“Everyone wants everyone to do as well as they can”: Norwegian First-Generation College Student Experiences in First-Year Mathematics Courses

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First-generation college students’ (FGCS) success in higher education is a growing area of research in the United States (US), but is infrequently recognized in the Norwegian education system; there is a need to investigate how FGCS are successfully navigating first-year mathematics courses to best support FGCS’ pursuit of a Science, Technology, Engineering, or Mathematics (STEM) degrees in the US and Norway. This study analyzes six interviews from Norwegian FGCS enrolled in first-year mathematics courses for navigational strategies employed to support their success in mathematics. The preliminary results highlight that the structure of the mathematics courses and the accessibility of resources at the university supported a community of collaboration between peers and instructors. The culture of teamwork across students positively influenced FGCS' success in first-year mathematics courses. We highlight the perspectives of each participant and provide directions for future research to gain a further holistic understanding of supporting FGCS thriving in STEM fields.

Keywords: First-generation college students, first-year mathematics courses, navigational capital

Science, Technology, Engineering, and Mathematics (STEM) fields are pillars of the United States (US) economy and key factors in the US’ reputation as a world leader (Langdon et al., 2011). However, there is a “demand rapidly rising for skilled STEM professionals” (Science & Technology Action Committee, 2024) and a perpetual shortage of STEM degree holders (Xue & Larson, 2015). The US is not the only country grappling with the disparity between the number of students graduating with STEM degrees, the increased technical skills required for the workforce, and an excess of STEM jobs (OECD, 2024); Norway is currently experiencing a technical and health sector labor shortage with “occupations that require vocational or higher education are among the most difficult to fill” (OECD, 2024). To meet the continuously growing demand for STEM workers, it is imperative that groups of students who frequently attrite STEM majors (e.g., women, students of color) are retained. One group that could fill this growing demand is the vastly underrepresented group known as first-generation college students (FGCS), or students whose parents did not obtain a bachelor’s or higher-level degree.

In Norway, there is minimal research conducted on FGCS, there are no FGCS organizations at institutions, and there is a lack of resources catering to the needs of FGCS. Yet, the demographics of Norwegian higher education are changing with an increase in FGCS enrollment, increasing the need for research centering FGCS. In 2015, Norway reported that 18–24-year-olds without tertiary-educated parents comprise 53% of the population (OECD, 2018, p. 243). The population of 25–34-year-olds in Norway who have attained a tertiary degree has increased by 20% over the last 20 years, meaning that as more students attend university, there will be an increase in FGCS enrollment (OECD, 2022). The Organisation of Economic Co-Operation and Development (OECD) addresses this increase in a report calling for governments to fund FGCS-specific programs (OECD, 2019; OECD, 2020). This study is part of a larger dissertation study drawing on a comparative analysis between FGCS in Norway and the US. This preliminary study aims to investigate Norwegian FGCS’ experiences navigating first-year mathematics courses to better understand how systems and structures in place in first-year mathematics courses support FGCS.

Conceptual Framing

We utilized Community Cultural Wealth (CCW), a student-centered, asset-based theory to capture the complexity and unique qualities of FGCS enrolled in first-year mathematics courses (Yosso, 2005). Community Cultural Wealth was originally developed to highlight capital unique to racially marginalized individuals and breaks down forms of non-dominant capital into the following categories: aspirational, linguistic, familial, social, navigational, and resistant (Yosso, 2005). Due to space limitations, this preliminary analysis focuses on navigational capital, which includes students' knowledge of moving through institutions and gaining social capital (Yosso, 2005). Social capital captures students' "networks of people" (Yosso, 2005, p. 79) and resources students can access, including community, academic, financial, or institutional resources. Within the realm of FGCS majoring in STEM fields, this capital can include students successfully maneuvering through mathematics courses and how students find academic, institutional, and financial resources. In this study, we draw on navigational capital to answer the following question: ***How do first-generation college, STEM-intending Norwegian students discuss navigating first-year tertiary mathematics courses?***

Context of Norwegian University

In Norway, first-year calculus courses (much like in the US) are viewed as gatekeepers for STEM disciplines with reports of first-year calculus failure rates ranging from 21.5% to 43% (Gynnild et al., 2005; Zakariya, 2021). Students pursuing STEM degrees commonly take first-year calculus through their specialized department (e.g. engineering department, mathematics department); yet, the structure of mathematics courses is the same across disciplines, requiring students to complete 70-80% of the course assignments to be eligible for the final exam worth the entirety of their grade (Zakariya et al., 2022). However, the Norwegian university in this study is shifting from high-stakes assessment and has developed multiple attempts, multi-exam first-year mathematics courses to reduce stress and improve student outcomes. Additionally, this Norwegian university has a Center for Excellence in Mathematics focused on improving student outcomes through peer-to-peer tutoring.

Participants

Table 1. Participant pseudonyms and major.

Participants	
Pseudonym	Major
Ellinor	Mathematics Education
Issa	Software Engineering
Jonas	Mechatronics
Maimona	Artificial Intelligence
Minyguy	Mechatronics
Tito	Mechatronics

This preliminary study features six participants who were recruited from the same Norwegian institution in Spring 2024. Each participant self-identified as a FGCS (neither parent obtained a bachelor's degree), was enrolled in a first-year mathematics course, and anticipated majoring in a STEM field. Additionally, some participants held other identities or backgrounds that impacted their experiences in transitioning to higher education and first-year mathematics courses. However, some participants did not identify salient identities in addition to their major; as a way to ensure anonymity of participants in this preliminary study, we are only reporting the majors provided by the participants (see Table 1).

Methods

Author 1 recruited participants through in-person, in-class presentations, Canvas posts, and emails from second-semester STEM courses, including Calculus 2, Core Elements in Mathematics 2 (modeling with calculus, statistics, and probability), Mathematics 2 (linear algebra, differential equations, and multivariable calculus), and Discrete Mathematics 1 (logic theory, graph theory, combinatorics, and formal models). Six participant interviews were collected and analyzed for this qualitative study. Due to the linguistic diversity of the participants, we provided the option to answer questions in the language of their choice with the option of the interviewer later translating their responses. Each participant chose to complete the interview in English and interjected Norwegian, Danish, Arabic, or Kurdish words when applicable. Each interview lasted for about an hour and participants were compensated with a nominal monetary incentive card.

The in-person semi-structured interviews were recorded via Zoom, transcribed using Microsoft Word, and analyzed to determine the clarity, effectiveness, and overall function of the drafted interview protocol (Clark et al., 2021). We reviewed the transcripts to ensure the transcript accurately reflected the audio as well as to start the data familiarization process. Using qualitative analysis software (MAXQDA), we completed two abductive coding passes. The first coding pass captured instances of participants describing their mathematical background and mathematics course structure. The second coding pass focused on predefined capital (Yosso, 2005) and additional forms of capital that emerged from the data. Through thematic analysis (Braun & Clarke, 2012), codes were grouped and condensed into similarly themed clusters. The quotes within each cluster were summarized to develop emerging themes. An iterative comparison between the codes and summaries occurred which produced the preliminary results found in this paper.

Preliminary Results

Participants discussed how the structure of first-year mathematics courses supported their learning and the collaborative community of peers and instructors they built to successfully navigate first-year mathematics courses.

The Structure of First-Year Mathematics Courses

Mathematics courses at this Norwegian university met twice a week for “an hour and 30 minutes usually [with a] 15-minute break in the middle” (Ellinor). The courses were taught in a lecture-based format where students mainly listened to the instructor and followed along with examples. Tito described his mathematics course in the following way: “the teacher explain[s] basics of what we’re going to do and then shows [the] theory behind it, and then maybe some practical examples.” Maimona recounted her instructor’s didactic practices saying “[the instructor] does go through some tasks. And he asks us, what do you think about [the task]? How do you think you should solve [the task]?” Minyguy similarly described the instructional practices featured in class, “[the instructor] go[es] through different topics on the stand and they explain stuff and you can ask questions, but mostly it’s the teacher explaining stuff.” Overall, the participants’ mathematics courses included the potential for student practice but mainly relied on instructor lectures to convey the material.

Some mathematics courses were paired with a group seminar where students engaged in "practice tasks and the teachers [attended] to answer questions" (Minyguy). The practice seminar was used as additional time for students to engage with the material before assessments which regularly took place throughout the semester. Minyguy elaborated on the assessment structure in the following:

> There are five tests throughout the semester and you have four attempts on each one… I like that over having one major exam because it means that there is less of a last ditch effort right before the exam…You have multiple attempts, so there's not really that much pressure.

However, even with the opportunity to practice outside of class and a more forgiving assessment system, some students found the transition to lecture-based classes to be difficult. For example, Maimona shared "I didn't know how the lecture worked because in high school [I] had [a] different class system." Jonas also expressed how the transition to exam-only assessment proved difficult when learning the material, "I spent the first one or two months pretty much just becoming good at the tests instead of actually getting a grasp on what we were working with." Ellinor confirmed that although the transition to the Norwegian university was "as smooth as possible" until she started second-semester calculus where she "came to the first lecture, and everyone's already a week behind." The twice-a-week frequency combined with seminar space for students to practice and the multiple-attempt, multi-exam assessment structure provided FGCS the opportunity to form a mathematics community.

Creating a Collaborative Community with Peers and Instructors

Two students emphasized their relationships with their instructors in addition to their peers as contributing factors to their success in navigating first-year mathematics courses. Jonas realized building relationships with instructors was key to his success, "if I show engagement, [the instructors] show engagement with me. If I show interest, [the instructors] show interest in me. So that's really good." Ellinor and Jonas noted that instructors were keen on having students ask questions in or outside of class.

> It's just like our professors ask us. Say it. If there's something you don't understand, just say it which makes it a little easier to do. Say, I don't understand that, and then they'll just show it again. Explain it in a different way which helps a lot. (Ellinor)

Instructors encouraged students to speak up during class yet made themselves available after class for any lingering questions from students. Jonas recognized that if he just waited, "most of [his] questions [would] be asked and answered throughout the course, and if they [weren't], [he'd] get a one-on-one with the teacher afterward. [The instructors] put in time for it." The instructors of first-year mathematics courses were seen as approachable and supported student growth through encouraging questions.

In addition to collaborating with instructors, students believed that their friends were "quite gifted" (Issa). Multiple students attributed their success in first-year mathematics courses to working with their peers: "those moments when we collectively understand things is… it's probably one of the most fun things I've ever had in math cause it's just so satisfying" (Tito), "everyone wants everyone to do as well as they can, and that is absolutely a support" (Ellinor), and "I learned the topic better. They learn the topic better. I'm having fun. They're hopefully having fun" (Minyguy). Students mainly collaborated on solving problems from lectures and studying for their mathematics assessments. Maimona noted that she specifically utilized her peers for exam review and corrections because every computer-generated exam was different and the multiple attempts provided more opportunities to practice on a mastery scale. "I feel like that's actually the reason I'm passing that because I do have multiple tries and other people send me their exams that I get to practice" (Maimona). Tito similarly believed that multiple exams influenced how he studied material. "I sit down with my friends and actually solve the problems and learn a lot from having just that type of exam… that's made me learn more stuff which I wouldn't have done if I'd had an exam at the end of the semester."

The culture of collaboration is normalized by the university's Center for Excellence in Mathematics where students have the opportunity to work together in a dedicated mathematics space and seek help from trained peer tutors. Ellinor described the Center for Excellence in Mathematics as "one of the greatest resources [the university has] that is used a lot." Issa also called the Center for Excellence in Mathematics "a system [at the university] that's really helpful" and the tutors as "really great." Minyguy confirmed that "[the Center for Excellence in Mathematics] is very accessible, it's very low bar of entry." The Center for Excellence in Mathematics is a popular option for students to utilize; when "everyone has finals here and there, it's like you have to fight for the spot at [the Center for Excellence in Mathematics], because so many people sit there to work. And it isn't really like that big of a spot. It's just like a corner of the library" (Ellinor). The accessibility of and normalized nature of seeking assistance through tutoring resources influenced how students collectively worked together.

The collaborative essence of first-year mathematics courses at the Norwegian university encapsulated more than sharing old exams or cooperatively solving mathematics problems, students in these courses were genuinely supportive of each other's growth. For example, Ellinor described sharing notes with peers: "you don't have to give up your notes. It's your notes, but it's like, of course because they would do the same. We always exchange everything. And if someone can't be in class, it's okay, then we take extra good notes." Peer-to-peer support extends to meeting the needs of peers and ensuring everyone in the class has the resources to be successful. "Everyone wants everyone to do as well as they can, and that is absolutely a support. I think this helps everyone in our class. I think it's really important" (Ellinor).

Discussion

We found that FGCS at this Norwegian university primarily navigated first-year mathematics courses by adopting a mentality of partnership or interdependent learning (Ives & Castillo-Montoya, 2020) instead of competition, which is noteworthy given the detrimental impacts of competitive cultures in STEM on FGCS (Canning et al., 2020). The structure of mastery-level assessment and practice seminars provided students with the impetus to collaborate and support each other's academic success in mathematics, which is one of the biggest predictors of retention in STEM disciplines for FGCS (Dika & D'Amico, 2016). Building in-class peer relationships and peer tutor relationships proved to be the most successful navigational strategy for FGCS. However, this preliminary study is just one example of ways FGCS can be supported during their first-year mathematics courses. Additional research needs to be done to address other forms of capital FGCS in Norway are leveraging to persist in first-year mathematics courses. In future work, we anticipate expanding to include all forms of capital captured in CCW (Yosso, 2005) and hope to discover additional forms of capital that are unique to FGCS in Norway. We hope that our findings positively impact structures inhibiting FGCS success in Norway and beyond.

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