

Bowling with walnuts: what we can learn from *Kyouzai Kenkyuu* (study of teaching materials)

“Raising the Quality of Teaching through *Kyouzai Kenkyuu* – the Study of Teaching Materials,” describes a case of lesson study in Iran, along with a response to the case by Japanese teachers and educational researchers who watched the lesson on video and read a translated version of the transcript. The authors contrast the post-lesson discussion held in Iran with the discussion conducted by Japanese teachers and researchers. The research lesson was a Grade 2 mathematics lesson, “Addition,” and the instructor chose walnuts as the material for the lesson, thinking that walnuts would provide a familiar and appealing object suitable for students to learn addition. The instructor’s main question posed to students was “How can we increase the number of walnuts that we have?” While the instructor hoped that this question would encourage students to add their walnuts together, instead students came up with the idea of splitting walnuts into pieces to make “more,” or planting them, to grow a tree that would yield more. Many educators have probably had an experience similar to the one described in the article: students take a question we pose in a direction we did not expect. *Kyouzai Kenkyuu* is the set of practices that allow us to better anticipate student responses, through careful study of the curriculum, specific teaching materials, and the students’ experiences.

Even within this single case on addition, the Japanese educators point out several types of *Kyouzai Kenkyuu* that were needed. First, they note that the lesson study team needed to consider the textbook’s examples for addition, and ask why the textbook uses these examples. As they point out, both Japanese and Iranian textbooks teach addition using materials that cannot be split into smaller parts: horses, chickens, birds, frogs, marbles. Second, the Japanese educators note that the lesson study team needs to consider students’ images of walnuts. Since students split walnuts when they eat them at home, their idea of splitting walnuts to make “more” should have been predicted by the lesson study team. The lesson study team “needed to consider the reason for using walnuts from the perspective of the students and their world. Iranian children go mad for the game of bowling with walnuts, in which they win the walnuts they can knock over” (p. 8). So the walnuts might have provided a suitable teaching material for addition – for example, by setting up a bowling game in which students add walnuts they win. In the eyes of the Japanese educators, “the Iranian teacher should have done more research on why children would want walnuts, given their role as teaching materials in this mathematics lesson” (p. 7).

The Japanese term “*Kyouzai Kenkyuu*” is made up of two words: *Kyouzai* (教材) means teaching materials or curriculum materials; *kenkyuu* (研究) means investigation, research or study. So, literally, *Kyouzai Kenkyuu* refers to the investigation of teaching materials. In practice, however, it refers to the investigation of a much broader set of materials and issues. Patsy Wang-Iverson and Yoshida(2005) note that *Kyouzai Kenkyuu* focuses not just on teaching materials, but also includes investigation of “students’ prior knowledge, learning experiences, state of learning, and understanding, which makes it possible for teachers to be able to anticipate students’ reactions and solutions [...]” (p. 152).

The research reported here was supported by the Institute of Education Sciences, US Department of Education, through Grants R305A150043 and R305A070237 to Mills College. The opinions expressed are those of the authors and do not represent views of the Institute or the US Department of Education. This material is based upon work supported by the National Science Foundation under Grant No. 1503342.



Watanabe *et al.* (2008) argue that *Kyouzai Kenkyuu* is an essential component of lesson study; and, while *Kyouzai Kenkyuu* is prioritized in pre-service teacher training in Japan, the same is not necessarily true in other countries that are beginning to take on the practice of lesson study. Hence, the author, Sarkar Arani Mohammad Reza, has good cause to highlight the importance of *Kyouzai Kenkyuu* in raising the quality of teaching.

As Watanabe *et al.* (2008) reveal, there is an adage in Japanese that illuminates *Kyouzai Kenkyuu*, “To teach one, you have to learn ten.” *Kyouzai Kenkyuu* then can be thought of as “learning ten” and this learning is deep and comes in many forms. Takahashi *et al.* (2005) divide the process of *Kyouzai Kenkyuu* into two broad phases: study of the subject matter and study of the instructional tools. Table I summarizes ideas about the questions and resources integral to each phase; it is based on Takahashi *et al.* (2005) and Lewis and Hurd (2011).

Fernandez *et al.* (2003) describe *Kyouzai Kenkyuu* as developing three lenses – researcher, curricular and student. The case of the Iranian teacher particularly pinpoints the development of the student lens. The teacher reflects on how she will carry out *Kyouzai Kenkyuu* differently in future lessons – “And most importantly, what I myself want to record, and put into practice in the future, is that I need to consider what the students want to think about and what the students want to do, and place importance on this issue in my lesson planning” (p. 11).

Developing a researcher lens through *Kyouzai Kenkyuu* is highlighted by an example from our own recent lesson study work in the US. High School mathematics teachers conducted lesson study in algebra, using as the basis for their research lesson, a lesson developed by the Shell Center, *Representing Quadratic Functions Graphically* (<http://map.mathshell.org/download.php?fileid=1734>). The lesson asks students to connect “dominoes” that have a graph on one half of the domino and an equation on the other half. Teachers solved the task themselves as part of their *Kyouzai Kenkyuu* and noticed that it was easy to forget that the materials were supposed to be dominoes, i.e., that the two halves of the domino do not correspond, but each half can be matched to a graph or equation on another domino. As they did the task, teachers kept forgetting that the graph and the equation on the same card were not supposed to match each other. Their own challenges with the task led them to modify it slightly prior to their first research lesson, by adding a number to the

Key questions

Phase 1: study of the subject matter, students and goals

What concepts are taught in the unit?
 What concept will be the focus for the research lesson, and what does it mean to understand it?
 What prior knowledge will students need to draw on?
 What new ideas will students build from this concept in the future?
 What do students currently understand about this topic, and what are their misconceptions?
 What does research tell us about the important understandings students need to develop and how they develop them?
 What is the desired outcome of this research lesson?

Phase 2: studying instructional tools

What is the value of this task? Why is it designed as it is?
 How will students respond to this task? What gaps or confusions will they have, and how will they move to a fuller understanding?
 How will instruction (including board use, materials, teacher questions, peer interaction) support student learning?

Source: Takahashi *et al.* (2005)

Key resources

Standards and related interpretive documents, textbook and teacher’s edition, reference materials that unpack the content and student learning of the content. Also, interviews and observations of students, reports from lesson study, and consultation with knowledgeable individuals (such as math coach). Curriculum maps that show flow of concepts over units and grades

Textbook and teacher’s edition; knowledgeable individuals (such as math coach); teaching experience; student interviews, observations and data

Table I.
 An overview of
Kyouzai Kenkyuu

graphic side of each domino, so students could refer to the graphic side easily. As one teacher explains in their pre-lesson study discussion:

One thing we did [...] was modified the domino so that each of the graphs has a number. They started out just with only a letter on the side with the equations and this will allow us to give slightly more direct instruction as to “Oh, letters always match up with numbers.” This is like a thing that’s going to happen because this activity could turn into chaos and people are like “I don’t even know what I’m supposed to be doing right now.” So, I think it will be a lot more clear now that we added that.

During the first research lesson, the teachers discovered, however, that students were focusing on the relationship between the two parts of a domino, rather than on finding a match for each end. One observing math teacher, for example, described how she “literally sat there for 45 minutes and they (the group she was observing) were pairing them [...] they don’t get how they are supposed to match up.” The instructing teacher agreed, “I remember thinking [...] I was worried that people weren’t going to know, yeah, it goes end-to-end, so I tried to say that.” The teachers discovered that explaining to the students that the materials were dominos and demonstrating to them how to match ends was not enough for students to make the adjustments in their thinking. As they began preparing their next research lesson, the teachers decided to “just make like a dark bar [...] in the middle” of the domino to emphasize that the graph and the equation on one domino were not related. This small adjustment was remarkably successful; during the next research lesson, students saw that the dominos should be matched end-to-end, rather than focusing on the relationship between the two parts of the domino. This example highlights the way *Kyouzai Kenkyuu* can develop a researcher lens; teachers observed the curriculum materials in use, and tested a minor modification that turned out to have a major impact on students’ use of the materials.

In *Kyouzai Kenkyuu*, teachers carefully study the curriculum, to understand why it is designed as it is and how it is intended to influence student learning. As Watanabe *et al.* (2008, p. 136) write, *Kyouzai Kenkyuu* addresses questions including:

- What does this idea really mean?
- How does this idea relate to other ideas?
- What is/are the reason(s) for teaching this idea at this particular point in the curriculum?
- Why is this particular problem useful in helping students develop this new idea?
- What are common mistakes? Why do students make such mistakes? How should teachers respond to such mistakes?

The list above excerpts only a subset of the questions about curriculum that Watanabe *et al.* see as central to *Kyouzai Kenkyuu*. As an example of learning about curriculum, we use the example of a lesson study team at an US elementary school who conducted a lesson study cycle on fractions, using a resource kit that included Japanese curriculum materials on fractions. As the educators spent time examining a Japanese textbook and comparing it to their own, they were initially very critical of the Japanese materials and incredulous about whether they would support a lesson. For instance, they described the Japanese curriculum as lacking a “script,” as being “a lot of work” and as being “pretty dry” with “no frills.” In contrast, for their own curriculum, “you have to read everything and do what it tells you.” Additionally, they did not see how the Japanese materials provided for a full lesson: “I saw somewhere where it says each page takes 45 minutes. How? Even if you said, ‘experiment with this,’ maybe five minutes, okay we are done.” They also voiced concern that the Japanese textbook would not provide enough material to pass the standardized tests for their state. As they continued to examine the Japanese curriculum and compare it with their

own, however, they began to see some potential strengths in the Japanese curriculum, as the following exchange illustrates:

Teacher1: We introduce (fractions) in so many different ways, you know, we have parts of a set, we have a circle, we have a square. What I notice here (in the Japanese textbook) is that they keep going back to the same thing so maybe the kids get a better idea of what does one fourth really mean, you know. If you've got this one meter constantly and you keep coming back to it, the fourth, the third, the half and you just keep looking at that [...].

Teacher2: See, we see this (taps Japanese textbook rapidly four times). They always do this.

Teacher1: Right. We have so many different ways to look at it. Maybe if we just use that one linear method – and then go to that.

Teacher3: After an understanding is built.

Teacher4: That's an interesting idea.

So, as the teachers thought deeply about why certain curricular choices were made in the Japanese curriculum, they collectively began to shift their thinking about what is important for learning fractions. When concern again surfaced about the suitability of the Japanese curriculum for standardized tests, one of the teachers responded, "You know what I was just thinking about [...] if they have a really strong understanding of it, can they apply it no matter what it looks like?"

These teachers later decided to use a lesson from the Japanese curriculum for their research lesson because they believed it would build a stronger understanding of the "whole" and how it relates to its fractional parts, compared to their own curriculum. "We start with pieces and never show the whole so we want to start with the whole. We want students to partition the whole rather than having the pieces (pre-) chopped up." They pinpointed the development of this understanding of the whole as the "biggest roadblock" for students and further explained, "That's what we don't do. We don't ever refer it back to the whole. It's a learning process for us." This change in teachers' views as they collaboratively studied the Japanese textbook illustrates the role of *Kyouzai Kenkyuu* in developing the third lens identified by Fernandez *et al.*, the curriculum lens.

As we have written elsewhere, lesson study does not improve student learning primarily by creating a set of "polished" lessons (Lewis *et al.*, 2009). As the Iranian teacher's experience with walnuts and the US teacher's experience with dominos both point out, *Kyouzai Kenkyuu* can indeed spark specific changes in lessons that enhance their effectiveness. But the bigger changes wrought by *Kyouzai Kenkyuu* have to do with seeing instruction through the lens of student, researcher and curriculum, and habitually asking oneself the questions that we can learn to ask through lesson study. What is the important idea in this curriculum unit? Why is this task designed as it is? What knowledge will students bring to this task?

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