Group Study in Calculus Courses at Brown

Mark Howison

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Introduction

This report describes an informal questionnaire I conducted of students enrolled in intro calculus courses (MA9/10/18/20) during the Spring 2006 semester at Brown University. The purpose of the questionnaire was to obtain feedback from students regarding their perceptions of and attitudes toward the use of group work in learning calculus. During the semester, I started a weekly group study session in cooperation with Brown's Academic Resource Center and the Women in Science & Engineering (WISE) program to provide group tutoring to students seeking additional help. I advertised this session at the beginning of the semester in two MA20 and two MA10 courses by giving brief verbal announcements. The session was also advertised in Brown's campus-wide email bulletin (Morning Mail). It drew a weekly attendance of roughly 10 to 20 students, about three-quarters of whom were regular attendees. Informal conversations with and observations of these students led me to develop the questionnaire.

Methodology

My primary design concern was to make the questionnaire efficient, that is, quick and easy to fill out. I included 5-point Likert scale questions and open-ended questions so that the data set would include both quantitative and qualitative data (McKnight et. al., 2000, p. 73). The questionnaire was adminstered online to increase the response rate and to eliminate having to enter data from paper forms. Also, the easiest way to notify all MA9/10/18/20 students was through the department's email lists for those classes, which made an online questionnaire a natural choice.

Participants were asked to respond to the following statements using a 5-point Likert scale of 1 (strongly agree), 2 (agree), 3 (neutral), 4 (disagree), or 5 (strongly disagree):

Q1. This calculus course accomodated my learning style.

Q2. Lectures were helpful in improving my understanding of difficult concepts.

Q3. Office hours or tutoring sessions were helpful in improving my understanding of difficult concepts.

Q4. I prefer to work on homework alone.

Q5. Mathematics is a social activity.

Q6. I am good at math.

The following open-ended questions were also asked:

Q7. Were you aware of opportunities for group study? Did you organize or participate in any group study sessions? If so, how were these helpful or unhelpful? If not, why not?

Q8. How frequently did you attend office hours or TA hours? Did you find them helpful? Why or why not?

Q9. Are there any additional comments you would like to make?

For the quantitative Likert scale data, I simply construced a table of the mean and frequency of responses for each question. I used 'content analysis' on the open-ended responses by developing simple categories for recurring responses, then ennumerating the occurences of each category (McKnight et. al., 2000, p. 82). In addition, I excerpted particularly informative responses for discussion in the conclusions section.

Results

There was a total of 118 responses. Table 1 shows the mean and frequency of responses for each of the Likert scale questions.

Out of the 118 total responses, 111 addressed at least one of the open-ended questions. Of these, 47 included only fragments or single sentences and the rest included more complete responses. Table 2 summarizes the occurence of open-ended responses fitting the selected categories.

Conclusions

The results for Q4, Q5, C2 and C4 indicate that students in calculus courses at Brown this semester value both individual and group work as part of those courses. Therefore, an accomodating sequence of calculus courses needs to provide students with opportunies for both.

However, students who prefer individual study had several resources at their disposal, notably office hours with professors and TAs, the Math Resource Center, and tutoring sessions arranged through the Academic Resource Center, all of which provide mostly individual atttention. Moreover, the results for C5 and C6 suggest that students are for the most part happy with and utilizing these resources.

On the other hand, group study appeared to be coordinated more informally. For instance, several students indicated in their written responses that they arranged to work together with students who lived on their floor. Informal arrangements can certainly be

Table 1: Descriptive Statistics for Likert Scale Data

	Mean	*Frequency* (1)	(2)	(3)	(4)	(5)
Q1	2.88	13	39	28	25	13
Q2	2.81	16	41	21	24	15
Q3	2.39	26	37	37	9	7
Q4	2.92	22	27	33	22	14
Q5	2.97	10	31	39	29	9
Q6	2.49	14	53	34	13	4

Table 2: Occurence of Categories in Written Responses

Category	*Tally*	*Percentage*
C1. Unaware of group study opportunities.	29	26.1%
C2. Organized or participated in group study (informal or formal).	27	24.3%
C3. Aware of group study but chose not to or unable to participate.	22	19.8%
C4. Prefers studying alone.	11	10.0%
C5. Attended instructor or TA office hours or section twice or more.	38	34.2%
C6. Unhappy with some aspect of office hours or section.	8	7.2%

valuable for these students, but a more structured resource for coordinating group work, such as the WISE session, can provide opportunities for students who are interested in group work but might otherwise not meet.

One argument for the use of group work in calculus instruction is that it encourages students to explain their thinking to other students and in the process solidify their own understanding. For instance, MA20 student Brian Bayes observed,

> Helping others to understand the concepts that were insufficiently explained in class was most helpful in developing my own understanding of the material.

This argument is rooted in Russian psychologist Lev Vygotsky's constructivist theory of learning, which holds that an individual constructs knowledge by organizing and internalizing social interactions (Steffe and Tzur, 1994, p. 10-11). Thus, as students work within a group setting to communicate their mathematical knowledge, they are also restructuring and developing that knowledge.

Yet, students also construct mathematical knowledge through working individually. An important consideration for effective group work is the individual preparation of the participants, as two different MA10 students indicated in their responses.

> I think it [group study] works best though when everyone tries the homework themselves and then collaborates to check their work and answer hard answers.

> Group studies are great when everyone has already studied and wants reinforcement of their knowledge but usually no one is prepared until late the night before.

A valid criticism of group work is that it allows some students to avoid engaging with the material by simply working off of or copying from other students' work. It is essential that students come to group sessions prepared to get the most out of interacting with their peers.

Another criticism of group work is that it can degenerate into unproductive socialization. Alexandra, a MA10 student, reported,

> I find a lot of time wasted while trying to study in groups because it is too appealing to converse on other less relevant topics.

Keeping students on task is a responsibility that the tutor moderating the group session may choose to take on.

Group work is also inherently political, and some students don't always get what they want out of it. An anonymous MA10 student wrote,

> I went to one homework-help session in Sayles Wednesday night but didn't find it particularly helpful due to the extended amounts of times spent on a single topic.

Again, the tutor can moderate the group sessions so that they accomodate as many of the participants as possible. However, I found that in the WISE sessions, excessive intervention ruined the spontaneous, student-driven nature that often turned out to be beneficial.

Finally, many of the responses, including the following by an anonymous MA20 student, echoed a narrow focus on homework.

> Though in general I tend to work more efficiently alone, the group study sessions were helpful because I could compare answers with my peers and tackle problems together.

This focus on 'problems' and 'answers' permeated the WISE sessions. Ocassionally, a participant would ask a question about when or how to use a concept, such as a theorem, that would then lead into a productive discussion of mathematical ideas. More often, unfortunately, questions and group interactions revolved around the mechanics of doing the homework, with questions such as "Is that the right answer?" and "Did you check the back of the book?" I attribute this to the structuing of calculus courses at Brown almost exclusively in terms of lecture, problem sets, and exams.

Limitations

The validity of the questionnaire is limited by its reliance on students self-reporting about their learning habits and styles.

Additionally, the Likert scale has documented biases, such as automatic agreement to statements as they are presented. For instance, using the statement "I prefer to work on homework alone" may lead to different results than using "I prefer to work on homework with others" if respondents are focused on presenting agreeable responses.

Most importantly, though, this case study was both simple and informal. A more complete and formal study would include, for instance, longitudinal components and a wider variety of data collection and analysis methods.

References

McKnight, C., et. al. *Mathematics Education Research.* Providence, RI, USA: American Mathematical Society, 2000.

Steffe, L. and Tzur, R. "Interaction and Childrens Mathematics" in *Constructing Mathematical Know ledge.* Ernest, P. (Editor). Wastington, D.C., USA: The Falmer Press, 1994.