercussions beyond the task's expectations. Diondre also mentioned college which was not included in this task saying, "If people like prefer to go to college to pursue their dreams or just to work full time, it … gives you a look at both sides." In this statement, he is combining the context of the Wage War task and recognizing its connection to the context in the Financial Aid task, which he had previously completed.

Continued Consistent Attention to Context. After he began solving the task parts, Diondre consistently mentioned or reacted to the context throughout. His responses after task parts 2 and 4 were particularly detailed, as were his responses when he reflected on the task as a whole. Many of his responses were lengthy and detailed, and sometimes included personal anecdotes that further emphasized how he understood or interpreted the context and found it to be personally relevant.

After part 2, Diondre did not indicate having a reaction to the task part, but when I asked why he left the markers where they were, his response again focused on the context:

> Like what will go on through the workers' minds and if they will take up on the job. Which I say the workers won't work at the lowest pay, because you know, if you're, if you're working at, at the lowest pay and you like the companies want to hire in specific of people, you're not like this. These companies need you. You don't need the company, you know, and you're working at the lowest pay. So like it doesn't, it doesn't like really need, it doesn't, you don't really need to work there.

This response lacked some of the detail that previous responses to this task included, but it demonstrated that he was interpreting the prompt through the perspective of the context. He was making sense of his answer that, no, the company could not hire enough people at minimum wage. He recognized, mathematically, that the company could not hire as many people, but instead of justifying it with the graph, he explained how the context would apply to the workers' experiences, and how it was not worth it for them to work there. Instead of saying that the company would not be able to get enough workers, he interpreted his response that the workers "don't really need to work there," and how the workers "don't need the company." This showed he recognized why workers may have felt undervalued at minimum wage and why they would decide not to work at that wage.

After task part 4, Diondre gave a lengthy and detailed response to explain his answer that the minimum wage should be raised from $7.25 to $15:

> So for this part, what I basically came across was how this can affect both employees and companies. And I said this would work greatly because it gives companies more opportunities to get way more workers and definitely a lot more workers at a younger age. Um, like how I said earlier about how people like, and especially in this school, how they're getting jobs at sophomore…very young, you know, and every time, every once in a while I hear somebody talking about, 'Yo, I gotta go to work' or, 'I get paid today.' And they're like, it's, you know, it's exciting. They're there, they're working for it. So if you raise, if you raise the limit, well the cap at the pricing range, it gives companies more employees to work, which means more, more profit they're making and the employees can also enjoy their job. Well, I don't know about enjoying, enjoying the job, but take the job up with getting the good amount, good pay and they actually like…even if you're not enjoying the job as much as you would anything else, that you would want to take it, at least you're getting good pay for it. So it kinda, it balances out, you know, so probably that just helping both ends, um, more workers, more income, more profit for the employees, encourages younger people to get involved with jobs. 'Cause like me, myself, right? I told my mom, I'm like, I don't want to get a job this summer because you know, it's like time is flying by so fast and I'm just like, man, I used to not even think about having a job now. I got driver's ed, all this stuff, you know, going into the being an adult and going into the adult world. So now it just, it encourages more kids to get a job, work for their stuff. And you know, they can spend it so …

> they can …definitely have a better time getting a job that pays more and... Companies, you know, as to where if demands people to work at them, it uh, the demand can go up higher, I would say.

Throughout his response, Diondre mentioned, and incorporated, the relevance of the context in his own life. He started by referring to younger people in general when he said that if the companies offered a higher wage then they would “get way more workers and definitely a lot more workers at a younger age.” He then clarified this perspective by mentioning things he had heard peers say about their jobs, and said that this was “exciting” to him. Later in his response, he brought the context closer to his own life when he talked about how he was unsure of getting a job, but that a higher pay may incentivize him in the direction of getting a job earlier. These personal connections are consistent with previous responses. Diondre even mentioned his previous responses when he said, “like how I said earlier,” and using similar language about “time is flying,” and “going into the adult world.” All of these statements demonstrated his focus on the relevance of the task to his life.

Other parts of this response demonstrated his understanding and focus on the context by describing details and expanding on the context to include emotions and secondary results of a changed wage for both the company and the workers. He said that a raised wage “gives companies more employees to work,” which showed he understood the supply and demand concepts with regard to the company. He also expanded on how the wage affects the workers’ emotions, not just their monetary well being. He started by saying that if they made more money they would “enjoy their job,” but quickly recognized that it was more accurate to say, “if you're not enjoying the job…at least you're getting good pay for it.” This interpretation showed that he recognized the context as it applied to actual experiences people would have, which is beyond the task prompt’s expectation.

His explanation for what caught his attention most about the task demonstrated the consistency of his responses, and the depth to which he was engaging with the context. He said that it was the low minimum wage that caught his attention the most and explained why:

> Just to show how hard… people are working and how they're getting paid this much little money at such. Like you're working this much time, but you're getting paid this much, this much money and it's not worth it. So it was just to show how it's unfair, how people are working so hard, but then not getting the … greatest outcome out of it. Also, this right here about how people, and I think this is another thing that is like a real-world problem of how people are telling the government. Some people think that the government should raise the minimum wage limit, which I think would be pretty profitable and pretty fair. You know, just to give these people, um, just to give these people actual like fairness and it would help…a lot of people 'cause some people are just like, they don't even want, they don't even want to work. They just want to sit in the house all day and do nothing and do nothing but you up the price limit that means, oh like you're getting more money; encourages people to work overtime or to…work more … and it helps the company, you know, and it just all around helps everybody.

This response included his emotional reaction to the scenario, and his explanation for why he believed the minimum wage should be raised. His emotional reaction was indicated by the phrases, "it's not worth it," and "it's unfair," as well as his declaration that, "people are working so hard, but then not getting the … greatest outcome out of it." He was affected by what he perceived as an unfair situation that was placed on people because of the minimum wage. He used the conclusion he reached throughout the task, that the minimum wage should be raised, to assert at the end of this response that if, "You up the price limit [minimum wage] that … encourages people to …work more … and it helps the company…and it just all around helps everybody."

He expanded on the included context with his own experience when he said, “some people…, they don't even want to work. They just want to sit in the house all day and do nothing.” This had a strong negative connotation, and indicated judgment of people who fit the description, and illustrated a preconceived notion which he brought into the task. However, after that statement he said that raising the minimum wage would motivate people to work more, he indicated that he thought raising the was a way to improve the situation of people who he perceived as not having enough motivation to work at the current minimum wage.

These two tasks, Wage War and Pic Me!, are the two tasks that Diondre explained reactions to most frequently. In these two tasks he attended to the contexts, and sub-contexts, in detail, and interpreted them in ways that he was able to recognize that they were personally relevant. His responses in, and reactions to, the other two focus tasks, Datelines, and Financial Aid, show that while he consistently reacted to context, he was less engaged with those particular contexts and how they were relevant to him. For Datelines, it was because he did not connect with the context personally, and for Financial Aid it was because he did not deeply understand the context nor the mathematical processes as well as necessary to engage more deeply with the context.

Diondre’s Reaction to the “Datelines” and “Financial Aid” Tasks

Diondre mentioned fewer reactions that were attributed to context in the Datelines and Financial Aid tasks. When he did mention context, it was with less depth and less intensity than his responses to the Wage War and Pic Me! tasks, but he remained consistent in his responses by mentioning the relevance of the context. The language he chose to use about the context was not as strong, and his responses were not as lengthy. He did not mention personal anecdotes or extend the context beyond the tasks expectations like he did for the other two focus tasks either. For Datelines, he did not connect as deeply with the context, and for Financial Aid, his perceived difficulty of the mathematical processes involved overwhelmed his attention to the context.

Diondre's Reaction to "Datelines"

Diondre only occasionally mentioned the context of the Datelines task, which was the informal dating rule of "half-plus-seven." Prior to solving the task parts, Diondre did mention the context of the tasks when asked what the task was about and what he noticed, which was consistent with the previous tasks. Unlike the previous tasks, he also included more specific math that was involved in the task, and his answers included less detail. Table 5.4 shows his responses.

Table 5.4 *Diondre's Responses Prior to Solving Datelines Task Parts*

Interview Prompt	Response
What is this task about?	The main task is probably determining ages and gaps in between age and how many years they're apart from each couple or just the age in general.
What are some things you noticed?	It says um, all ages, like half a lot of half. And like this age cut in half, and like these many years put with this. So like I guess like a mixture and like totaling the years that was there asking me what I think, um, what I think I can modify the question, like how could I modify the questions that are right here? So asking me, um, about, uh, about the question and what could make it, I guess, easier for me to answer the question. So probably there…and um, I know Beyonce, Jay-Z, Mariah and, Nick Cannon. So probably just noticed the celebrities.

In his first response, he mentioned the context that is included in the task, which was the "gaps in between age[s]," But he did not extend that context, or provide additional personal connections like he did with the other tasks. In the second response, he was mentioning "age" and "years" but in terms of the math steps that he would be expected to do with those quantities, not as specific details of the context. At the end of the response, he briefly mentioned that he had heard of some of the celebrities, but he did not include how he know about them, or his thoughts about them. These responses showed me that while he was still attending to context, it was not as deeply as it had been for other tasks.

Diondre only mentioned context beyond the expectations of the task prompts when he reflected on the task after solving it. After he solved the entire task, he mentioned the age difference between Jay-Z and Beyonce twice, although neither time was part of an explanation for a reaction. The first response was when he was sharing what he thought about the task and why he did not have a positive or negative reaction to it:

> Like, uh, more of a, give it like a neutral lesson. So wasn't, it was asking me, it was just asking me like, what would you like, what would you say is the appropriate way to like put this. And like say if these couples are matching and if it's like, does it seem natural for people to be around this age dating people around this age. Which I mean, these ages aren't bizarre other than maybe the Jay-Z and Beyonce one, um, because she was just turned into an adult at 18, just like a year before that. So, and he's like 30 or so. I mean probably other than Jay-Z one, like everybody else was like, probably at a good age group. Plus it's, I mean sometimes it is like a lot of people say like, um, the male should be older or whatever, but like, you know, the age groups aren't totally bizarre.

Diondre himself said he did not have a deep connection with the task or context when he labelled it a "neutral lesson." He did extend the context and include external considerations twice in this response. The first was when he explained why he thought the age gap between Jay-Z and Beyonce was “bizarre,” and said, “because she was just turned into an adult at 18.” The second was when he mentioned a different societal construct he heard about saying, “a lot of people say like, um, the male should be older or whatever.” He did not acknowledge personally believing that construct nor did he provide more detail or judgment about that construct or the half-plus-seven rule.

His response when I asked what caught his attention the most was the only time that he made a clear personal connection to the task:

> Um, so for me it was probably, it was probably just like, um, the fact that, um, the fact that once you asked me at number five when I was done with it, um, their age group started to pop out even more. Like these were all 20 by 20 by 20, other than Nick... And Nick and Mariah Carey one. So I was just like, I was looking, I was like, wow, I've never known that Jay-Z has this many years on Beyonce. So probably just like the real-life factor that these couples are the, this, these far apart of years from each other. But they're still, you know, dating. So probably just like it makes you think like any age. I mean it makes you think like this age can still get with this age just because depending on like how old they are. So probably just their ages that stood out to me the most.

It is notable that what caught his attention was exclusively the context and not the mathematical processes of the task. This demonstrated that he remained consistent in his attention to context, even when he had minimal personal connections to it. He did mention that he noticed and was surprised by learning about the age difference between Jay-Z and Beyonce, “I was like, wow, I've never known that Jay-Z has this many years on Beyonce.” He used that connection to determine that the problem did include a “real-life factor,” but he did not mention any affect the context or the task had on his life or opinions.

The ways that Diondre mentioned context in Datelines was different from how he talked about it for Wage War and Pic Me! since it was less personal and less detailed. He did mention some relevance to real-life when he said he noticed the celebrities, but he did not explain a personal connection. His responses indicated that he understood the context, and also that he did not engage as deeply with it as he had in the other two focus tasks.

Diondre's Reaction to "Financial Aid"

The Financial Aid task was Diondre's least favorite task, indicated by where he placed the markers on the indicator tool, and its placement last in all task sorts in which it was included. At the beginning of the task, Diondre placed the enjoyment marker at 2 and the desire to solve marker at 1, and after the first task part moved the enjoyment marker down. The markers stayed there until the end of the task when he moved the enjoyment marker back up to a 2. He completed the Financial Aid task second, and for each intermediate task sort, he placed it last.

Diondre attended to context in the Financial Aid task, and recognized its relevance, but his responses showed he did not understand the details. When he explained that context attributed to a reaction, it was in connection with a task part that did not involve mathematical processes. Throughout the task, most of his responses were explaining reactions to his perceived difficulty of the mathematical processes asked by the task prompts. In his own words explaining why he placed it lowest in a task sort, he acknowledged that, "the math kind of shadowed the questions to where I didn't even focus on the question."

Consistent with the other three focus tasks, Diondre attended to, and mentioned context prior to solving any of the task's parts. When I asked what the task was about, he summarized the overarching context of the task, and when I asked what he noticed, he provided specific details from the task, but his response showed he was not clear about what those details represented. These responses are in Table 5.5.

Table 5.5 *Diondre's Responses Prior to Solving Financial Aid Task Parts*

Interview Prompt	Response
What is this task about?	Basically, how much you're making or the, the, the decision whether you want to take a workforce job or go into college and how much you're going to be making in those years for college or out after college basically.
What are some things you noticed?	I've seen definitely high school diploma is like $30,000 a year, $47,000 for someone with a bachelor's degree. You know, um, definitely the high school diploma, like cost per year for someone. Um, and then on here I heard, I see bachelor's degree for Petroleum Engineering, which I know engineering, they make a lot of money. Um, so it was like $98,000 and $33,000, which $33,000 is still like, I think it's the lowest for the lowest for um petroleum engineering, but it's also around a whole workforce job, which is $30,000. And that's $33,000. So you're just getting three thousand more.

Neither of these responses mentioned relevance of the context, nor do they include an extension of the context beyond the expectations of the task. In the first response Diondre briefly, but correctly summarized the context of the task of the comparison between different post-high school options, of a "workforce job" or "go into college" and the benefits of each option. In the second response, he mentioned several details from the task, but it lacked specificity, and in some cases he showed that he had misunderstood the details. At the beginning he correctly pairs the amount of median income for someone with a high school diploma ($30,000) and a bachelor's degree ($47,000) but he did not explain that those numbers indicated income, instead said that it was, "the cost per year for someone." In the second part of his response he mentioned confusion that engineers “make a lot of money” and thought the task said that $33,000 was the lowest salary for a petroleum engineer. The task actually said that $33,000 was the average income for a social worker, a detail Diondre did not mention in his response. This explanation showed he lacked full understanding of the context in terms of yearly cost versus income, and the difference between job descriptions.

Diondre did not mention context again beyond the expectations of the task prompts until after he solved the last part, task part 5. Task part 5 gave the students the average salary of a petroleum engineer ($98,000) to the average salary of a social worker ($33,100) as an example of two jobs that both required a bachelor’s degree and asked the students to consider the importance of potential income when determining what you study. Diondre mentioned this task part immediately after solving it, and when he reflected on the task.

After he solved this part, Diondre explained his positive reaction which was indicated by moving the enjoyment marker up to a two:

> You know, math isn't my greatest subject, but I definitely like, uh, definitely like answering real-life questions as to problems, um, as to career problems as well. So I definitely, I definitely enjoy that. So, you know, I'll move it up to a two, just from that last question.

When he said that “math isn’t my greatest subject,” he was referring to the struggles he had during the task because of the difficulty of the math he was expected to do. He then acknowledged that he “like[d] answering real-life” and “career problems,” which showed his clear and consistent general preference for tasks that included a context.

When he selected task part 5 as the task part he liked most, he expanded on the context by connecting it to the Pic Me! task, which was the only other task he had completed before the Financial Aid task:

> Answering this question as to what you said as to, um, is it an important factor? Because yes, it is a, like you don't want to be taking, you only be putting all this time into your career or the job. I mean, you're the college to pursue your career and then when you get to your career, you don't make as much money what's your, but you know, you've wasted all that time kind of in a way. I'm thinking kind of correlates to the prom thing, spending so much money but only for one time, just like kind of flip flops spending so much time only for one job and then it's not going to plan [pan] out the way you want it to where you might not get the likes and comments that you want. Um, when you spent all those thousands, so probably, yeah. Number five,

This is the most detailed response Diondre had that included context in the Financial Aid task. This response is more similar to the responses he made during the Wage War and Pic Me! tasks since it included support for his personal opinions using additional context that was not included in the task itself. He explained that there was a possibility that your career would not "make as much money," and concluded that meant that "you've wasted all the time." He connected that "waste of time" with "the prom thing" from the Pic Me! task, in that both scenarios are "not going to plan [pan] out the way you want it to."

He also used the context of this task in connection with the context of the Wage War task in a response during the Wage War task interview. By making the connection to two other tasks, he showed that he did recognize and understand the importance and relevance of the task, even though he could not leverage his understanding to support his mathematical processes. This task remained his least favorite, but his explanation for the low placement in task sorts was difficulty, not because he did not appreciate the context.

Janelle's Contrasting Reaction to the Inclusion of Context

Janelle's responses and experience provided a contrast to Diondre's. Diondre said that he generally preferred context in problems, and Janelle said that she preferred tasks that did not have a context. Diondre frequently mentioned context throughout some of the interviews, and Janelle mentioned it much less. Both mentioned the relevance of the contexts, but their perspectives about the relevance of specific contexts were different.

Janelle leveraged the difference between the comparison task and the focus tasks to clarify her thoughts about the inclusion of context during the comparison task interview. It was this clarified thinking that she used in her explanations during the task sorts. During the comparison task interview, before the task sort at the end of the interview, she mentioned context three times, each in her explanation for moving the markers up on the indicator tool. Her three responses are in Table 5.6.

Table 5.6 *Janelle's Explanations for Moving the Markers Up During the Comparison Task*

After Part	Janelle's Explanation
2	Because I'm figuring this out! And um, I don't know. I already like this anyway 'cause it was just simple. It's just like right there do it, you know, instead of all these other words and stuff like that. So I already like it anyway.
4	'Cause this is simple. I like it. It's simple, It's right there.
5	Um, 'cause it was definitely like, you know, it's like I got stuck at times, but it was like definitely like easier to just like get a hang of I guess. Um, I just like how this is simple. I don't like words a lot. Um, and like that's why I like turn it over 'cause I was like just ready for the next one. So it's like, you know, it's not even like a problem or it's not stressful at all to really like get a hang of it. So I like that.

All three of her explanations focused on a preference for the comparison task because it lacked "words and stuff like that," which I interpreted as meaning a context in general. She repeated variations of two phrases multiple times in her explanations, "it was simple," and "it's right there." While "it was simple" on its own may be interpreted as meaning she thought the task part was easy, in her response after task part 5, she immediately followed up with, "I don't like words a lot." Her response to task part 5 is also where she recognized the emotions that she felt during what she called "word problems," when she said, "it's not stressful at all." She used these clarified ideas about the comparison task versus the focus tasks when explaining the order of the tasks in her task sorts.

Janelle maintained a consistent preference for a lack of context in a task during the two task sorts that included the comparison task. During the task sort immediately after completing the comparison task, when she explained why she put the comparison task first, she compared the lack of context in the comparison task with the presence in the focus tasks that she had completed:

> 'Cause it's [comparison task] not extra like the rest of these [focus tasks]. It's not way too much. And it's not like just from looking at this like automatically…If you were to give like just put this together and like to say to your student like, 'pick one' they're going to pick that one [comparison task] 'cause they know that they're going to get it done faster. It's going to be a lot of asking questions and stuff unless they like have no clue at all. But like if they have like even the slightest clue they would automatically pick this. This [Wage War] like you're just like, Oh my God. Like at least for me like I get anxiety when I see these things, I'm like eee!

Janelle used strong language throughout this response which indicated her strong opinion about the focus tasks versus the comparison task. She began by saying "it's not extra," which is slang that she clarified by saying, "It's not way too much," in comparison to "the rest of these." She explained her preference for the comparison task, not for positive emotions towards it, but with the emphasis of her negative emotions towards the focus tasks. She explained what the comparison task *was not* instead of what it *was*. At the end of her response she said, “You're just like, Oh my God. Like at least for me like I get anxiety when I see these things, I'm like eee!” This emphasized what the focus tasks *did* against what the comparison task *did not.*

When she explained why she put the comparison task first in the final task sort, she did not make the same comparisons, but her explanation was consistent, “I don't like word problems to, so this one was just like right there easy and it was like cool to like figure it out pretty easily. Like it's just right there.” When she said “word problems,” she was referring to the focus tasks, and by “right there” she meant she did not have to interpret what the problem was about before solving the math problem.

Janelle’s Contrasting Reactions to Specific Contexts

When Janelle and Diondre mentioned their perspectives of the relevance of specific tasks, their perspectives did not always align. This was especially true for the Wage War task. I presented Diondre’s strong positive reactions towards the Wage War task’s context above, and Janelle’s was very different. Diondre, in his responses about Wage War, said that he thought the task was relevant because of how many students he knew got their first jobs as sophomores, and he was at the end of his freshman year. Janelle’s first reaction to the task, before solving any of the task parts was a stark contrast to Diondre’s perspective, “Why do, why do like these equations always have to be about, about like unnecessary things? Like, I don't know…Like companies and things like, I don't know, just useless things that we need to know.” In this response, she inferred that the context was “unnecessary,” and “useless.” She remained consistent with that perspective when she mentioned Wage War in the final interview, “This blew me. I was like, I did not care for any of it. They were talking about companies and supply and demand and like no one cares for that right now.” Janelle assumed that “no one cares” about “companies and supply and demand,” which contradicted Diondre’s experience.

Another specific task to which the two students had opposite perspectives was the Financial Aid task. I showed above that Diondre was not able to deeply interact or respond to the context because of the difficulty of the math involved, and his lack of understanding about the context, although he did say that the college context was relevant to him. When he mentioned the college context being relevant, that relevance invoked a negative response because it made him, “think I'm getting so old and time's getting so faster.” Janelle, on the other hand, had positive reactions regarding the relevance of the context and mentioned the specific context of the Financial Aid task more often than any of the contexts in the other focus tasks.

During the Financial Aid task interview, Janelle included the specific context of post high school plans as part of her explanations for all her reactions throughout the task. Furthermore, the reactions were consistent, and indicated a positive inclination to the context. Table 5.7 shows her responses related to context throughout the Financial Aid task.

Janelle’s explanation remained consistent in all of her responses, that she liked the context because it was college, and she felt that context was important and relevant to her personally. In the first response, she said that the task was an “unintentional reminder of…how college is going to be” which indicated she was attending to the information and how it might apply to her in the future. When she explained her positive reaction after the task parts she said, “it's actually … making me think about college,” after task part 2, “I'm …thinking…what would happen if I went to college?” after task part 4 and, “gave me an open eye to how college is,” after task part 5. All of these statements indicated that she was encouraged to consider how these factors would apply to her in the future by the task. This was the only task where Janelle's positive reaction for context was consistent and frequent.

Table 5.7 *Janelle's Responses During the Financial Aid Task*

When	Janelle's Response
Before	I do like how it is telling you, I mean if, if this is actually like, because it's saying according to like national centers and stuff, I do like how it is telling you these things. Like, you know, how, how much money you are going to get and how much money you got to take out. Because it's like… a unintentional reminder of like how college is going to be. So, it, it does like refer to like our age.
After Part 1	Kinda want to figure out, why do we need to go to college? And if it's so, like put you in a hole. So stressful then you barely get up and not as high as the regular high school diploma person.
After Part 2	'Cause it's actually like making me think about college and stuff right now. 'Cause like I'm all about college and like I really want to go to [a specific college] for real. Um, when I'm just like 13 years, I'm like, I don't know if it's worth it or not, but like if this is like telling me about that, then like I'm definitely like into it.
After Part 3	I do want to solve it. I do. Um, 'cause still like this college thing, like, 'cause I guess, I guess this, this, these type of problems would be different to other people 'cause you know, some people don't want to go to college so it might be different for them ... But for me at least I do like when I like get into it.
After Part 4	Really just the college thing really. It's really making me think like, I keep like getting off track and I'm like thinking, I'm like, well what would happen if I went to college? I just kept thinking about that.
After Part 5	I liked this because it, um, gave me an open eye to how college is and like, you know, things that I would be interested in the future.
Task Sort	I really liked this one because it shows about college and that's…important.

Janelle's and Diondre's reaction to the Datelines task was another difference between their experiences. Diondre mentioned the Datelines task the least, and when he did, the only connection he made to relevance was the presence of the celebrities.

Janelle, while she did not mention it frequently, she had a strong initial reaction to it and thought that it would be a good task to give to students because of the context. While Janelle read through the task, she exclaimed, "Eeww, that is really a nasty age gap." And when I asked what she was talking about she said, "Eeww, like 25 and 45, 25 and 41, 19 and 30 like eeww. That's nasty." When working with that part of the task, she again used strong language, "That is so gross, man. Oh my God, I don't like that.... I don't like it. It's just wow. Uh, wait was, was every couple inside the …? Haha! You guys missed by one. You suck! You suck." As she was saying this she was smiling, so I interpreted her saying "I don't like it," to mean she did not like the age gap, not that she didn't like the context. Her choice of the words, "Eeww," "nasty," "gross," and saying, "you suck," show her strong, albeit lighthearted, emotions towards the specific context of that task part.

Janelle only mentioned context as a explanation for her reaction two other times while interacting with Datelines, once before solving the task, and once during the final task sort (Datelines was the last task she completed). Before solving the task, Janelle explained her placement of the markers:

> Like I do want to figure out like what's mine [dating range] I guess. Um, 'cause it like it involves you into it. And then I just like this [celebrity couples], like this just makes me laugh. Um, 'cause you're just gonna like see if they're in the range.

During the final task sort, Janelle explained why she placed Datelines high (second only to the comparison task):

> This one I like because, um, it like kind of gets you into it and you know, at least for me at least, that was like funny to me. Like, oh wow. Like you wouldn't know that. So it was like something that, um, a kid will probably like, like I guess not exactly relate to, but like know about.

Neither of these responses contain strong language, but they are consistent with each other. Both responses included appreciation of personal applicability, as well as enjoyment of the context. In the first response she said, “it involves you into it,” and in the second response she said “it…gets you into it,” both indicated the personal applicability. In the first response she said, “this just makes me laugh,” and the second she said, “that was…funny to me,” both statements indicated that she enjoyed the context. She presumed that others would appreciate it too, “it was like something that… a kid will probably like, like I guess not exactly relate to, but like know about,” which showed she recognized the frivolity of the context, but that it could still be enjoyable. Janelle’s reaction contrasts with Diondre’s lack of reaction and feeling of relevance to the context in the Datelines task.

Janelle’s experience and perspective are a contrast to Diondre’s for the reasons I presented above. Janelle strongly preferred tasks without a context and assumed other students would too. Janelle’s statement during the task sort after completing the comparison task captured her preference, “…it’s not extra…it’s not too much…If you were to … say to your student like, ‘pick one’ they're going to pick that one.” She also had a different perspective on which tasks were relevant and irrelevant to her experiences. She responded favorably to the Financial Aid task because of context, but her reaction was because of the specific context, and she did not respond in ways consistent to that in other tasks. She thought that the context in Financial Aid was personally relevant, and that students would appreciate the Datelines task because of its context, while thinking that the context of the Wage War task was not relevant to hers or her peers’ experiences.

Takeaways from Diondre and Janelle

Both Diondre and Janelle had general preferences about the presence of a context in math tasks and their reactions typically supported their general preference, but the nuances of a specific task induced atypical reactions. Diondre's general preference was the inclusion of contexts in a task while Janelle's general preference was for tasks that lacked an included context. The Financial Aid task induced both students to have reactions that were atypical of their general preference towards context because of task-specific details.

Diondre found the computations required in the Financial Aid task difficult and he did not deeply understand the context. He was not able to leverage his understanding of the context to help him with the computations, so his reaction to and responses during the task the inclusion of the context was not enough to help him appreciate that specific task. Janelle generally preferred tasks that lacked context so she could focus on the computational problems, but she reacted favorably to the Financial Aid task because of the college context. She felt a connection with the context since it directly pertained to her future, and she said her reason for wanting to attempt the computations was because the answer was relevant to her future decisions. These contradictions reveal the nuances the students experienced and reacted to in specific ways.

Both Diondre and Janelle perceived the relevance and applicability of specific contexts differently, and presumed their preferences were universal. Diondre thought that the context of Wage War was imminently applicable to himself and his classmates as they pursued employment. Janelle thought that students would not care for business concerns like supply and demand, and that decisions made at the business level were not relevant to them as students. They also had different perspectives on the context of the Datelines task. Diondre noticed and mentioned that the celebrities connected the context to “real-life,” but he did not expand on his personal connection with the task and ranked it low on his task sort because of this lack of connection. Janelle wanted to find out her personal dating range and thought the enjoyment of the context would attract positive attention from students. Her positive reactions to the task showed by the high ranking she put it in in the task sort.

Diondre’s case represented a strong focus on, attention to, and preference for an included context. By contrasting his case with Janelle’s strong preference for tasks without a context, and lesser attention to context throughout the tasks, the differences between individual students is made clearer. Each student brought their own personalities, background experiences, preferences, and expectations to the interviews, and as such they demonstrated different reactions and provided different explanations for their reactions.

Case 2: Arthur’s Reactions to the Opportunity to Justify in Tasks

Arthur’s case about being given the opportunity to justify his answers had supporting evidence from reactions to four of the five tasks. Arthur mentioned the opportunity to justify as an explanation for a reaction in the four focus tasks, but not with regards to the comparison task. The focus tasks all included at least one question that gave the students the opportunity to justify their answer with their opinions or experiences, but the comparison task did not. This provided Arthur (and the other students) with the chance to differentiate between tasks that contained such a prompt and one that did not, but Arthur did not mention the difference in any of his responses. The supporting evidence Arthur provided for his case is frequent and consistent across tasks and within tasks.

Throughout the interview process, Arthur frequently talked about being given the opportunity to justify his answers and how that opportunity affected his reactions to the task and task parts. Typically, when Arthur explained how the opportunity to justify affected his reactions, he gave an explanation that demonstrated a preference for the task parts that provided him with the opportunity and that he appreciated engaging with that opportunity. In some responses, he said that it was because he appreciated sharing his opinions and experiences, and in others it was because he was not expected to perform additional mathematical processes, such as computations or interpreting data from a graph, to construct his answers to the questions. Being given the opportunity to justify was frequently the primary reason Arthur gave in his explanations for choosing the task part he liked the most. For these reasons, Arthur represented a case of a student who was positively influenced by being given the opportunity to justify his answers.

In contrast to Arthur's case, there were three students who mentioned having a negative reaction to tasks or task parts because they did not require performing a mathematical process before constructing a response. The three students, Andrew, Francis, and Jorge, only explained this specific reaction for one task, or one task part, so they do not represent a consistent case of having that preference, but their responses show a contrasting reaction to Arthur's consistent positive reaction. There were no students who said that they did not want to share their opinion on a topic as a reason for a negative reaction to the opportunity to justify.

Arthur's Reactions to the "Wage War" and "Pic Me!" Tasks

Arthur reacted more strongly to the opportunity to justify his answers using his opinions and experiences during the Wage War and Pic Me! than he did to the other two focus tasks. When he explained his positive reactions to task parts in both the Wage War and Pic Me! tasks, he provided two different reasons, first that he wanted the chance to share his opinions, and then because he did not have to perform a mathematical process before giving his answer. Because he mentioned the chance to share his opinion first, I determined that was the primary reason for his reaction in these two tasks. His secondary reason for his reaction was not having to perform a mathematical process.

Arthur's Reactions to "Wage War"

The Wage War task had two task parts, task parts 3 and 4, that included prompts that asked the students to provide a justification for their answer that did not include a mathematical process. Figure 5.1 shows these two task parts with the included prompts. Arthur did not indicate a reaction to task part 3 that was attributed to being given the opportunity to justify, but he explained a positive reaction to part 4 multiple times through the interview. Arthur attended to, and mentioned, the opportunity to justify that was included in task part 4 before the task, immediately after solving task part 4, and in his reflections of the task after all parts were completed.

3 Find the lowest wage at which the restaurant will be able to attract as many employees as it wants. Do you think this is the amount the company should pay its employees? Why or why not?

4 Millions of Americans work full-time at or near minimum wage. Still, many of them struggle to afford rent, childcare, and other expenses, and rely on public assistance programs such as food stamps and Medicaid. To help these "working poor," some people think the government should raise the minimum wage from $7.25/hour to $15/hour. If this happened, how do you expect it would impact workers at the business?

Figure 5.1 *Wage War Task Prompts that Include the Opportunity to Justify*

After reviewing the task, but before completing any of the parts, Arthur attended to the presence of the prompt in task part 4:

> I noticed that the probably the number, I mean, like the questions are pretty much the same. Like they ask like about like minimum wage and then when you get to, they still ask about minimum wage and if it should get higher or lower or if it should stay the same it asks you about your opinion about that.

In this response, Arthur only briefly mentioned the opportunity to justify when he said, "it asks you about your opinion about that." This showed that he noticed the prompt, attended to it, and thought it was something he should mention. This response does not indicate whether he thought being given the opportunity was a positive or a negative thing. He clarified that he thought the opportunity was a positive thing when he explained his placement of the markers on the indicator tool. For the placement of the markers, he put the enjoyment marker at 2 and the desire to solve marker at 3:

> The enjoyment, I mean, I put that there because like the numbers, I don't really enjoy it, like the math that's going on right now on here and desire to solve. I mean, I do want to solve it, but I want to solve it, but it's like the questions that they're asking, it's probably like opinions and stuff. That's why I probably want to solve it, yeah.

In this response, Arthur explained that he had both a positive and negative reaction to the task. He used the markers to distinguish the reasons for each reaction. He connected his negative reaction to a lower enjoyment marker to the math in the task, "I don't really enjoy…the math," and connected his positive reaction to a high desire to solve marker. In this response he said, "I do want to solve it…it's probably like opinions and stuff. That's why I…want to solve it," which directly connected his positive reaction to his primary reason, the opportunity to share his opinion.

After solving task part 4, Arthur indicated having a positive reaction by moving both markers on the indicator tool up. When he explained his decision, he again mentioned being given the opportunity to justify his answer:

> ‘Cause this is like an opinion question. Like about like the minimum wage. Like should they go up or down? and then how would it like impact workers? And I could just answer that like snap of the fingers like I just use my head and use my opinion.

Arthur attributed his positive reaction to the opportunity to justify giving the explanation, "'Cause this is like an opinion question." He then explained his reason in more detail, he started by mentioning the specifics of the scenario for which he provided his opinion, "Like about like the minimum wage. Like should they go up or down? and then how would it like impact workers." He mentioned the overall scenario, "minimum wage," and also said what the prompt specifically asked him to evaluate. These details showed me that he was engaged with the task prompt, understood what he was expected to include in his answer using his opinions. Because Arthur attended to the additional details in his explanation for his reaction, I determined that his primary reason, liking the chance to share his opinion, partially influenced his positive reaction.

Arthur also tacked on an additional explanation that included his secondary reason for his positive reaction, not having to perform a mathematical process. At the end of his explanation, Arthur said, "And I could just answer that like snap of the fingers like I just use my head and use my opinion." I interpreted this as a secondary reason for his positive reaction since it was not the first thing he mentioned. This part of his response indicated that he reacted positively to the prompt because he did not have to perform mathematical processes. When he said "snap of the fingers," he meant that he could begin answering immediately, he did not have to do any additional steps to gather information for his answer. This was the first time he said, “use my head,” but he repeats it in several of the interviews. When he said “use my head,” he meant that he did not have to use other information or computations, all of the information he needed was in his head. He also added on “and use my opinion,” which again emphasized his appreciation of having the opportunity to share his opinion, that it was not entirely that the prompt was made easier or quicker.

When Arthur was asked to reflect on the Wage War task after he solved it, his positive reactions were both partially attributed to the opportunity to justify. When I asked him what caught his attention the most (good or bad), he referred to the fourth task part:

> Probably this one caught my attention the most … in a good way. ‘Cause they asked about like, like a real-world thing. Like the minimum wage that people get in jobs, and then they talk about how people can't even pay their bills and some people need Medicaid so they're probably trying to push my opinion to like risen it more, like they should rise it more. So I think this one probably caught my attention the most.

In this response, Arthur primarily attended to context, attributing the task part to be “about…a real-world thing.” He continued to provide more detail about the context, but in a way that showed he recognized the purpose of the context was to draw out his opinion. He mentioned “minimum wage,” and the struggle to pay bills, and “Medicaid,” and concluded that “they’re probably trying to push my opinion…” This showed me his attention was still on the opportunity to give his opinion, even while he focused on the context. My interpretation was also supported when he mentioned how the prompt influenced his opinion, “…push my opinion to like risen it more, like they should rise it more.” He mentioned that it “pushed his opinion,” as I noted above, but he went on to explain how it pushed his opinion, which demonstrated that the influence on his opinion and the opportunity to share it were explanations for why that part stood out to him the most, and “in a good way.”

Consistent with the task part that caught his attention, Arthur selected the fourth task part as the part he liked the most. The explanation he provided for his selection mirrored the secondary reason he gave for why he moved the markers up after solving it, that it did require a computation, “Probably this one because all I had to do was bring my opinion.” His response to what caught his attention the most reflected his primary reason, his appreciation of being able to share his opinion, and this response reflected his secondary reason, appreciating not having to perform any mathematical processes.

Arthur’s Reactions to “Pic Me!”

The Pic Me! task had four parts, with all four parts including at least one prompt that asked the students to provide a justification for their answer that did not include a mathematical process. Figure 5.2 shows these prompts. Arthur mentioned having a positive reaction to each task part that was at least partially attributed to being provided the opportunity to justify. Consistent with his responses to the Wage War task, Arthur mentioned both his primary and secondary reasons for his positive reactions to being given the opportunity to justify in at least one of his explanations for his reactions. He only mentioned his primary reason in his explanation for his reactions after task parts 1 and 4, but he mentioned both reasons in his explanations for his reaction after task parts 2 and 3. Again, like the Wage War task, when both of his reasons were mentioned, he mentioned that the opportunity to share as a reason before he mentioned the lack of requiring a mathematical process.

1 People who post photos on Instagram often want them to be popular. A group of users shared information about their most recent images. According to the line of best fit, how do additional followers affect the number of interactions (likes + comments), and do you think having more followers will make a picture more popular?

2 Different Instagram users have different strategies for making their pictures popular. Some try to gain followers by following *other* users, while others add #hashtags to their images. Based on the graphs below, which seems like a more effective strategy for getting people to interact with an image and why?

a. Does it appear that brands who post more frequently receive more comments and likes?	b. How often would you suggest that a brand post a new image to Instagram and why?

4 A 2014 *Business Insider* article reported that "Teens are spending thousands on prom so they can look cool on Instagram." Meanwhile, websites such as Buzzoid actually *sell* Instagram likes. How valuable do you think interactions are on Instagram, and what might be some consequences of trying to build a "personal brand?"

Figure 5.2 *Pic Me! Task Prompts that Include the Opportunity to Justify*

After reviewing the task, but before solving any of the task parts, Arthur placed the markers on the indicator tool the same way he did for the Wage War task, placing the enjoyment marker lower than the desire to solve marker. The reason he gave for his choices was consistent with his explanation for the marker placement from the Wage War task as well:

> First one [enjoyment] because like I don't really enjoy like the um, the scatter plot and then the graph. …And then the desire I mean it talks about like it has some opinions in here and like the Instagram thing, like social media talks about it. So like I'll want to solve it. Like I want to like solve the question, like put my opinion in.

He again chose to use the different markers to indicate that he had opposing reactions to the task. According to his response, he had a negative reaction caused by the mathematical topic, and a positive reaction caused by having the opportunity to give his opinion. Just like he did in the Wage War task, he mentioned the context of the task which showed he was aware both that he could "put [his] opinion in," and what that opinion would be about.

Also similar to the Wage War task, he provided his secondary reason for his positive reaction to the opportunity to justify, when he explained why he chose the task part he was most looking forward to solving, “Probably just only this one [part 2]. This one. Because it's just like all you have to do is put your opinion like I don't have to like really need to solve a lot.” In this response, he explained his positive reaction to task part 2’s inclusion of the opportunity to justify and gave the reason, “I don’t have to…solve a lot.” This response is consistent with previous responses where he also explained that he preferred a task part because he did not need to perform a mathematical process. Also consistent with his responses to the Wage War task, Arthur mentioned that he wanted to share his opinion before mentioning that he appreciated the lack of necessary computations. This emphasized that for those reactions, he was most influenced by his primary reason, but his secondary reason also affected his reaction.

Reactions after Task Parts 1 and 4. Arthur’s explanation for his positive reactions immediately after task parts 1 and 4 only included his primary reason, being given the chance to share his opinion. In his explanations for each, he also mentioned details of the specific context around which he was to form an opinion. This was consistent with his response in Wage War and demonstrated that he was engaged with the prompts and attended to the specific context in a way that informed his answer, and he wanted to share what he thought.

After Arthur completed task part 1, he moved the marker on the enjoyment indicator up one, and when he explained his decision, he included his primary reason, wanting to share his opinion:

> Like there'll be more interactions with more likes from how many like the more followers you have. And like, that's part of opinions ‘cause

> people like, people bein' like, I would like, I've been on social media too. And then you can use like what you already experienced to help solve. Like I said, like my opinion and like your experience to solve this.

Arthur began his explanation by voicing the answer he wrote on the paper, “Like there'll be more interactions with more likes from how many like the more followers you have.” By starting with his answer, he attended to the specific context of the task, “more interactions…from…more followers,” which showed he engaged with the context to inform his answer. He then said, “that’s part of opinions,” which highlighted his attention to the opportunity to share his opinion about the context. In this response he also mentioned personal experience when he said “I’ve been on social media too,” and connected that with how that experience also helped inform his answer. These details supported my interpretation that his reaction to this task part was primarily because of his primary reason, wanting to share his opinion.

Arthur’s explanation for his positive reaction to task part 4 is consistent with his explanation for his reaction to task part 1. In his response he mentioned context, opinion, and personal experience as part of why he wanted to share his opinion:

> Well because, like I said, it's like a real like real life question. The question that people could relate to like how does, like, uh, like building personal brand can like affect you or not. So like I could use my opinion and use like experiences and stuff to help answer the question. Like most of these questions.

In this response, he did not share the answer that he wrote on the task paper like he did for task part 1, but he did paraphrase the prompt and included specific details from the context, “The question that people could relate to like how does, like, uh, like building personal brand can like affect you or not.” He mentioned the context, “building a personal brand,” followed by the question he was supposed to answer, “can like affect you or not.” This again demonstrated that he was engaging with the task and attending to the specific details of the prompt in an attempt to inform his answer. He also talked about using his, "opinion and…experiences and stuff," to inform his answer. This showed that he recognized that his own background would inform his answer and he appreciated that opportunity. Finally, at the end of this response he said, "like most of these questions," which supported the consistency of his responses and his attention to, and appreciation for, prompts that provided him with the opportunity to justify.

Although Arthur only gave his primary reason for his positive reaction to task part 4 as the explanation for his marker placement, he did mention his secondary reason when he reflected on the task as a whole. He selected task part 4 as the only he most liked solving, and his explanation included his secondary reason:

> Pretty much this one because it was just a simple question about like opinions where they still had to do with the problems that we were doing. So like, all I had to do was put down, my opinion, put down like what I think about the question.

In his explanation he used the two phrases, "just a simple question," and "all I had to do." Both of those phrases indicated that his selection was based more heavily by his secondary reason, not having to perform mathematical processes, than his primary reason of providing his opinion. This explanation showed that he selected task part 4 because the nature of the prompt, and the lack of mathematical processes made forming an answer easier. It was "just a simple question" and he only needed to say his opinion and "what [he thought] about" it. It is noteworthy that when he first explained his reaction to the same task part, he attributed his reaction to wanting to share his opinion, and the second time he explained a reaction it was because it did not include a mathematical process.

Reactions after Task Parts 2 and 3. Arthur's explanation for his positive reactions after task parts 2 and 3 relied more heavily on his reasoning that prompts that provided the opportunity to justify were easier than prompts that included mathematical processes. Unlike previous responses where he mentioned ease, however, he recognized that he needed to incorporate information obtained from a graph, which is a mathematical process, to inform his answer. In both parts he mentioned that the answers required his opinion, but he only mentioned how the specific context informed his opinion in one of the responses.

For task part 2, he did attend to the context and how that enabled him to incorporate his own experiences to form his answer but emphasized ease over the chance to share his opinion:

> Because at the same time it relates to this. Like it asks like, which one do you think will like will be like which one do you think will be the best way to gain more followers and stuff like that. So then you can learn from the graph. So like it makes it easier to solve a question and it Like puts like, like a real life question in it at the same time so like they have an opinion of it of yourself to answer the question.

Consistent with previous responses, he started by paraphrasing the prompt, "which one do you think will…be the best way to gain more followers and stuff like that." Unlike previous responses, his attention to the specific context lacked detail. He said "which one" instead of saying something about followers versus hashtags, and ended with "and stuff like that." This demonstrated to me that he did not engage as deeply with this task part's specific details and prompt as he had previously. He also mentioned that you needed to "learn from the graph" which is unlike previous responses that did not include references to mathematical processes. In this instance, he mentioned that the graph made it "easier," which showed he was focused on the difficulty of answering the prompt. He ended by explaining that the connection to "real life" enabled him to "have an opinion of it…yourself to answer the question," which showed he recognized that the intention of the task was to be able to incorporate previous experiences along with his opinions. Unlike previous responses, he did not mention the details of specific experiences to the answer based on the context, nor did he share what his opinion was.

For task part 3, unlike most of his previous responses, he did not mention the context, or personal experiences, being able to inform his answer, and only mentioned ease of the prompt type, not the chance to share his opinion:

> Because like I said, like the previous ones are like opinions. Like you can use your opinion to solve this. And this and then the graph is like it goes up. So like it's easy to use the graph and it's easy to use this graph ‘cause like it starts little and starts at the seam and it spreads out as it goes up. So I feel like and the opinions make it like I said make it more easier to solve that problem.

Arthur recognized the consistency in his reactions, demonstrated by the beginning of this response, “like the previous ones are…opinions.” When he said the previous ones he was referring to the first two task parts. After this statement he clarified his explanation for his reaction, “Like you can use your opinion to solve this.” These two statements together demonstrated that Arthur was attending to, and reacting positively to, the opportunity to incorporate his opinion. Arthur next talked about “the graph.” There were two graphs in the task part, and he describes both, “the graph…goes up” and “the graph starts little and…spreads out as it goes up,” but he did not mention what either graph represented in context of the task. This showed me he did not engage with this task part as deeply as he had others since it lacked detail and specificity. He also ended with a general statement that did not mention any specifics about that particular task part, “and the opinions make it…more easier to solve that problem.” In most other responses he mentioned the context around which the opinion was formed, or stated the opinion he shared in his answer, in this response he only said, "the opinions." He also didn't paraphrase what the question was asking like he consistently had in other tasks, and instead said, "that problem." I interpreted his response and the included explanations as Arthur not engaging with this task part as deeply as he had with others, although it is not possible to determine why.

Arthur's Reactions to the "Datelines" and "Financial Aid" Tasks

The explanations Arthur gave for his positive reactions in the Datelines and Financial Aid tasks were less frequent and less detailed than the responses he gave for the other two focus tasks. For these two tasks, the primary reasons he gave for his reactions were either that the prompt type made the question easier to answer, or because he did not have to perform additional mathematical processes before constructing his answers. He did mention generally wanting to share his opinions in the Financial Aid task, but his explanation was not specific to the task like it had been when he mentioned wanting to share his opinion as a reason in previous tasks.

Arthur's Reactions to "Datelines"

The Datelines task had six parts, three of which (parts 1, 4, and 6) included at least one prompt that asked the students to provide a justification for their answer that did not need to include a mathematical process. Figure 5.3 shows these prompts. Arthur mentioned having a positive reaction task parts 4 and 6, but both mentions were brief and lacked specific details. He did not mention wanting to share his opinion as a reason for his reaction, only that the task prompts were easier because they were prompts that did not require him to find information he did not already know.

1 To determine the age of the youngest person you can date, some people recommend using the formula **half-plus-seven**: *start with your own age, take half of it, and add seven years.*

Use this to fill in the table below. Does half-plus-seven make sense for all ages? Explain.

4 Finally, shade in the **total acceptable dating region**. What do you notice about its shape, and what does it suggest about your dating prospects as you get older? Explain.

6 Finally, once someone is inside your RoCo, will (s)he ever be outside of it again? Explain your reasoning.

Figure 5.3 *Datelines Task Prompts that Include the Opportunity to Justify*

Before solving any of the task parts, Arthur mentioned the opportunity to justify once as an explanation for a positive reaction. He said that task part 6 was the part he was most looking forward to solving, primarily because of the lack of having to perform additional mathematical processes:

> Arthur: Probably just the second page because like I said, most of the time I can actually use my brain and then with some of this I could actually use my brain too. But not all of it.
>
> Interviewer: When you said use your brain, what do you mean?
>
> Arthur: Like opinions, like, I like I could pull an opinion and then put it with the question and then form it together to make it uh easier like answer like I could, like I don't have to rely on the paper or think about like the graph or something that I'm looking at. I could actually use my opinion … to put it together and make it a good answer.

When Arthur said that he chose the “second page,” he meant task part 6. He explained his choice by saying, “most of the time I can actually use my brain,” and contrasting that with “some of this I could actually use my brain too. But not all of it.” These descriptions showed that he recognized that task part 6 did not require him to perform any additional mathematical processes, while “some of this” (which referred to the first page’s task parts) were prompts that asked for justification of his answers after he had to perform other mathematical processes.

When he clarified what he meant by “use your brain,” his explanation supported my interpretation from previous tasks, that he didn’t “have to rely on the paper.” In other words, he could answer the question without having to use additional resources or having to “think about…the graph.” Instead, he would only need to “pull an opinion,” or “use his opinion,” to construct a “good answer.”

After task part 4, Arthur explained his positive reaction in a way that was consistent with his previous explanation for task part 6:

> Because like all I had to do was look at the shape and then use my head to like just use what I know. Just like the shape and then like what does it tell about like as you get older, how many people you can date and now it was just open. It was just here, like the sources was here.

Throughout this explanation, Arthur indicated that he thought the task part was easy, and that was the primary reason for his positive reaction. He said “all [he] had to do was…use my head,” “use what I know,” and followed up with “It was just here,” all of which indicated ease. He recognized the need to use the graph along with “his head,” but noticed he just needed to “look at the shape,” which implied that he did not need to perform additional mathematical processes with the graph. He briefly mentioned the context in connection with the graph, but it was not as detailed or specific as previous responses when he mentioned context.

Arthur’s Reactions to “Financial Aid”

The Financial Aid task had five parts, two of which (parts 2 and 5) included at least one prompt that asked the students to provide a justification for their answer that did not need to include a mathematical process. Figure 5.4 shows these prompts. Arthur only mentioned having a positive reaction to part 5 of the task, and his reason was primarily because of ease, although he did generally mention wanting to share his opinion. He did not mention context at all in his explanations for his reactions, which was unique to this task.

2 Imagine an 18 year-old high school senior is debating whether to take a job after graduation or to go to college. How many years would it take until each option resulted in the same net income, and how old would she be at this point? Based on this, do you think it would be a smart decision for her to attend college? Explain.

5 In reality, how much you earn depends not just on what degree you have, but also what you studied. The average starting salary for someone with a bachelor's degree in petroleum engineering is $98,000, and $33,100 for someone with a bachelor's degree in social work. When deciding what to study (and for how long), how important do you think average income is, and do you think it's the most important factor? Explain.

Figure 5.4 *Financial Aid Task Prompts that Include the Opportunity to Justify*

Arthur explained his positive reaction to the opportunity to justify in task part 5 twice. The first was immediately after solving the task part when he explained why he moved one of the markers on the indicator tool, and the second was when he explained why he chose task part 5 as the part he most liked solving. In his first explanation he attributed his reaction to the ease of the task because of the prompt's requirements. In the second explanation he attributed his reaction to a general appreciation for being able to share his opinion. Both of his responses included language that was consistent with, and similar to, his previous responses.

His first explanation indicated that he was attending to the ease of the prompt:

> All I had to do was use my head for that one, like solve like, like it says how important do you think like this is to then do you think this was the most important thing and all that? I can use my opinion like, yeah, pretty much all I had to use was my opinion. Like for like the last question.

There were several phrases he used that showed me that he primarily reacted to the ease of the task part. First, he began and ended his explanation with the phrase, “all I had to do,” which I interpreted as him saying that it required minimal effort to construct his answer. He also repeated the phrase, “use my head,” which he had used in previous explanations as meaning he did not have to incorporate additional information. He connected the ease of the question to the opportunity to justify by using his opinion when he said, “all I had to use was my opinion.”

His second response was his explanation for why he chose task part 5 as the part he most liked solving, “I kinda like enjoy it. ‘Cause like I was saying, you can think about like, like a real-life thing and then put it on a paper like answer like what you think about it.” In this response, even though he is talking about the same task part that he was before, he did not primarily attend to ease and instead said it was because he “enjoy[ed] it.” He also clarified that what he enjoyed was “think[ing] about…a real-life thing and …answer[ing] what you think about it.” His two responses about task part 5 show both perspectives that he shared about why he reacted positively to the opportunity to justify his answer in task prompts.

Other Students’ Contrasting Reactions

There were three students that had negative reactions to the opportunity to justify because those prompts did not require a mathematical process to construct their answers. This explanation directly contrasted with Arthur’s explanation for his positive reaction to some task parts, when he explained that *not* having to perform a mathematical process was a reason for his positive reaction. One of the students, Andrew, mentioned this opposing explanation (preferring to perform additional mathematical processes before constructing his answer) for his reaction in response to a task part in two tasks, and the other two students, Francis and Jorge, only mentioned it with regards to one task part in one task. Table 5.8 shows these four responses and to which task part they had a reaction. I added emphasis on the phrases that indicated their preference for the inclusion of mathematical processes.

Table 5.8 *Student Responses that Explained a Negative Reaction to the Opportunity to Justify (Emphasis Mine)*

Student	Task or Task Part	Explanation
Andrew	Financial Aid part 5	Because they look like they involve the most writing. These ones look like they're *more involved with math* and figuring out the problem.
Andrew	Datelines	But this one [Datelines, second in his final task sort] also like you, you're explaining more stuff in it too. This one [the comparison task, first in his final task sort], you're just like *solving like problems* the whole time and *graphing* the whole time.
Francis	Financial Aid part 5	'Cause it was just a question I just had to write. I had to write what I thought and yeah...I mean It's not really enjoyable and there's *nothing I had to solve* I just write what I did or what I figured out.
Jorge	Pic Me! part 3	I don't like doing questions like these...Like I don't even know. I just, I like, I'm like *I'd rather be doing graphs like doing the plotting* and all that than answering the questions.

All four students' responses indicated a preference for tasks or task parts that included mathematical processes. Both of Andrew's responses indicated a preference for tasks by explaining a preference for tasks that included a process. He said he selected task part 5 as the one he least wanted to solve because the *other* task parts were "more involved with math. When he explained the order of the task sort, he said he placed the comparison task first because it involved "solving…problems the whole time and graphing the whole time." Jorge clarified his negative reaction to Pic Me! task part 3 by explaining what he would have preferred to do, "I'd rather be doing graphs…doing the plotting…than answering the questions.” When he said “answering the questions,” he meant writing a response that did not involve a mathematical process.

Francis’ response mirrored language used by Arthur in his explanations for a positive response, “It's not really enjoyable and there's nothing I had to solve I just write what I did or what I figured out.” If the “It’s not really enjoyable,” phrase was removed, it sounded similar to Arthur’s explanation for his preference for these tasks, but the addition of the phrase makes it clear that Francis had an opposite reaction and preference. Francis wanted something “to solve,” and he did not appreciate that perceived lack in part of the task prompt. His response, like Andrew and Jorge’s showed that these students did not want to solve questions that involved writing, but none of them explicitly mentioned not wanting to share their opinion.

Takeaways from Arthur and the Other Students

Arthur’s responses indicated that he recognized, and appreciated, being provided the opportunity to justify his answers with his opinions and experiences. He frequently preferred task parts that both informed his opinions and gave him a platform with which he could share his opinion on that topic. His responses showed me that he thought it was important that the task was asking him to share what he thought about the “real-life” things they mentioned and used the included specific contexts to inform his answer. These sentiments indicate that Arthur, like Diondre in the case for context, reacted to the meaningfulness of the prompt, a characteristic of tasks that has been shown to trigger interest (Renninger et al., 2019).

In some cases, Arthur wanted to share his opinion, but he also thought task parts that asked for justification from previous, non-mathematical knowledge was easier than task parts that required a mathematical process to inform his answer. In other tasks and tasks parts, he never mentioned wanting to share his opinion and only focused on his perception that those task parts made the prompts easier to answer. There was never an indication that Arthur had a negative reaction to the opportunity to justify his answer, the only variation was the primary reason for his positive reactions.

In contrast, Andrew, Francis, and Jorge, all preferred questions that included a mathematical process to ones that did not. In their responses, these students did not make the connection between the math involved in the task and what they were asked to share their opinion about. They did not mention the context of the problems, only the lack of a mathematical process, which further highlighted the separation they indicated between the prompts, their opinions, and the math in the tasks. It is not possible to determine if their reactions were caused by what they expected to see versus what they saw (i.e., in math class, they are supposed to be doing mathematical process), but they did verbalize what they did not want to do. It is notable that these students only mentioned this reaction on occasion, not every time they were asked to answer a prompt that required justification that did not need to include a mathematical process, whereas Arthur consistently reacted positive to the opportunity in several tasks and task parts.

Case 3: Callie's Preference for Ease in Tasks

Every student mentioned only a preference for ease when they attributed reactions to perceived difficulty in at least one task, and five students only preferred ease in at least four tasks, but Callie mentioned it more frequently and more consistently than anyone else. She mentioned perceived difficulty as a reason for nearly every reaction in every task, and in all but one instance, she said she preferred ease over challenge. She also explained that the difficulty of the tasks was the only reason for the order of tasks in her task sorts. When Callie mentioned her preference for ease, she either reacted positively because of a perception of ease, or negatively because of a perception of challenge or difficulty. The language and phrases she used to explain her reactions were consistent throughout and across the tasks. Throughout her responses, she occasionally mentioned context as a secondary reason for her reaction, but her emphasis was consistently and frequently limited to her perceived difficulty. I will present her case in the order in which she solved the tasks. Figure 5.5 shows the order in which Callie put the tasks during all intermediate task sorts and the final task sort. The placement of each task in the task sort provided support for the reactions she had and the responses she made while solving them.

Pic Me!	Pic Me!	Pic Me!	Pic Me!	Pic Me!
	Control Task	Control Task	Control Task	Control Task
		Datelines	**Wage War**	Wage War
			Datelines	Datelines
				Financial Aid

Figure 5.5 *Task Sort Order After Callie Completed the Bolded Task*

Callie's Reactions to "Pic Me!"

Pic Me! was the first task that Callie completed and was the task she thought was the easiest of the five. She always placed it at the top of her task sorts and indicated that the placement was because of its ease. In this task she mentioned that context was a secondary reason for her positive reactions, but she still explained that her preference for ease was the primary reason for her reactions. Table 5.9 shows her responses explaining her reactions to perceived difficulty as she solved the Pic Me! task parts.

Table 5.9 *Callie's Responses During the Pic Me! Task*

When	Callie's Response
Before	[Thoughts before solving] Um, it looks pretty easy. Um, it's straightforward, which I like and um, it's talking about Instagram and like a clothing store, so I like that too.
	[Placement of markers] Because when I was reading it, I wasn't getting bored. I wasn't getting that bored, so I, that was like more enjoying and then the desire to solve it was more up because they're talking about the things I like, and it looks straightforward and easy.
After Part 2	[Moved a marker down] Because this one was a little more confusing… Because I didn't understand the question that much…I had to like re-read over again, and then I started to pick it up.
After Part 3	[Moved a marker up] Because this one was easier than the one before. And it was straightforward. And I knew, um, how to answer to the questions
After Part 4	[Moved a marker down] Because the one question confused me and I had to think for a long time and I was very confused until you, um, um, described it to me and then I answered it.
After All Parts	[Liked least] Number four, because it confused me, and I didn't know what they were talking about until you had to explain it to me.
	[Liked most] The front [parts 1 and 2] because the problem was the most easiest for me and I understand what they're saying.

Her responses before she started solving any of the task parts were the only times where she attributed her reactions to anything other than perceived difficulty. In both responses she mentioned that she had a positive reaction to the context because of its relevance, but both times also mentioned ease. When she explained her thoughts before solving, she started with, "It looks pretty easy... it's straightforward, which I like," and then added her thoughts about the context, "it's talking about Instagram and like a clothing store, so I like that too." This indicated that her primary attention was to the ease of the task, although she had noticed the context. Her explanation for the marker placement reversed the order of attention from her first response, but both still included attention to ease.

The rest of her responses included the language that she used consistently across all the tasks for her reactions. When she indicated a positive reaction to something that was easy [i.e., before solving the task and after task part 3], she used words like, "straightforward," "easy," and "I knew how to." When she indicated a negative reaction to something that she found difficult [i.e., task parts 2 and 4], she used words like, "confused," and "I didn't understand." She clarified in her response to task part 4 that she "was very confused until [I] described it to [her] and then [she] answered it," which showed me that my help was an indication of her lack of knowledge, not a tool to help her solve the problem. This was consistent across the tasks, she tended to react negatively to task parts that she asked for my assistance with.

Callie's Reactions to the Comparison Task

Most of Callie's explanations for her reactions to her perceived difficulty in the comparison task were consistent with her preference for ease. Notably, this task included the one time that Callie explained her positive reaction to a challenging task part. All of her responses that explained reactions through the task only included perceived difficulty as the reason. Callie's responses throughout the task are in Table 5.10.

Table 5.10 *Callie's Responses During the Comparison Task*

When	Callie's Response
Before	[Thoughts before solving] It looks pretty easy. Looks straightforward.
	[Placement of markers] Because I remember doing this before and it seems pretty easy but I kinda forget what to do at some of them, but yeah.
After Part 1	[Kept markers high] Because it was straightforward, and I expected it to be like this.
After Part 2	[Kept markers high] Because the first one was pretty straightforward but the second one was kind of confusing but I kind of liked it 'cause I like a challenge and I like, yeah, challenge my mind. So yeah, that's why.
After Part 3	[Moved a marker down] Because this one was more confusing than the other ones.
After Part 4	[Moved a marker up] 'Cause this one was kind of like the one on the front and the front was easy for me.
After Part 5	[Moved a marker down] Because I didn't know how to do it at all and it was confusing.
After All Parts	[Liked least] The inverse one [part 5] because I didn't know how to do that.
	[Liked most] The front [part 1] 'cause I knew how to do that.

In all of her responses, with the exception of her response after task part 2, her language is consistent with the language and explanations that she provided during the Pic Me task. She used, "easy" and "straightforward" before solving, after task parts 1 and 4, and when explaining why she chose task part 1 as the one that she liked most, all of which she had positive reactions to because of their ease. She used, "confusing," and "I didn't know how," after task parts 3 and 5, and when explaining why she chose task part 5 as the one that she liked least.

Task part 2 was the anomaly to the consistency of all her other reactions that she attributed to perceived difficulty. When she explained why she kept the markers high, she started by explaining they were high for part 1 because it was, "pretty straight forward," and that she kept them there because she "like[d] a challenge." She also said that part 2 "was kind of confusing," which was a term she used in other responses to explain a negative reaction. In this instance, she said that she still "kind of liked it," because she "like[d] a challenge," and to "challenge [her] mind." This statement is in direct opposition to all of her other responses and explanations. This might be explained by Callie's feelings of self-efficacy because she struggled with the problem but solved it without asking for my assistance. While this is a single incident, it showed that Callie could be positively influenced by a challenge.

Callie's Reactions to "Datelines"

Consistent with her previous responses, most of Callie's explanations for reactions to the Datelines task are attributed primarily to, or exclusively to, her perceived difficulty. She did include the context of the task once in her explanations, but mentioned it after she indicated her preference for ease. Callie's responses through the Datelines task are in Table 5.11.

Before solving any of the task parts, Callie did mention the context, "they're talking about celebrities, so I like that." That was the last time that Callie mentioned context as an explanation for a reaction during any tasks or as an explanation for placement in a task sort. The rest of her responses include explanations that are consistent with her preference for ease, although she used different language in this task when she explained why she had a negative reaction to perceived challenge. For the task parts that she thought were easy [i.e., task parts 2, 4, 5, and 6], she continued to use words like, "easy," "I knew how to do it," and "I knew what I was doing." When she explained her negative reaction to task part 1, she said that it "took a lot of time and effort," which is a phrase she had not previously used. She invoked the same thought again, but using even different terminology when she explained why she put the Datelines task last in her task sort and said that it “is the hardest…’cause I had to think more about it.”

Table 5.11 *Callie’s Responses During the Datelines Task*

When	Callie’s Response
Before	[Placement of markers] Because I filled in graphs before and I did the tables before, and they're talking about celebrities, so I like that.
After Part 1	[Moved markers down] Because it took a lot of time and effort and that's it.
After Part 2	[Moved markers up] Because this one was easier, and I knew exactly what I was doing.
After Part 4	[Kept markers high] Because the, um, question was easy, and I knew what to do.
After Part 5	[Kept markers high] because the, um, question was explained easily, and I know what they're talking about, and I knew how to do it.
After Part 6	[Kept markers high] because the question was just easy, and I knew what to do and the finding the answer was easy.
After All Parts	[Liked part 4 most] Because I knew what the graph was like linear and everything and I knew how to explain it.
	[Placed last in task sort] Because the top [Pic Me!] is easiest and the uh bottom [Datelines] is the hardest. And the task that I just did was the hardest one ‘cause I had to think more about it.

Callie’s Reactions to the “Wage War” and “Financial Aid” Tasks

By the time Callie solved the Wage War and Financial Aid tasks, her responses had gotten much shorter and less detailed. After this point, she only explained that difficulty was the reason for all her reactions. There was limited variation in the language she used from previous tasks, and her reasoning for her reactions remained consistent. Her responses to the Wage War and Financial Aid tasks are in Table 5.12 and presented in chronological order.

All of her responses in both of these tasks were consistent with the explanations she gave in previous tasks. She consistently used “easy,” “knew what to do,” and “straightforward” for parts she perceived were easy, all terminology she had used previously. The only addition was that she thought that task part 4 of the Wage War task was “explained good,” and that made it easier for her. She also consistently used terminology from previous responses when describing what she thought was hard, by using “hard,” “I didn’t know what I was doing,” and “confusing.” She added the word “frustrated,” and the phrase, “a lot of work,” as new descriptions for parts she perceived were challenging.

The frequency with which Callie mentioned her perceived difficulty as an explanation for her reactions, and by using consistent language in her explanations across all tasks, supported her case of having a strong preference for ease above all other aspects. She did mention having a positive reaction to context on occasion before solving tasks, which showed that she noticed the context, and its relevance to her life (in the Pic Me! task) or her enjoyment of it (in the Datelines task), which meant she did attend to it on some level when looking at the task. There was also the one instance where she acknowledged a positive reaction to perceived challenge, when she struggled with comparison task part 2, before she was able to find the answer. These limited instances, however, do not override her consistent and frequent attention to perceived difficulty and preference for ease.

Table 5.12 *Callie's Responses During the Wage War and Financial Aid Tasks*

When	Callie's Response
Wage War	
Before	[Placement of markers] Because um, when I was reading the first question it seemed a little confusing, but the other ones don't look that bad.
After Part 1	[Kept markers] Because the question was easy and straightforward. I knew what to do.
After Part 2	[Moved markers up] Because the question was easy and straightforward.
After Part 3	[Kept markers high] Because the question was straightforward, and I knew what to do for the most part.
After Part 4	[Kept markers high] Because the question was explained good, and I understood it and I knew it and I knew what I needed to answer.
After All Parts	[Liked part 1 least] Because I had to look for the answer on the graph and I got kinda confused and I had to like really look for it and like determine which one would be, um, the right one to attract more employees.
	[Liked part 2 most] 'Cause that was the easiest question.
	[Why third in task sort] Because that one [Wage War] was easier than the one before [Datelines], but it wasn't as easy as the ones on top [Pic Me! and the comparison task].
Financial Aid	
Before	[Most want to solve part 2] 'Cause it seems the easiest.
	[Least want to solve part 4] 'Cause it seems hard… I'm going to have to figure out when, uh, each educational path yields at the same net income. That seems like a lot of work.
	[Placement of markers] Because the entire thing just seems a lot of work and hard.
After Part 1	[Moved marker up] Because um, the problem wasn't that hard, and I knew what to do.
After Part 2	[Moved markers down] Because I didn't know how to do any of it. and I was very frustrated.
After Part 4	[Moved markers down] Because both of them, well the top one wasn't that hard, but the bottom one was hard. So that makes an impact on top of it.

After Part 5	[Moved markers up] Because the problem was straightforward, and I knew what to do.

Table 5.12 Cont.

When	Callie's Response
After All Parts	[Liked part 4 least] Because I had to, I had to figure out, um, how old they would be and um, with their respective life, line lifetime net income would be and it's a lot of work. [Liked part 1 most] 'Cause I knew I do it from the start. [Why last in task sort] The top [Pic Me!] was the easiest and the bottom was the most hard, and this task [Financial Aid] was the, um, hardest one out of all of them.

Khalil's Preference for Challenge

Khalil indicated a preference for challenge at least once in four tasks. In each of these tasks, he also indicated a preference for ease, but he mentioned a preference for challenge more than any of the other students. Khalil explained both positive reactions to things he thought were hard, and negative reactions to things he thought were easy. He indicated that challenge kept him more engaged with a task part, and disliked tasks that did not require much work. Furthermore, most of his positive reactions to perceived ease were because he struggled at first but ended the task or task part with an understanding of what he needed to do, which supported his consistent preference for a level of challenge to maintain his engagement. There was also only one instance in which he reacted negatively because he thought a task part was hard after he attempted to solve it. The other times he reacted negatively because of his perceived challenge, it was before he had started solving any of the task parts. He also explained that the challenge the tasks presented was the primary reason for the order of tasks in his final task sort.

Khalil's Positive Reactions to Successful Struggle

In some of the tasks, Khalil attributed his reaction to the difficulty in terms of solving a problem after engaging in a struggle. This was especially true with regards to his experience with the Financial Aid task. He completed the Financial Aid task first, and he placed his at the top of every task sort. His feeling of self-efficacy after struggling was the explanation that he gave for all of his reactions throughout the task and as his explanation for its placement in most of the task sorts. Notably, Khalil mentioned having a negative reaction to his perceived challenge of the task prior to solving any of the task parts, placing the markers on the indicator tool low. His explanation was, "I don't really know like how to do it and what it means and stuff like that." Once he began solving the task, all of his explanations were attributed to a feeling of self-efficacy. Table 5.13 shows his responses during the Financial Aid task that illustrate this reaction.

Table 5.13 *Khalil's Responses During the Financial Aid Task Explaining a Positive Reaction to a Successful Struggle*

When	Khalil's Response
After Part 1	[Moved markers up] Because once I got the hang of it, it got easier. So I started liking it more.
After Part 2	[Kept markers high] Because I like solving stuff like this because I really focused, and it helped me…Because I ain't even know how to do none of this stuff for real for real. But when I try, I got the hang of it. So I started feeling it, and so I and like and how I can work things out.
After Part 3	[Kept markers high] 'Cause I, once you start doing, doing like, trying to figure out stuff, it gets easier. And when it gets easier it gets better because now you know how to do it.
After All Parts	[Noticed after task] To me, once I got the hang of it, it was easy, and I like doing this work because I can, I can do it if I put my mind to it.
	[Most like part 2] Because it took me a little time, but then when I got the hang of it, it was like, now I can do this.

All of his responses through the Financial Aid task indicated that his reactions were caused by recognizing his self-efficacy. His first response that “it got easier. So I started liking it more,” was because he “got the hang of it,” not because it started out easy. He recognized his own growth throughout the task, and had a positive reaction to his own accomplishments. He reflected on this growth in his response after task part 2 when he said, “Because I ain't even know how to do none of this stuff for real for real. But when I try, I got the hang of it. So I started feeling it.” After part three he clarified in his explanation that when he said “got the hang of it” in his earlier responses that he meant that he was “trying to figure out stuff.” He was very explicit about the reasons for his reactions in his declaration that “I like doing this work because I can, I can do it if I put my mind to it.” He is clearly saying that he appreciated the struggle and the resulting success he achieved.

In the task sorts, the explanations he gave for putting the Financial Aid task first were again because of its challenge and his success with it. After he completed the second task, which for him was the comparison task, he explained why he put Financial Aid first by saying, “I mean I like this one [Financial Aid] because it was actually challenging a little bit, rather than this one [comparison task], this one’s just easy.” After the third task, the Pic Me! task, he mentioned his feelings of accomplishment with the Financial Aid task as his explanation for its top placement. For that task sort he said, “Because it [Financial Aid] was challenging and I didn’t know it. I didn’t never tried it, and then I randomly, well, I ain’t randomly, but I worked hard to get that to know it.” Even after completing two other tasks, the feeling of accomplishment stayed with him and caused a strong positive reaction to the task.

There was only negative reaction that Khalil mentioned having after trying to solve a task part. This occurred after part 2 on the Wage War task and he moved the markers on the indicator tool down. Notably, this was the only time in the entire interview process that he moved them down. When he explained his reasoning he said, “Because it was confusing. I ain’t get too happy trying to process it because it was confusing.” In the Financial Aid task he struggled, but he eventually succeeded. In this task part, he was unable to succeed after his struggle, causing a negative reaction because of his frustration. In the final task sort, he placed Wage War after two other tasks and explained that his reason was, “I didn’t like it because the second one was confusing.” The feeling of success after struggle stayed with him from the Financial Aid task and similarly the lack of success after struggle also remained.

Khalil’s General Preference for Challenge

During and after solving the other tasks, Khalil mentioned a general preference for challenge, either by explaining a positive reaction to perceived difficulty, or a negative reaction to perceived ease. Table 5.14 shows some of his explanations that mentioned his general preference for challenge.

Khalil’s three responses for the comparison task demonstrate how his reactions changed within a task because of difficulty. The first response was given after completing the first part and moving the markers down. Since he had completed it after the Financial Aid task, his response compared the two tasks’ difficulty levels. Not only does he say that “it’s not…fun as the last one because the last one was hard,” but he then explains that the reason he liked that the Financial Aid was challenging because he had to “sit there for a minute” to figure it out. He enjoyed the productive struggle that led to success, whereas for most of the comparison task it was “just nothing." I interpreted his reaction after part 5 to be caused by the relief of being challenged. He moved the markers up because he "actually worked harder" to get that answer than the other task parts, further emphasizing his preference for a challenge.

Table 5.14 *Khalil's Responses that Indicated a Preference for Challenge*

Task	Response
Comparison task	[Markers down after part 1] I don't have interest in it. 'Cause it's not, it's not like fun as the last one [Financial Aid] because the last one was hard and …I had to see it and sit there for a minute to actually know like how to do it. But this one is like, just nothing. [Markers up after part 5] Because this one, I actually worked harder than most of the other ones. [Why comparison task is last in a task sort] Because it really, I really didn't do nothing. Like, it was just plain easy.
Pic Me!	[Markers stayed low after part 1] Still don't like it...'Cause I don't get to think hard enough.
Wage War	[Placement of Wage War in a task sort] Wage War, I like it because you learn things. So I got used to it. Then I started building up my confidence and stuff.

All of the responses to the Financial Aid task above, as well as the ones in Table 5.14, showed that he was attending to his preference for challenge across most of the tasks. His response for the Pic Me! task was an example of disliking perceived ease, "'Cause I don't get to think hard enough." Meanwhile, his response to the Wage War task was another example of his preference for challenge and the emotions that it evoked for him. He liked the Wage War task because he "learn[ed] things," and that by learning those things it, "[built] up [his] confidence." After he completed all of the tasks and was reflecting on the experience, he summarized his reasons for preferring a challenge [emphasis his]:

> Because I like *challenging* stuff. So when I work on *challenging* stuff, they make me want to go even harder because now I *don't* know it. I *don't* know what it's talking about, but I wanna *learn* what it's talking about. So I want to do challenging stuff.

This response, not being in response to any particular task, showed that his focus was on challenge and awareness that his engagement is strengthened when he is challenged by the task.

Takeaways from Callie and Khalil

Callie and Khalil demonstrated opposing student preferences for perceived difficulty. Callie mentioned perceived difficulty with more frequency than Khalil and most other students, and her preference for ease was made clear throughout her interview experience. She only deviated from her preference for ease once when she said that she liked that comparison task 2 “challenged [her] mind.” All of her task sort choices were based on her preference for ease, and she preferred task parts that were “straightforward,” and therefore “knew what to do.” Meanwhile Khalil demonstrated a consistent preference for learning and challenge. He mentioned appreciating the confidence he felt with success after struggling and indicated boredom when he was not challenged. Both students came from the same course, received the same classroom instruction, and showed two very different reactions towards, and preferences for, perceived difficulty.

This chapter, along with the previous chapter, described how the students explained their reactions to the tasks with an interpretive focus on a single task aspect, whether it was a task feature or an emergent aspect. In the discussion section I will explore some of the ways in which students reacted to multiple features and aspects that were concurrently present in the tasks. I will also synthesize how the students reacted to the included task features as well as the emergent task aspects in ways that reinforce research saying that “novelty, challenge, and meaningfulness” (Renninger et al., 2019, p. 5) can be triggers of interest across academic subjects.

Chapter 6

DISCUSSION

The purpose of my study was to investigate the reactions that students reporting low situational interest in mathematics had to aspects of multiple mathematical tasks. Specifically, I wanted to learn (a) to what they reacted, (b) the ways in which they reacted, (c) the reasons they gave when explaining their reactions and (d) if any of the aspects they reacted to were intentional task features, that is, features that previous research has shown may trigger interest. The three task features that were included in the four focus tasks and excluded from the comparison task were the inclusion of a real-life context (e.g., Van den Heuval-Panhuizen, 2005), the opportunity to justify their answers using non-mathematical procedures (e.g., Boaler & Staples, 2008), and the interpretation of visual representations of data in the form of graphs to inform their answers (e.g., Krawec, 2014). My study showed that students had reactions to all three included task features as well as two additional aspects: mathematical topic and perceived difficulty.

Reactions to Task Features

My findings demonstrated that the students generally reacted to the three task features I explored, context, the opportunity to justify, and graph interpretation, in ways that indicated that the features could trigger their interest in the mathematical tasks. My results showed that while students generally reacted in ways that directly supported findings from previous research, in some instances their explanations for their reactions expanded on previous research. When their reactions expanded on the previous research, it was because the students described reactions that indicated potential increases or triggered interest, but their explanations did not reflect the same reasons described in the research or provided additional nuance to the reasons described in previous research for why each feature could trigger interest (Van den Heuval-Panhuizen, 2005; Boaler & Staples, 2008; Krawec, 2014). It is important to note that, in addition, my findings showed that there were some instances when students described having reactions to task features that indicated that the features could also suppress student interest in mathematical tasks, which provided insight into why and how intentional features can suppress student interest.

Reactions to the Inclusion of a Realistic Context

My findings supported and extended findings from previous research that looked at how student interest can be influenced by the inclusion of a realistic context. The students in my study generally reacted in ways that indicated that the inclusion of a realistic context could have triggered their interest most of their explanations directly supported previous research that they reacted positively because they found the context relevant, enjoyable, or meaningful (Gutstein & Peterson, 2013; Walkington, 2013). Some of the examples that I presented included Shantel's reaction to the relevance of the context of the Pic Me! task because, "everybody got Instagram", Janelle's enjoyment of the context of the Dateline's task expressed when she said, "I didn't know the age difference was so big and that was kinda like, like, Whoa," and Diondre's appreciation for the relevance and applicability (i.e. meaningfulness) of the Wage War task because it helped determine if "some jobs are really worth that much pay."

My findings also provided insight into the range of ways in which individual students reacted to the same contexts. Walkington (2013) and López and Sullivan's (1992) studies provided their participants with tasks that were personalized to them and showed that the inclusion of those contexts increased their positive affect towards math. While my study did not provide those choices, two of the tasks I selected, Pic Me! and Datelines included contexts that were meant to be relevant and enjoyable for the students by including elements most students had experience with or awareness of (i.e. dating and Instagram use). As I mentioned above, some students responded in expected ways to these contexts because they saw them as relevant or enjoyable, but Jorge's comment that the context in the Datelines task, "wasn't really to me that's something I needed or something that important either" shows that not all students will react to tasks simply out of recognition of the context.

My findings also expand our understanding of what tasks students see as meaningful. The descriptions provided by Turner and Strawhun (2013) Gutstein (2003) and Dean (2013) illustrated reactions that students had to the inclusion of meaningful tasks and they provided evidence of individual students' responses to those tasks. The case I presented about Diondre's reaction to context, and Janelle's opposing reactions, illustrate that not all students will find the same tasks meaningful. In the literature I cited, the authors described tasks that all students were assigned and selected students that found them meaningful to share evidence of their interest. My findings demonstrate that while some students may find one task meaningful, another student may not see it as valuable or important. Diondre found Wage War to be very relevant and meaningful, while Janelle did not see how that context applied to her. Meanwhile, Janelle explained why Financial Aid was so important to her and her peers while Diondre did not find that task as relevant or meaningful. This suggests that care must be taken when making assumptions about the importance and meaningfulness of tasks for all the students and recognize that students will place different levels of importance based on their own opinions and experiences.

Reactions to the Opportunity to Justify

My findings suggest that accounting for students' voices could shift the way that mathematics educators conceptualize justification approaches to expand the definition to encompass ways of justifying that are meaningful and interesting to students. Past research has centered justification on connecting mathematical concepts while my findings show that students reacted in ways that indicated interest in using their mathematical reasoning along with knowledge that was not immediately connected to a mathematical process. Simon and Blume (1996), Hanna (2000) and Staples et al. (2012) expanded the role of justification in math education from formal proofs to include explanations as a means to understand the underlying mathematical concepts, which opens up the possibility to include explanations that may not involve direct mathematical processes.

Boaler and Staples (2008) and Staples et al. (2012) showed that students in their studies reacted positively to curricula that included more conceptual questions that the students were expected to answer than a traditionally instructed curriculum. Boaler and Staples (2008) and Staples et al. (2012) showed that both students and teachers recognized the impact the opportunity to justify has on the students. In Boaler and Staples' (2008) study a student explained that math is "more interpretive. It's not just one answer. There's more than one way to get it. And then it's like: 'why does it work'?" (p. 630). In Staples et al. (2012), they said that "teachers noted that justification allowed students to build on prior knowledge, connect two ideas in a new way, and review other course material" (p. 454). Both of these quotes end with a focus immediately on the connections to the mathematical concept at hand. My results showed that the students could use their past opinions and experiences to reason about, and make sense of, the quantities involved in the mathematical tasks they were presented with.

In my first results chapter, I presented several instances where students mentioned that they appreciated the opportunity to bring their opinions and experiences to their answers. Janelle recognized that a question that drew on the students' shared experiences with Instagram was more accessible to students and provided an opportunity for discourse, "let's talk about this. Cause this was like more, I guess opinionated. So it would get everyone into it." Shantel reinforced this perspective in her explanation for why she liked a prompt asking for her to explain her opinion in the Wage War task, "I didn't have to write down or use the calculator or I just had to think about, like, literally my life. I didn't have to, like, think of nobody else's, I just had to think about my life." In her response, Shantel was using quantitative reasoning, and mathematical justification for her response, even while she did not see it as doing math, and she found that opportunity to demonstrate her understanding more accessible. Most of the time the students reacted to being able to use their opinions and experiences to demonstrate their understanding of the context, the prompt, and the reasonableness of their answers, they reacted in ways that indicated it could trigger or support their interest. Opening up opportunities for students to demonstrate their understanding in these ways as an acceptable means of justification could improve students' experiences and provide more students with access to mathematical reasoning.

Reactions to Graph Interpretation

My findings regarding graph interpretation aligns with previous research suggesting the reasons for how it can support student interest. Previous research has shown that visual representations of data can support students' understanding of the data and support their approach to a problem-solving task (Stylianou, 2020, Tripathi, 2008, van Garderen et al., 2021). My results support those conclusions as every time a student mentioned a graph as a reason for a reaction, it was in a way that indicated that they recognized the graph was included as a support to access the data more effectively. One way in which the students' reactions indicated this occurred when a student said a graph made finding their answers easier. This reaction is illustrated by Andrew talking about the graph he constructed during the Datelines task, "When I looked at the graph, it helped a lot too when I put them on the graph because it showed like which ones were in the range and which ones were out of the range." Alternatively, there were other students whose reactions indicated that they knew the graph was *supposed* to make finding their answers easier, but they did not think the graph was clear. This is illustrated by Arthur explaining what he would change to improve his negative reaction in the Financial Aid task, "probably if there were separate graphs it would make it easier." These results both highlight the importance of ensuring that a graphical representation can be readily interpreted by the students so they can make use of the data that it is representing.

Reactions to the Emergent Task Aspects

With respect to the two emergent aspects, mathematical topic and perceived difficulty, the students generally preferred familiar topics that they had previous success with, and they generally communicated a preference for ease over challenge. This general reaction supports findings in previous research that suggests students can be drawn to activities in which they presume they will find success (Ryan & Deci, 2016; Fredricks & Eccles, 2002). However, similar to student reactions to the task features, there were some instances when students preferred new topics because they learned something new or preferred to be challenged while interacting with a task. This supports Clark's and Roche's finding "[suggesting] that students see liking, learning and ease as different" (2018, p. 104). This discernment demonstrates the nuanced reasons students can recognize for how tasks can trigger their interest.

The results of my study also highlight the importance of recognizing the diversity of student perspectives within a group with several common characteristics. All of the students who participated in my study reported having a low level of situational interest in math and all experienced the same learning opportunities in their math class, yet the students provided a range of reactions to the tasks. The students provided different explanations for similar reactions to task aspects and attended to the task aspects and features to a differing extent. My results showed three such instances: Diondre's attention to and preference for the inclusion of a real-life context, Arthur's appreciation of the opportunity to justify, and Callie's preference for ease. Meanwhile, there were students that mentioned opposing reactions to these same aspects, albeit their reactions were less frequent. This demonstrated that general assumptions about how students will react to particular tasks, even students with shared traits as they relate to math, are not always beneficial when selecting tasks. Rather, it can be suggested that it is important to present a variety of tasks that provide students with different experiences.

Students' Concurrent Reactions to Multiple Aspects

In addition to learning about how students reacted to singular task aspects, my results also showed ways in which students' reactions aligned with multiple task aspects concurrently. My concluding stances about each of the aspects in my first results chapter were influenced, in part, by the students mentioning multiple aspects in an explanation for a reaction. The two most common combinations of aspects were (a) the inclusion of a real-life context along with another task feature, either the opportunity to justify or graph interpretation, and (b) perceived difficulty along with any of the other four task aspects. Understanding how two task features concurrently affected students' responses can help explain how features that are included to trigger interest can interact in ways that either support triggering or increasing interest or have the opposite effect for students. Exploring how a students' perceived difficulty relates to their reaction to other aspects, including task features, can illuminate how interest can be triggered or suppressed by the perceived accessibility or challenge of tasks or task parts.

Explanations Including Context and Another Task Feature

When two task features were mentioned by a student to explain their reaction to a task, it was typically context in connection with one of the other two features: the opportunity to justify, or graph interpretation. Generally, when the context was mentioned in conjunction with one of the other two features, it was because the context reinforced the students' reaction to the other feature. The three task features are distinct in their characteristics with context being a supporting scenario in which the rest of the task is based, and the other two features being a type of question prompt.

There were two ways in which students mentioned how the included context influenced their reaction to the opportunity to justify their answers. The first was students who mentioned that they appreciated how the context allowed them to leverage their experiences outside of school when formulating their answers to prompts that asked them to justify their answers. The other way in which students mentioned the connection between context and the opportunity to justify is when they expressed an appreciation of, or desire to, share their opinions and ideas about a particular context.

When they referenced the context in their explanation for their reaction to a prompt that required them to use the graph representation of the data, they usually mentioned how the representation assisted in their sense making. This connection worked in both directions, when the context helped the students make sense of the graphical representation that they needed to interpret to form their answer in context, as well as using the graphical representation to help them make sense of the context. Both connections demonstrated how the context and the representations worked in conjunction to support student understanding, which could lead to increased interest.

Recognizing how multiple task features included in a single task influence students' reactions is important to increase our understanding about the ways in which each individual aspect influences interest. Looking at each feature in isolation, which is what most previous research has done (Renninger et al., 2019), can limit our interpretation of the reasons why they influence the reactions and experiences students have with the task. By considering combinations of multiple task features, we can better understand the nuances about each feature to which the students react in different ways to find more ways to trigger or support student interest when including these features.

Explanations Including Perceived Difficulty and Another Aspect

Every student mentioned perceived difficulty as a reason for their reaction in most of their task occurrences, and usually they attributed their perceived difficulty as a reason for their reaction to a different aspect. Students mentioned the combination of perceived difficulty with each of the other four aspects as a reason for their reactions. These combinations generally indicated whether or not the student found that the other aspect made the task more, or less, accessible to them. These connections indicate the importance of accessibility as it relates to students' interest in the tasks.

Perceived Difficulty and Context

There were two main categories of reactions students had that they attributed to perceived difficulty along with context: (a) students who said context in general influenced their perceived difficulty, and (b) those who mentioned that a specific task context influenced their perceived difficulty. Both categories had students who said the context decreased their perceived difficulty and others that said that it increased their perceived difficulty. Some students recognized the utility of contexts on which they could draw prior understanding and knowledge to make sense of the task prompts. Other students said that the addition of a context made the task more convoluted and regarded the inclusion of a context as a hindrance rather than a support. When students mentioned individual contexts that lowered their perceived difficulty, they tended to mention the contexts of tasks that they had the most familiarity with or that they found the most relevant such as the use of Instagram in the Pic Me! Students tended to say that the context increased their perceived difficulty of the task when they either found the task to be non-relevant, or when they did not have sufficient experience with the contexts to leverage it for increased understanding. Research that supports the inclusion of contexts emphasizes relevance to the students' experiences on which students can draw as a supporting structure to reason about the math (Ridlon, 2009; Walkington, 2012; Schukajlow et al., 2012; Palm, 2008).

My results show that the students are not always able to leverage the contexts as a support, especially when they do not have sufficient prior knowledge or experiences with the included contexts. Furthermore, multiple students had opposing reactions to the same context, some thinking a specific context made a task harder, while another student thought the same context made the task easier. This is important to recognize since it means that generalizations cannot be made about how contexts, in general, affect accessibility, instead, it depends on the individual students' experiences with, and connection to the included contexts.

Perceived Difficulty and Opportunity to Justify

There were two ways in which students explained that their reaction to the opportunity to justify was influenced by their perceived difficulty of the task prompt. In all cases, the students indicated that the prompts that allowed them to justify their answers reduced their perceived difficulty of the task prompt. One way was because they were able to draw on their previous experiences and share their own individual thoughts and ideas, which they already held, to formulate their answers. The second way was that the students explained that the lack of requirement to perform any additional mathematical processes to formulate their answers made it easier.

The first way, drawing on personal experiences and beliefs, supports the research on justification, with the supports for students to draw on additional knowledge in their efforts to make sense of the mathematical concepts (Mueller et al., 2011; Cobb & Yackel, 1998). The second way is important to explore because it indicated that the students may not have recognized the connection between the justification and the mathematical concepts on which the task was based. Instead, they may have thought that the prompt was easier because they did not have to perform additional mathematical processes. In this way, the students may not have been recognizing that the use of justification is "a means to learn and do mathematics" (Staples et al., 2012, p. 447). Exploring this explanation further could help unpack how to help students make deeper connections between the opportunity to justify answers as it relates to the accessibility and understanding of the underlying mathematical concepts they are intended to support.

Perceived Difficulty and Graph Interpretation

All students who mentioned how a reaction to graph interpretation was connected to their perceptions of difficulty indicated that they recognized that the graphical representations were intended to facilitate the construction of their answers. This supports research on the importance of multiple representations for understanding (van Garderen et al., 2021; Krawec, 2014; Van Meter et al. 2020). Generally, students recognized that the visual representation was a source of data. In most cases, the students said prompts that required them to interpret the data from a graph reduced their perceived difficulty of the task. It is important to note that the students who said that a graphical representation made a task part harder, all indicated ways in which a particular visual representation could have been made clearer, or easier to use. This demonstrated that the students recognized the utility of the graphical representation when determining answers, but that inclusion of a graph is not enough; it is equally important that the representations clearly indicate the data that is required if they are to support accessibility of a task. This conclusion aligns with Ioannidis's (2018) assertion that for a visual representation to be beneficial it has to be effective, that is, the person interpreting it has to be able to comprehensively understand what is being communicated through the representation.

Perceived Difficulty and Mathematical Topic

Generally, students indicated a negative reaction to mathematical topics they had struggled with in the past, and a positive reaction to topics they had previous success with. However, it is interesting to note that there were some students who reacted negatively to a topic they had previous success with because they did not like how easy it made the task or task part. There were also students that mentioned that an unfamiliar topic increased the perceived difficulty of a task, but they reacted positively because they wanted to learn how to answer the prompt. This aligns with novelty as a trigger of interest for students (Renninger & Bachrach, 2015). Given this, it cannot be presumed that students with low situational interest in math are always satisfied with easy tasks. Some of the students appreciated being provided with the opportunity to be challenged, or desired increased difficulty of something they perceived was easy.

Contributions to Research on Triggering Interest Through Mathematics Tasks

My study supports and extends previous research that showed that including design elements in tasks that incorporate "novelty," "meaningfulness," or "challenge" (Renninger et al., 2019, p. 5) can trigger student interest. As some examples, referring to the cases I presented in the previous chapter, Diondre's consistent preference for the business-oriented context in which the Wage War task was embedded indicated that the specific context was *meaningful* to him. Similarly, Arthur found it *meaningful* to have the opportunity to share his opinion and experiences to justify his solutions. Khalil, in opposition to Callie's primary preference for ease, indicated that he preferred *challenge*, and, based on his explanations, the task parts that challenged him may have triggered his interest. With reference to my results for research question 1, there were seven task occurrences where students explained a positive reaction to an unfamiliar mathematical topic. This preference can represent how *novelty* may have triggered the interest of those students. These examples are a representative sample of the students' reactions to task aspects that support research that indicates that novelty, meaningfulness, or challenge can trigger interest.

Importance of Student Voice in the Study Design

The reactions students had to the task aspects, and the explanations they provided for those reactions, were presented in this dissertation in their own words. I designed my study with four focus tasks that included three task features, and one comparison task that was absent of those features, but the students were not prompted to attend to any of the features. Even without directing their attention to them, all three features were mentioned by the students in multiple task occurrences. The students were also not aware that my study was investigating how the features and other aspects of the tasks could influence their interest, yet students still described ways in which this occurred. This is important because it means that, as I conjectured, students can attend to certain task features that are intended to trigger interest. Furthermore, they also attended to and reacted to other aspects that were not intentionally included to trigger their interest. When they attended to the features and aspects, they voiced their reactions to them as they related to triggering or deactivating their interest without external guidance directing their attention to these purposes.

Contributions of the Study Design to Research on Interest

I designed the methods I used for data collection in a way that addressed some of the limitations faced in previous research on student interest. Some previous studies on interest relied primarily on data collected in post intervention interviews (e.g., Ridlon, 2009) which rely on students reflecting about their interest after the fact or surveys (e.g., Schukajlow et al., 2012, Frenzel et al., 2010) which are both after the fact, and their responses are limited by the answer choices. Other studies relied on observation of students (e.g., Renninger & Bachrach, 2015) which provides in-the-moment data but may not be able to discern the reasons for the observed students' actions. I designed my study in a way that captured open-ended, in-the-moment data that allowed the students to explain their reasons for their reactions.

My study also provided frequent and varied opportunities for the students to provide explanations about their experiences. The only part of my study that limited their range of responses was the survey I used to recruit students for the interviews. During the interviews, the students were invited to say what they were experiencing at any time, with specific prompts being provided at structured times. I asked specific questions before the task, after each task part, after each task, and after all tasks were completed, to which the students' responses could include any mention of any of the tasks. I did not tell them to limit their responses to the current task, which gave them the opportunity to compare their experiences with different tasks, which provided me with a rich explanation for their reactions. The use of the indicator tool after each task part also elicited reflections by the students that they may not have had if they had not been asked to continually evaluate their desire to solve the task and their enjoyment level. This process addressed concerns stated in previous literature that students may not recognize when or if their interest had been triggered or suppressed (Renninger & Su, 2012). The structure of my data collection process allowed me to collect rich and nuanced data about students' interest that was in-the-moment and did not rely on assumptions about their observable reactions.

Implications for High School Classroom Mathematics Teachers

High school classroom mathematics teachers can use the results of my study to inform their practice in ways that could improve the experience for their students who have identified as having low situational interest in math. Three specific areas of teaching that are informed by my results are 1. selecting tasks, 2. launching tasks, and 3. the importance of listening to students' voices. Recognizing that there is a lot of variety to the ways in which these reacted to mathematical tasks can improve or refine the criteria teachers use to select the tasks that they provide to their students. Understanding that these students generally appreciated the inclusion of a real-life context in which to embed the math tasks, it is important to be aware that the students need to be able to understand the context in order to leverage it for understanding the mathematical concepts, which is something that can be addressed while launching the task. Finally, recognizing and respecting what the students were able to tell us about their own experiences highlights that teachers can learn about their own students by listening to them as individuals. Incorporating these three elements, teachers can potentially increase the likelihood of triggering interest, or supporting higher levels of situational interest in math for students who identify as initially having low situational interest.

Task selection

The tasks that teachers select to provide to their students in their classroom can influence students' experiences in the class (Stein & Lane, 1996). My results showed that there were many different ways in which students reporting low situational interest reacted to a variety of tasks, especially with regards to context and perceived difficulty. The students did not have a consensus reaction to any of the tasks, demonstrating the need to provide students with a variety of tasks when attempting to include more students' preferences within the classroom. The inclusion of a wider variety of tasks can lead to increasing students' positive reactions to tasks which can lead to triggered or increased interest.

When I investigated the students' reactions to context, there was variation in whether or not students preferred tasks that were situated in a context, and there was a variation in reactions to specific contexts. Students like Diondre, who would react positively to the general inclusion of contexts in tasks, may not appreciate or react as positively to a specific context, like Diondre's negative reaction to the context of the Financial Aid task. Meanwhile, students like Janelle, who would generally prefer context-less tasks, may appreciate, or react positively to a specific context, like Janelle and the context of the Pic Me! task. For all four focus tasks, there were students who thought the specific context was relevant and/or enjoyable, and others who thought the opposite. Given this data, teachers could decide to provide their classes with tasks that include a variety of different contexts, as well as tasks that are not situated within a context.

With regards to the students' perceived difficulty, it was not surprising that the students generally preferred ease, but it is important to emphasize that there were students who indicated that they preferred more challenge. Multiple students mentioned a preference for a challenge at least once, either by reacting negatively to an easy task, or positively to a task that provided them with a challenge or the opportunity to learn something new. While all students mentioned a preference for ease in at least three task occurrences, very few reflected Callie's consistent and frequent attention to a preference for ease at the near exclusion of the other four aspects. Furthermore, all students, including Callie, mentioned reactions to aspects that were not exclusively attributed to difficulty. These results suggest that teachers should provide students with tasks with various levels of difficulty, and provide support through their struggles, not reduce the level of challenge, to trigger or support students' interest.

Prior research in schools with underserved populations have shown both how teachers can support student struggles, as well as how providing them with the opportunity to engage deeply with challenging, high-cognitive demand tasks can increase their interest in mathematics. Through work with the QUASAR Project, Henningsen and Stein (1997) found that teachers can support students through struggles by avoiding providing the students with explanations on how to overcome a challenging aspect of a task, and instead encourage them to try a new approach, or have them focus on the meaning of their solution, de-emphasizing the importance of a correct answer. In classrooms where these practices occurred, the students' mathematical achievements were increased more than in classrooms where the cognitive demand was decreased. As interest and achievement are linked, it is possible that the students' interest was also increased, although the studies did not explore this connection. Boaler and Sellings (2017) found that students who were provided with mathematical tasks that required problem solving and whose teachers did not guide them to a specific method or solving approach reflected more positively on both their experiences and its relevance to their adult lives than their counterparts who did not engage with the same style of tasks. These findings should be encouraging to teachers and increase their willingness to give students more challenging tasks and support their struggle as they solve them.

Supporting Students Whose Interest is Not Triggered by a Feature

My findings showed that no two students reacted in the same way to all of the tasks or all of the task aspects. This means that regardless of the selected tasks, prompts, or included context (or lack thereof), there can be students who need additional support to encourage triggering or support of interest. For students like Janelle, who generally do not appreciate tasks with included contexts, teachers may decide to spend more time with them to ensure they understand the contexts and can leverage that to attend more to the included math. For students like Diondre, teachers may try to encourage him to think of a context in which the math can be situated, even if it is not immediately presented with the task. Students who prefer ease over difficulty may require more scaffolding to provide them with access to the task, along with assurance they will also be provided tasks that they may find easier for them in the future. Students who prefer a challenge can be provided with opportunities to extend their thinking in ways that are either included in the prompt, or provided to individual students.

Based on my findings, it is not reasonable to expect that all students will have their interest triggered or supported by the same features or aspects. In addition to the suggestions above, it can also be beneficial to the students to explain why certain aspects or features are included. If students are told that contexts are included to help support their ability to grapple with the quantities and make sense of the mathematical concepts, they may be more willing to approach contextual tasks with an open mind. Similarly, telling them that the opportunity to justify gives them additional ways through which to demonstrate their mathematical understanding, they may see the importance of those prompts and how they are related to mathematical reasoning.

Task Launching

The way I designed my study demonstrated how the students interpreted each context in different ways, and the differences in their depth of understanding about each context. While all the students were very familiar with Instagram for the Pic Me! task, some students had less familiarity and understanding with some of the other contexts. For example, Janelle struggled to understand the supply and demand for employees that a company would need in the Wage War task, and Diondre did not have much background knowledge or understanding about the financial requirements for higher education in the Financial Aid task. Because of this lack of understanding about the underlying contexts, both students struggled with the difficulty of the tasks since they were not able to leverage the contexts to help them understand the underlying mathematical concepts that the task addressed.

My results supported the idea that students' familiarity with specific contexts may vary and "it is unlikely that all students will be equally familiar with the scenario described in a task statement (Jackson et al., 2013, p. 648)." To address this discrepancy in student understanding, it is important that the teachers ensure that all students have a shared understanding of the context prior to engaging with solving the task. This can be done effectively when launching the task by facilitating a class discussion to elicit what the students already know about the context and guiding them toward figuring out how the context can support the mathematical ideas of the task (Jackson et al., 2012). A shared understanding of the context is important so the students will all be able to leverage the context to support their approach to the mathematical concepts of the task.

Student Voice

The results from my study came from listening to what the students said influenced their reactions to the tasks. There is value in understanding students as individuals, demonstrated by my results which showed that each of the 11 students mentioned different reactions and different reasons for those reactions. I provided the students a setting in which they felt comfortable sharing their thoughts, or I would not have been able to elicit the detailed responses they provided. Throughout all the interviews, the students willingly shared their honest thoughts and opinions about math and the math tasks. This willingness indicated that the students felt they were being listened to, and that they believed me when I said that I was interested in what they said because it was important. If the students did not trust that I valued their voices, they likely would not have been as forthcoming or honest in their responses.

Classroom teachers can provide opportunities for students to share their experiences, preferences, and suggestions in ways that do not require spending the amount of time I was able to have with each student. Short amounts of time can be set aside to have meetings with students, either individually or in groups, and prompting them in ways to elicit feedback about their experiences. Furthermore, teachers can provide students as a class with written questionnaires or surveys and providing them class time to complete it. Both the meetings and the questionnaires can involve structured questions with a limited range of responses, or more open-ended questions or sentence starters that can elicit a response with more explanation about their reactions (Demetriou, 2009). Demetriou also suggests that student diaries in which students can reflect on their classroom experiences, can also be a useful way for teachers to gain insight about the students' experiences. The teachers can then follow up with individual students if they want someone to expand on their entry or ask for clarification. Discussion groups can be another useful tool to elicit student voice as the students can build on each other's responses (Cushman et al., 2009). Regardless of the method a teacher uses, it is important that the teacher uses the feedback in meaningful ways, so the students feel valued for providing their feedback (Cook-Sather, 2009). Empowering students to share their experiences in their own words, and then acknowledging and responding to their feedback, can improve the students' experiences in the classroom, which could lead to more interest in math as a subject.

Limitations of the Study

One limitation of my study is the low number of participants that I interviewed. In order to spend the amount of time that was necessary to gather detailed data from each student, I had to limit the number of participants. This prevented me from making generalizations about my results. On my own, and given the time constraints I had for data collection, it was not feasible to interview more students while still providing them with sufficient time to solve the tasks and share their reactions. Following the methods of my study, a team of researchers could conduct the study in multiple places which could result in a larger number of participants. If enough students were interviewed, it may be possible to explore generalizations about trends in the results as they relate to different student characteristics such as gender or ethnicity.

Another limitation of my study is the reliance on self-report for recruitment purposes and for data collection. When the students filled out the survey that I used as a recruitment tool, it is possible that some students did not feel comfortable enough to answer the questions honestly. Some students may have selected answers that inflated their actual level of situational interest in math by selecting answers that they presumed would be more desirable to me as a math educator. This could also have occurred in reverse, with some students rating their situational interest lower than it actually was, possibly because of societal support towards disliking math as a subject. Both of these reactions could be due to social desirability bias which is when "subjects change their [responses] for impression management (to look better to others), self-deception (to feel good about themselves), or identity definition" (Larson, 2019, p. 534).

The use of interview data also has disadvantages and limitations. Social desirability bias may have also occurred during the interviews, with the students either expressing something they thought I wanted to hear or withholding something they experienced because they thought I would not want to hear it. Furthermore, by nature of an interview, the students were not anonymous to me, and they may have altered their responses, withheld reactions, or provided alternate explanations for their reactions in response to feelings of discomfort or vulnerability (Corbin & Morse, 2003). This was especially likely when the students encountered task or task prompt with which they struggled. For my study, it was important to me to collect data that was in the students' own words and own voice, which required me to collect self-reported data. The benefits that I got in the form of rich authentic descriptions and reactions outweighed the disadvantages that necessarily come with interview data.

Future Research

This study was an exploratory study investigating the reactions that students have to multiple math tasks and there were three intentional choices I made when designing my study that, if changed, could expand on the results I obtained. First, I chose to specifically recruit students who report having low situational interest in math. Second, the focus tasks I opted to use were intentionally selected to include the task features of context, opportunity to justify, and graph interpretation, and I designed the comparison task to represent the mathematical topics that were included in the focus tasks. Finally, I chose not to analyze the students' mathematical answers to the task parts in any capacity for this study.

Levels of Students' Reported Situational Interest in Math

I focused my study on better understanding the experiences of students who reported having low situational interest in math and, based on the survey results, this population represented less than a quarter of the total number of students in the course. It then follows that a future study could investigate reactions of students with different reported levels of situational interest. For example, to investigate how students with high reported levels of situational interest in math react to mathematical tasks, a future study could recruit students who scored higher than a 40.5 (90%) on the recruitment survey. A study that gathers data from students on the other end of the spectrum of situational interest could provide insight into the similarities and differences between the students' reactions. Since most classrooms are comprised of students with all levels of situational interest in math, understanding different students' reactions to tasks would provide more information about the nuances of how students experience tasks and how that may or may not be influenced by their situational interest in the subject.

Study Task Selection

Another possibility for future research would be to select tasks using a different procedure or different resource than I did for my study. The focus tasks that I selected came from a resource that was intended to supplement a comprehensive classroom curriculum. Future research could select tasks from a widely used published curriculum. Results from a study using tasks from a single curriculum could inform decisions around how a task or curriculum might be altered to improve the student experience. Results from a study using tasks from multiple comprehensive curricula could inform decisions made by school districts about which curriculum they would want to adopt in their districts. Regardless of how the focus tasks are selected, future research should still include a comparison task that would contrast with the focus tasks. The inclusion of the comparison task provides the students with a concrete and contrasting example on which they can draw to refine their explanations for their reactions.

Analysis of Students Written and Verbal Mathematical Processes

Future research could also explore connections between the students' mathematical processes that they used to answer the task parts and their reactions to the prompts. Glancing at the student work, I noticed that some of the students who provided detailed responses during their interviews had minimal work or writing on their paper tasks. Systematic analysis of the students' interview responses and their mathematical answers may inform both research and teachers about the differences between what we can and cannot observe about a students' experience from their written work.

I also opted not to evaluate the correctness of the students' answers at any time, while future research could analyze students' perceptions about their performance and reactions with their evaluated performance. For example, while Callie claimed that she "knew what to do" on some task parts, I did not verify whether she performed the mathematical processes correctly. The students do not need to be made aware that their math performance will be analyzed as that may inadvertently focus their reactions to the task on success of completion. After the interview process is over, connections between students' perceived performance and actual performance on the tasks can be explored. These connections can provide insight into how closely the students' self-perceptions about their mathematical capabilities align with their performance.

Conclusion

The contributions that my study made to both research and practice came from the design of the study itself. To start with, I intentionally recruited participants from a population of students that self-identified as having low situational interest in mathematics. Furthermore, I recruited student participants from a school with a predominantly marginalized population, a population that research has suggested historically under-performs when compared to their non-marginalized peers. From that population, I chose to recruit students who were considered low achieving by the school, as indicated by their course placement. I then gave those students a platform with which they could share their own experiences with mathematical tasks in their own words.

Each student had the opportunity to interact with and solve four rich mathematical tasks and an additional contrasting mathematics task while sharing their reactions and the reasons they had for their reactions. I gave the students the chance to reflect on their experience with the task, listened to and recorded what they had to say and did not guide their attention to a particular feature. As such, nuances were revealed in how students attended to the features that are included in task designs to trigger student interest in tasks. This was especially true for context as a task feature with students indicating opposing reactions to the same contexts as well as reactions to contexts in similar ways but with different explanations provided for their reactions.

With regards to perceived difficulty, it is not surprising that many people in the field of math education, both researchers and classroom teachers, believe that students generally attend to and prefer ease in school mathematics tasks. This was true in my study as well, as all of the students did indicate, multiple times, a preference for ease. However, the students I interviewed demonstrated that they also attended to and had positive reactions to other task aspects, including all three of the task features of the focus tasks, context, opportunity to justify, and graph interpretation in a wide variety of different ways. Overall, my results contribute to the field a better understanding of how low-achieving students with low situational interest in math experience math tasks and task aspects, in the students' own voices.

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Appendix A

STUDENT-FACING INTEREST SURVEY

Name: ______________________

Please answer each question using the following scale:

5-Strongly Agree
4-Agree
3-Slightly Agree
2-Slightly Disagree
1-Disagree
0-Strongly Disagree

For the first 4 questions, think about how you felt about mathematics before the school year began.

1. I think mathematics is very interesting

5	**4**	**3**	**2**	**1**	**0**

2. Mathematics fascinates me

5	**4**	**3**	**2**	**1**	**0**

3. I'm excited about mathematics

5	**4**	**3**	**2**	**1**	**0**

4. I think what we are learning in this class is important

5	**4**	**3**	**2**	**1**	**0**

5. I think what we are studying in mathematics is useful for me to know

5	4	3	2	1	0

6. I think mathematics is an important subject

5	4	3	2	1	0

7. To be honest, I just don't find mathematics interesting

5	4	3	2	1	0

8. I find the content of this class to be personally meaningful

5	4	3	2	1	0

9. I see how I can apply what we are learning to real life

5	4	3	2	1	0

The following two questions will be used for demographic purposes

Gender Identity: ___________________________

Ethnic Identity: ____________________________

Appendix B

DATELINES TASK

DATELINES

What's an acceptable dating range?

name

date

Act One: The Dating Game

1 To determine the age of the youngest person you can date, some people recommend using the formula **half-plus-seven**: *start with your own age, take half of it, and add seven years*.

Use this to fill in the table below. Does half-plus-seven make sense for all ages? Explain.

Age, Older Person	80	50		30		12	10	
Age, Younger Person			30		15			10

2 Let a represent your age and d that of your date. Write an equation for the age of the **youngest person** you can date, and graph it. Then, does this show *all the ages* you can date? If not, how could you modify the equation?

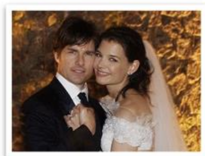
3 Now write an equation for the age of the **oldest person** you can date, and modify it to be more inclusive.

4 Finally, shade in the **total acceptable dating region**. What do you notice about its shape, and what does it suggest about your dating prospects as you get older? Explain.

Act Two: The Waiting Game

5 The celebrity couples below had significant age gaps on their wedding days. Was every couple inside the half-plus-seven "**Romance Cone**?" If not, how many years would they need to wait until they entered the "RoCo?"

Mariah Carey: 38
Nick Cannon: 27

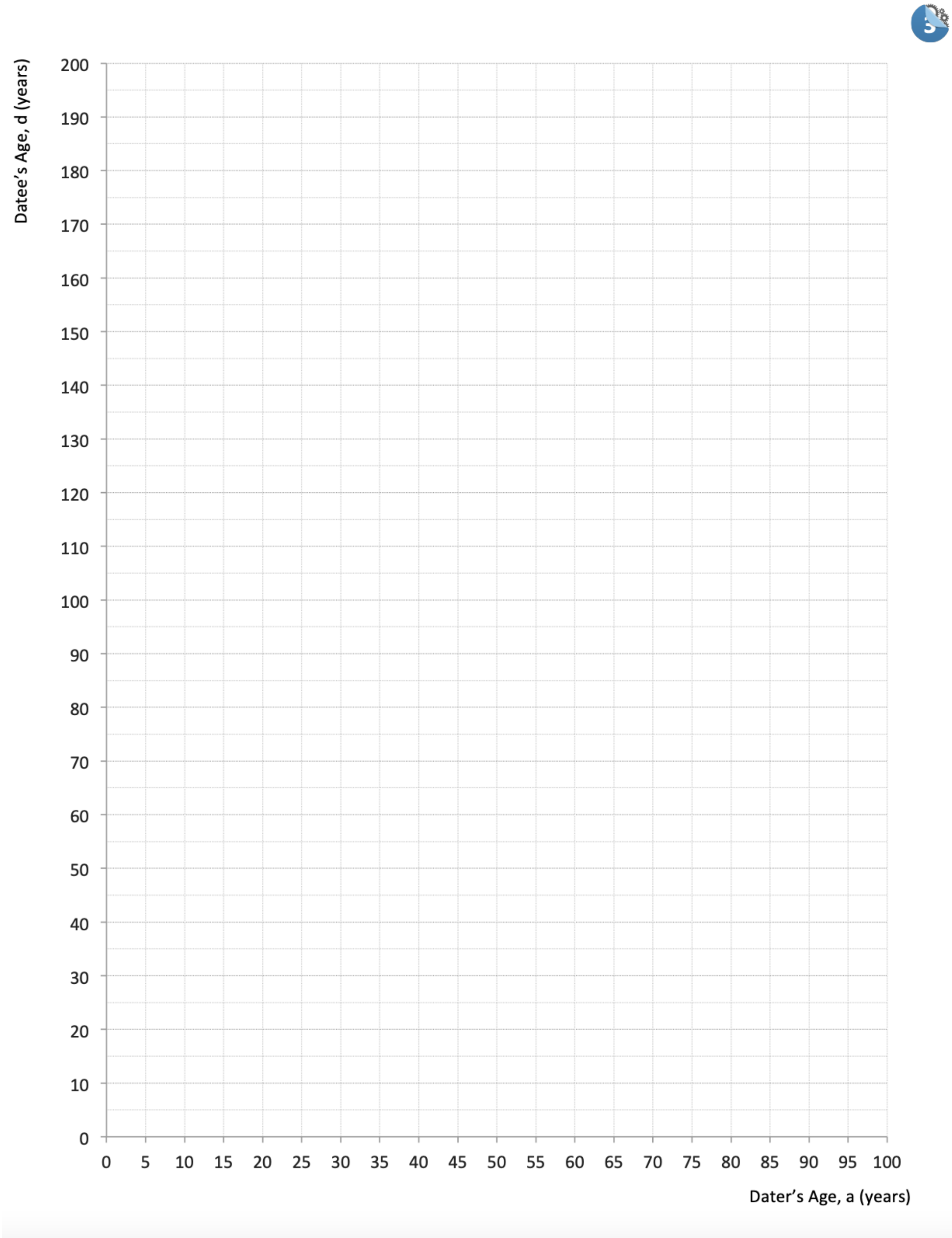


Tom Cruise: 44
Katie Holmes: 28

Brian Austin Green: 37
Megan Fox: 24

Clint Eastwood: 65
Dina Ruiz: 30

6 Finally, once someone is inside your RoCo, will (s)he ever be outside of it again? Explain your reasoning.


Datee's Age, d (years)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Dater's Age, a (years)

Appendix C

FINANCIAL AID TASK

FINANCIAL AID

Is college worth the cost?

name

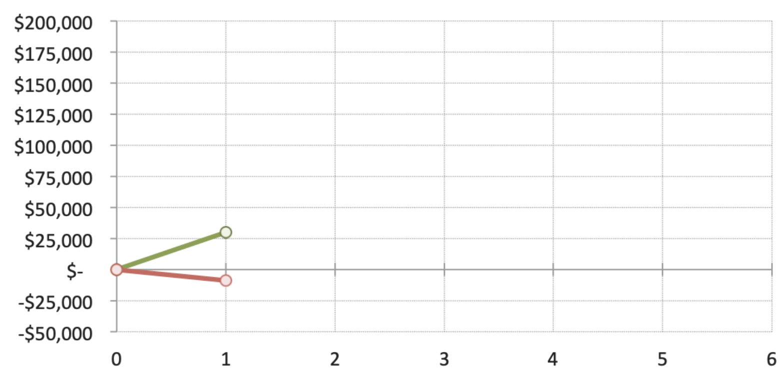
date

Act One: Commence(ment?)

1 When you graduate from high school, you can enter the workforce or go to college. According to the National Center for Educational Statistics, the median income for someone with a **high school diploma** is $30,000/year, and $47,000/year for someone with a **bachelor's degree**. A bachelor's degree typically requires four years of college, and a year of college – tuition and expenses – costs $8,800 on average in the United States.

For each option, calculate and graph the net income – total income minus costs – in the years after high school.

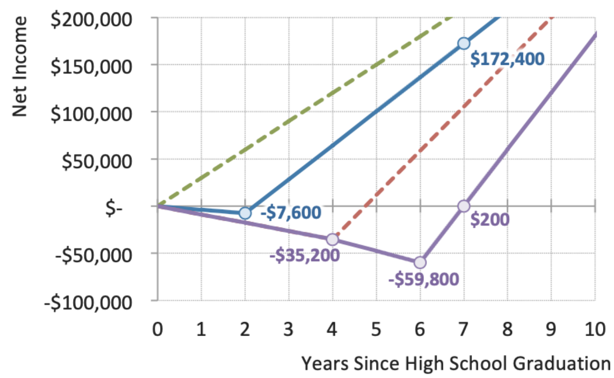
	Net Income Since High School Graduation						
	0 years	1 year	2 years	3 years	4 years	5 years	6 years
High School Diploma	$0	$30,000					
Bachelor's Degree	$0	-$8,800					



2 Imagine an 18 year-old high school senior is debating whether to take a job after graduation or to go to college. How many years would it take until each option resulted in the same net income, and how old would she be at this point? Based on this, do you think it would be a smart decision for her to attend college? Explain.

Act Two: Cap & Gown

3 Students who opt for college have another decision to make: which degree to pursue. In addition to a **bachelor's degree**, the graph below shows the net incomes for two additional degrees: an **associate's degree** and a **master's degree**. For each, determine the annual tuition and expenses, as well as the median annual income.

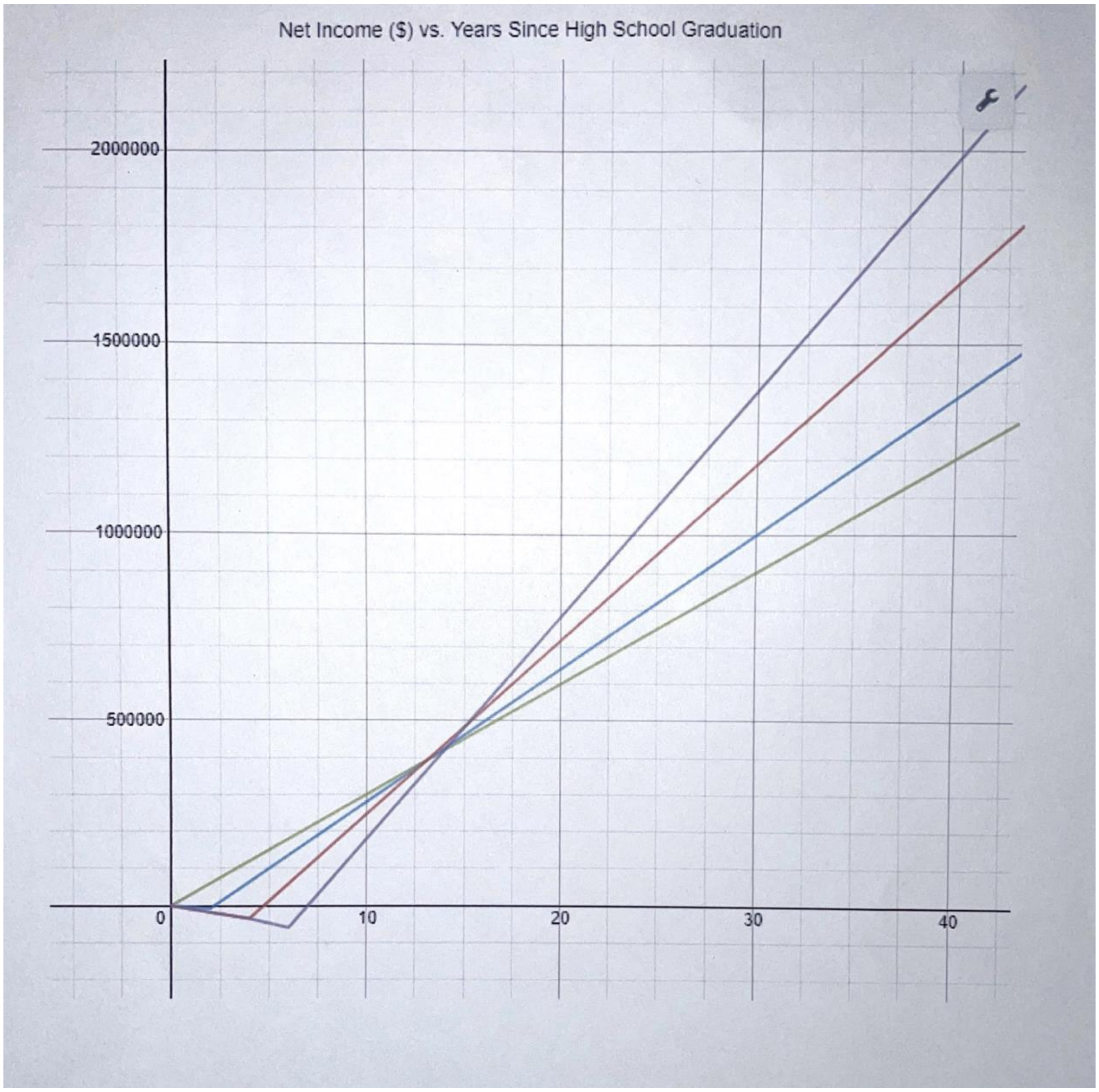


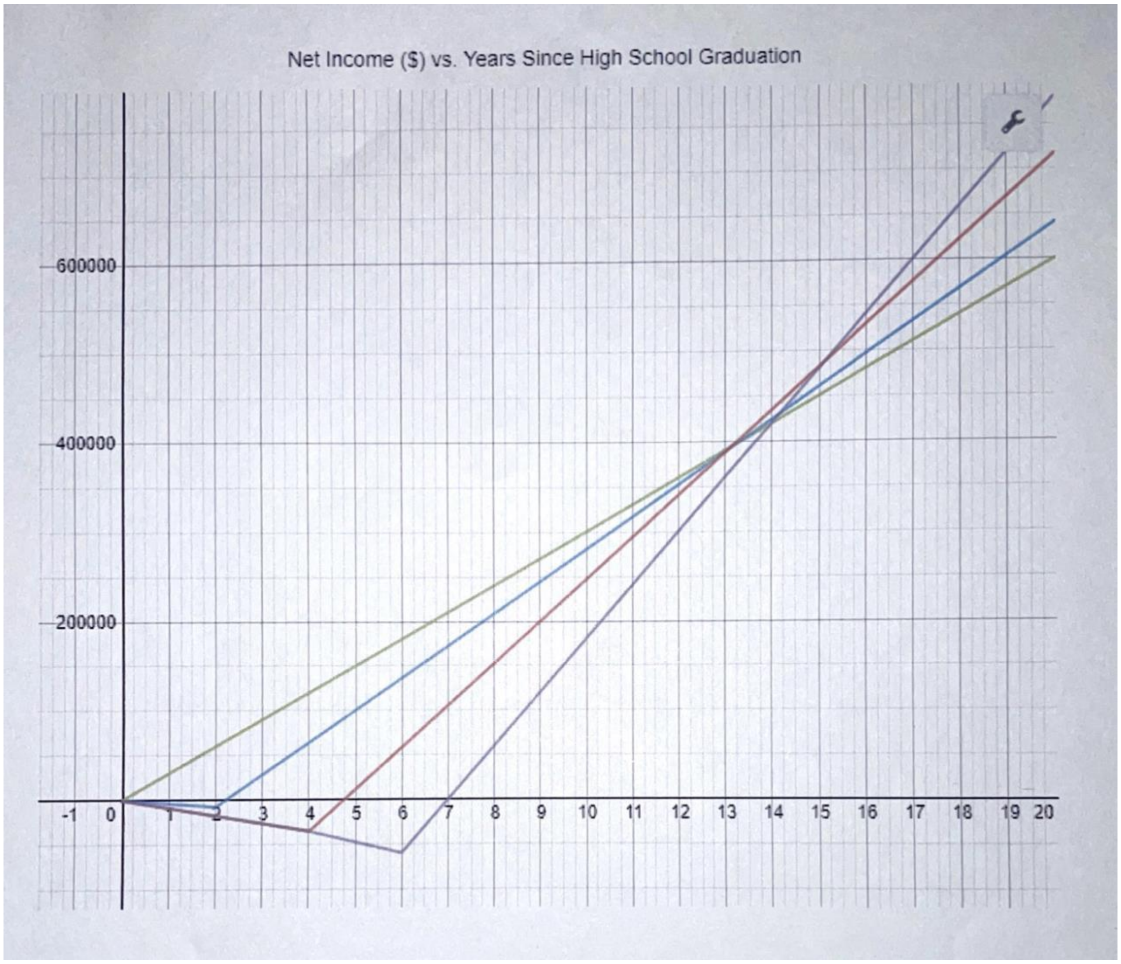
4 Imagine three high school seniors are debating which degree to pursue. For each choice, determine how old they would be when each educational path yielded the same net income. Then, if workers retire at 65 years old, what would be the expected lifetime net income for each option?

	Associate's vs. Diploma	Bachelor's vs. Associate's	Master's vs. Bachelor's
Age when Paid Off			

	Diploma	Associate's	Bachelor's	Master's
Lifetime Net Income				

5 In reality, how much you earn depends not just on what degree you have, but also what you studied. The average starting salary for someone with a bachelor's degree in petroleum engineering is $98,000, and $33,100 for someone with a bachelor's degree in social work. When deciding what to study (and for how long), how important do you think average income is, and do you think it's the most important factor? Explain.


Net Income ($) vs. Years Since High School Graduation
2000000
1500000
1000000
500000
0
10
20
30
40


Net Income ($) vs. Years Since High School Graduation
600000
400000
200000
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Appendix D

PIC ME! TASK

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PIC ME!

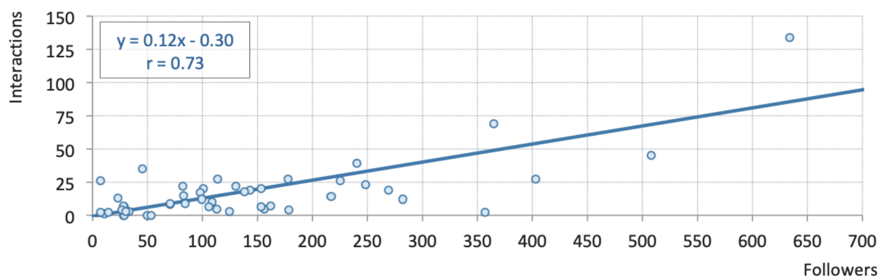
How can you become popular on Instagram?

name

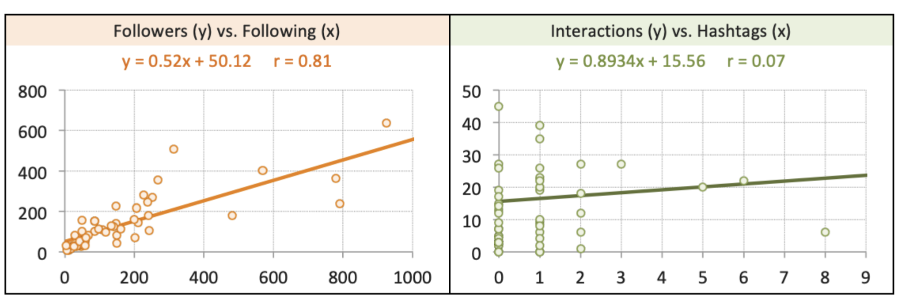
date

Act One: #PopularityContest

1 People who post photos on Instagram often want them to be popular. A group of users shared information about their most recent images. According to the line of best fit, how do additional followers affect the number of interactions (likes + comments), and do you think having more followers will make a picture more popular?



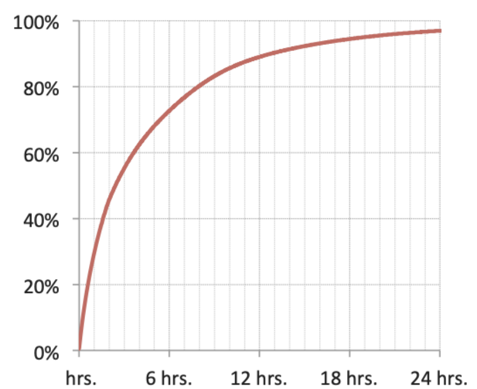
2 Different Instagram users have different strategies for making their pictures popular. Some try to gain followers by following *other* users, while others add #hashtags to their images. Based on the graphs below, which seems like a more effective strategy for getting people to interact with an image and why?



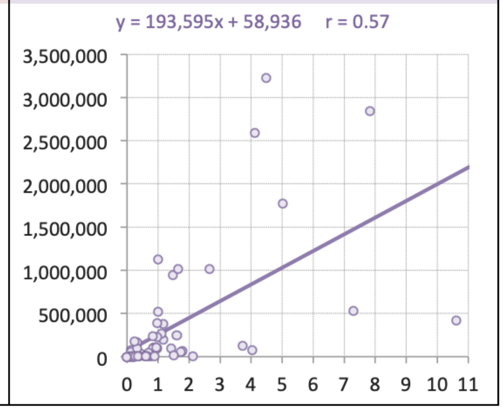
Act Two: Instametrics

3 Union Metrics is a company that analyzes Instagram data for major brands such as Nike and Urban Outfitters. The graph on the left shows the percent of total interactions that an average post received in its first 24 hours. The graph on the right shows the relationship between the total number of interactions a brand's Instagram feed received in a month and the number of images it posted on average each day.

Percent of Interactions (y) vs. Hours Since Post (x)



Total Monthly Interactions (y) vs. Avg. Posts/Day (x)



a. Does it appear that brands who post more frequently receive more comments and likes?	b. How often would you suggest that a brand post a new image to Instagram and why?

4 A 2014 *Business Insider* article reported that "Teens are spending thousands on prom so they can look cool on Instagram." Meanwhile, websites such as Buzzoid actually *sell* Instagram likes. How valuable do you think interactions are on Instagram, and what might be some consequences of trying to build a "personal brand?"

Appendix E

WAGE WAR TASK

WAGE WAR

How much should companies pay their employees?

name

date

Act One: Apply Here

1 Companies from McDonald's to Walmart rely on hourly workers to prepare food, work as cashiers, etc. Imagine a business opens in a new city and is hiring. The following table shows how many people would want to work at three different hourly wages (**supply**), and how many the company would want to hire (**demand**).

As the wage increases, how do the supply and demand change, and will the restaurant be able to hire as many workers as it wants at each hourly wage?

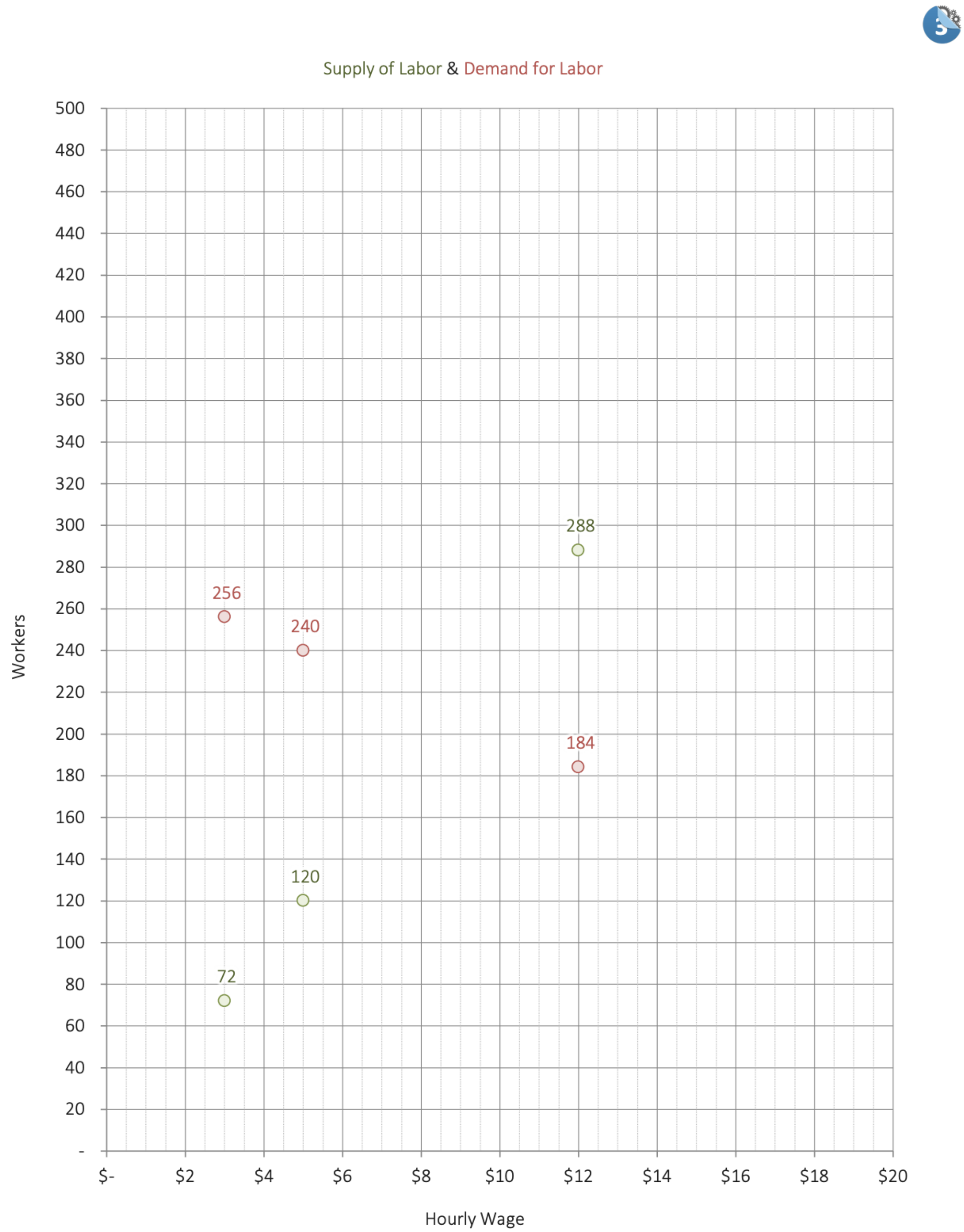
	$3/hour	$5/hour	$12/hour
Supply: # individuals who want job	72 people	120 people	288 people
Demand: # employees company wants to hire	256 people	240 people	184 people

2 In the United States, the federal **minimum wage** is $7.25/hour; this is the lowest amount an employer can legally pay its workers each hour. If the company only pays minimum wage, can it hire as many workers as it wants?

3 Find the lowest wage at which the restaurant will be able to attract as many employees as it wants. Do you think this is the amount the company should pay its employees? Why or why not?

Act Two: Raise the ~~Roof~~ Floor?

4 Millions of Americans work full-time at or near minimum wage. Still, many of them struggle to afford rent, childcare, and other expenses, and rely on public assistance programs such as food stamps and Medicaid. To help these "working poor," some people think the government should raise the minimum wage from $7.25/hour to $15/hour. If this happened, how do you expect it would impact workers at the business?

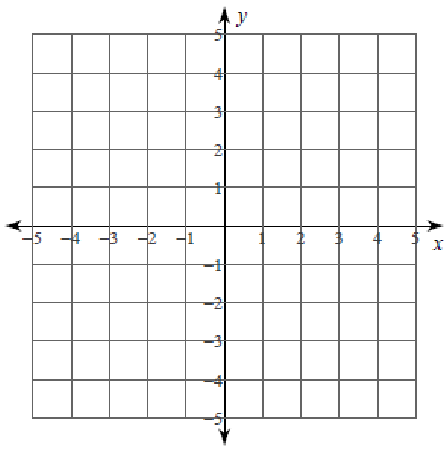

Supply of Labor & Demand for Labor
Workers
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
-
288
256
240
184
120
72
$-
$2
$4
$6
$8
$10
$12
$14
$16
$18
$20
Hourly Wage

Appendix F

COMPARISON TASK

1. Solve by Graphing

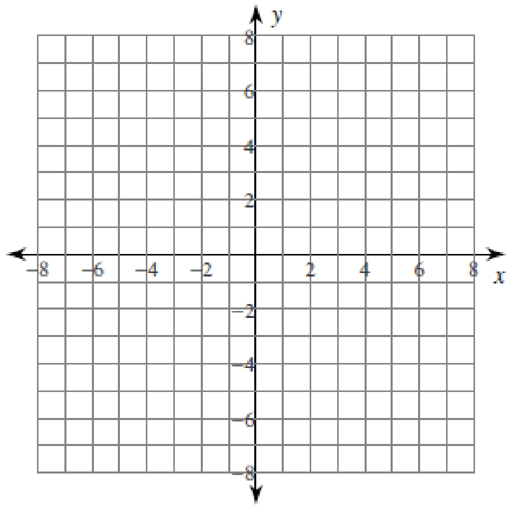
$$\begin{cases} y = -\frac{1}{2}x - 1 \\ y = \frac{1}{4}x - 4 \end{cases}$$



2. Solve by Graphing:

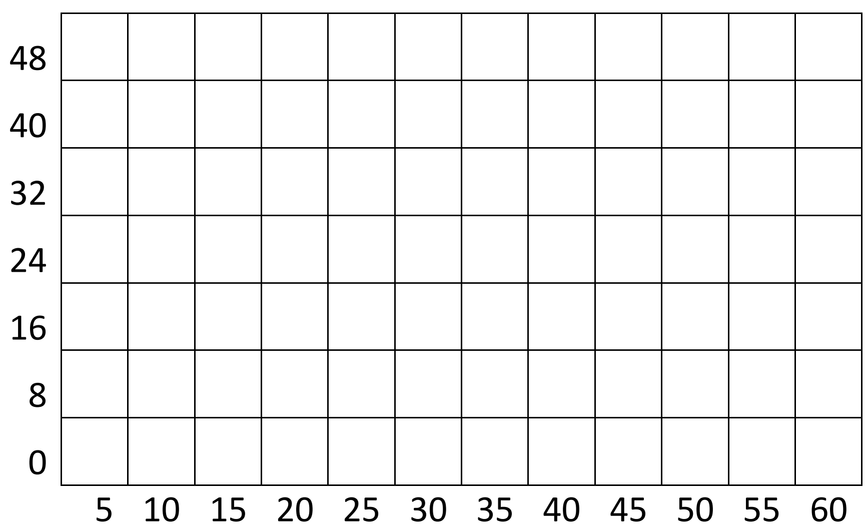
x	0	1	2
y	-2	0	2

x	7	5	-1
y	2	3	6

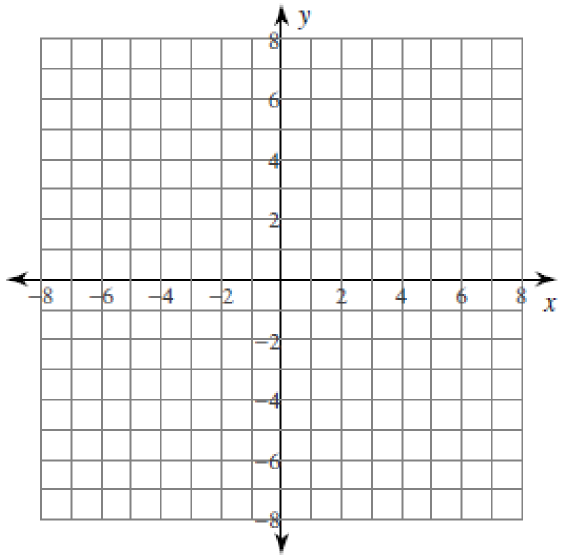


3. A) Make a scatterplot from the points in the table
   B) Draw a line of best fit
   C) Figure out the equation of your line
   D) Use your equation to predict the missing value

x	5	10	20	25	35	40	50
y	9	17	22	30	38	44	?

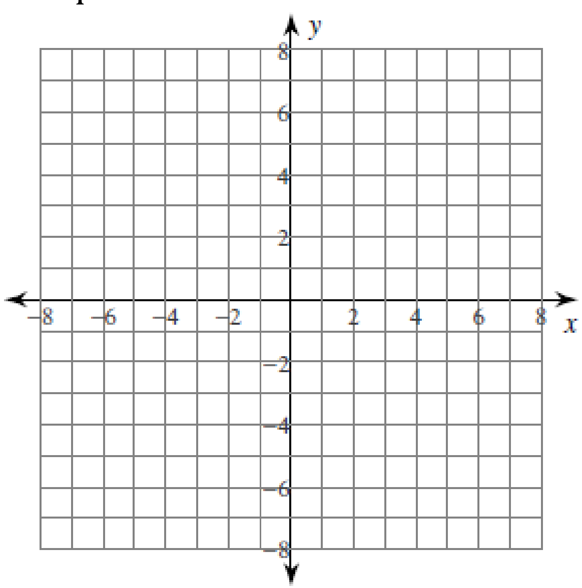


4. $y \leq \frac{4}{3}x - 4$



5. Graph the function, then find and graph the inverse

$$y = \frac{1}{4}x - 3$$



Appendix G

INITIAL INTERVIEW PROTOCOL

Thank you for being willing to participate in my research. As I mentioned when I talked to your class, I'm talking to you to collect data for my dissertation. My ultimate goal is to improve math classes for students in the future, and in order to do that, I need to know what current students think about their math classes and what they think can be improved. I'll be asking you some general questions today, and then I'll be asking you to solve a variety of different math problems and having you tell me what you think about them. It is really important that you tell me what you think and feel, not try to guess what I want to hear. I'm not here to judge or grade your performance on the math tasks and nothing you say will be told to any of your teachers or administrators. If I use some of what you say in my writing or during presentations, I will use a pseudonym, a fake name, so no one will know it was you. Do you have any questions before we start?

I'm going to start with some general questions:

What math class are you taking in school right now?

Is the class optional or mandatory for graduation?

Why do you think math is a required class in high school?

Can you describe what happens in a typical class period in math?

What are some things that would make math class or math as a subject more interesting?

What makes some math topics more interesting to you than others?

What about those topics make them more interesting?

What math activities are more interesting to you than others?

What about those activities interests you?

When do you notice that you use math in school but not in math class?

When do you use the skills you learn in math class outside of the school setting?

Is there anything else you'd like to tell me about your experiences with math or math classes?

Thank you for your honesty. If at any time you remember something else, feel free to let me know.

Now I'm going to show you five math activities. These are the tasks that I will be asking you to solve during the rest of the interviews. I am not asking you to solve them now, I would like you to read through all five of the tasks (Make sure you look at the back of the pages) and order them by your level of interest in solving them. Again, please be honest about your order, there is no right or wrong way to place them. I will give you three minutes to sort them. [set watch for 3 minutes]

Great! Can you please explain why you put them in this order?

Prompting questions:

Why is this one first?

How did you decide to put this one before this one?

What made you put this one last?

Did you have any that were hard to decide where to put it?

Thank you so much for talking to me today

Appendix H

TASK INTERVIEW PROTOCOL

Thanks again for taking time out of your schedule to help me. Today I will be asking you to solve ____ math tasks and will be asking about your experience with those tasks. Neither your solutions nor your responses will be shared with your teacher, so you do not have to worry about your grade being affected. If at any point you need clarification about what a prompt is asking you, feel free to ask me and I'll share as much information as I can to help you continue solving the problem. While working on the problem, I want you to say as much as possible, since I can't record what your pushing into the calculator or thinking in your head, I'll only be able to record what you actually say and do. For that reason I may ask questions like "What are you thinking" if I notice you've paused or seem to be considering something.

For each task, during this session and the others, I will ask you to place these markers (show them the Checkers pieces) on these two scales. This one is "desire to solve" and means how much you want to work on the problem to get to a solution. This other one is "enjoyment" and indicates how much you are enjoying the experience. I will ask you to place the markers right after you read the question and then you may move the markers if you find that your ratings have changed after you complete each part of the task. If they haven't changed, you can leave the markers where they are. Do you have any questions?

Please read through the entire task first and let me know when you are done.

What is this task about?

What are some things you notice about the task?

What are your thoughts about this task before you start trying to answer it?

Which parts are you most/least looking forward to solving?

Please go ahead and place the markers and begin to solve the task.

[after each problem part, prompt the student about moving the markers]

Why did you put them there/keep them there?

[Once student completes task and moves the markers the last time, continue with protocol]

Have you seen a task like this one before?

(if yes) How often?

What part of this task caught your attention the most, good or bad? Why do you think that is?

What parts of the task did you least like? Why is that? What would have made it better for you?

What parts of the task did you like the most? Why did you like that?

If you could change the task at all, what would you change? How would those make the task better for you?

Thank you for those responses.

For the next tasks I will be asking you to follow the same directions and will be asking the same questions about your experience. Here is the second task, [Go back to “please read through the entire task and let me know when you are done”]

[After second and each subsequent task]

Here are the tasks you’ve completed so far. Can you please put them in the order that you most enjoyed or appreciated solving them?

Why did you put them in that order?

Thank you for your time and I will see you for our next session! Please make sure you are not sharing the tasks with your classmates.

Appendix I

FINAL INTERVIEW PROTOCOL

I have really enjoyed our time together and still appreciate your willingness to participate in my research. This is our last session together and I will be asking you questions about all the tasks I've had you solve.

The first thing I want you to do is rank all of the tasks in the order that you most appreciated actually solving to least appreciated, similar to what you did during the first session before you had the chance to solve them.

What helped you make the decision to put the tasks in this order?

Did you have difficulty making decisions about where to place any of the tasks?

What made that decision difficult to make?

What are the reasons that make you put these two tasks in the top two positions?

What about these two in the bottom two positions?

Is there anything else you would like me to know about your decision-making process during this sorting activity?

Now I am going to ask you to move the tasks around and put them in the order in which you thought they were the most difficult. So, the most difficult would be on top with the easiest task being last.

What made the _______ task particularly difficult for you?

What made the ______ task easier for you?

Tell me what you would tell your friends about each of the tasks.

Now that you have seen a variety of different types of math tasks, all of which can be completed in a school classroom, what types of tasks would you prefer to see in your math classroom? Why?

What did you find especially appealing about any of the tasks?

Is there anything else you would like me to understand about your experience with the tasks you solved?

What do you think I learned from your experience?

Once again, I would like to thank you for your time and insight. Your input is important in helping me and my colleagues understand how to make math class better for you.

Appendix J

IRB LETTER

UNIVERSITY OF DELAWARE

RESEARCH OFFICE

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DATE:	March 13, 2019
TO:	Laura Willoughby
FROM:	University of Delaware IRB
STUDY TITLE:	[1401900-1] Investigating Features of Mathematical Tasks and Their Influence on Secondary Students' Situational Interest
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	March 13, 2019
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # *(6,7)*

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.

Please note that all research records must be retained for a minimum of three years.