Tutors' Perceived Differences in Working With Students on Online and Written Homework

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Mathematics tutoring centers are places where students learn math, but little work exists about learning from tutoring. Much of the research about tutoring is from an observer's perspective. We build on this work by presenting a study of tutors' experiences and actions when tutoring students with written and online homework, as described by tutors. We also suggest ways the Instructional Triangle could be adapted to account for the presence of a tutor as an agent in learning.

Keywords: tutoring, online homework, instructional triangle, written homework

Introduction and Background Literature

Undergraduate peer drop-in mathematics tutoring is generally defined as a collaborative educational support system in which experienced students assist their peers with course material with no specified time for a particular interaction (Burks & James, 2019; Johns, 2022; Johns & Burks, 2022; Johns et al., 2022; Mills et al., 2020). Previous research has indicated that the majority of higher education institutions in the United States provide some form of mathematics tutoring (Bressoud et al., 2015; Mills et al., 2020). Moreover, studies have shown that undergraduate peer mathematics tutoring may correlate with improved final grades, increases in students' mathematical confidence, and more ownership in the learning process (Byerly et al., 2018; Rickard & Mills, 2018).

Tutoring centers play a critical role in providing peer homework help, which is a crucial supplement to undergraduates' learning experience (Johns, 2022; Lepper & Woolverton, 2022; Topping, 1996). Undergraduate students are expected to dedicate significant time outside of the classroom to complete homework assignments and study (Dorko, 2020, 2021, 2024; Ellis et al., 2015; Krause & Putnam, 2016; Lew & Zazkis, 2019; White & Mesa, 2014). Instructors and students view homework as essential to learning (Dorko, 2019, 2021; Glass & Sue, 2008; White & Mesa, 2014). Hence, at the undergraduate level, students tend to have written and/or online mathematics homework (Kehoe, 2010; White & Mesa, 2014). However, there is a paucity of research comparing differences in online and written homework in terms of the activity of the people who might be involved in doing it – that is, students and tutors. Our study, which looks at tutors' experiences with tutoring online and written homework, contributes to a better understanding of learning from homework.

Although undergraduate mathematics peer tutoring is common, the research community is just beginning to focus on this out-of-the-classroom learning context. Some work has been done. For example, Johns and Burks (2022) discuss the general structure of a tutoring interaction as students seek assistance from a tutor, the tutor asks them what they need help with, students request help with broad content material or, more commonly, ask for assistance with a problem where they have hit a dead end or cannot find an error in their work. The tutor-tutee interaction concludes when the tutee has an answer accepted by the homework system or when the tutor and tutee agree upon an acceptable solution or summary of the problem. Johns et al. (2022) did a finer-grained analysis, looking at the observable actions tutors made during an interaction with a student. Their study identified 83 observable behaviors through the examination of 31 tutoring interaction transcripts. These behaviors were subsequently classified according to knowledge type (i.e., Factual, Procedural, Conceptual, and Metacognitive) and further organized into specific categories (e.g., Supplied Facts, Immediately Reducing Cognitive Orientation, Heuristics, etc.).

The Johns et al. (2022) work was from an observer's perspective. Few studies have explored the knowledge and experiences afforded when carrying out the work of tutoring with different homework platforms (Johns et al., 2022). Our study, by interviewing tutors about their experiences and activities when tutoring written and online homework, aims to help fill that gap. That is, a key contribution of our work is adding to the knowledge of tutoring actions by documenting those actions from two tutors' voices.

A second contribution is the expansion of the Instructional Triangle theoretical framework (Cohen et al., 2003; Herbst & Chazan, 2012) to describe tutoring. This framework, which conceptualizes instruction as interactions between an instructor, students, and content, does not, in its current form, provide a useful way to look at tutoring. Hence, the paper focuses on the following three research questions:

1. What are some of the ways the Instructional Triangle can be adapted to account for the presence of a tutor?
2. What differences do undergraduate peer drop-in mathematics tutors experience while tutoring in the context of online homework as compared to the context of written homework when working with students?
3. What differences do undergraduate peer drop-in mathematics tutors describe in their tutoring actions when working with students in the context of online homework as compared to the context of written homework?

Introduction and Background Literature

We follow Cohen et al. (2003) in defining instruction as interactions between teachers, students, and content, situated in environments. Cohen et al. (2003) use the teacher, student, and content as vertices of the Instructional Triangle (IT). Edges of the triangle represent interactions between vertices, which need not occur face to face but are defined as encompassing the collaborative work of teachers and students. For example, an interaction may include a student engaging with a teacher-assigned written homework. Others have used the IT to study student learning in various environments, including student learning from homework (e.g., Dorko, 2020, 2021; Ellis et al., 2015).

Herbst and Chazan (2012) elaborated on the IT to frame studies of teachers' work. Their triangle, developed to focus on the teacher's perspective, does not account for the presence of a tutor in undergraduates' learning. In our study, tutors are humans who have face-to-face interactions with students around content. Tutors also have their own content knowledge and have historical and "present" interactions with instructors. As an example of the former, tutors may be tutoring for a class they previously took as a student and hence know something about the instructor's aims for a particular problem. As an example of the latter, professors may communicate with tutoring centers about homework to support more efficacious tutoring interactions. It is necessary to figure out where the tutor should be in the IT to employ the IT to study tutoring interactions. One possibility is as a resource, since the role of a tutor is that of a helper. We argue that because tutors are humans - like the student and teacher - positioning them as a resource is limited. Instead, we propose a theoretical modification to the IT framework that integrates a tetrahedral model with a tutor as one of the vertices (Figure 1). We developed this model on the hypotheses stated above: there are interactions between tutors and students, tutors and professors, and tutors and content. We propose that the incorporation of a tutor vertex within the IT is imperative in fully elucidating the experiences and actions of undergraduate drop-in peer mathematics tutors during their interactions with students on both OHW and WHW. This model, shown in Figure 1, guided our data collection. In data analysis, we sought to verify and refine our hypothesized model.

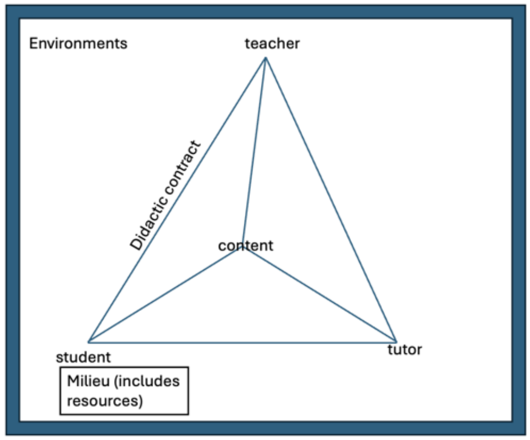

Figure 1. Our proposed modified IT with a tutor component resulting in a tetrahedral model.

Methods

The data comes from transcripts of 45-minute audio-recorded narrative interviews (Agee, 2009; Tracy, 2019) with two undergraduate drop-in peer tutors at a large public university in the United States in the spring of 2024. The first author selected two participants who worked at the university's mathematics tutoring center, possessed a minimum of two semesters of tutoring experience to ensure their familiarity with tutoring, and had experience working with students on OHW and WHW. Interview questions focused on having tutors describe their interactions with students when doing online homework and when doing written homework.

To analyze the data for RQ1, we aimed to verify and refine the six theoretical tenets we hypothesized (Figure 1; edges: tutor-student, tutor-professor, tutor-content; faces: tutor-student-content, tutor-student-teacher, tutor-teacher-content) and to identify theoretical tenets that are important but that we did not account for in our hypothesized model. We sought quotes that represented each of the six components (verify/refine our hypotheses) and instances that did not fit into those six components (identify new important parts of a model). This process allowed us to confirm, refine, and contest our expanded model. If we had at least one quote for a tenet, we kept it in the model. We had quotes supporting all six hypothesized components. With the quotes that did not fit in the model, we sought themes via grounded theory (Strauss & Corbin, 1998). That is, we looked for themes within the quotes. The emergent themes were the didactic contract and tutors' experience with the milieu. To analyze the data for RQ2 and RQ3, we used grounded theory to seek themes in tutors' experiences and actions.

In analyzing the data for RQ1, we read one transcript together, highlighted any statement that commented on an experience with a particular homework format, and then looked for themes in the statements. We then individually read the second transcript, coding it with the themes we had identified. We met to compare our coding of the second transcript, added to our list of themes, and then re-coded the first transcript together. This supported the validity of the analysis. The analysis for RQ2 and RQ3 was the same iterative, together/separate/together procedure. In the analysis for RQ1, the difference in coding was that we were looking for themes we hypothesized, with our minds open to themes we had not thought of.

RQ1 Results: Adapting the Instructional Triangle to Account for Tutoring

We found evidence of the three additional edges and three additional faces we hypothesized (Figure 1), as well as three emergent components. The emergent components were the didactic contract between the tutor and student, the didactic contract between tutor and instructor, and the tutor's knowledge of the milieu. Figure 2 shows the visual answer to RQ1; the verbal answer is that the IT can be adapted by adding a tutor vertex, the edges, and faces between the other vertices that represent the interactions with the other vertices/edges and make the model a tetrahedron; and by considering the didactic contract between the tutor and student, the didactic contract between tutor and instructor, and the tutor's knowledge of the milieu.

Due to space limitations, we provide evidence for only some of the edges and faces we hypothesized to be important, though the data contain evidence that all exist and are key components of an IT model that accounts for tutoring.

As an example of the tutor-content edge, tutors drew on their own content knowledge to make sense of questions in written homework. For example, Tutor 1 said, "written homework sometimes it's like okay, how should this be interpreted… I have to just say, 'I think this is how it should be interpreted'". We infer that the tutor drew on his knowledge of math to interpret the question. As an example of the tutor-content-instructor face, a tutor said online homework often followed class notes. We infer tutors looked at class notes to help students and see class notes as a way tutors and instructors interact because students tend to write what professors write (Lew et al., 2016). That is, the instructor communicates content to the tutors via class notes.

The first emergent component was that tutors felt there were expectations between the tutor and instructor, which we call a tutor-instructor didactic contract. For example, a tutor said tutoring interactions were "like trying to explain concepts, explain stuff, but you're not in a lecture situation… it's almost like you're trying to explain like the bare minimum to get this problem". Another tutor agreed, saying, "I catch myself… trying to explain this concept from scratch when that's not what I'm supposed to be doing… I'm not supposed to be replacing a professor." We infer the tutor expected the instructor to have explained the concept fully and the tutor expected to be able to fill in gaps or explain just enough for the student to connect back to what they had learned in lecture. These quotes are some of the evidence that tutors have expectations for instructors. They also support our hypothesized tutor-instructor edge because tutors thinking about the instructor represents a tutor-instructor interaction.

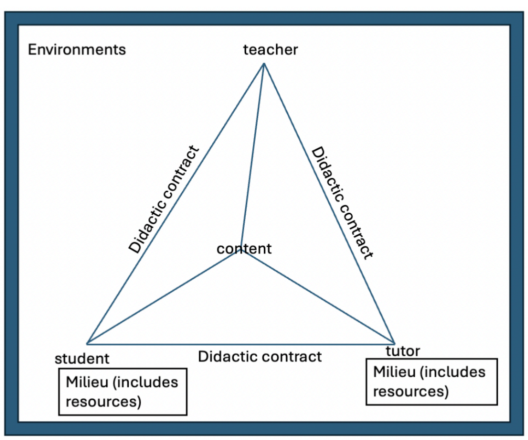

Figure 2. Our adapted tetrahedral model to include the three emergent components.

The second emergent component was a didactic contract between tutors and students. Tutor 1 said, for instance, his job “isn’t to make sure the student gets homework right” but rather “learn with the student or like help, bare minimum, make sure the student is better off than when you sat down with them.” This emphasizes the role of tutors as supporters of learning and growth, rather than just correctors of mistakes.

The third emergent component was the tutor’s knowledge of the online homework platform (in this framework, a milieu). Tutors described how their experience with online homework affected their interactions with students. For example, Tutor 1 described, “the student is frustrated because they’re like, I thought I did this right’ and then I look at it and I’m like, oh, well, actually, I’ve seen this before, you have the right answer, there’s a formatting thing that’s wrong.” This quote shows how the tutor knew online homework platforms often have precise expectations for answer format. A tutor also described how he felt written homework was “more detailed, it’s more intricate… questions that require you to think about things in certain ways” whereas he felt the online homework was “practice, practice, practice.” That is, tutors had different expectations and activities for the different milieu, which was reflected in their activity with students because of the ways they helped students navigate the two milieu. RQ2 and RQ3 lend insight into the nature of that navigation.

RQ2 Results: Differences in tutors’ experiences working with students on OHW vs WH

The answer to RQ2 is the list of themes that describe the differences in tutors’ experiences working with students on online homework as compared to written homework. These themes were the frequency with which they were asked questions about either, that students were more reliant on solution templates and online resources for OHW, that they thought more about the instructor while tutoring WH, that the expectations for correctness felt different, that students were more willing to write for WH, and that the differences between OHW and HW depended on course level.

Tutors differed in whether they said they answered more questions about written homework, or more questions about online homework. Tutor 2 said he fielded more written homework questions because those assignments were “usually created by the professor, so [students are] not going to Google and find that. [They] have to come in person”. That is, he attributed the difference in number of questions asked to the availability of resources. In contrast, Tutor 1 answered more questions about online homework, which he thought was because students simply had more online homework tasks than written homework tasks.

Tutors said one difference in their experience with the two formats was that for lower division courses, HW and OHW were similar and tended to follow the notes, but upper division courses’ WH differed from OHW because “[instructors] are able to get a lot more creative and force a lot more of like critical thinking into [it]” (Tutor 1).

Both tutors described a key part of their experience with OHW was working with students on template-based solutions, which was not the case with WH. Tutors detailed how, on OHW, students often defaulted to pattern-matching strategies from worked examples and were less inclined to engage deeply with the material. Tutor 2 said, “the most frustrating thing sometimes is the trying to pull them away from ‘I saw [the solution] online, and they did it this one way’… it kind of like sucks them in… I try and be like ‘yes, I understand that, but let’s look at it like this’… in terms of like online versus written homework… the biggest struggle… it’s just trying to get them in the realm where they’re open to like different approaches to solving the problem.” That is, the tutors felt students were attached to worked examples in OHW, and more open to problem-solving in WH.

Tutors described how they thought more about the instructor's goals and expectations with WH than they did with OHW. They often discerned the instructional design of the problems, in part because they often had taken a particular class with that professor. Tutor 2 commented, "different professors will look at things very differently" and that they knew professors often wanted "certain things shown in certain ways."

Part of tutors' experience with the two formats was helping students navigate their affect toward the two formats. Tutors described helping students work through frustrations with OHW platform constraints, something they did not have to do with WH. For instance, the tutors talked about students being frustrated with OHW wanting answers in particular formats, or students feeling demoralized by having limited attempts. Tutors also described students "enjoy [WH] less" than OHW because students felt WH sometimes had "confusing wording" or required more critical thinking. They also said students were more willing to write on paper on WH, while getting students to write anything down on an OHW task was challenging.

Tutors described one difference in formats was whether they knew their answers were correct, though Tutor 1 said he knew his job "isn't to make sure the student gets homework right. Your job is to learn with the student or like help, bare minimum, make sure that the student is better off than when you sat down with them… written homework… we don't get feedback on it." The tutor noted that OHW gave immediate feedback as to correctness.

Finally, tutors noted that a key difference in their experience between working with students on the two formats was students' willingness to write. Tutor 2 said, "in WH… you have to write it. It's not on a screen… it takes less effort for me to get them to be doing stuff… in WH… they are expecting to write. Online HW, it's on the computer… you do see students more willing to engage [with WH] because the more that they're writing, the more that they're thinking about it". In summary, the tutors found students were more willing to write and engage in work on WH than OHW.

RQ3 Results: Differences in tutoring actions for OHW and WH

To identify the differences in tutoring actions for OHW and written homework, we found themes in their actions for both milieu, then compared and contrasted the themes. We found in OWH, tutors worked with students to navigate using platform-provided similar examples; sought procedural and conceptual mistakes in students' work; had students explain problems; leveraged immediate feedback; directed students to resources; encouraged students to write down their work; and had students attend to particularities in the formatting of answers. We found in WH, tutors worked through problems themselves while modeling their process for students and directed students to use their course notes.

As an example, both tutors talked about how a key difference in their activity for OHW and WH was that in the former, they spent a lot of time helping students make sense of the worked solutions available in most OHW platforms (called "Help Me With This" (HMWT) in one platform) at the click of a button or directing students away from that resource. For instance, Tutor 2 tried to avoid HMWT. He said, "I always try to steer away from…usually I have them explain the problem, and then if [the students] have work, I'll start to go through that, and that's usually where I catch mistakes. Sometimes I'll catch the conceptual mistakes". Tutor 2 also describes here how when tutoring with OHW, one of his actions was to try to identify mistakes.

As another example, tutors leveraged electronic resources with OHW and directed students to those resources. For instance, Tutor 1 said he used the immediate feedback and multiple tries with online homework to try ideas, telling students, "I like the idea that you have, let's go through that, see if that answer's right". Tutor 2 said he used online resources a lot, describing “online homework, it’s easier to get them to approach a question graphically. ‘Oh hey, can you open a tab of Desmos? Like that kind of stuff is a lot easier to show online than written”.

As a final example of a difference tutors noticed in their activity with OHW versus written, tutors said they spent time encouraging students to write their work down in OHW. One said of WH, “this is on paper, you have to write it” and so students more naturally wrote steps in written homework, but had to be reminded the same could be useful for online homework.

Tutors described in written homework, some of their activity entailed thinking about how the professor wanted the students to approach the problem, and they often directed students to look at their class notes. Tutor 2 described that the WH were usually “tailored specifically to the notes”.

In summary, the answer to RQ3 is that the key differences in tutoring actions between WH and OHW were related to the nature of the various milieu. In OHW, much of the tutors’ activity was helping students to navigate the resources available online, while in WH, much of their activity was helping students to leverage their resources from class.

Discussion and Conclusions

We aimed to build the body of knowledge about tutoring by adding tutors’ voices to complement literature about tutoring actions from an observer perspective. While Johns et al. (2022) conducted a fine-grained analysis of tutoring session transcripts by open coding, our study introduced the invaluable voices of the tutors themselves, thereby contributing new insights to the field. In akin with Johns et al. (2022), our research also identified specific instances where tutors employed specific actions to actively engage students and facilitate their understanding of mathematics.

We also aimed to build the body of knowledge about student learning from homework. We did this by comparing written and online homework from a tutoring perspective. We found many of the differences in tutors’ actions and experiences were related to differences in milieu, in particular, students’ reliance on worked solution templates in online homework. Our finding affirms those of Dorko et al. (2023) and Dorko (2021, 2020) that such templates often play a key role in students’ online homework completion.

A key area for future work is to describe the specific content students learn from tutoring interactions, and how tutors contribute to that learning. We hypothesize the adaptations to the IT that we have proposed are a possible frame for such work. Another area for future work is to continue to develop this adapted model of the IT, in particular, because our adaptations were based on interviews with only two tutors.

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