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How to assess students' learning in mathematics literacy education: An attempt to use students' comments for assessment

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Research objective and questions.

It is increasingly important for all students, regardless of educational level, to acquire mathematical skills for use in various contexts, especially in real-world situations. An education that fosters such skills is often referred to as *mathematical literacy education*, the aim of which often includes improving students' attitudes toward mathematics and deepening their interest in the subject. This raises the question, "How can we assess the success of such courses?" Accordingly, this study focused on students' text feedback, which is a rich resource that represents students' learning and attitudes (cf. Di Martino and Zan, 2010), and examined whether students' comments could be useful in assessing their mathematical literacy learning. With this aim, this study analyzed the students' reflection comments collected during one semester. Our research questions are as follows:

(RQ1) What categories are identified in students' reflection comments?

(RQ2) Do the students' responses stem from their actual learning? Or do they instead stem from their prior learning in high school or even from their attitudes at the beginning of the course?

Two analyses on students' comments in mathematical literacy education.

A qualitative and quantitative analysis was conducted on students' comments collected during a mandatory one-semester mathematical literacy course for first-year students in social sciences and humanities majors. The course was designed as "learning mathematics through application," but the lecturer emphasized the nature of mathematical knowledge in each lesson. Students' reflections were collected over 14 weeks from an area reserved for comments on each lesson's worksheet. There were 68 first-year students in the class, and a total of 952 comments were collected. We distributed a questionnaire at the beginning of the course; before the students attended the class, we collected data on their courses in high school (science-oriented or humanities-oriented) as well as their attitude toward mathematics (good/bad at math, like/dislike math), using a five-point Likert scale.

The first analysis focused on RQ1, and an open coding method was used to determine a set of categories in order to understand how students described their learning. In the analysis, students' comments were segmented, and we assigned one code to each segment. The analysis was conducted with the help of the following three models: a three-dimensional model for attitudes toward mathematics by Di Martino and Zan (2010); the three phases of learning by Polya (1981, chapter 14); and the ICE model (Fostaty Young and Wilson, 2000), in which learning outcomes are distinguished in three levels. We found seven important categories that indicate learning progress or attitude improvement. We listed the categories with short explanations, and indicated the percentage of comments containing segments that were assigned with the codes: IA (expressing their Interest in Application, 17.1%), IM (expressing their Interest in Mathematics, 17.2%), MR (expressing their

Metacognitive Reflection, 7.9%), EL (expressing their Enjoyment of the Lesson, 7.9%), RQ (Raising Questions that extend their learning, 5.1%), MM (expressing their Motivation in using/learning Math, 8.5%), and RA (expressing their Reduced Awareness of being bad at math, 2.4%). IM and RA were regarded as being related to “vision of mathematics” and “perceived competence” in the model of Di Martino and Zan, respectively. MR was regarded as being related to a phase of “verbalization and concept” in Polya’s model and to a level of “connection” in the ICE model.

The second analysis focused on RQ2. Using statistical analysis, this study examined the codes IA, IM, and MR, and investigated whether the frequency of comments corresponding to each category per student depended on students’ courses in high school or on their attitude toward mathematics at the beginning of the course. For the second analysis, this study set the following groups based on the students’ answers for the aforementioned questionnaire: S+/S- (students who took science-oriented/humanities-oriented courses in high school), G+/G- (students who are good/bad at math), and L+/L- (students who like/dislike mathematics). The numbers of students in each group were 24 (S+), 43 (S-), 13 (G+), 38 (G-), 19 (L+), and 29 (L-). Next, the differences in the frequency of comments corresponding to each category per student between S+ and S-, between G+ and G-, and between L+ and L- were examined. A significant difference was found in the frequency of MR per student between L+ and L-. A Mann-Whitney test indicated that the frequency of comments containing descriptions corresponding to the rate of MR per student was greater for L- (Mdn=1) than for L+ (Mdn=0), U=371.5, p=0.032. No significant difference was found for other codes, and no significant difference was found between the differences in students’ courses in high school.

Discussion.

The first analysis showed that students’ comments collected from lessons in a mathematical literacy course contained multiple descriptions, including both their attitudinal change toward mathematics and their metacognitive reflections. An interesting result of the second analysis was that less-motivated students showed better results in terms of metacognitive reflection. The second analysis also suggested that students’ comments that showed their interest in mathematics or their metacognitive reflection did not stem from their prior learning in high school or their attitude toward mathematics before attending the course. These results seem to indicate that students’ comments are potentially useful to assess their mathematical literacy learning. However, more research is needed. One of future tasks is to analyze the changes in students’ comments over time.

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