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A Study of Students' Help-Seeking Behaviors in Undergraduate Mathematics Tutoring

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This observational study considers the help-seeking behaviors of students who drop in to receive free tutoring at a university's mathematics tutoring center. It reports how these students enter the tutoring space, act, and interact with others, comparing the students in two different areas of the center. One of the areas serves students taking mathematics classes for natural sciences, technology, engineering, and mathematics (STEM) majors. The other area serves students taking mathematics classes for business, life science, and social science (BLSSS) majors. Findings suggest that most students enter the center alone, stay for over an hour, and are industrious, no matter the area they visit. However, students in the STEM area were more social with others in the tutoring center, more focused on gaining a conceptual understanding, and less likely to be dependent on tutors than the students in the BLSSS area. These results add to the research literature on what is known about student actions and interactions in university tutoring centers. They have implications for those who organize and lead mathematics tutor training that might help them provide better support to students.

Introduction

In colleges and universities, classrooms are not the only places where learning occurs. Mathematics tutoring is a common academic service in U.S. postsecondary education that is provided to support students' learning outside of the classroom

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(Johnson & Hanson, 2015). Many students have the opportunity to work with tutors, often advanced undergraduate or graduate students (Johns et al., 2023a; Rickard & Mills, 2018), at their campus mathematics tutoring centers, henceforth referred to as math centers. These math centers are usually physical spaces on collegiate campuses "where students enrolled in a mathematics course can get optional out-of-class resources to support their learning" (Mills et al., 2022, p. 3). The free tutoring services offered at math centers are most often in the form of drop-in, rather than appointment-based, tutoring (Byerley et al., 2019; Johns et al., 2023b)

Math centers provide a range of services to students. The services typically offered include guiding students to solve problems, supplying additional problems for students, and offering support and encouragement as students solve problems (Wepner, 1985). The services provided have led to documented benefits for students, such as reinforcing the ideas addressed in instructors' lectures (Ali et al., 2015) and providing students with a sense of community (Bjorkman & Nickerson, 2019). Undergraduates who regularly visit math centers have been found to have higher grades, better retention, and increased degree completion than those who do not (Byerley et al., 2018; Rheinheimer et al., 2010; Rickard & Mills, 2018; Xu et al., 2001). Even though researchers have begun to investigate math centers and their common aspects (Byerley et al., 2018, 2023), there have been calls for more studies to better understand math centers and the students who visit them (Byerley et al., 2023; Lawson et al., 2020; Mills et al., 2022; Tinsley et al., 2018).

This study provides information on undergraduate students who attended a math center that offers free drop-in tutoring. The following research questions guide the study. How do undergraduate students enter the math center? Once there, how do they act and interact with others? How do students' behaviors in math centers vary by the designated area of the math center they visit?

Help-Seeking Behavior

Help-seeking behavior involves the self-regulated actions people take when they face challenges and recognize that assistance is needed (Karabenick & Newman, 2013). Academic help seeking involves how an individual looks for and then utilizes resources to aid in dealing with whatever scholastic challenge has been presented (Ryan & Pintrich, 1997). Academic help seeking is meant to reduce the gap between current and desired levels of learning and academic performance (Magnusson & Perry, 1992). This paper focuses only on academic help seeking, although other types exist, and the authors will henceforth refer to it simply as help seeking.

Help seeking is a social, interactive behavior in which students seek help from humans and other types of resources to assist with learning. Help seeking has been found to be correlated with higher academic success (Fong et al., 2023; Li et al., 2023) and is an important learning strategy because, without it, students either quit or continue fruitlessly to persist in studying without assistance (Karabenick, 2012).

Help seeking has been found to be correlated with students' learning goals (Butler, 1993; Schworm & Gruber, 2023). Two general goal orientations are typically considered. Students with a *mastery* goal orientation focus on learning, understanding, and self-improvement, whereas students with *performance* goal orientations focus on academic outcomes rather than learning processes and how they and their abilities are perceived or judged in relation to others (Pintrich, 2000). Sakiz (2011) reports mastery goal orientation as being significantly positively related to students' perceived academic self-efficacy and how often students seek help. On the other hand, performance approach goal orientation was reported as being significantly negatively associated with help seeking, meaning students were more likely to avoid help seeking.

Nelson-Le Gall and Jones (2015) report there are two common forms of help-seeking behavior. Adaptive (also called instrumental) help seeking is when students are independent and leverage resources only to the extent needed to promote their understanding (Newman, 2000). Adaptive help seeking involves

requesting just the minimal amount to complete a task on one's own (Martín-Arbós et al., 2021). Students engaging in this type of strategic help seeking are pursuing assistance in the present so that they have a decreased need for subsequent help in the future (Karabenick, 2004; Karabenick & Newman, 2013). Expedient (also called executive) help seeking is when students are dependent and rely on any resource, including help from other humans, to aid while putting forth little effort themselves. Students engaging in this type of help seeking are typically performance-oriented and pursue assistance to conveniently obtain answers rather than gain understanding (Karabenick, 2003, 2004). In contrast to the goal of adaptive help seeking, which is autonomy in learning, expedient help seeking perpetuates dependency (Karabenick & Newman, 2013).

Karabenick and Knapp (1988) distinguish formal help seeking, where students receive assistance from a teacher in the classroom, and informal help seeking, where students solicit aid from others with whom they are close (e.g., family, friends). Math centers with the use of peer and near-peer tutors (Mac an Bhaird & Thomas, 2023) fall somewhere in the middle of the formal vs. informal help-seeking spectrum.

Research suggests that social aspects, as well as prior experiences, play a role in students' academic help-seeking practices in mathematics (Ryan & Pintrich, 1997; Ryan et al., 2001). Peeters and colleagues (2020) found that students are more likely to seek help in a private setting (e.g., seeking help in a forum without or with few others around to witness the request for help), even though the help received in the private setting was not more effective than seeking help in a more public setting (e.g., asking a teacher during class). Karabenick & Knapp (1991) suggest that a primary reason for some individuals to not seek help, especially seeking help that can be witnessed by others, is that the act of help seeking can be perceived as a display or admission of failure and could pose a threat to the self-worth of the person seeking help.

Studies have shown that formal help seeking is more positively associated than informal help seeking with students' grades (e.g., Kitsantas & Chow, 2007). Students who seek out help via college math centers have higher success rates than

those who do not use these services (Meuschke & Gribbons, 2005, as cited in Meuschke, 2005). However, college students tend to prefer seeking out informal sources of help (e.g., friends) over more formal sources, such as peer tutors at a math center (Knapp & Karabenick, 1988).

Most of the help-seeking literature at the post-secondary level has been related to classroom environments or students' self-reports of their help-seeking behaviors (e.g., Karabenick, 2003, 2004; Meuschke, 2005; Kitsantas & Chow, 2007). Moreover, in help-seeking literature, "the quality and characteristics of help-seeking behaviors … are often overlooked" (Fong, 2023, p. 2). This study looks to fill these gaps in the help-seeking literature by considering the characteristics of college students' help-seeking behaviors that occur within one math center.

Methods

Data were collected during the spring 2023 academic semester. The context for the study and the methods used to collect and analyze the data now follow.

Context

The study was conducted in a research-focused university in the southwest U.S. with an enrollment of close to 25,000 undergraduates. Most first-year students reside on campus; other undergraduates tend to live near the university. The university has a math center that offers free drop-in tutoring. During the day, this tutoring is in person. During weekday evenings, it is offered online. All tutors in the math center are hired because of their academic performance, particularly in mathematics, and all attend both general tutor training as well as specialized training for the mathematical content that is covered in the areas of the center where they tutor.

This math center is located on the main floor of the building where the Math Department is located, where all math instructors' offices are located, and where about 75% of all math classes are offered. During the spring 2023 semester, when data

were collected, the center had over 7,000 site visits, over 95% of which were in person. The math center has separate, adjacent areas for the different math classes served, which keeps the volume of students and noise in each area at reasonable levels for students to study. Tutors provide tutoring for specific, related courses. These related (often sequential) courses are grouped together in the different areas of the math center.

This study considered the students who came for in-person tutoring visiting two of the five different areas in the math center. The two areas of the math center that were involved in this study each could seat at least 36 people. One of the areas was for tutoring vector and multivariable calculus, serving STEM majors who are in mathematics courses that require trigonometry and do not allow students to use any digital resources on examinations. The other area featured tutoring for the precalculus and calculus classes taken by students with BLSS majors. The tutoring in this area is for topics up to and including applied differential and integral calculus. The courses served by the BLSSS area do not require trigonometry and allow students to use graphing calculators on all assessments.

Data Collection

We now describe how data were collected and analyzed. This section includes details regarding the training prior to data collection as well as information on the observations, including the coding categories used.

Two research assistants conducted observations of in-person tutoring in both the STEM and BLSSS areas of the tutoring center mentioned above. Prior to collecting data, the two spent at least five hours in the math center separately getting to know the layout and the general procedures used for in-person, drop-in tutoring (e.g., the use of lanyards and name badges for tutors, the sign-in system for all entering the math center).

For six weeks prior to collecting data, the two research assistants met with the lead researcher weekly to discuss tutoring center research and how data should be collected for this study. The research team determined that the unit of analysis would be a student who came in for tutoring. Data coding sheets were

developed that allowed for coding categories to be marked with space for detailed notes to provide justification for each code selected. These coding categories are explained in more detail in the next section of the paper.

Data collection occurred after extensive training during which the team practiced coding videotaped tutoring interactions. The team practiced coding together at first and then coded separately comparing the codes they had assigned. This training continued over three weeks until the three researchers on the team were consistently in agreement on the coding of the tutoring videos.

Once the training was concluded, data were collected over a six-week period from the end of February until the middle of April. In order not to disrupt the tutoring environment, the research assistants sat in one seat through each observation session where they could easily see the front desk check-in area as well as the tables and chairs where actual tutoring occurs. They selected a seat in the middle of the tutoring area and were able to visually observe all students who entered the tutoring area. To avoid disruptions and to keep only data where students could not be identified, no video or audio recordings were collected. Only assigned codes and written observations of the students' actions were collected on the data coding sheets during the observations.

The research assistants only coded students for whom they were easily able to observe all the student's behaviors and interactions with other students and with tutors. This included being able to hear what was being said and visually see the interaction. The only student observations not recorded were when the student-tutor discussion was not loud enough to overhear. Both observers reported that this was rare. The two research assistants tried to divide their observation time evenly so that each spent roughly the same amount of time on observations in both the STEM and BLSSS areas. There were 20 total observations, which ranged from just over 60 to 120 minutes, for a total of 38 hours. These 20 observations were the 20 instances in which the research assistants collected data. Each research assistant conducted at least five observations in each area and spent at least eight hours in each area. Over this period,

64 different students sat close enough to the observers to have their interactions heard and visually observed, 39 from the STEM area and 25 from the BLSSS area. The observers did not notice any of the students as being ones that they had observed previously, so the 64 different students observed were all unique students.

The tutors on staff at the math center have varied schedules and typically have shifts that last for an hour or two at a time. Hence, there were a variety of tutors during the observation periods. The math center helps students on a need basis; when students raise their hands, an available tutor comes to help them. In no cases did the observers witness a student coming to the math center in search of a particular tutor. In most cases, students in the math center work on assigned homework problems (either online or on paper), or they come for extra review of the material. The research assistants noted that students interacted with tutors in similar ways regardless of the homework platform. For both online and on-paper homework, students typically worked problems out either on paper or on a whiteboard, sometimes checking their digital devices to access an online textbook, locate additional information from an external source, or perform calculations. Even in cases where students seemed to be reviewing ideas from the class (i.e., concepts and theorems rather than working on a specific assignment), it was common for students to consider example problems.

For each student observed, the research assistant started a new coding sheet. Occasionally, the research assistants were recording codes and written observations on more than one coding sheet at the same time. The coding sheets included data on the time the student entered, the time the student left, the area the student visited, and the number of other students in the area. In addition, three different coding categories were included, which are now explained.

Coding Categories

The first coding category was related to a student's entry into the tutoring space. More specifically, it was noted if the student *entered* alone (i.e., walked into the math center without

a companion), *entered with others* (i.e., walked into the math center talking to another student with whom it was apparent there some familiarity), or *entered alone to meet others* (i.e., walked into the math center without a companion and then had another student enter and sit next to the first student with some comment that implied the two were meeting, such as "did you wait long").

For the second coding category, the research team considered how students conducted themselves and their particular help-seeking behaviors in the math center. In their study of tutoring for developmental education at the university level, DeFeo and colleagues (2017) described five student typographies that are typically observed in tutoring centers. The student typographies included *dependent*, *industrious*, *scrambling*, *social*, and *statue*. The research team slightly adapted the wording of five typographies, each of which is outlined in Table 1, using profiles to describe the ways students occupy their time and interact with others in the tutoring space that make them distinguishable from one another. The research assistants assigned a primary student typography code to each student. In cases where a student met more than one student typography, a primary and a secondary code were assigned. The research assistants reported that they were easily able to assign at least one code to each student observed, which speaks to the efficacy and completeness of DeFeo and colleagues' (2017) coding categories.

Table 1
Student Typography Coding Categories.

Category	Description
Dependent	Behavior suggests that these students are not comfortable, used to, or capable of working without relying on a more knowledgeable other. These students prefer to work directly with a tutor rather than alone or with other students. They often ask specific questions about assigned problems, frequently state "just one more question," and ask to have their work checked.
Industrious	Behavior suggests that these students are task-oriented and not easily distracted. These students enter the math center

	and immediately start to work. They engage tutors as needed, but tutoring interactions are often short and with a specific purpose. They will move on with or without tutoring help, skipping to the next idea if they must wait for a tutor's assistance.
Scrambling	Behavior suggests that these students are often frustrated or worried and are desperate to make up for lost time. They enter the math center trying to catch up after being behind or to study (often for an assessment) at the last minute. They are often disorganized and distracting to others in the math center (e.g., flipping frantically in notes or in textbooks or sighing loudly).
Social	Behavior suggests that these students enjoy and may feel that it is beneficial to engage in interactions with others; they may have good intentions but are often off task. These students enter the math center and engage in conversations with others (both tutors and peers) that may or may not be related to mathematics. They might listen in to others being tutored and may ask other students what they are working on or if they want to work together. They are more likely to laugh and be loud than others in the math center. They might compliment the tutor and extend conversations, and they may treat tutors as informal sources of information about university issues (e.g., how to drop a course) or loosely math-related topics (e.g., best instructor to take for the next course).
Statue	Behavior suggests that these students know they need help but do not know how to start or what to ask. These students enter the math center, and upon a glance, seem to be hard at work, typically spreading out pertinent materials (e.g., opening the textbook and/or having notes open). However, upon closer inspection, it becomes apparent that little to no progress is being made. These students do not actually read the book or notes for long, do not do much writing, and might seem to be frozen in place or even petrified.

For the third coding category, the team decided to look at three levels related to the student's pursuit of understanding to further depict students' help-seeking behaviors. This category relates to students' cognitive engagement (Lawson & Lawson, 2013), specifically the extent to which students demonstrated that they wanted to think deeply about the mathematical

concepts at hand and how they went about the learning and meaning-making process while in the math center. This coding was a means to study the students' expectations and actions that often drive the tutoring sessions, including the degree to which students were trying to understand the material at hand. More specifically, these three codes included students having a *strong*, *mixed/ambiguous*, or *weak* pursuit of understanding. Table 2 outlines the three categories that were used for coding. Only a single student pursuit of understanding code was assigned to each student.

Table 2
Student Pursuit of Understanding Coding Categories

Category	Description
Strong	Behavior suggests that these students are looking for mathematical connections and meaning. These students try to understand concepts deeply in addition to achieving procedural fluency. With a goal of robust, flexible understanding, these students are likely to ask why an idea is such, how ideas connect to each other, and if there are exceptions.
Mixed/ Ambiguous	Behavior suggests that these students are satisfied with some knowledge of the concept; this is often a limited, isolated conceptual understanding or a focus only on being able to do the related procedures and when to apply appropriate equations and formulas. These students focus on clarifying the rules that govern when to use certain formulas and how to perform procedures rather than obtaining a deep understanding of the concepts at hand and how they are related. They may ask questions such as, "This formula applies in this case, right?" They are likely to dismiss a tutor's efforts to explain further how a concept ties to previous ideas or to future classes.
Weak	Behavior suggests that these students want to memorize steps to follow to get to an answer without any understanding or connections. They often ask for a tutor to solve a problem for them in its entirety. If the tutor is not willing, they may request to be directed to a similar problem they can mimic or to be given a formula they can plug into.

The lead researcher and two research assistants met weekly to discuss the observational data. Individual students who had been observed were each assigned a data record where the following were recorded: which of the two areas they attended, the research assistant who had conducted the observation, the date, the length of the observation, the average number of students in the area (i.e., the mean of the number of students present at the start and then at the end of the observation), the student/tutor ratio, the length of the visit, the codes for student entry, the primary code for student typography, the secondary code (if applicable) for student typography, and the code for student pursuit of understanding. Narrative entries that summarized the related research team's discussions of the observations and the observational notes made by the research assistant during the observation on the coding sheets were used to verify the codes assigned for student entry, student typography, and student pursuit of understanding. A general summary was also written for each student.

Data Analysis

The data, once the observations were completed, were then considered first as an aggregate set to determine patterns. Next, data were considered by area and by research assistant to determine if the two research assistants were consistent in their findings in each of the two areas. When it was determined that the observations were consistent across the two research assistants, the data were divided according to the two areas to consider patterns by area.

Patterns were considered through frequency counts, relative frequencies, and comparative analyses between areas, supported by qualitative information from the initial observational notes made by the research assistant as well as from the team's narrative entries describing the observed behaviors. Patterns were considered across each of the three coding categories in addition to both how the students entered the math center and how long they stayed. For example, here are the verbatim observation notes that were written about one student who coded as industrious with a strong pursuit of knowledge in the STEM

room: “entered, greeted by tutor on entery [sic], sat down, took out pencil and papers, appears working on assignment, still working on assignment, occasionally references notes and book, alternates between writing/reading/thinking, seems to be here as a quiet work space to study rather than to get help, still reading/writing/thinking, just asked a tutor about how to approach a problem after stuck on it for a while, tutor answered question, student said “Okay, I got it now” but student has not yet written up solution, student extends conversation with tutor asking ?s about current assignment & past topics, tutor move [sic] on, student is writing up the problem just discussed, rest of assignment seems to already be done, puts papers away, looks up something in index at back of book, flips to page in middle, starts reading, student packs up book, leaves.”

Results

Student Entry and Time Spent in Math Center Visit

There were no notable differences in the two areas between the time students spent in the math center. The majority of students in the study spent over an hour in the math center. This was observed in the STEM area (74%, 29 of 39 students) as well as in the BLSSS area (72%, 18 of 25 students). The next most common duration for tutoring was for a student to stay 30 minutes or less, both in the STEM area (21% or 8 of 39 students) and in the BLSSS area (16% or 4 of 25 students). This often occurred when a student came in solely to get help with one specific problem. Only one student in the STEM area (3%) and three students in the BLSSS area (12%) stayed between 30 and 60 minutes. Based on the observations, it seems that most students come when they are trying to dedicate a chunk of time to spend in the math center, followed in a distant second by others who come to get help on something specific and then leave.

None of the students observed entered the math center with other students. Students most frequently entered the math center alone, as was noted for 57 of the 64 students. Seven students entered to meet others; this occurred both in the STEM area

(11%, 5 of 39 students) and in the BLSSS area (8%, 2 of 25 students).

Student Typographies

The top half of Table 3 displays the coding counts and relative frequencies by area for the student typography category for the primary student typography (if two typographies were coded for the student). Over half of all students in the study were identified by the industrious typography. Both the STEM and the BLSSS areas had more industrious students than any other type; however, this was more commonly noted in the STEM area than in the BLSSS area. The least common typography across all students was the scrambling student. This was true for both the STEM and the BLSSS areas.

Table 3
Primary Student Typography and Pursuit of Understanding Counts

	STEM Area (n = 39 students)	BLSSS Area (n = 25 students)	All (n = 64 students)
Student Typography			
Dependent	4 (10%)	6 (24%)	10 (16%)
Scrambling	2 (5%)	1 (4%)	3 (5%)
Statue	3 (8%)	4 (16%)	7 (11%)
Social	7 (18%)	3 (12%)	10 (16%)
Industrious	23 (59%)	11 (44%)	34 (53%)
Student Pursuit of Understanding			
Strong	26 (67%)	12 (48%)	38 (59%)
Mixed/Ambiguous	12 (31%)	12 (48%)	24 (38%)
Weak	1 (3%)	1 (4%)	2 (3%)

The dependent, social, and statue student typographies had similar percentages of students when considering all students in the study sample. However, the relative frequency of each student typography varied when the results were considered by area. We now describe how students in each area typically occupied their time and interacted with others at the math center.

In the STEM area, most students were industrious. They entered the area, started working on their own, engaging in productive struggle, then asked tutors questions for help, ending the interactions after they felt that they had sufficient understanding to return to individual work until additional assistance from the tutor was needed.

Social students were the second most common typography in the STEM area. It was obvious that many of the students felt at home in this physical space, doing math, and being adjacent to others who were doing math. Social students were more likely to be observed talking to others in their area, even if it did not appear that they knew the others to whom they were speaking. These conversations were often, but not always, about math. The STEM area saw a much greater variety in the types of resources that tutors and students used in their interactions, including textbooks, rolling whiteboards, paper and pencil, and occasionally a digital device. In the STEM area, some students would enter and immediately start working on the whiteboards that were in the room without interacting with a tutor; this use of whiteboards initiated by the students never occurred in the BLSSS area. It was not uncommon to see students in the STEM area working in groups rather than just by themselves. This allowed them to engage with each other often rather than with the area tutors, although an occasional dependent student in the STEM area would try to monopolize the tutor's time.

In the BLSSS area, industrious students were also the most common but with lower percentages than noted in the STEM area. It was common for students to pull out laptops, tablets, or graphing calculators to assist them with their studies as soon as they entered the math center. Because calculators are allowed in the courses served in the BLSSS area, it was not surprising that they were used. However, laptops are not allowed on exams in

any of the BLSSS courses. The use of digital devices rarely occurred in the STEM area.

Dependent students were the second most common typography in the BLSSS area. Students in the BLSSS area often asked a series of specific questions, typically from a particular assignment, or requested validation on the work they had done to see if it was correct. Many of these students relied heavily on the tutors to provide structure during their time in the math center. Because these students depended on the tutors and did not interact as much with other students in the area, this allowed for constant conversation between students and tutors that was not seen as frequently in the STEM area. It was also noted in observation notes that students in the BLSSS area coded as being dependent were the most likely to use their laptops to look up information if a tutor was occupied with another student. There were few interactions between students in this area, and only two were coded as being social. In general, the students in this area did not display the camaraderie that was noted in the STEM area.

Rarely would a student would be seen as frantically scrambling or as a frozen statue not working on any mathematics. This was neither unique to, nor common in, either area. When this did occur, the students would typically have the textbook and some papers they were working on laid out in front of them but would spend long periods staring at the same spot in the textbook or in the notes with no eye movement to denote reading was occurring or staring at the table they were working on with little other movement.

When considering both the student entry and the student typography, a noticeable but unsurprising trend was seen in those students identified as social. Of the ten students identified as such as their only (or primary) typology, five were noted as having entered the math center and subsequently meeting up with other students, whereas the others entered the math center alone. This was a notable departure from the trends seen in each of the other four student typographies, where most students entered and remained in the math center alone, only speaking to the tutors, especially in the BLSSS area.

Out of the 64 observed students, only five students were coded with two typographies. Of these five, two were coded with

the same typography, social then scrambling. These two students met each other in the center. They were relatively unproductive and "all over the place" (as cited in the research assistant's observation notes) while working on math problems but were extremely social with each other. The research assistant's observation noted that the two talked more about movies, friends, and the difficulty of the class than any actual math content while trying to work on their assignment.

The other three students each had different typography combinations. One was coded as social then statue because this student was observed to look over problems for several minutes without ever writing anything down but interacted with tutors regularly in an informal manner about non-math topics. Another was dependent and industrious because this student sought help from a tutor initially and relied very heavily on the tutor. However, when the student began to understand the concept after completing a few problems, the student worked alone to complete the remainder of the problems with limited tutor interaction. The final student who was recognized to have two typographies was industrious and social. This student was seen conversing with other students and tutors alike about math and non-math issues, but this student was able to focus and complete tasks for extended periods without any socialization. The observations of the last two students mentioned suggest that there are cases in which the typographies might be somewhat fluid depending on the context of the learner.

Student Pursuit of Understanding

The bottom half of Table 3 displays the coding counts and relative frequencies by area for the student pursuit of understanding category. When considering all students in the study, most students demonstrated a strong pursuit of understanding. Some features noted in the observations were that these students would ask why questions, refer back to other problems to compare what was similar and what was different, and try to work out the relationships between different concepts (e.g., "Please go over the difference in directional and partial derivatives."). These students were more likely to continue

conversations with the tutor about the ins and outs of the topic at hand after an assignment task was completed. They were also the most likely to come to the math center to study without a pending assignment. This was followed by the next largest group, which had a mixed/ambiguous pursuit of understanding. These students tended to attend the math center to work on an assignment or to work on a review sheet prior to an exam. They seemed to desire knowing how a problem should be worked but were often focused on particulars and procedures (such as "Would the chain rule apply here?") and did not extend conversations with the tutors once the task at hand had been solved.

Only two students from the entire sample displayed a weak pursuit of understanding. One of the two was coded with the statue typography. The observation entry recorded for this student in the STEM area noted that the student "entered area, sat down, sets book and assignment on table, seems about to start assignment but doesn't, spends time observing tutor assisting another student instead, stares off into space, glances at problem again but eyes are not moving (doesn't appear to be reading), shifts eyes to table, glances at assignment again, asked by tutor if needs help, declines help, looks at page in book then stares at assignment, looks away from book staring at table, packs up things, leaves." This student stayed for just under 30 minutes. The other student marked as having a weak pursuit of knowledge was in the BLSSS for over an hour and was marked as scrambling. This student had papers and a textbook out and was observed to shuffle through them frequently and loudly but also took three breaks to walk outside of the center (apparently to the water fountain). This student was marked as often starting to work on a problem but then abruptly alternating between pulling out a cell phone to glance at it in what appeared to be perusal of social media sites or texting, glancing at the book, and glancing back at the papers. The research assistant also wrote on the coding sheet that the student was "easily distracted by others, looking up at even the slightest movement in the room" and noted that this student did not ask the tutor in the area any questions and seemed to make "little to no real progress on problems initially started."

If we consider student pursuit of understanding by math center area, there are notable differences. A strong pursuit of understanding was more common in the STEM area than in the BLSSS area, where a mixed/ambiguous pursuit of understanding was most common. The questions asked by students in the STEM area were often more conceptually based, exploring content seen across assignments, lectures, and even courses. In the BLSSS area, students often entered with the goal of getting help with a specific homework assignment, going over material that had been covered in a particular lecture, or preparing for a major assessment. Some students in the BLSSS area did try to develop a deep understanding; however, many seemed content to get the correct answer to a problem and move on to the next.

Student Typography and Pursuit of Understanding

To determine if differences in students' pursuits of understanding in the math center were generally associated with certain student typographies, consider the data in Figure 1. Due to the low number of scrambling students, they are not included in the discussion provided below.

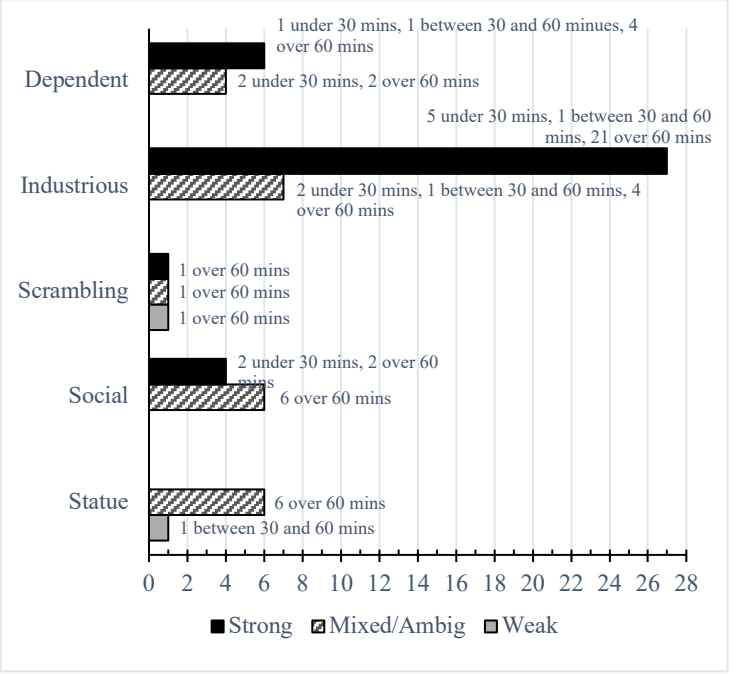
Students classified with industrious and dependent typographies were most associated with having a strong pursuit of understanding. Students classified with social and statue typographies were most associated with having a mixed/ambiguous pursuit of understanding. Scrambling was the least common typography and had no clear trend in student pursuit of understanding. Below are the four most common student typographies described, along with the most common student pursuit of understanding of each typography.

Industrious students were by far the most noted to have a strong pursuit of understanding. They often took time to search and work towards the solution to the problem presented. The majority of these students rarely asked for help over basic concepts, seeking out answers on their own in the textbook or notes. They did not shy away from productive struggle. For example, one student was noted as spending 20 minutes on the same problem, carefully rereading notes and the textbook before finally asking a tutor for help, then stopping the tutor from

giving too much help, saying he preferred to "work this out on my own so it sticks." Instead, industrious students tended to seek help primarily when they were struggling with overall comprehension that crossed topics and lectures. Their strong pursuit of understanding was seen in them going beyond assigned problems to work on additional problems and to connect to past lessons and topics.

Figure 1

Group Bar Chart of Student Typography by Pursuit of Understanding with Lengths of Time in Math Center.



Dependent students typically searched for answers for a very short amount of time, if at all, most often by glancing at their notes and/or their textbooks and then promptly reaching out to contact a tutor for direct instruction without any thorough search through their notes or textbooks. On more than one occasion, a book would be taken out of a backpack but never opened. Common variations of the phrase "I think that this was covered, but I don't understand it" were heard from dependent students.

Other common statements from dependent students mentioned not being able to glean information from reading, needing a human to explain, and not understanding what the professor meant thereby needing someone else to cover the material. The dependent students often wanted continuous attention until they appeared to feel they had achieved their goal. Although the dependent students coded as having a strong pursuit of understanding seemed to truly want to understand the concepts, they appeared to believe that this understanding should be provided to them by the tutor. They were not seen as engaging in the independent productive struggle that was noted in the industrious students with a strong pursuit of understanding.

Students who are both social and have a mixed/ambiguous pursuit of understanding often had trouble giving their full attention to their tutor and the task at hand. Instead, they often diverted to discussions with other peers about topics not related to the math they were supposed to be studying. When social students were helped by tutors, they usually did not seek to further their knowledge of the subject. Instead, they concluded the mathematical discussion with the tutor, often with a polite phrase like "Thanks for your help" after a desired answer to a specific problem had been obtained as a means of dismissal without asking any further questions.

Statue students, many of whom possessed a mixed/ambiguous pursuit of understanding, often spent long periods in the math center without demonstrating progress in their mathematical studies. They often did not move much and were noted as "staring" by the research assistants frequently without any evidence that they were actually working on any math. They rarely sought out a tutor for assistance and often rejected help when offered by a tutor. Statue students, although not engaging with others, often seemed to observe the interactions between others to provide them with some directive to guide their learning.

Discussion

This study adds to a relatively new, but growing, body of research literature related to math tutoring centers. In the sample

of students studied, it was noted that most students entered alone and stayed for at least an hour. While in the math center, most of the students observed were industrious, working and then seeking help from tutors only after putting in some effort on their own. The industrious students were much more likely than any other typography to demonstrate a strong pursuit of understanding. This is not surprising, because productive struggle is often associated with being able to eventually achieve a more robust understanding of the material (Hiebert & Grouws, 2007; Paurowski et al., 2024; Warshauer, 2015).

Some differences in student behaviors were noted by area. The STEM area students were more social with others in the math center. Most seemed very comfortable with both other students and tutors. In this regard, our findings of students who went to the STEM area differed from DeFeo and colleagues' (2017) findings that the students in developmental mathematics classes whom they observed in tutoring worked primarily individually and only regarded tutors, not other students in the center, as resources.

Another difference in the two areas was the students' pursuit of understanding. The students in the STEM area were more likely to be focused on gaining a conceptual understanding by themselves, or collaboratively by working with other students, and less likely to aggressively ask tutors for help while expecting the tutor to work a problem step-by-step in its entirety than the students in the BLSSS area. It is plausible that students in the STEM area are more focused on conceptual understanding because they recognize that they will need to take additional classes in the future that are likely to build on prior mathematical understanding. Although this study was limited to a small sample, it would be valuable to have future research investigate if these trends by students with different majors are found at other math centers. Regardless, it seems that tutors should be made aware that students in different areas may not have the same socialization levels at the math center nor the same goals for attending.

. A limitation of this study is that it was only conducted at a single university and only in two of the center's areas due to the number of observers available. We acknowledge that we do not

have data on how commonplace it is for students to seek help in either area of the math center that was studied. The students in the study are not necessarily representative of all students in the courses served in the areas. Another limitation is that the data were collected only until mid-April for logistic and analysis purposes. However, it is possible that students preparing for comprehensive, often heavily weighted, final examinations might display different behaviors or typographies at the end of the semester than were noted during the middle of the semester. Still, the findings, especially when considered in light of the DeFeo et al. study (2017), suggest that it is important for tutors to recognize that students' actions, interactions, and expectations in the math center might not be those that are most beneficial to their learning. Granted, most students in the study were industrious. However, the industrious typography does not fit all students; other typographies noted in a developmental mathematics tutoring center by DeFeo and colleagues also applied. So, tutors should be prepared to handle students' different help-seeking behaviors, whether they be adaptive or more expedient.

Some students who came to the math center seemed to be more concerned with social aspects than mathematics. It is possible, even likely, that many students might benefit from some degree of a social aspect that allows for a pleasant tutoring experience. This aligns with the socialization seen in the STEM area and corresponds with Bjorkman and Nickerson's (2019) findings about the sense of community that can develop among students who attend a math center. Such socialization, as opposed to an individual student engaging in solitary, unproductive struggle, could lead to an extended pursuit of understanding that is ultimately more productive for students. However, without paying attention to the nuances of conversations between students who come into a math center, a tutor might mistakenly believe that all students are engaged in productive mathematical collaboration without offering help when it might have been needed and appreciated.

Some students also digress to emphasize social, nonmathematical topics with tutors. Although it is desirable that students feel comfortable in the tutoring space, tutors should

have strategies to help steer interactions so that students are engaging in productive mathematical activity and not only social pursuits. This is especially the case if socializing is distracting others who are trying to work in the math center. Future research should further explore the social aspects of students attending math centers.

Math centers may also have students who may be frantically scrambling or sitting almost frozen. Even though scrambling students might look hard at work and statue students may look like they are deep in thought, neither may have the skills or confidence to know what to ask. Without careful attention, it would be easy for a tutor to fail to notice that these students may not be making much progress and might need attention even more than a dependent student. In our opinion, tutor training should at least alert all tutors to the different types of help-seeking behaviors noted by the various student typographies. For example, tutors who encounter students who they suspect might fit the scrambling or statue typography might want to try to engage the students by asking something other than a yes or no question like the one most commonly reported by research assistants from tutors, "Do you need any help?" For scrambling and statue students, it might be better if tutors look at the papers or textbook section that is opened and ask about the topic the students are covering. This might start a dialogue about the math ideas with which the students need help.

Students who come to math centers may or may not have a strong pursuit of understanding. Some might be focused solely on isolated topics, missing the bigger picture of how topics are interrelated and build on each other. Other students might come just to get answers with little concern for developing their own understanding and have a dependent help-seeking manner where they look to the tutors to supply answers. This study suggests that tutors need training to have viable strategies on the best ways to recognize and handle these different kinds of students and their various expectations and help-seeking behaviors.

Future research might study other factors that could influence help-seeking behaviors, such as ethnicity or gender. This might be an especially valuable insight in comparing math center tutoring areas, where certain groups are underrepresented

in the mathematics courses that are being tutored. It would also be interesting for future investigation to track individuals coming to the math center to consider how fluid typographies are, to determine if and for what reasons (e.g., studying for an exam vs. doing a homework assignment) a topography might change within the same student over a semester. All of these suggestions would provide math center leaders and tutors with a better understanding of the students they serve.

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