

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

by

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A dissertation submitted to the Faculty of the University of Delaware in partial
fulfillment of the requirements for the degree of Doctor of Philosophy in Education

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TABLE OF CONTENTS

LIST OF TABLES	xi
LIST OF FIGURES	xiv
ABSTRACT	xv

Chapter

1	INTRODUCTION	1
2	LITERATURE REVIEW	8
	Interest	9
	Student Interest and Academic Outcomes	10
	Student Interest in Math in High School	12
	Measuring Interest	13
	Four-Phase Model of Interest	16
	Triggered Situational Interest	17
	Triggering Interest Through Features in Math Tasks	19
	Inclusion of a Realistic Context	19
	Opportunity to Justify a Solution	26
	Visual Representations of Quantitative Data	30
	Student Voice	31
	Summary of the Ways in Which the Literature Informed the Study Design ...	32
3	METHODS	35
	Context of the Study	36
	Selecting the School and Teacher	36
	School, Teacher, Grade Level, and Course Selection	37
	Participant Selection	40
	Situational Interest Evaluation Tool	40

Survey Administration and Participant Selection.....	45
Data Collection.....	48
Task Selection	48
Four Focus Tasks.....	50
“Datelines” Task.....	53
“Financial Aid” Task.....	55
“Pic Me!” Task.....	58
“Wage War” Task.....	60
Comparison Task.....	63
Interview Process.....	66
Initial Interview	67
Task Interviews	69
Indicator Tool.....	70
Task Interview Procedure.....	72
Final Interview.....	77
Transcriptions and Recordings	78
Data Analysis.....	79
Preparing Transcripts for Code Assignment	80
Code Development and Assignment	82
First Cycle Coding.....	83
Revision of First Cycle Codes and Creation of New Codes	86
Revision of Context Code.....	87
Revision of Opportunity to Justify Code.....	88
Revision of Interpretation of Graphs Code.....	89
Development of Codes from Fourth First Cycle Code.....	90
Second Cycle Coding	93
Organization of Coded Chunks.....	93
Real-Life Context.....	94
Opportunity to Justify.....	104
Graph Interpretation.....	109

	Mathematical Topic.....	112
	Perceived Difficulty.....	118
	Assigning Codes to Task Occurrences	124
	Reliability	125
	Selecting Student Cases.....	129
	Coded Task Occurrences to Determine Cases.....	129
	Selecting Student Representatives for Cases.....	132
4	RESULTS: ASPECTS OF MATHEMATICAL TASKS THAT ELICIT POSITIVE OR NEGATIVE REACTIONS	135
	Student Reactions to Perceived Difficulty	139
	Preference for Less Difficulty	140
	Preference for Less Difficulty and a Reaction to a Featured Aspect .	141
	Context and a Preference for Less Difficulty.	141
	Graph Interpretation and a Preference for Less Difficulty.	142
	Opportunity to Justify and a Preference for Less Difficulty.	144
	Preference for Less Difficulty and Reaction to Mathematical Topic.	144
	Preference for Less Difficulty in Isolation	145
	Preference for More Challenge	148
	Concluding Stance.....	151
	Task Aspects Included as Features of the Focus Tasks.....	151
	Inclusion of a Real-World Context as an Intended Feature	152
	Evidence Supporting and Providing Nuance to Initial Conjecture	153
	Evidence Contradicting Initial Conjecture	157
	Concluding Stance.....	160
	Providing Students with the Opportunity to Justify as an Intended Feature	160
	Evidence Supporting and Providing Nuance to Initial Conjecture	161
	Evidence Contradicting Initial Conjecture	164
	Concluding Stance.....	166

	Requiring the Interpretation of Data Visually Represented in a Graph as an Intended Feature	167
	Evidence Supporting and Providing Nuance to Initial Conjecture	168
	Concluding Stance.....	171
	Student Reactions to Mathematical Topic.....	172
	Liking the Presence of a Familiar Topic or Disliking the Presence of an Unfamiliar Topic	174
	Disliking a Familiar Topic.....	179
	Liking an Unfamiliar Topic.....	180
	Concluding Stance.....	183
	Summary.....	183
5	RESULTS: CONSISTENT AND FREQUENT STUDENT REACTIONS TO TASK ASPECTS	185
	Case 1: Diondre’s Reactions to Context.....	187
	Diondre’s Reactions to the “Pic Me!” and “Wage War” Tasks	188
	Diondre’s Reactions to “Pic Me!”	189
	Initial Impressions of the Task	189
	Attention to Relevance in Task Parts 1, 2, and 3.....	191
	Conflicting Reactions to Task Part 4.....	193
	Diondre’s Reactions to “Wage War”	196
	Initial Impressions of the Task	197
	Continued Consistent Attention to Context.....	199
	Diondre’s Reaction to the “Datelines” and “Financial Aid” Tasks.....	203
	Diondre’s Reaction to “Datelines”	204
	Diondre’s Reaction to “Financial Aid”	207
	Janelle’s Contrasting Reaction to the Inclusion of Context	210
	Janelle’s Contrasting Reactions to Specific Contexts	213
	Takeaways from Diondre and Janelle	218
	Case 2: Arthur’s Reactions to the Opportunity to Justify in Tasks	219

Arthur's Reactions to the "Wage War" and "Pic Me!" Tasks.....	220
Arthur's Reactions to "Wage War"	221
Arthur's Reactions to "Pic Me!"	225
Reactions after Task Parts 1 and 4.	227
Reactions after Task Parts 2 and 3.	229
Arthur's Reactions to the "Datelines" and "Financial Aid" Tasks.....	232
Arthur's Reactions to "Datelines"	232
Arthur's Reactions to "Financial Aid"	234
Other Students' Contrasting Reactions	236
Takeaways from Arthur and the Other Students	238
Case 3: Callie's Preference for Ease in Tasks	239
Callie's Reactions to "Pic Me!"	240
Callie's Reactions to the Comparison Task.....	242
Callie's Reactions to "Datelines"	244
Callie's Reactions to the "Wage War" and "Financial Aid" Tasks.....	245
Khalil's Preference for Challenge	248
Khalil's Positive Reactions to Successful Struggle.....	249
Khalil's General Preference for Challenge.....	251
Takeaways from Callie and Khalil	253
6 DISCUSSION.....	255
Reactions to Task Features	255
Reactions to the Inclusion of a Realistic Context.....	256
Reactions to the Opportunity to Justify	258
Reactions to Graph Interpretation	260
Reactions to the Emergent Task Aspects	261
Students' Concurrent Reactions to Multiple Aspects.....	262
Explanations Including Context and Another Task Feature.....	262
Explanations Including Perceived Difficulty and Another Aspect	264
Perceived Difficulty and Context	264
Perceived Difficulty and Opportunity to Justify	265

Perceived Difficulty and Graph Interpretation	266
Perceived Difficulty and Mathematical Topic	267
Contributions to Research on Triggering Interest Through Mathematics	
Tasks	268
Importance of Student Voice in the Study Design	268
Contributions of the Study Design to Research on Interest	269
Implications for High School Classroom Mathematics Teachers	270
Task selection	271
Supporting Students Whose Interest is Not Triggered by a Feature	273
Task Launching	274
Student Voice	275
Limitations of the Study	276
Future Research	278
Levels of Students' Reported Situational Interest in Math	278
Study Task Selection	279
Analysis of Students Written and Verbal Mathematical Processes.....	280
Conclusion	280
REFERENCES	283
Appendix	
A STUDENT-FACING INTEREST SURVEY	292
B DATELINES TASK	294
C FINANCIAL AID TASK	297
D PIC ME! TASK	301
E WAGE WAR TASK	303
F COMPARISON TASK	306
G INITIAL INTERVIEW PROTOCOL	309
H TASK INTERVIEW PROTOCOL	311
I FINAL INTERVIEW PROTOCOL	314
J IRB LETTER.....	316

LIST OF TABLES

Table 3.1	Original Survey Questions from Linnenbrink-Garcia et al. (2010) Study 1 and Modified Survey Used for Recruitment Tool.....	41
Table 3.2	Student Participants for Interviews.....	47
Table 3.3	Titles, Context Descriptions, and Mathematical Topics Included for Focus Tasks and Comparison Task	50
Table 3.4	First Cycle Codes and Definitions	83
Table 3.5	Second Cycle Codes and Definitions	84
Table 3.6	Code Definitions for Context.....	88
Table 3.7	Code Definitions for Opportunity to Justify.....	89
Table 3.8	Code Definitions for Graph Interpretation	90
Table 3.9	Code Definitions for Mathematical Topic	91
Table 3.10	Code Definitions for Perceived Difficulty.....	92
Table 3.11	Interrater Reliability Percentages by Transcript	127
Table 4.1	Number of Task Occurrences in Which Each Aspect was Mentioned.	136
Table 4.2	Initial Conjectures and Concluding Stances for Student's Reactions to Task Aspects.....	137
Table 4.3	Examples of Explanations Indicating a Preference for Less Difficulty as Related to Accessibility of a Mathematical Topic (Emphasis Mine)	146
Table 4.4	Examples of Student Statements Indicating a Preference for Less Difficulty in Isolation	147
Table 4.5	Examples of Student Statements Indicating a Preference for More Challenge.....	149

Table 4.6	Number of Task Occurrences in Which Each Featured Aspect was Mentioned.....	153
Table 4.7	Number of Task Occurrences for Students' Reactions to a Specific Mathematical Topic.....	174
Table 4.8	Examples of Positive Reactions to the Presence of a Familiar Mathematical Topic (Emphasis Mine)	176
Table 4.9	Examples of Negative Reactions to the Presence of an Unfamiliar Mathematical Topic.....	178
Table 4.10	Examples of Negative Reactions to the Presence of a Familiar Mathematical Topic.....	181
Table 4.11	Examples of Positive Reactions to the Presence of an Unfamiliar Mathematical Topic.....	182
Table 5.1	Diondre's Responses Prior to Solving Pic Me! Task Parts	190
Table 5.2	Diondre's Responses to Pic Me! Reactions to Task Parts 1 and 3	192
Table 5.3	Diondre's Responses Prior to Solving Wage War Task Parts	197
Table 5.4	Diondre's Responses Prior to Solving Datelines Task Parts	204
Table 5.5	Diondre's Responses Prior to Solving Financial Aid Task Parts	208
Table 5.6	Janelle's Explanations for Moving the Markers Up During the Comparison Task.....	211
Table 5.7	Janelle's Responses During the Financial Aid Task.....	215
Table 5.8	Student Responses that Explained a Negative Reaction to the Opportunity to Justify (Emphasis Mine)	237
Table 5.9	Callie's Responses During the Pic Me! Task	241
Table 5.10	Callie's Responses During the Comparison Task	243
Table 5.11	Callie's Responses During the Datelines Task.....	245
Table 5.12	Callie's Responses During the Wage War and Financial Aid Tasks...	247

Table 5.13	Khalil's Responses During the Financial Aid Task Explaining a Positive Reaction to a Successful Struggle	249
Table 5.14	Khalil's Responses that Indicated a Preference for Challenge	252

PREVIEW

LIST OF FIGURES

Figure 3.1	Summary of Interview Process	67
Figure 3.2	Indicator Tool.....	72
Figure 3.3	Array with Totals for Each Student for Each Aspect.....	131
Figure 3.4	Array Highlighting Possible Student Representatives for Cases	132
Figure 5.1	Wage War Task Prompts that Include the Opportunity to Justify	221
Figure 5.2	Pic Me! Task Prompts that Include the Opportunity to Justify	226
Figure 5.3	Datelines Task Prompts that Include the Opportunity to Justify	233
Figure 5.4	Financial Aid Task Prompts that Include the Opportunity to Justify...	235
Figure 5.5	Task Sort Order After Callie Completed the Bolded Task	240

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’