Exploring Experiences of Students of Humanities and Social Sciences in an Undergraduate Mathematics Course and Their Perceptions of its Usefulness

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This hermeneutical phenomenological study explored the experiences of students in the College of Humanities and Social Sciences (CHASS) in an undergraduate mathematics course and their perceptions of its utility. Field observations and semi-structured interviews were conducted. Six themes emerged from the collected data. The phenomenon of being a CHASS student in Topics in Contemporary Mathematics is perceived as enjoyable, but impractical and useless. Moreover, what moves students to be successful are mostly (or only, in some cases) external regulators that do not promote autonomy. A set of implications is provided.

Keywords: Phenomenology, Attitudes Toward Mathematics, Self-Determination Theory

Undergraduate students in the College of Humanities and Social Sciences (CHASS) are required to take what may be the last one or two mathematics courses in their lives as requirements for their degree. Understanding how CHASS students perceive their experiences in an undergraduate mathematics course designed for them, and their perceptions of the course's usefulness are first steps to deciding if the curricula for these courses need revisions to better meet students' interests and needs. Furthermore, caring about their perspectives is crucial for future generations because parents' attitudes toward mathematics significantly predicts their children's attitudes toward mathematics (Mohr-Schroeder et at., 2017). Therefore, the purpose of this study is to explore CHASS students' experiences in an undergraduate mathematics course and their perceptions of its utility. To fulfill this purpose, the following research questions are addressed: (a) How do students feel about being required to take mathematical courses for their degree? (b) What is the perceived relevance and usefulness of the mathematics course they are taking to their life, major, and future career? (c) What motivates them to be successful in the mathematics course? and (d) What are their attitudes toward mathematics?

Literature Review

There is important literature about affect in mathematics and motivation, in general, that can provide meaning and serve as a theoretical framework to this study. This section will focus on attitudes toward mathematics (ATM) and Self-Determination Theory (SDT) as lenses to understand CHASS students' experiences and perspectives of mathematics.

ATM has been extensively studied and this construct has been constantly developing (Middleton, Jansen, & Golding, 2017). It has been shown that ATM is reciprocally correlated with achievement (Ma, 1997; Ma & Kishor, 1997). Additionally, recent studies consider other factors affecting (or affected by) ATM, such as math anxiety, gender, cognition, self-efficacy, problem-solving, cooperative learning, absenteeism, class participation, homework completion, urban and rural differences, socioeconomic factors, teaching materials, teachers' content knowledge and personality, and teaching with real life enriched examples. (Green et al., 2012; Ho et al., 2000; Hopko, Ashcraft, Gute, Ruggiero, & Lewis, 1998; Kolhe, 1983; Mishra, 1978; Saha, 2007; Schoenfeld, 1985). Thus, ATM relates to students' perceptions of mathematics.

Motivation has also been studied in mathematics education, but not as much as ATM. Given that motivation explains a big portion of human behavior in almost every situated context, it is

relevant in education. In general, the more autonomous the motivation is, the better students' achievement is (cf. Lee, Bong, & Kim, 2014). Ryan and Deci (2000a) shed light when they introduced different types of extrinsic motivation by presenting them on a continuum of the Organismic Integration Theory starting from less autonomous to more autonomous. When combined with other theories, the seminal Self-Determination Theory is created. Summarized by Ryan and Deci (2007), this theory also explains basic psychological needs for optimal motivation and reward contingencies, which can also serve as lenses to understand students' experiences.

As suggested by Middleton et al. (2017), ATM and motivation should be considered together along with other affect in mathematics and social interactions. Relationships found between ATM and motivation in mathematics are that both are correlated to engagement and achievement (Ma, 1997), both are malleable (Middleton et al., 2017) and tend to change negatively across the school grades (Mata, Monteiro & Peixoto, 2012). Additionally, having positive ATM does not guarantee an autonomous motivation and vice versa (Mata et al., 2012). However, many factors can enhance or diminish positive ATM and an autonomous motivation.

One conclusion that can be extracted from this is that if students are lead into the abstract and demanding mathematics' curricula without providing meaningful activities for them, they could easily lose autonomous motivation and develop negative ATM, both of which relate to mathematics achievement, engagement, enrollment in mathematics courses, cognition in mathematics, and general behaviors in the classroom, among other constructs (Middleton et al., 2017). Now, are we providing students with meaningful and interesting activities related to their majors and future professions so that we promote positive affect and internal motivation?

Methods

This study is a hermeneutical phenomenology study oriented toward the lived experiences of students from CHASS enrolled in *Topics in Contemporary Mathematics*. This course is primarily designed for CHASS students, and it should illustrate contemporary uses of mathematics frequently including topics such as sets and logic, probability, modular arithmetic, and game theory. This study includes six research foci (van Manen, 1990, 2014). Two of them are described as follows: First, the lived experiences in mathematics of whom may be seen as *the others* in STEM, CHASS students, and the research community not paying attention to their voice is an abiding concern to the researcher. Second, this experience is investigated in terms of how the participants live it, and *their reality* will be presented.

The data for this study consists of field observations and semi-structured interviews. During the week of field observations, the researcher was a nonparticipant observer and used natural descriptions (Bernard, 2011). Semi-structured interviews were conducted one week later. Three students enrolled in the course, majoring in History or Political Science, were interviewed. The interviews were audio-recorded and transcribed. The purposes of these interviews were to understand the phenomenon under study from the participants' point of view, to understand the meaning of their experiences, and to uncover their perspectives of the phenomenon (Brinkmann & Kvale, 2015). Therefore, open-ended questions, such as "How do you feel about mathematics being a requirement for your program?", "What has been your experience so far in the course?", and "What moves you or motivates you to study and be successful in that class?", were asked.

Codes were created, defined, and used for significant statements in the transcripts. Then, significant statements were grouped by codes. Afterwards, themes emerged when groups of codes were analyzed together with their significant statements. Finally, textural and structural descriptions were developed to describe the essence of CHASS students' experiences (Creswell & Poth, 2017).

Findings

The six themes that emerged from 63 significant statements will be discussed in this section.

Emerging Themes

Theme 1: Calculus as a turning point. To understand the essence of the students' experiences in the course, it is important to understand their perceptions of mathematics in general. During interviews, two participants discussed their experiences with high school calculus; both Tom and Jake expressed that calculus was very difficult for them and that they did not do well. In fact, Tom expressed, "I liked math before calculus". As Jake mentioned, mathematics was getting "confusingly harder" in high school. Having these experiences, where they were not as successful as they wanted to be, may have created negative ATM and low motivation to learn mathematics. Consequently, this experience and mindset would follow them to undergraduate mathematics courses.

Theme 2: Overcoming math anxiety. CHASS students' previous perception of mathematics was described as: "Confusing. I think math is pretty confusing" and "I just find it harder than anything else". When expressing how they felt upon noticing that their undergraduate program required two mathematics courses, Tom expressed, "I get nervous when I have to take math classes. Um… probably just nervousness. Um, I try to study for math more than anything else." Then, he explained that he felt anxious about taking mathematics, and that he "just wanted to get through it". Additionally, Jake was worried that he was going to have to take "hard math". However, once they were told a description of the course and experienced it, they seemed to overcome math anxiety.

The course's low difficulty level seems to be the key for students to overcome math anxiety. Perhaps knowing that they can do it changes the way they feel about mathematics? Before, they felt worried, nervous, and anxious. Now, Sarah, Tom, and Jake, respectively, expressed: "I don't really mind that class. It is going to be an easy A. I don't have a problem with it anymore", "It's pretty simple and definitely way easier than calc in high school", and "Is pretty simple that is honestly like easier than most of the math courses I took in high school".

Theme 3: Defining a mindset. The type of mindset these students had before and during the experience of being a CHASS student in the mentioned mathematics course was still defining itself or getting more concrete. Statements, such as: "I'm not a math person", "[Math] wasn't my thing" "I am not good at math, like complex math", and "But when you are required to do that, and you don't have a brain that is good understanding math, I think that can really put people off school" evidenced that most of these students had the belief that they do not possess the "ability" to be good at math. Thus, making it clear that they had a fixed mindset (Dweck, 2008). Although all the statements related to their mindset suggested that they did not believe they could master higher level mathematics, the following statement is particularly interesting:

> I've become a different person from high school in college. So, like the person that didn't like math in high school is not around anymore. I think it'll be interesting to go in a high-level class to see if I can perform. Like having an increased in work ethic and trying to have good grades and stuff like that, whereas I didn't care like that in high school.

Thus, suggesting that the experience changes the mindset of some students, but for others it reaffirms their fixed mindset thinking that they are only successful because the course is "easy".

Theme 4: Increasing enjoyment with controlling motives. Students have been enjoying an "easy" math course at college. One student had the following epiphany: "And I honestly kind of miss it, like I like math, and I realize, I think that I realize now that I do like it". Another student

expressed that his negative ATM changed because he considers this course to be easy. It seems that, this course, by being "easy", allows them to enjoy it more.

When asked what moves them to be successful in that course, all replied that grades are what moves them. None mentioned the content of the course or what they may gain from it. If the difficulty of the course matched that of the calculus, they may feel the same negative feelings that they expressed before. Thus, what they seem to enjoy is the low complexity and the "easy A". For example, Jake mentioned: "But sometimes I just miss like 'here is a problem and figure that out' and it's kind of basic and you can do that". Therefore, the enjoyment seems not inherent in this case but caused by external factors, such as grades. These external factors are controlling motives and grades in particular are extrinsic motivators with the lowest autonomy in the SDT.

Theme 5: Viewing mathematics as useless. Students showed their perspective that most applications were impractical and that there has not been an evident transfer of knowledge, except for the topic of voting methods. Most topics, according to them, are useless because "one could solve the given problems by flipping a coin" (e.g., deciding where to eat with friends) or simply "cutting the cake however you want". A student described it as "unnecessary and dumb". Another student expressed that although it is simple math, he would not know where to apply it. In particular, Sarah mentioned: "I don't think I'll use anything to be completely honest. Once I'm out of this class, I'll keep the notebook and not think about it again." All expressed an inability to apply what they have learned to real-life situations, except for the topic of voting methods, whose relevance was clear to them and they enjoyed it.

The transfer of knowledge to new contexts is one of the main goals of education (Bransford, Brown, & Cocking, 2000). However, students found themselves unable to make this transfer of knowledge from the mathematics classroom to other contexts. In fact, they do not see the relevance of most topics to them, their careers, or their majors. Thus, referring to SDT, this experience does not seem to promote identified or integrated regulation. Oppositely, the experience lets them stay with low autonomy, low internalization and externally regulated.

Theme 6: Reflecting on its appropriateness. Here, students focused on the characteristics that make or do not make this course appropriate. First, they all explained that the course is appropriate for CHASS students because it is a "simpler math" that is "digestible". Additionally, they expressed that they have a good instructor and that a "good teacher is what probably makes the difference between really hard or getting through it better". Then, a dilemma emerges when they talk about the course content:

> Also, it has real world applications which humanities majors usually like. Um, but also, like I said with the apportionment with like the cake problem, it doesn't seem practical for use in like daily life. Some of the things we learn about, I feel are things I'm never gonna have to use again.

That is, although it has concrete applications, they seem to be impractical, inappropriate or useless for them. Although they clearly enjoy the easiness that characterizes the course, they want more out of that experience. For example, Jake shared: "I wish that like I could have a math course that related to me more". Sarah added: "So, like, um, not just here you would use it but also why we would need to use it". Moreover, Jack added: "...so that the course would be more difficult and challenging and also related to what I'm doing, and I would enjoy that", expressing that more challenging and related topics would be more enjoyable.

According to Ryan and Deci (2007), satisfying students' basic psychological needs for autonomy, competence, and relatedness leads to optimal motivational function. By contrast, they explained that "whenever the social context thwarts or neglects one of these needs, intrinsic

motivation and internalization, as well as positive experience, wither" (p. 7). Students seem to have one or two of these psychological needs satisfied. Having what they consider a good instructor may satisfy the need for relatedness, which makes them feel comfortable and part of a community. On the other hand, it is unclear whether they feel competent in this course. They are doing "good" in this course, but they feel that it is not complex. Perhaps they may feel competent in the course, but not in general. For example, Sarah said: "I also understand that this level of math is easier than the one I had in high school. So, it's good but I also understand why I'm doing good". However, what is clear is that this experience is not supportive of their need for autonomy. For example, when asked about the assignments, a student said: "There just um, basically he'll tell us a formula in class and I will go over one or two examples and it's just a copy of those questions pretty much. The test is the same as the web assigns". Lastly, they have expressed that almost nothing in that course relates to their interests, major, or future careers.

Conclusion and Implications

In general, at the beginning of the experience of being a CHASS student enrolled in *Topics in Contemporary Mathematics*, students felt anxious and had negative ATM. The perceived low difficulty of the course and the positive reinforcement of good grades made them overcome the anxiety and helped them enjoy the course. The instructor also plays a role that, in this case, was positive in helping them enjoy the course. However, except for one topic, their perception is that there is no clear relationship between what they are learning in that course and their interests, major, or future careers. That seems to make transfer of knowledge almost impossible for them. Therefore, the phenomenon of being a CHASS student in Topics in Contemporary Mathematics is perceived as enjoyable, but impractical and useless. Moreover, what moves students to be successful is mostly (or only, in some cases) the grade, which is an external regulator that does not promote autonomy. Nevertheless, they got their desired A.

For CHASS students, what may be the best kind of motivators are those that are perceived as integrated and identified regulators, which are considered as the most internal types of extrinsic motivators in the continuum (Ryan & Deci, 2000b). That is, intrinsic motivation is desired, but we do not want students to do mathematics only because they inherently enjoy doing mathematics. We also want them to understand its importance, why they need it, how they can use it, how they can relate mathematical reasoning in other contexts, etc. We want them to transfer that knowledge in a way that it is useful for them. Based on these students' perceptions, this is not happening in this course, even when the field observations suggested that the professor was teaching for conceptual understanding and also giving applications. The researcher plans to keep interviewing students in the future as it is clear that there is an opportunity to optimize students' experiences in this course. Therefore, this study has the following implications: (a) more activities in which students can feel in control of the learning process, see its relation to them, and, at the same time, feel that it is challenging are needed. Those activities promote students' autonomy, which is required for their cognitive development, transfer of knowledge and optimal motivation; (b) applications given in the classroom should be changed to more practical ones. For example, making a decision matrix to decide where to eat is not practical. Making a decision matrix to decide which graduate schools to apply, where to move, what job to accept, what topic to investigate, and the like, are worthwhile and relevant; (c) topics discussed in the classroom should cater the needs of most students, not only those majoring in political sciences; (d) make instruction more individualized through assignments; (e) collaborate with professors from CHASS to create the mentioned assignments; and (f) more research is needed with this population in mathematics.

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