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Investigating Factors that Influence the Peer Tutoring Experience in Mathematics

Melissa Haire
University Of Connecticut, melissa.haire@uconn.edu

Fabiana Cardetti
University of Connecticut, fabiana.cardetti@uconn.edu

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Study Purpose

Quantitative literacy is considered a fundamental trait of college graduates; yet almost 50% of students fail to pass entry-level mathematics courses at a C-level or better (Saxe et al., 2015). Given the combination of inadequate preparation for success in college mathematics and a lack of motivation or mathematical confidence in students, significant further action is necessary to support students. One response has been the creation of quantitative learning centers (QLCs). They have become widespread on college campuses attracting large numbers of students across disciplines and influencing their mathematics learning. Thus, QLCs provide a critical venue to study crucial aspects of students' difficulties and corresponding successful pedagogical strategies which may help improve practice both within and outside the centers. However, we do not yet have a strong empirical base for understanding QLCs at this level. The purpose of our study is to help advance this understanding by investigating mathematics tutoring practices. Specifically, we focus on the factors that influence mathematics tutors' practice when helping their peers overcome mathematical learning challenges.

Theoretical Framework

QLCs use primarily peer tutoring: successful students help those in need in one-on-one or small group settings. Empirical studies at school level attribute peer tutoring to increased motivation and learning for students and tutors (Miller & MacGilchrist, 1996; Wentzel & Caldwell, 1997), avoidance of hierarchical power (Lopez, 2004), and tutors' growth (Parkin & McKegany, 2000). Although scant, research at the college level found that tutoring at QLCs has

a significantly positive effect in outcomes for at-risk students (Berry, Mac an Bhaird, & O'Shea, 2015), increased mean scores (Cai, Lewis, & Higdon, 2015) and final exam scores (Xu, Hartman, Uribe, & Mencke, 2001) for all students. Moreover, acceptance of peer tutoring as a viable approach at the college level is extensive (Ender & Newton, 2000; Falchikov, 2001; Mazur, 1997). These provide a sound basis to further examine this venue, especially with respect to tutors' insights about students' thinking, pedagogical decisions, and challenges that can inform teaching and learning beyond QLCs.

Methodology

We designed an exploratory study taking a qualitative phenomenological perspective (Moustakas, 1994) on the research question: *Which factors influence QLC tutors' practice when helping their peers overcome mathematical learning challenges?*

To address this question we observed six tutors at our QLC (details in Table 1) during tutoring shifts focusing on tutor-student interactions and the strategies that tutors used. Participants were volunteers who responded to an email sent by the research team to all mathematics tutors at the QLC. Semi-structured interviews followed the observations, where tutors reflected on specifics from the observation and their practice at the QLC in general. Observations and interviews were conducted by the graduate student researcher. Transcripts were analyzed by both researchers using thematic analysis to allow themes to emerge naturally from the data (Grbich, 2013). Data from observations served to supplement and support emerging themes.

Table 1
Study Participants

Pseudonym	Academic Year	Tutoring Experience at QLC	Courses they frequently tutor

Trace	Senior	Three semesters	Calculus I, II, III Business Math Business Calculus Differential Equations Linear Algebra
Shaniya	Senior (fifth year)	Eight semesters	Calculus I, II, III Business Math Business Calculus Differential Equations Linear Algebra
Wayne	Second year PhD	12 semesters	Calculus I, II, III Differential Equations Linear Algebra Some Statistics
Seth	Senior	Six semesters	Calc I, II Business Math Business Calc Stats I, II
Elias	Sophomore	Two semesters	Precalc Calc I, II, III Differential Equations
Drake	Junior	One semester	Calc I, II, III Business Math Business Calculus Linear Algebra Differential Equations

Results

Our analyses of the data rendered codes that were subsumed into themes as presented in Table 2. We found that tutors' practices are guided by their understanding of *students' predetermined goals* for the session which are not necessarily related to the *challenges* that tutors identify as the primary cause for their peers' difficulties. Another factor that surfaced was their view of the *nature of mathematics* involving flexibility with the material that they do not see fully developed in students. Their practice is primed by their *tutor identity* which informs the

different *strategies* they choose for helping their peers. Details connecting each theme with its corresponding codes are presented below.

Table 2
Themes and Codes

Theme	Codes
Students' Predetermined Goals	Online homework, Getting the answer, New concepts
Challenges	Prerequisites, Functions, Learning from lectures
The Nature of Mathematics	Intuition, Creativity
Tutor Identity	Power dynamics, Be relatable, Avoid just giving the answer
Tutoring Strategies	Make interpersonal connections, Make connections to what the students know, Engage students, Avoid overload, Check understanding

Goals

Tutors identified online homework help as a predetermined goal of students who seek help. Additionally, tutors felt that students come with a focus on just getting the correct answer rather than understanding the mathematics behind it. Tutors also identify newer concepts as the catalyst for students to seek help.

Challenges

Tutors recognize that lack of understanding of prerequisite knowledge can hinder students' success. They specifically mentioned that many students do not have a firm grasp of the concept of a function and this affects their ability to understand the new concepts they are learning. Another challenge that arose was the struggle for some students to learn from lecture.

Mathematics

Data also revealed the tutors believe the nature of mathematics involves a level of creativity that their peers may be unaware of. They also showed a desire to help students gain intuition about how to incorporate the concepts they were learning to solve problems.

Identity

An important facet of peer tutoring is that the student-instructor power dynamic is not present. Tutors attempt to relate to students at their level to make the experience more comfortable and friendly suggesting that this facilitates students' learning. They also work hard not to just give away answers but to help students discover the solutions themselves.

Strategies

Two tightly related strategies surfaced. First, tutors get to know the students so that tutoring is more enjoyable and they can enact the second strategy effectively by making connections with other math concepts or real-world applications relevant to the students. Then, asking questions as they move along helps keep students engaged and gives tutors a gauge of the students' knowledge. Tutors cautioned against introducing too many concepts at once as the students may become overwhelmed. Finally, to compensate for confusion that the student may not realize or want to admit, tutors ask questions throughout the session and create similar problems to probe for understanding.

Conclusions and Educational Implications

QLCs provide support to vast numbers of students across disciplines. Investigating the experiences of tutors can give insight into the mathematical needs of the students and provide a new frame through which to consider how we can improve the college mathematics learning experience. Our study contributes to this research by highlighting important factors of the peer-

tutoring experience. These results can be considered as an avenue for improving tutor training and can be readily extended to other teaching contexts such as office hours, discussion sections, and the classroom itself.

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