Principles of High Quality Instruction

Blake E. Peterson, Douglas Corey, Benjamin Lewis, and Jared Bukarau

Brigham Young University

MATHEMATICS EDUCATION
∞ TEACHING AND LEARNING MATHEMATICS ∞

BYU

What is High Quality Instruction?

- High quality instruction is . . . .
- For a lesson to be effective the teacher needs to . . . ..
- For a lesson to be effective the students need to . . . ..

The Teaching Gap

Characteristics of Japanese instruction

- Reasoning and Proof
- Coherence
- Connections
- Engagement

Closing The Teaching Gap

Common Across all High-Achieving Countries

- Engagement of students in active struggle with core mathematics concepts and procedures (not found in US)
- The focus on problems solved in class was on relationships. This focus was determined in large part by the teacher and not the initial nature of the problem (US students just practiced problems)

Our Study

- Japanese junior high school
- Three student teachers (ST)
- Three cooperating teachers (CT)
- Each ST taught three lessons once with each CT
- The ST and CT met for about 60 minutes across ~3 sessions prior to the teaching of each lesson
- These sessions were analyzed to see what the CT focused on as important to crafting a high-quality lesson

Principles of High-Quality Instruction

- **Intellectual Engagement Principle**

Intellectual Engagement

High-quality mathematics instruction intellectually engages students with important mathematics.

Intellectual Engagement

Near the beginning of the conversation, ST Motori is concerned about having too much time at the end of the lesson. CT Ueno changes the topic by responding:

CT Ueno: I want you to think about this. Are there any places that students use their heads?

ST Motori: (after a short pause) There is no such place. Nothing at all.

Intellectual Engagement

CT Ueno: You are going to get to this point in the lesson, right? Students won't use their head at all. I don't know what your plan in this part of the lesson is, but they won't use their heads here either. This part only requires them to fill in the blank. I don't know if you really want to do that yet. You didn't plan to stimulate students' "thinking process." So it will become a shallow lesson. Do you think this [problem] will make students think?

ST Motori: No, I don't think this will make them think.

CT Ueno: What you are planning is just to kill the time. If you do this in class and ask them to grade with a small group, they'll be confused. The only difference is that variables are replaced by different characters. Some student may use *a* or *m* and others may use *x.* I think it is meaningless.

Intellectual Engagement

The emphasis by these 3 Japanese teachers seems to focus on *intellectual* engagement as opposed to just physical engagement or on-task behavior.

Questions

What kind of questions generate good intellectual engagement?

Are there any social norms that need to be established in connection with those questions?

Principles of High-Quality Instruction

- Intellectual Engagement Principle
- **Goal Principle**

Goal Principle

An ideal lesson is guided by an explicit and specific set of goals that address student motivation, student performance, and student under- standing.

Goal Principle

- Multiple goals for each lesson
- Goals used to guide decisions

Goal Principle

CT Ueno: So your goal is to teach "the necessity of thinking about and using variables." Students are interested in variables so they can set up expressions by using variables.

ST Motori: Yes

CT Ueno: If these are your goals, is it important to do this [task] and spend 25 minutes on [it]?

ST Motori: No, it's not

Questions

How can goals be used in the preparation of questions in a lesson?

Principles of High-Quality Instruction

- Intellectual Engagement Principle
- Goal Principle
- **Flow Principle**

Flow Principle

The flow of an ideal lesson is built from a question or a problem that students view as being problematic. As students intellectually engage in the problem, building on their previous knowledge, the students are supported in learning the lesson's big mathematical idea.

Flow Principle

In the lesson plan that ST Motori has written, he refers to an abstract use of variables, *a* x b, and then poses a concrete—and yet complicated—use of *a* x b. The problem is about a group of four friends each buying a different type of noodle bowl with different toppings (shrimp or egg). Each topping costs a different amount per item and each person gets a different number of each topping. Thus *b* was assigned as the number of pieces of a certain topping and *a* was the cost of each topping. The students were to determine the overall price for all four friends. CT Ueno questioned the flow of ideas in the lesson.

Flow Principle

CT Ueno: One thing you should do is to think about the flow of the human thinking process. If you want to find how much the "price" will be, you should follow this path and develop it. . . .

ST Motori: Well, the reason why I decided to do this is because I wanted them to understand a good attribute of variables. Because this part [of the lesson] uses expressions in words, it's difficult to understand. . . .

CT Ueno: I think this is hard. You go there and come back and go there and come back. [CT Ueno is pointing to the lesson plan and referring to the place where ST Motori has an abstract use of variables, a x b, and then moves to the problem described above and then back to the abstract discussion again.] If you want to do that [the problem] in your mind, you should start there.

Flow Principle

The concept of *pedagogical flow* is what these cooperating teachers use to craft their mathematics lessons. It builds on students' current knowledge and ideas and leads them in a natural way to the learning objectives.

Questions

How can questions be used to support the flow of a lesson?

How can thinking about the flow of a lesson support the creation of quality questions?

Principles of High-Quality Instruction

- Intellectual Engagement Principle
- Goal Principle
- Flow Principle
- **Unit Principle**

Unit Principle

A lesson is created in the framework of past and future lessons, particularly between lessons in a unit but also between units and grades. The lessons in a unit help students progress to ways of thinking, writing, and representing mathematics evident in the discipline of mathematics.

Unit Principle

CT Ueno: When you become a real teacher, what would you teach next? Which path would you follow in your lesson?

ST Motori: In the next lesson?

CT Ueno: When you become a real teacher, you won't teach only this lesson, right? You have 365 days in one year from seventh grade to ninth grade. If you are going to teach math classes well, you have to have an image of what you would do next in your mind. What would you do?

Unit Principle

- From our research about lessons connecting with surrounding lessons, we also found that the placement in the unit affected how the lesson should be approached.
- *guided instruction* (do-nyu), *learning unfolding* (ten-kai), *kneading knowledge* (neri-age), and *integration* (katsu-yo) (Murata, 2010)

Questions

How does a focus on the unit principle influence the questions that are prepared for a lesson?

Principles of High-Quality Instruction

- Intellectual Engagement Principle
- Goal Principle
- Flow Principle
- Unit Principle
- **Adaptive Instruction Principle**

Adaptive Principle

High-quality instruction adapts so that all students are engaged in mathematical work that appropriately challenges their current understanding.

Adaptive Principle

CT Ueno: For instance, if you have many students who are having difficulty in understanding, you should prepare instruction for them. For students who understand well, you should also prepare different types of instruction. This part [pointing to a section of the lesson plan] is about instruction, so you should write both teaching material and what would be appropriate instruction by considering each student's circumstance.

Adaptive Principle

- Anticipate two groups – those who understand and those who don't.
- Focus on commonalities among students to decide if instruction needs to be adapted.
- Students who "understand" should also be adapted for and should be challenged.

Adaptive Principle

ST Tomoko offer the following reflection:

"There were some that solved the problem very quickly, and there were others who couldn't do anything at all. I wasn't able to follow up on those two groups. Now I can, but at that time I wasn't sure what should have been said. Nobody was able to come up with all four methods, but there were groups that used two or three methods. To those groups, I said, "Are there any other ways?" or "How would elementary school students solve this problem?" But, there was little reaction to those questions, and I wonder if my questions weren't appropriate."

Questions

When is the best time to generate questions for adaptive instruction?

What kinds of questions facilitate better adaptive instruction?

Principles of High-Quality Instruction

- Intellectual Engagement Principle
- Goal Principle
- Flow Principle
- Unit Principle
- Adaptive Instruction Principle
- **Preparation Principle**

Preparation Principle

High-quality instruction requires a well-thought-out, detailed lesson plan that addresses the previous five principles and interconnects them in a coherent lesson.

Preparation Principle

CT Ueno: Do you think kids will know that they have to set up an expression? I am not sure it will go smoothly. However, it's possible that our students will use a variable on this step. They may use the variable *A* or *X* for the number of eggs. It is possible that kids will skip those steps. Do you think kids will set up an expression like 30 x *X?*

ST Motori: If it happened that would be good.

Preparation Principle

CT Ueno: In that case, what would you do then? [15-second pause] Of course, because this is a lesson, you will begin with some activities, and you will give a problem. It is good if the correct answer is given, but you have to prepare if the students will say this [incorrect] answer, right? You also have to prepare what you will say in this [incorrect] situation. In the first situation you need to make this response, then if they understand, then they return here. But if students still don't understand, you need to think of something else to do. This means the more alternatives there are for students the more you have to prepare.

Questions

How do you get better at writing good questions during the preparation phase of a lesson?

Summary

- Intellectual Engagement Principle
- Goal Principle
- Flow Principle
- Unit Principle
- Adaptive Instruction Principle
- Preparation Principle

Do you see a way to use these principles in your instruction?

Shared Conception

- US teachers don't tend to have one
- Japanese teachers have one

Jacobs and Morita, 2002

This study supports this finding relative to the Japanese teachers.

Are there benefits to having a shared conception?

Word of Caution

It teachers were able to check off all 6 principles for a lesson, does it mean it was “High-Quality?”

The teacher may find many points which can be improved, and most of such points are not realized by other participants. The capable teacher [will] never be satisfied with the lesson, and we can say, he is a capable teacher because he is always seeking for [a] better lesson. (H. Ninomiya, personal communication, June 22, 2009)

Bibliography

- Corey, D. L., Peterson, B. E., Lewis, B. M., & Bukarau, J. (2010). Are there any places that students use their heads? Principles of high-quality Japanese mathematics instruction. *Journal for Research in Mathematics Education*, *41*, 438-478.
- Jacobs, J. K., & Morita, E. (2002) Japanese and American teachers' evaluations of videotaped mathematics lessons. *Journal for Research in Mathematics Education*, *33*, 154–175.
- Murata, A. (2010). *Moving to the balanced middle: Mathematics teaching phases that support understanding and fluency development.* Manuscript submitted for publication.
- Stigler, J., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York, NY: Free Press.
- Stigler, J., & Hiebert, J. (2009). Closing the teaching gap. *Phi Delta Kappan*, *91*(3), 32-37.