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# A practical study of a design of university mathematics courses for humanities and social sciences students

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## Problems in university mathematics education: in the Japanese context

It is becoming more important for all students regardless of educational level to acquire the ability to use mathematics in a variety of contexts, especially in real world situations (Niss & Jablonka, 2014). From this viewpoint, mathematics education for non-mathematics students at university is becoming an important issue; however, it is still under-investigated (Artigue, 2016). In Japan, it is an emergent issue that we have no successful mathematics curriculum designed especially for humanities and social sciences students. Many of those students have math anxiety and difficulty in doing and learning mathematics, and do not understand how mathematics is used in the real world. Hence mathematics education for those students is a challenging issue.

## Design principles of mathematics courses for humanities and social sciences students

Continuing empirical studies from our previous research (Kawazoe et al., 2013), we have developed the following design principles of mathematics courses for humanities and social sciences students: (1) Design lessons according to mathematical modelling processes; (2) Choose topics and contexts by considering which mathematical knowledge students will encounter in real life and in which situations they will encounter it; (3) Present problems in different contexts associated to the same mathematical knowledge; (4) Connect different areas of mathematical knowledge by using different *mathematizations* of the same problem or mutually related contexts; (5) Explain mathematical concepts and operations in both mathematical language and everyday language; (6) Engage students in group activities rather than individual activities; (7) Design worksheets based on hypothetical cognitive processes of students' understanding and use them as tools for formative assessment.

The above principles originate in the four perspectives of learning environments developed in learning science (Bransford, 2000, Chapter 6). The first four principles (1)-(4) also originate in discussions on mathematical literacy (cf. Sfard, 2014) and mathematical modelling (cf. Kaiser, 2014). Especially, (3)-(4) are aimed at making students' knowledge *decontextualized* and *structuralized* respectively, because it is often claimed that teaching mathematics in real world contexts makes students' knowledge restricted to the learning contexts (cf. Sfard, 2014). In a previous study (Kawazoe et al., 2013), we showed that mathematics courses designed according to the above principles are successful in reducing students' math anxiety and motivating them to learn math. However, their effectiveness for decontextualization and structuralization was not examined. To examine this effectiveness is the research objective of the present study.

## Evaluation of decontextualization and structuralization

To evaluate the effectiveness of our design principles for decontextualization and structuralization, we analyzed the performance of examinations and the free descriptions in the self-report questionnaires conducted at the end of each semester in *Basic Math I* and *Basic Math II*, which are successive one-semester mathematics courses for humanities and social sciences students designed according to the above principles. The data were collected in the academic year 2012, when 300 and 244 students took the courses respectively, with students divided into four classes.

The examinations mainly consisted of problems in real world contexts, but the contexts were different from the learning contexts. The mean scores of the exams of Basic Math I & II were 85.9 and 75.4 out of 100, respectively. The results of the exams indicated that students were able to use mathematics in contexts different from those they had studied before, suggesting that they acquired abilities to use mathematics in real world situations.

In the qualitative analysis of the self-report questionnaire, we found evidence of structuralization of mathematical knowledge only in a small number of descriptions. Here we show an example:

Student: In this course, it seemed that mathematical formulae, which were just isolated pieces of knowledge, had been changing into meaningful ones. I felt that the knowledge base of mathematics that I had become harder and stronger; in that respect, it was a meaningful time.

In sum, the design principles can be considered to be effective for decontextualization, however, the structuralization is still a challenge. More study is needed for structuralization.

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