An examination of oral and literal teaching traditions through a comparative analysis of mathematics lessons in Iran and Japan

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Abstract

Purpose – The purpose of this paper is to examine a seventh grade mathematics lesson in Iran and Japan through a comparative analysis for illuminating what actually goes on in the classroom in different cultural contexts. Emphasis is here placed on Iranian oral and Japanese literal teaching traditions.

Design/methodology/approach – Qualitative research methods were employed for data collection, including cross-cultural lesson analysis meetings in Iran and Japan and semi-structured interviews with the participants of the meetings. In doing this, the study plans to make apparent the structure of meaning hidden in lesson practice – a so-called cultural script of teaching – by comparing this practice in cultural context, through the eyes of educators from different socio-cultural perspectives.

Findings – The findings are intended to clarify the mathematical communication approach used in Iran and Japan. Mathematical communication proceeds through speaking rather than writing in Iran, discussing before summarizing and taking notes (speaking/listening), while in Japan, it proceeds through writing before telling and speaking (writing/reading).

Research limitations/implications – This study delivers a transnational learning opportunity for educators to learn how to provide evidence-based analysis of a lesson for professional learning to raise the quality of teaching. However, as this is a case study, it opens up the possibility for comparative lesson analysis of more sample lessons, and how active learning and dialogic teaching can be designed in different educational contexts. In addition, it may be interesting for educators to see how this comparative lesson analysis helps practitioners to revise their teaching. These are very important research questions which the researcher hopes to cover in his next manuscript.

Practical implications – Comparative lesson analysis has the potential to expand more "research in practice" for designing mathematics lessons from the perspective of the students – so-called "customized teaching." In addition, how the silent process of each individual student in the lesson has impacted on their learning and understanding – so-called "personalized learning" – is one of the issues arising from the case studies.

Social implications – The value of comparative lesson analysis as a lens is in its ability to reveal to educators their own unconscious teaching script. It provides an opportunity for evidence-based critiques of our own teaching traditions that we accept culturally, share tacitly and may not even be aware of in the construction process.

This research was supported in part by the Japan Society for the Promotion of Science (JSPS) under the Grant-in-Aid for Scientific Research C (Reference Number: 15H03477). The author would like to express his gratitude to the JSPS for the assistance that made this research possible. He is also grateful to the principals, teachers and the students of the schools in Iran and Japan for their valuable contributions to the study.

International Journal for Lesson and Learning Studies
Vol. 5 No. 3, 2016
pp. 196-211

2046-8253
DOI 10.1108/IJLLS-07-2015-0025

Originality/value – This study combines careful measurement with "insider" and "outsider" perspectives to provide a deeper understanding of the real world of the classroom and the cultural context of teaching.

Keywords Japan, Iran, Comparative lesson analysis, Mathematical communication style, Teaching traditions

Paper type Research paper

1. Introduction

Raising the quality of teaching, looking at what actually goes on in the classroom, and how the quality of teaching can be improved has become a pressing concern in national and international contexts (e.g. Cuban, 2013; Lo and Marton, 2012). Contemporary scholarship shows a transnational consensus that more in depth understanding of teaching traditions can be possible through a review of and reflection on qualitative-oriented comparison of teaching in different cultures and educational contexts (e.g. Alexander, 2012; Cai and Wang, 2010). The research literature also suggests the need for more comparative lesson analysis which is more evidence based in order to understand the cultural script of teaching as well as teachers' tacit knowledge of what actually goes on in the classroom. It also points to the need to focus more on teaching rather than teachers in raising the quality of teaching (e.g. Bryk *et al.*, 2012; Hiebert and Morris, 2012) – an assumption that underlines this research in expanding comparative lesson analysis and dialogue across cultures so as to understand in depth Iranian oral and Japanese literal teaching traditions and bring about changes in the cultural script of teaching.

1.1 The purpose of this study

The aim of this study is to uncover the culture of teaching mathematics in Iran and Japan through the lens of a comparative lesson analysis. Emphasis is placed here on oral (speaking/listening) and literal (writing/reading) teaching traditions and their impact on the quality of teaching and how it can be improved in practice, such as expanding "active learning" and "dialogic teaching."

2. Theoretical context

According to the theories of linguists, research in linguistic discourse analysis, and work on the impact of language, communication styles, shapes of discourses (spoken/written) and different styles of reasoning (moral/factual) on teaching and learning, in the Japanese (literal) and Persian (oral) cultures, more responsibility tends to be placed on the listener or reader (the learner) than the speaker or writer (the teacher) (e.g. Katagiri, 2009; Watanabe, 1998). If this is the case, there is an urgent need for lesson structure and process that nurtures autonomous/proactive learning.

Both of the Japanese and Iranian schools in this study have tried to apply lesson study in order to improve teaching mathematics in the classroom and provide a learning environment which supports "active learning" from the students' perspective and "dialogic teaching" from the teachers' perspective (Barkley, 2010; Lewis, 2015).

Active learning in the schools as Barkley (2010) has noted "means that the mind is actively engaged. Active learning' is an umbrella term that now refers to several model of instruction, including cooperative and collaborative learning, discovery learning, experiential learning, problem-based learning, and inquiry-based learning" (pp. 16-17).

Characteristics of "dialogic teaching" in schools as Alexander (2005) has noted, include being collective, reciprocal, supportive, cumulative and purposeful. Alexander intentionally focusses more on dialogue rather than conversation based on a

Bakhtinian version of dialogue, in which the critical issue is what follows from answers: "if an answer does not give rise to a new question from itself, then it falls out of the dialogue" (Bakhtin, 1986, p. 168, quoted from Alexander, 2005, p. 8).

In the case of the mathematics classroom, a growing body of research on mathematics education in different cultures indicates that the role of the teacher depends on the cultural script of teaching mathematics (e.g. Ghousseini and Herbst, 2016; Stigler and Hiebert, 2009), and the purpose of teaching mathematics in practice (e.g. Bakker *et al.*, 2015; Martin, 2007). For instance, Ghousseini and Herbst (2016, p. 79) argue that "leading classroom mathematics discussions requires an implementation of different pedagogies of teacher education in deliberate ways."

Consequently, in order to apply learning from comparison to improving the quality of teaching, it is crucial to consider the educational basis, traditions and linguistics, and the cultural script of teaching. Alexander (2005, p. 5), for example, reconsiders how comparative enquiry reminds us the language and communication style and cultural constructs of education. He concluded that "we have England's traditional and unchanging definition of the educational 'basics' as reading, writing and calculation, but emphatically not speaking. On the other hand, French schools celebrate the primacy of the spoken word. Here, literacy: there, language."

Given the theoretical context of linguistics, active learning and dialogic teaching as found in the literature (e.g. Chapin *et al.*, 2009; Kazak *et al.*, 2015), the main research question addressed here is meant to demonstrate the relationship between culture and teaching mathematics. The comparative lesson analysis of teaching traditions in Iran (oral) and Japan (literal) engages educators to promote transnational professional dialogue and to reflect critically on teaching through different points of view.

3. Research method

This paper draws on qualitative data collected by the researcher and a meta-analysis of a part of his research report in Japanese (Sarkar Arani, 2011) on mathematics lessons in Iran and Japan, with the aim of providing a comparative lesson analysis to examine oral and literal teaching traditions. This involved observation of the mathematics lessons (Iran: November 27, 2008; Japan: April 15, 2010), examining the transcripts of the lessons, post-lesson discussions with the teachers (Iran: November 8, 2009; Japan: June 4, 2010), ethnographic field notes of the researcher and semi-structured interviews with the participants in Iran and Japan. Based on the data collected in each local context, the transcript of the lessons and the contents of each post-lesson discussion meeting (Japanese and Iranian) were translated from Japanese into Persian and from Persian into Japanese. Further comparative lesson analysis on the mathematics lessons was held in Iran (September 9, 2013), and in Japan (February 19, 2011) with the participation of teachers, and their ideas and critiques on the lessons were shared and analyzed from a range of perspectives and through different socio-cultural lenses.

The participants of the comparative lesson analysis meetings in Iran consisted of 32 teachers of the middle school. They were all female as schools in Iran are segregated, and the teachers each had several years of teaching experience. The participants of the comparative lesson analysis meeting in Japan consisted of 34 teachers (16 of whom were female) from four different schools. The teachers who conducted the mathematics lessons in Iran and Japan were both veteran math teachers. All names in this paper are pseudonyms.

All of the communication between the teacher and students in the classroom was recorded and transcribed. Then, each of the two lessons was divided into

four stages: introduction, development, turn, and conclusion, and six segments in order to speculate about the teaching intentions of teachers and help uncover their underlying outlooks on teaching (see Table I).

3.1 Case of Iran

The Iranian seventh grade mathematics lesson was on the topic of "Negative and Positive Numbers" as described by Iran's mathematics syllabus. The topic of the lesson covers six pages of the mathematics textbooks entitled "Whole Numbers" (Farzan, 2008, pp. 125-130). There were 26 girl students without group and peer activities set during the lesson.

3.2 Case of Japan

The Japanese seventh grade mathematics lesson was on the topic of "Positive Numbers and Negative Numbers" as described by Japan's national curriculum for middle school mathematics. The topic of the lesson covers eight pages of the mathematics textbook entitled "Positive Numbers and Negative Numbers" (Okamoto, 2010, pp. 8-15). There were 24 students (15 boys and nine girls) with group and peer activities set during the lesson.

4. Findings

This section will mainly examine the content of the comparative lesson analysis meetings in Japan, as well as in Iran and the Japanese and Iranian educators and teachers' critiques on the lessons, in order to distinguish between the cultures of teaching mathematics in Iran and Japan. Emphasis is placed here on oral (speaking/listening) and literal (writing/reading) teaching traditions and their impact on the quality of teaching and how it can be improved in practice from the following perspectives:

(1) approach to dealing with mathematical concepts; and

(2) way of mathematical communication between the teacher and students.

The features of the teaching script observed in each lesson are categorized from these two perspectives and a comparison of these is summarized in Figure 1.

4.1 Approach to dealing with mathematical concepts

4.1.1 Teacher teaching. Teacher I (Iran) used number lines to aid visual and aural learning by students. In middle school, negative numbers are taught using number lines. The Japanese lesson also had students develop their learning by recording points on number lines. Regarding this, a Japanese researcher who is currently conducting research on the teaching of measuring length in lower year level arithmetic gave the following opinion. "The measuring of length" is intimately related to the concept of zero and the idea of number lines (Azuma, discussion meeting, Japan). This learning of negative numbers takes place in Japan in middle school, and is considered to be closely related to the concept of zero and the idea of number lines. It is important to consider what concepts are required in order for students to understand number lines.

At the start of Segment 2, Teacher I remarked, "T35: […] today it is plus 4 in Gorgan. Or we say it's minus 7 degrees in Abhar. So, everyone, tell me some different models for expressing numbers. How would you feel if I said that it is minus 10 degrees in Tabriz today?" After asking this question, Teacher I attempted to have the students

Category	Middle School I (Iran) Teacher I	Middle School J (Japan) Teacher J
Introduction	Segment 1 (T1-Sa34) Using the TV news (e.g. accidents, finance, weather, a summary of the news, temperature) to give direction to the learning The lesson began with a question posed by the teacher T1: "Let's talk about something new today. When you watch the news, what normally comes at the end of the news?"	Segment 1 (T1-T99) Preparing to present positive and negative numbers found in the newspaper at home The teacher had set students the task of finding numbers with pluses and minuses in the newspaper, and checked their homework and notes
Development	Segment 2 (T35-Ca109) Questions and answers (vocal only) about whether hot and cold temperatures are above or below zero. How many degrees above zero is it in Isfahan, how many degrees below zero is it in Tabriz, how would you feel if someone said that it is $-x$ degrees in Tabriz? (e.g. T68: "That's right. So we've all discussed numbers together. We talked about how we can measure higher, lower, more, or less. How did we know this? Raise your hand if you can tell me what we measured. What did we measure? Sa69: "Temperatures start from zero." T70: "Excellent. Where does it start from?") This question and answer style scene appeared repeatedly throughout the lesson orally	Segment 2 (T100-T161) Giving students seatwork space (e.g. noting and confirming) and having them give presentations, with priority on those who found the positive and negative numbers in the newspaper at home E.g. a student presented traffic accident deaths on a specific day in Japan. S114: "At the bottom are the number of deaths (child +2, young −2 and older −1) in comparison with the last year data. It means (in case of child: age less than 15 years old), there are 2 more than last year, and (in case of young: age between 16 and 24) 2 less, and (in case of older: age more than 65) 1 less." The teacher tried to summarize and comment on the presentations visually. He encouraged students to ask questions, but there was no reaction from students. However, they took notes carefully
	Segment 3 (T110-Ca276) Questions and answers looking at a number line drawn on the board showing hot and cold temperatures and big and small numbers (e.g. why are there two arrows pointing in different directions? What are these arrows?). Teacher then brings the students' attention to distance, in order to link to learning about finding difference (e.g. T192: "Raise your hand if you can tell me how many degrees hotter Tehran is than Tabriz. Look above the axis (the number line). Cs196: 8 degrees. T207: Excellent.")	Segment 3 (T162-T235) Giving students seatwork space (e.g. noting, confirming, categorizing and cataloguing) and having them give presentations on what they found at home based on the textbook content, and questions and answers about this. (e.g. S170: "This shows the maximum and minimum temperatures in every place in Japan. For example, the maximum temperature in Nagoya is 13.9 degrees. And the minimum is 5.2.")
Turn	Segment 4 (T277-Ca505) Working on textbook problems (how to say temperatures with pluses and minuses on them), and questions and answers about this (e.g. T279: "Read the	Segment 4 (T236-T431) Giving students seatwork space (e.g. noting, confirming and analyzing) and having them give presentations on the positive and negative numbers they found

Table I.
The process of the mathematics lessons

(*continued*)

Category	Middle School I (Iran) Teacher I	Middle School J (Japan) Teacher J
	news like a good newscaster. F280: a chill is approaching Iran and temperatures have become particularly cold. What is happening? 'Tehran will be 5 degrees above zero.' What is meaning?"). Rather than allowing students to attempt the textbook problems themselves, work individually as seatwork space and then share their answers, the teacher works on the problems together with the students (verbal only)	in the newspaper during the lesson, and questions and answers about this. 1) Calendars; S247: "Minuses and pluses on the calendar. 2) Golf; T289: There are minuses, zeros and pluses in golf, aren't there? T294: Mr R, what is this zero? R301: It's a set number that shows the correct number of strokes". 3) Cherry blossom news; T392: "We have the cherry blossom news. T410: Where the cherry blossoms are not yet in full bloom, where they are close to full bloom, have just started blooming, are half in bloom [call for seatwork]"
Conclusion	Segment 5 (T506-Ca561) Working on textbook problems (completing summaries) and questions and answers about this orally Segment 6 (T562-T682) Questions and answers that situate the knowledge learned in the previous lesson and the knowledge learned in this lesson verbally No information about next lesson	Segment 5 (T432-T525) The teacher looks back over the presentations and summarizes the main points visually (*Bansho* via projector) Segment 6 (T526-S554) Working on practice problems to check students' understanding of the knowledge in this lesson (e.g. confirming students' notes, summarizing the main points visually). Giving information about the next lesson

Notes: T, denotes speech by the teacher, S, students, Ca, most students in the class, and Cs, several students in the class. Other letters are used to denote individual (pseudonyms) names of students. Contact Mohammad Reza Sarkar Arani to access to the full transcript of the Iranian and Japanese mathematics lessons

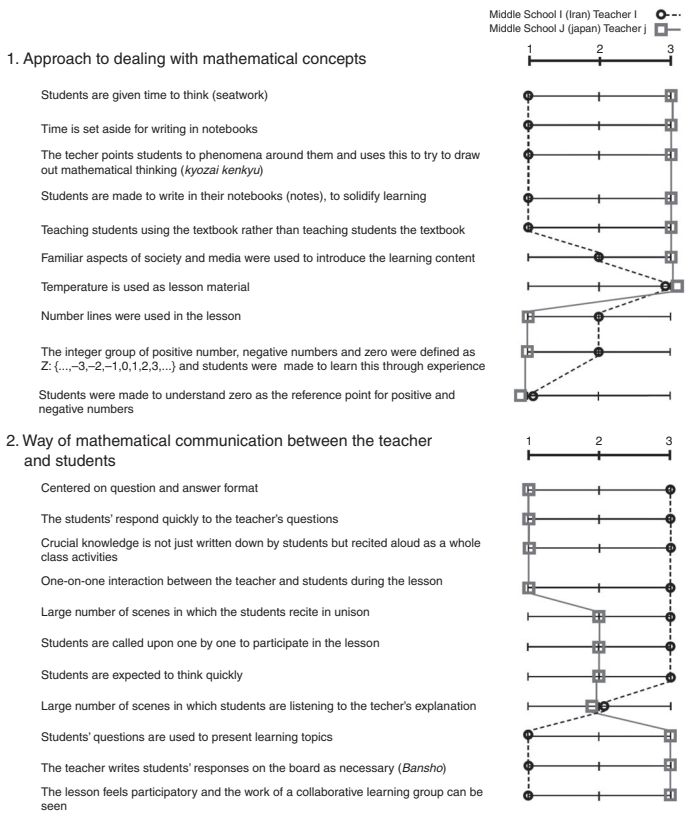
Table I.

think about the problem through their own experience, using temperatures at specific places and having them respond how they would feel (hot or cold), as follows:

> T68: We talked about how we can measure higher, lower, more, or less. How did we know this? Raise your hand if you can tell me what we measured. What did we measure?
>
> Sa69: Temperatures start from zero.

Following this, through questions and answers between Teacher I and her students, the teacher used concepts other than atmospheric temperature to teach students about zero. For example she suggested that the top of a desk was zero and prompted students to say that below the desk was minus and above the desk was plus, and in this way she repeatedly had the students confirm that the boundary between plus and minus was zero. The appearance of the thermometer also appears to fit with the objective of this lesson.

As a Japanese scholar pointed out in the discussion meeting, there may have been students who wondered about the basis of the selection of zero degrees Celsius as a standard, and wanted to discuss this. If we also consider the lessons of Teacher J from



Notes: 1, 2 and 3 are used to indicate the features of each view of teaching. It means that the feature is slight, moderately or strongly present in the lesson. 1. Slightly present. 2. Moderately present. 3. Strongly present

Figure 1.
The characteristics of the lessons based on the comparative lesson analysis

this perspective, neither of the two lessons managed to enable students to grasp the concept of zero as a reference point on their own (Shibata, discussion meeting, Japan). It can also be seen from the dialogue in Teacher I's lesson (e.g. T110: "If we think of this in terms of mathematics, what would it look like? Everyone, do you know what kind of scale is on the tool in our laboratory? T124: What did I say was in the middle of this?" Ca125: Zero.). It seems the teacher was attempting to use problems related to temperature of the atmosphere or the body (high temperatures and low temperatures) to encourage students to think about negative numbers mathematically (interview, Taheri, Iran).

Gradually moving from concrete to abstract by introducing zero as a scale on a test instrument, as a desk with above and below being plus and minus, and then as a point on the board with scales drawn to the left and right, may be a more effective teaching method than that of the teachers in Japan (discussion meeting, Japan). However, one of the topics that was raised during the comparative lesson analysis meeting in Japan was the lack of board work (*Bansho*) by Teacher I, and shortage of taking of notes by her

students (discussion meeting, Japan). The only thing Teacher I drew on the board was a solitary number line to teach the students:

- Knowing which of two numbers is larger/smaller.
- Zero is neither a positive nor a negative number. Zero is the mid-point of all numbers and is used to measure them.
- The difference between the sizes of two numbers can be found from the distance between the start point and the end point (discussion meeting, Japan).

From a Japanese educator's lens, it is worth considering what motivation or judgment was behind this "single number line" lesson. If we consider the link between students' existing knowledge, students already understand negative numbers and have everyday knowledge about how temperatures are expressed. They also know that when numbers go below zero these are expressed with a minus sign. The objective of the lesson should be to find a way to renew this existing knowledge (Hiro, discussion meeting, Japan).

4.1.2 Student learning. A participant of the discussion meeting in Japan commented on the interaction between Teacher I and a student called Zohre. In the lesson Zohre's comment about addition and subtraction and number lines was dismissed as irrelevant. But picking up on this comment may have helped deepen understanding of number lines for some students. It appears that Zohre had done her revision and had sufficient knowledge for this learning topic. The student is stating that if we move from –3 in Tabriz to +5 in Tehran, we will go past zero and enter positives, meaning the temperature will become plus. In other words, this is headed toward finding the distance or difference between –3 and +5. By adding –3 and +5, Zohre probably meant to say finding the distance or difference between these two numbers. The Iranian participants believe this idea shows the development from number lines into a method for finding the answer using addition (Yoshie, discussion meeting, Japan). However, from the Iranian participants' perspective it is true that if the teacher had picked up on this now, the lesson would have gone off course. This may be the reason why Teacher I tried to bypass this statement (discussion meeting, Iran).

However, from the Japanese lens, if Teacher I had put aside the thermometer and started building connections to the number line, it may have been easier to create a link with students' existing knowledge. Moving to the right the temperature increases; moving to the left the temperatures decreases. To find the difference, we should count from Tehran's +5 on the right to Tabriz's –3 on the left. If this is done with a calculation, it would link to learning the following: $(+5)-(-3)=8$. Similarly, if we take the example of golf that appeared in Teacher J's lesson, zero is par, over is plus, and under is minus. To find the difference, for instance we could find by how many strokes one player is losing if their score is 5 over and their competitor's is 3 under. Again, the calculation would be $(+5)-(-3)=8$, and this could develop into a method of learning about calculations with negative numbers (discussion meeting, Japan).

In Segment 5 Teacher I also asks, "T580: Where do real numbers start?" and defines positive numbers, negative numbers and zero as the integer group. This teaching method was not particularly seen in the lesson of Teacher J, but is very easy to understand. In Teacher I's lesson, negative numbers, positive numbers and zero are defined as the integer group $Z:\{\ldots,-3,-2,-1,0,1,2,3,\ldots\}$, and students are taught this through experience. Negative numbers are introduced six months earlier

at Middle School I than at Middle School J, and teachers incorporate a range of familiar topics and concrete examples to make the content as easy to understand as possible, and ensure that each individual student (and at times the class as a whole) can actively respond to the teacher's questions. In addition, in Teacher I's lesson, students are made acutely aware that plus represents better/hotter/more, and minus represents bad/colder/less. This is something that is rarely seen in Japan, and is likely to stem from the English word "negative" (whereas the Japanese word, *fu*, means "burden" or "debt") (discussion meeting, Japan). The Iranian educators also believe that the structure and process of the lesson fit well with the teaching of negative numbers, and the lesson is summarized with the practice and knowledge-checking and extension questions, improving the students' understanding and encouraging their motivation to learn, and these positive points were also brought up in the discussion meeting (discussion meeting, Iran).

However, while in extension content students gave the names of various number groups and responded about the integer group Z:{…, –3, –2, –1, 0, 1, 2, 3, …}, there is still doubt about the students' level of understanding of the main lesson content. Compared with Teacher J's lessons, Teacher I's taught a much larger range of content, and this was a lot to include in a mere one-hour lesson (discussion meeting, Japan). These concepts are introduced one after the other without differentiating or summarizing, and students are answering the teacher's questions as though they have been conditioned to respond. The lesson has good tempo, creating a fun learning environment, but, compared with Teacher J's lesson, it may risk leaving behind students who take more time to understand concepts (discussion meeting, Japan).

In addition, what is interesting is the way in which each of the two teachers introduces the textbook content differently. This seems to be related to the students' understanding. Teacher I at the 19th minute says, "T277: OK, open your textbooks. Page 125," and Teacher J 46 minutes into the lesson, "T528: Everyone look at your textbooks" (discussion meeting, Japan). The two lessons link plus and minus in temperatures to the physical sensations of hot and cold that can be felt by the students. This can be seen in the textbooks of the two schools and the teaching of the two teachers, with each of these lessons being an introduction to negative numbers (discussion meeting, Japan). Temperature was selected as something that students could physically experience, and for this reason the physical sensations of hot and cold were treated as important (discussion meeting, Iran).

4.1.3 Pedagogical reasoning. The point where mathematics becomes more abstract is the point where the division begins between students who like and hate the subject, and therefore the teacher believes that placing a high value on physical sensations is a good teaching method. However, from pedagogical reasoning and mathematical understanding points of view in the cases, the following points were raised at the discussion and analysis meetings in Japan and Iran.

4.1.3.1 Lesson signature. Where Teacher I's lesson entered the abstract world, the teacher then returned to the physical world of the students' senses (e.g. "T470: you've got it then. Let's say it again together, the further numbers get into minus, the more the atmosphere […]"). This means the lesson progression was based on the teacher's instruction more than the students' understanding. This is underpinned by three key characteristics – teacher-led, fast-paced teacher questions and immediate student responses, and dialogue-centric lesson process that relies little on board work and note taking (discussion meeting, Japan).

4.1.3.2 Kyozai kenkyu. This lesson teaches students that minus = bad/worse/colder/lower/less – is this necessarily the right thing to do? In golf, for example, negative numbers are a good thing, as pointed out in Teacher J's lesson. Incorporating presentations using the projector, and using objects and issues from students' daily life (known as *Kyozai kenkyu* in Japanese), such as current affairs that students were aware of, traffic accidents, temperature, stock prices, golf, etc., also made the concepts of plus, minus and zero easier to understand. Teacher J also clearly explained that negative is not always bad, such as in Segments 4 and 5 when he noted that in golf minuses are used as a good thing (discussion meeting, Iran).

4.1.3.3 Seatwork space. While much procedural knowledge is taught in the Iranian lesson, there is little opportunity for students to think, confirm and note individually (seatwork space) during the lesson, especially about the meaning of the topic. It is true that if the teacher were to accept every student's questions and talk, the lesson would move far from its intended path and fail to progress as planned. However, students' comments in this lesson are rarely permitted to continue, and there is little time for each student to think and note compared with the lesson of Teacher J. Most of the teacher's questions, therefore, are leading, with no space to nurture students' ability to think, confirm, solve problems for themselves and note, collectively known as seatwork (discussion meeting, Japan).

4.2 Way of mathematical communication between the teacher and students

4.2.1 Oracy. Overall, the two lessons (Iran and Japan) progressed in a question and answer format. However, in the lesson by Teacher I, students think within a dialogue with the teacher, while in Teacher J's lesson, students think through seatwork space (taking notes, etc.) and after the teacher questions them.

Within the one-hour lesson by Teacher I, the number of utterances she made was 343, with the students making 339 utterances (49.7 percent). The teacher's utterances include some with multiple sentences. There was not one student who failed to speak at all in the lesson. However, Teacher J spoke 466 times in his lesson, compared to just 88 utterances by his students (15.9 percent) (see Figure 2).

In the comparative lesson analysis meeting, a Japanese mathematics teacher commented, "it appears that the students and teacher are creating the lesson together" (Ichikawa, discussion meeting, Japan). The overall flow of Teacher I's lesson is in a dialogic style whereby students respond to the teacher's questions. Rather than simply unilaterally teaching students and having them remember facts, the teacher encouraged them to think about phenomena around them and tried to draw out mathematical thinking from this (discussion meeting, Japan).

However, from the Iranian lens, the flow of the lesson is based on a question and answer format, and the teacher's questions are not open-ended but rather always have a set answer. Moreover, while the teacher's questions are designed to make students notice that temperatures can be expressed as minuses, the students seem to be answering based on what they think the teacher wants them to say, rather than with the intention of pursuing learning (discussion meeting, Iran).

Even in the Japanese case, when Teacher J asks at the end of each presentation things such as, "T122: OK, any questions?" there are no questions from the audience (the researcher's observation). Although he clearly intended to teach students to use the question and answer format, this did not develop into dialogic learning between the students (discussion meeting, Japan). Perhaps if he had asked the students an

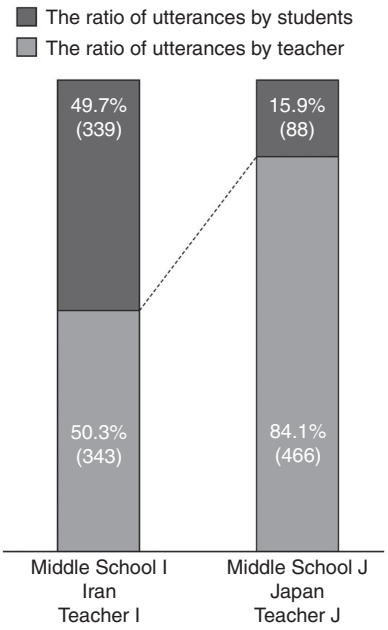


Figure 2.
Percentage of utterances in the mathematics lessons

open-ended question about what they had thought, felt or been reminded of through the presentations, rather than trying to move straight to a different topic, there would have been more thought development around the mathematical concepts of the lesson.

If we consider Teacher I's lesson from this perspective, both the teacher and students speak quite frequently (discussion meeting, Japan). Teacher I continuously walked among the students who were facing each other and interacting with them. This interaction was such that she could encourage students to talk and comment and give the answers she was looking for and recite these as a group, and through this she constantly sought answers from students. She agreed with the students' comments and made sure the whole class understood them (discussion meeting, Japan).

In fact regarding Teacher I's lesson in the Japanese discussion meeting, one participant noted that, "The tempo was quick, and the teacher used her speaking skills to encourage the students to experience the enjoyment of orally participating in the lesson, thus allowing them to participate without getting bored. Teacher I did not use the board and students did not use their notebooks either. Both talk frankly most of the time" (interview, Ishikawa, Japan).

From Iranian eyes, this lesson can also be contrasted with some lessons they had observed previously that left too much time to "let students think," or lessons in which students do not know what they are supposed to be thinking about, or the ideas thought up by students are not picked up on by the teacher (discussion meeting, Iran).

If we compare the script of teaching seen in each of the two lessons, Teacher I's lesson appears to constitute dialogic teaching. The teacher was not utilizing just a few students, but rather calling on every one of the students. In this way, students could hear each other's opinions before raising their hand, creating overall balance in the classroom. It seems that a silent coordination of who would raise their hand to

give these comments – a dynamic group movement was taking place (discussion meeting, Japan).

On the whole, the questions Teacher I asks of the students appear to be well thought out, limiting the flow of the lesson to what was prepared in advance. Using the dialogue between herself and the students, Teacher I has students understand the concept of minus through experiencing it, before having them grasp the group that combines positive numbers, negative numbers and zero (discussion meeting, Japan). One of the participants in the discussion meeting in Japan pointed out that "this was a logical and highly commendable aspect of Teacher I's lesson design" (interview, Keisuke, Japan).

4.2.2 Literacy. Another lesson characteristic that received attention during the comparative lesson analysis meetings in Iran and Japan was the use of written instruction (planned board writing, having students write in their notebooks, using the projector, providing students seatwork space, etc.) by Teacher J. This approach was evaluated in both countries as an effective way of improving teacher questions and mathematical communication (so-called *Hatsumon* in Japanese) and supporting students to understand the learning tasks in depth.

In the discussion meeting in Japan, a veteran math teacher commented on the *Hatsumon* of Teacher I, "It seems to me that some of her questions and mathematical communication were very difficult for students to respond to, comment on and understand. For example have a look at T235: 'This time we are going from Tehran to Tabriz. Everyone, which way are we going now?' Based on my interpretation the challenges most students face to react, comment, answer and talk are because of Teacher I's *Hatsumon* rather than students" level of achievement or mathematical knowledge. *Bansho* is a way of bridging such a gap between students and teachers in conversation' (Inoue, discussion meeting, Japan).

In the discussion meeting in Iran, a teacher also commented that Teacher I's students "accurately discern the answers sought by the teacher based on what they have learned so far and the flow of the lesson. However, some of what the teacher says is ambiguous or difficult to understand, and it appears as though there are some students who have misunderstood what she means. Japanese *Bansho* is a helpful approach for us to learn how we can revise our teaching quality as well as *Hatsumon* in practice. I think teacher *Bansho* and student notes are effective documents for teachers to reflect on their *Hatsumon* and its impact on students' learning in practice" (Amiri, discussion meeting, Iran).

5. Discussion and conclusion

Upon conducting comparative lesson analysis of the two lessons based on their transcripts, in the Iranian lesson, thinking occurs within dialogue, and vocalizing is the pillar of teaching and learning. In the Japanese lesson, students think when prompted by the teacher, and writing is the pillar of learning. Here we can see the difference between the teaching traditions in the countries. The utterances are also evaluated through "two sample tests for equality of proportions." The results show a significant difference in Segments 1, 3 and 6 (see Figure 3).

Upon comparison with the Japanese Teacher J, the participants could see that each of the two lessons was set out to teach "numbers" less than "zero," leaving doubt over whether the lessons were teaching students to grasp the concept of zero as a reference point. Regardless of differences in lesson style, the genuine attempt by

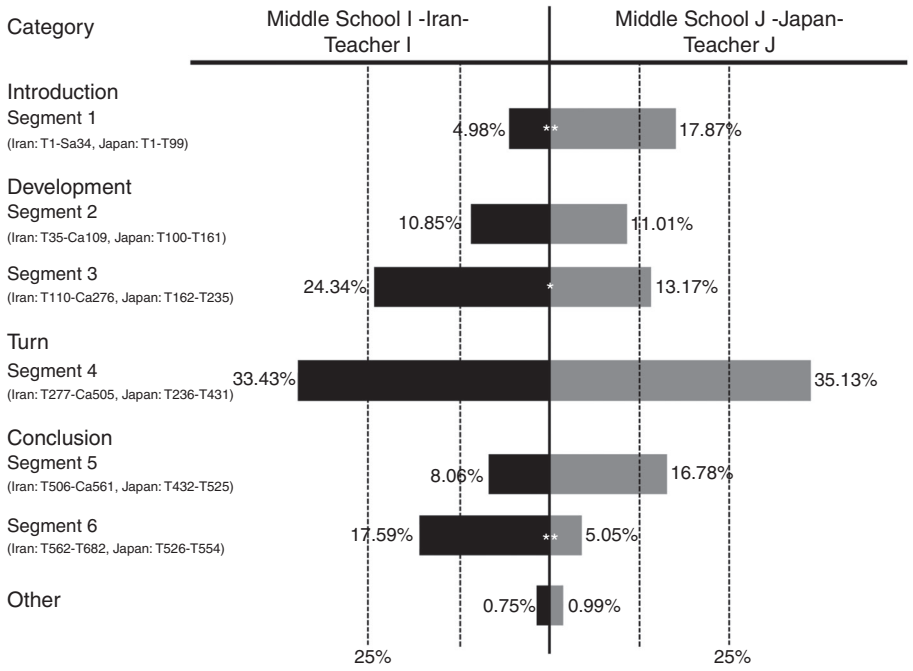


Figure 3.
The ratio of utterance in the mathematics lessons

Notes: The utterances are evaluated through "two sample test for equality of proportions." The results show that a significant difference of the segments 1, 3, and 6 can be seen. $*p<0.05$; $**p<0.01$

students to partake in the lesson remains important, and educators must consider what factors are likely to capture students' attention.

It is also important to consider what kind of view of teaching held by the teacher best facilitates active learning. If active learning is what we are aiming for, which is more effective – having students recite things out loud, or having them copy information into their notebooks; writing something down before telling it to the class (literal/Japan) and/or discussing something before summarizing it in written form (oral/Iran)? These factors surely affect the creation of active learning.

Rather than allowing too much inaccurate discussion or chit-chat, it is more effective to learn the pillars of mathematical concepts and the symbols for expressing them (number lines, formulae, graphs and tables, etc.). In this sense, the Japanese teacher used the board and projector well in his lessons. He, assisted the students' learning by summarizing and confirming the content of students' comments (responses to his own questions) using the *Bansho*. This tendency to make frequent use of the board is a characteristic that is particularly developed in Japan and highly regarded overseas (e.g. Fleming, 2011; Kubota-Zarivnij, 2011). It can serve as a point of reference for the improvement of mathematics teaching in countries other than Japan, and for lessons other than mathematics.

Compared with that of Japan, the teaching script in Iranian mathematics lessons generally involves a teaching and learning process that has students understand problems by reading aloud, rather than reading silently. During the lesson, both the

teacher and students speak to each other more frequently than they write on the board or in their notebooks. Mathematical communication proceeds through speaking rather than writing. In the teaching culture of Iran, speaking is at the center of learning; that is the oral (listening/speaking) is used more effectively than the literary (reading/writing). This means the oral is the central method for dissemination of mathematics knowledge in Iran. This type of literacy is characteristically different to the text-based culture of Japan (e.g. Katagiri, 2009; Maynard, 1997), and of the West as identified by Olson in his *The World on Paper* (Olson, 1994).

According to the theories of linguists, in the Japanese and Persian worlds, more responsibility tends to be placed on the listener or reader (the learner) than the speaker or writer (the teacher) (e.g. Hinds, 1987; Watanabe, 1998). If this is the case, there is an urgent need for lessons that nurture autonomous/proactive learning. Thus, in order to deepen the mathematical understanding of students, it seems that lesson improvement needs to encourage students to speak as much as possible. Even in Japan, there is potential to introduce lively lessons in which teachers and students engage in spoken exchanges. Lessons that involve such a large amount of speaking build good relationships between teachers and students. It seems that compared to lessons in Japan, in which writing by both teachers (*Bansho*) and students (notes) is central and students rarely speak, Iranian lessons enable the building of greater relationships of trust and cooperation between teachers and students.

As such comments show, the value of comparative lesson analysis is in its ability to reveal to educators their own unnoticed teaching script through lesson analysis across cultures and different pedagogical reasoning. Japanese education is underpinned by a written culture, while the culture of Iranian education is spoken, and changing the setting or script of lessons has a huge impact on the way they are carried out. For instance, one participant of the lesson analysis remarked that, "today in the meeting I saw a mathematics lesson conducted in a format completely different to the one I had been following for a long time. I should try to analyze my lesson through the lens of Teacher I's teaching script for expanding more math talk in my classroom" (interview, Masao, Japan).

In the process of carrying out the comparative lesson analysis, it became clear that the lesson objectives and the wishes of teachers and students were essentially the same across the two lessons. However, problems for future consideration include that both lessons seem to suffer from a weak "turn," which is the point that should introduce new perspectives and developments, enhancing lesson development by highlighting points within it (see Figure 3). This means that designing lessons from the perspective of the students, or "customized teaching," and how the silent process of each individual student in the lesson has impacted on their learning (personalized learning), may be one of the issues surrounding the quality of teaching arising from the case studies.

As this research is in the form of a case study, it opens up the possibility for comparative lesson analysis of more sample lessons around the world, and consideration of how active learning and dialogic teaching can be designed. Further study is required to determine what each student's learning (understanding, thinking, solving and analyzing) is dependent on, and what meaning can be drawn from learning content (mathematical phenomenon) through dialogic teaching, focussing on the creation of inquisitive learning activities. In addition, it may be interesting for educators to see how this comparative lesson analysis supports the Iranian and Japanese teachers to understand and revise their cultural script of teaching, especially

in terms of *Bansho* and notes for Iran, and student talk and dialogue for Japan. The study also points to four further research agendas:

RQ1. What constitutes the asking of "not-open-enough" questions in the classrooms of the two regions?

RQ2. Why did the teachers in Iran not follow up with the students' misunderstandings during the classroom interactions?

RQ3. In what ways can mathematical communication be effectively enhanced through the uses of oral utterances as well as writing?

RQ4. What is the role of lesson planning in the two forms of teaching?

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