Key Elements of a Good Mathematics Lesson as Seen by Japanese Junior High School Teachers

Marlon Ebaeguin
The University of Melbourne
<m.ebaeguin@student.unimelb.edu.au>

Max Stephens
The University of Melbourne
<m.stephens@unimelb.edu.au>

This study makes a comparison between what literature on Japanese Lesson Study suggests are key elements of a good mathematics lesson and what junior high school mathematics teachers in Japan value in planning their lessons. The teachers' strong consensus in their endorsements of these key elements explains why Japanese teachers strongly support and engage meaningfully in Lesson Study and sheds light on the tensions that may form when introducing Lesson Study to teachers outside Japan who may value these key elements differently.

Lesson Study (LS) is considered a powerful tool for effecting teacher growth through understanding student thinking and has spread to many countries over the past decade. However, these LS implementations seem to have varied results. Some efforts have been successful and still on-going, while others were somewhat successful but was not sustained, ending up as wasted efforts. The success of introducing an innovation is dependent on the extent the stakeholders are convinced by the innovation. However, getting people to favour change is largely influenced by the extent to which the innovation is aligned with what they value in their practice. This study aims to find out what values are embedded within the construct of Lesson Study and to what extent Japanese mathematics teachers endorse these values. It is also hoped that this study of Japanese mathematics teachers can alert us to potential areas of tension that may arise when LS is implemented in a different national context.

Cultural Assumptions of Japanese Lesson Study

In an earlier paper, the authors discussed the relevance of Hofstede's (2001) dimensions of national culture and how this might throw light on how Japanese teachers in particular approach LS and what they are likely to value most highly. This implies that when we try to introduce Lesson Study outside Japan, cultural factors could be significant.

Hofstede's (2001) work focused on comparing work-related values, behaviours, institutions and organisations across nations. His landmark studies (Hofstede, 2001) were based on extensive matched samples of participants who were employees of IBM. In his study, Hofstede (2001) came up with scores for at least 60 countries according to five dimensions: Power Distance Index (PDI), Individualism/Collectivism (IDV), Masculinity/Femininity (MAS), Uncertainty Avoidance Index (UAI), and Long-term Orientation (LTO). PDI pertains to hierarchy in the system which influences interaction between stakeholders and distribution of key roles, while IDV deals with propensity towards collaboration. MAS distinguishes between achievement and competitiveness or harmony and consensus. UAI relates to openness to change and innovation, while LTO is associated with having future-oriented or short-term perspectives (for a more detailed discussion on Hofstede's dimensions of national culture, please refer to Hofstede, Hofstede, & Minkov, 2010). Figure 1 below shows the scores for Japan.

2016. In White, B., Chinnappan, M. & Trenholm, S. (Eds.). Opening up mathematics education research (Proceedings of the 39th annual conference of the Mathematics Education Research Group of Australasia), pp. 206–213. Adelaide: MERGA.

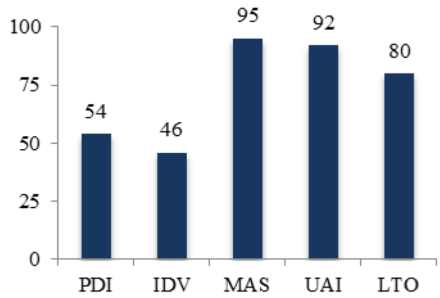

Figure 1. Hofstede's scores for Japan (from data in Hofstede, Hofstede, & Minkov, 2010)

Table 1 summarises the relevance of Hoftsede's dimensions of culture to LS. The very high scores for Japan on MAS, UAI and LTO are particularly important in offering a cultural underpinning of the values embedded in LS. In particular, the high value for UAI and LTO help to explain the importance given to detailed lesson planning and to seeing LS as continuous and on-going program of teacher professional growth. However, other features of Hofstede's dimensions of culture are also relevant to seeing LS, to some extent, as a reflection of deeply embedded features of Japanese culture.

Table 1
Summary of Key Cultural Assumptions of Japanese Lesson Study as Seen Through Hofstede's Dimensions of National Culture (Ebaeguin & Stephens, 2014)

Dimensions of Culture	Japanese Lesson Study Assumptions	Japan
Power Distance Index (PDI)	Everyone is given a chance to play a key role in every cycle. Everyone's voice is valued and respected	Moderately hierarchical
Individualism/Collectivism (IDV)	Lesson study is done in a collaborative environment. Everyone is able to engage in self-reflection and self-evaluation.	Moderately collective
Masculinity/Femininity (MAS)	There is a continuous improvement in teacher capacity. A better lesson is developed at the end of every cycle.	Extremely masculine
Uncertainty Avoidance Index (UAI)	Research and planning phase is intended to be thorough and time consuming.	Extremely uncertainty-avoiding
Long-term/ Short-term Orientation (LTO)	Teachers and schools are committed to continuing cycles. Goal is to build up a collective knowledge over many cycles.	Extremely long-term orientated

As Hofstede's (2001) study shows, we cannot expect the same features to be present to the same degree in other countries. How would LS be received if it is introduced to a short-term oriented context or one that is less open to change (low UAI)? Would the very collaborative nature of LS persist in a very hierarchical environment? Furthermore, we need to be cautious in assuming that Hofstede's data derived from a business environment automatically applies identically to teachers.

Key elements of planning a good mathematics lesson

Japanese Lesson Study is a cycle of Plan, Do and See (Fernandez & Yoshida, 2004; Hart, Alston, & Murata, 2011; Inprasitha, 2011; Lewis, 2002). It may appear to be a very simplistic model but in actuality much happens at each stage. By looking at what transpires during each phase, we can identify aspects or elements of lesson planning that Lesson Study regard as essential.

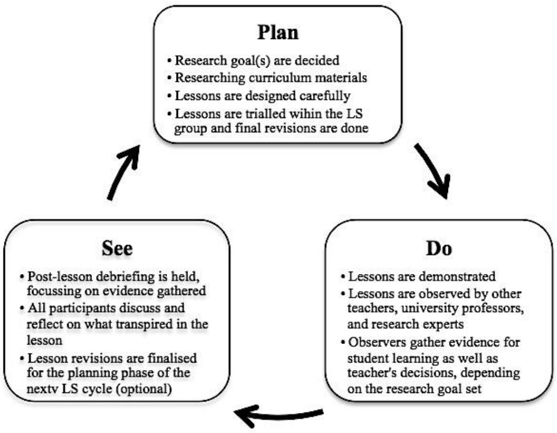

Figure 2. The Lesson Study cycle (adapted from Ebaeguin & Stephens, 2014; Fernandez and Yoshida, 2004; Lewis, 2002*)*

Plan

At the outset, it is important to distinguish lessons planned during Lesson Study (research lessons) from regular lessons as the former are seen more as a research proposal (Fujii, 2014). This is one of the reasons that the planning phase takes time and is done thoroughly. The school and the LS group consider the long-term goals for student learning and development and determine and focus on a particular research goal (Ebaeguin & Stephens, 2014; Lewis & Hurd, 2011; Lewis & Tsuchida, 1998). Doing this involves looking at different curriculum materials such as the National Course of Study in the case of Japan, textbooks, course syllabus, scope and sequence, etc. Once the research goal has been determined, the group then decides on the topic for the research lesson. The LS group looks at different textbook's approaches to the topic and/or look at existing lessons or research lessons that they can adopt, build upon and/or modify. This whole activity is referred to as *kyozaikenkyu*.

The lesson plans are then designed carefully such that it includes the long-term goals, range of anticipated student responses, data to be collected, model of a learning trajectory and the reasoning for the choices made (Lewis & Hurd, 2011). The Lesson Study group also tries to think the way their students think by anticipating the range of student responses which does not only include the correct responses but also incorrect responses caused by student misconceptions. Critically examining the widest range of student responses allows the Lesson Study group, especially the teacher that will be assigned to conduct the lesson, to plan support to students when such responses come up (Ebaeguin &

Stephens, 2014). The research lesson can then be trialled within the LS group to allow the demonstrating teacher to be more at ease with the lesson and to pre-empt problems in lesson before conducting it with the students.

Several elements are clearly predominant in this phase: (1) collaboration of the teachers; (2) utilisation of different curriculum materials; and (3) focus on the students' learning (anticipation of responses and trialling of the lesson). In fact, Takahashi (2006) said that writing of a lesson plan has three principal functions: (1) amalgamation of teachers' ideas for a common goal; (2) *kyouzaikenkyu* (see above); (3) the focus is on teaching, not on the teacher.

Do

After the research proposal comes the data gathering. The research lesson is conducted by one LS group member. The rest observe the lesson and collect data/evidence. The data/evidence collected depends on the research goals so the observation is not focussed on the teacher, but rather on the teaching. University professors and/or research experts are usually invited as the knowledgeable other. They are expected to serve as external resource persons and to provide support to the LS group in their research.

While all members of the group have important roles to play, the demonstrating teacher's role is quite critical because he/she must be able to facilitate mathematical discussion based on the solutions that students come up with. This is why the lesson plan should have a clear plan for the discussion, which is essentially based on the student responses the group has anticipated during the plan phase. The lesson plan is obviously quite detailed but this does not mean that it has to be strictly followed like a script–it is, after all, a proposal (Takahashi, 2006; Fujii, 2014). As the lesson unfolds, the demonstrating teacher may opt to deviate from the lesson plan depending on how the discussion progresses.

What is evident in this phase is the importance of the following: (1) having other 'eyes' to observe the lesson; (2) having a detailed lesson plan that includes anticipated student responses; (3) extensive discussion based on students' work as LS experts such as Takahashi (2006), Lewis (2002), Lewis and Hurd (2011) and Fujii (2014) make clear.

See

A post-lesson discussion is held usually right after the lesson demonstration. The demonstrating teacher and the observers reflect on what transpired in the lesson demonstration. Discussion focusses on data/evidence gathered from the lesson that gives insight into student learning, deviations from the lesson design, and even broader issues in teaching and learning (Ebaeguin & Stephens, 2014; Lewis & Hurd, 2011; Fernandez & Yoshida, 2004). It is crucial here that everyone is able to reflect on their own and others' observations, with the research goals and student learning in mind. In the case that the research lesson is to be re-taught, revisions, if any, are finalised and will be a focal point in the plan phase for the next cycle.

Methodology

From the above literature review, several key elements of planning a good mathematics lesson become manifest. These are (1) collaboration amongst the teachers (planning and sharing lesson ideas); (2) researching on curriculum materials; (3) anticipating student responses to problems; (4) preparing a detailed lesson plan incorporating the anticipated responses; (5) having others observe the lesson; (6) utilising students' work samples in evaluating the success of a lesson; and (7) reflecting on own and others' observations. Another pertinent aspect, indirectly implied by the LS process, that also needs to be considered is being involved in LS. Japanese teachers recognise and accept that there is an expectation for them to be involved, directly or indirectly, in LS. Each of these seven key elements can be seen to inform the construction of the questionnaire used in this study.

In a prior study, the authors designed and used the Mathematics Teachers' Perception of a Good Mathematics Lesson (MTPGML) questionnaire. Embedded in this questionnaire are the same seven key elements of mathematics teaching that are implied by Japanese Lesson Study as discussed by experts (see literature review) and as practised by teachers. The first key element, collaboration amongst the teachers, is reflected in items 2 (*Working with other teachers to plan a lesson*) and 6 (*Talking about and sharing successful maths lessons with colleagues*). The second key element, researching on curriculum materials, is reflected in item 1 (*Using/researching curriculum materials (national curriculum, textbooks, course syllabus, scope and sequence, etc.) in planning your lessons*). Preparing a detailed lesson plan with the anticipated responses and having others observe the lesson are manifested in items 4 (*Identifying in advance the range of expected student responses to the task, including likely wrong responses, in a problem-solving lesson*) and 5 (*Writing a detailed lesson plan addressing the range of expected student responses*), respectively. Item 8 (*Evaluation of a lesson through analysing collected samples of students' solutions and attempted solutions*) refers back to utilising students' work samples in evaluating the success of a lesson. The fifth (having others observe the lesson) and seventh (reflecting on own and others' observations) key elements are reflected in items 3 (*Having other teachers in the classroom to observe my teaching*) and 7 (*Relying on my own opinion whether a lesson has been successful or not*). Item 9 (*Getting involved in school research*) refers to the clear expectation of being involved in LS.

A Japanese version of MTPGML was developed and was piloted with some Japanese graduate students. The questionnaire was then administered to a convenience sample of sixteen Japanese junior high school mathematics teachers (Japan1), ten of whom were teaching in Tokyo. Half of the sample had at least ten years of teaching experience, while six teachers were relatively novice having less than five years of teaching experience at that time. The teachers were asked to indicate their endorsement of each key element by rating it Essential (E), Very Important (VI), Important (I), Undecided (U), or Not Important (NI). With the exception of item 7 (Relying on my own opinion whether a lesson has been successful or not), positive disposition to key elements were indicative of a positive disposition towards Lesson Study. For item 7, we expect that teachers would value the judgements of colleagues in determining the success of a lesson. Table 2 below shows the result of this prior study undertaken in 2013 with the assistance of a Japanese professor based in Tokyo.

From Table 2 below, it can be seen that there were uniformly consistent responses to all key elements from the Japan1 sample. However, this could be influenced by the fact that majority of the sample are from Tokyo and working in a university-attached school. To enhance the robustness of this questionnaire's results, the authors decided to recruit a new sample of teachers. Their responses form the basis for the remainder of this paper.

This follow-up study commenced in 2016 and involved 41 junior high school mathematics teachers in Japan (Japan2). MTPGML was made available online to reach more mathematics teachers across Japan. The majority of the respondents who were recruited with the assistance of Japanese colleagues came from Kanto and Chubu regions, while the rest are from Hokkaido, Kansai, and Chugoku regions. 19 out of 41 (46%) of the sample have at least ten years of teaching experience, while 10 out of 41 (24%) have no more than five years of teaching experience.

Results and Discussion

Table 2 below shows the results of the questionnaire for both samples Japan1 and Japan2. It can be seen that this sample of Japanese teachers has very strong endorsements in all of the key elements.

Table 2

Mathematics Teachers' Perceptions of How to Prepare a Good Mathematics Lesson

	Japan1 (%) n = 16					Japan2 (%) n = 41				
Items	NI	U	I	VI	E	NI	U	I	VI	E
1. Using/researching curriculum materials (national curriculum, textbooks, course syllabus, scope and sequence, etc.) in planning your lessons.	0	0	13	25	62	0	5	10	34	53
2. Working with other teachers to plan a lesson.	0	18	38	25	19	0	20	29	34	18
3. Having other teachers in the classroom to observe my teaching.	0	0	25	38	37	0	0	15	39	48
4. Identifying in advance the range of expected student responses to the task, including likely wrong responses, in a problem-solving lesson.	0	0	0	25	75	0	2	5	34	60
5. Writing a detailed lesson plan addressing the range of expected student responses.	0	6	31	31	32	7	20	17	29	28
6. Talking about and sharing successful maths lessons with colleagues.	0	0	44	44	12	0	0	22	51	28
7. *Relying on my own opinion whether a lesson has been successful or not.	0	44	50	6	0	22	34	27	15	3
8. Evaluation of a lesson through analysing collected samples of students' solutions and attempted solutions.	0	0	19	31	50	2	5	27	37	30
9. Getting involved in school research.	0	6	6	19	69	0	2	22	27	50

Notes: Shading indicates combined percentages of *Very Important* (VI) and *Essential* (E) ≥ 50%.
* Lower values are important for this item.

From Table 2, combining the percentages for VI and E, it can be seen that Japan 2 has a somewhat higher endorsement for items 3, with 87% of Japan2 rating "*Having other teachers in the classroom to observe my teaching*" VI or E compared to 75% in Japan1;

and for item 6, 79% of Japan2 rating "*Talking about and sharing successful mathematics lessons with colleagues*" VI or E compared to 52% of Japan1. Both samples give very high endorsement to items 1, 4, and 9. For item 4, in particular, 100% of Japan 1 and 94% Japan2 rate "*Identifying in advance the range of expected student responses to the task including likely wrong responses in a problem-solving lesson*" VI or E. This signature feature of LS is clearly valued very highly by teachers in both samples even for regular lessons. Likewise, 87% of both samples rate item 1 "*Using/researching on curriculum materials (national curriculum, textbooks, course syllabus, scope and sequence, etc.) in planning out your lesson*" VI or E. For item 7, the impact of LS is evident with nearly half of the teachers in each sample reporting that "*Relying on my own opinion as to whether a lesson has been successful or not*" is either NI or U.

Generally speaking, however, the responses from the two samples are very consistent across eight of the nine items where the difference between the combined percentages of VI and E is no more than 15% and often much less. Only in item 6 "*Talking about and sharing successful mathematics lessons with colleagues.*" is Japan2 stronger by 23% than Japan1. But even in this case, the majority of the teachers in both samples believe that "*Talking about and sharing successful mathematics lessons with colleagues*" is VI or E. If we include the three ratings I, VI and E, for item 8 "*Evaluation of a lesson through analysing collected samples of students' solutions and attempted solutions*", more than 90% in both samples endorse this feature of a mathematics lesson.

Overall, the consistency in the strong valuing of all these key elements (value orientations) across the two samples of Japanese teachers is very evident. This strong consistency between the two samples serves to validate MTPGML. Several conclusions or questions can be drawn from these results. First, among junior high school mathematics teachers, there seems to be a strong consensus in what is highly valued in a good mathematics lesson. Second, one can ask whether this consistency in what the sampled Japanese junior high school teachers value in a good mathematics lesson is a result of the pervasive influence of LS in Japan over the past 100 years, or are these values also a reflection of deeply held beliefs and values in Japan. This latter question strengthens the authors' claim that what we are looking at may equally well be described as culturally specific features. If these are culturally specific, then we would expect evidence to be available in contexts outside of school. If this is true, then it would be unwise to assume that these values could be replicated in the case of other countries where LS may be introduced.

Conclusion

In both samples of Japanese junior high school mathematics teachers, there was a consistency in the strong endorsements (value orientations) of the key elements of LS. It can also be seen that both samples of Japanese teachers can clearly distinguish research lessons from regular lessons. The signature elements of LS that they value the most are those that are also central to designing regular lessons, for example *kyouzaikenkyu*, identifying in advance students' responses, and evaluating the success of a lesson using student artefacts. On the other hand, teachers in both samples recognise that some signature elements of LS may be less relevant in regular teaching such as writing a detailed lesson plan and working with other teachers to plan a lesson. However, these elements still received clear endorsement in both samples of Japanese teachers. Can we assume that these conclusions apply in other countries?

Lesson Study is recognised in many countries as having the potential to foster teacher growth especially if teachers are able to engage in it meaningfully. However, this is not achieved merely by learning the processes and the skills needed to participate in it. These processes and skills that make LS successful in Japan are not simply a set of transportable behaviours that can be shifted from Japan to other countries. They need to be seen as embodying and reflecting values that are specific to Japan. This may explain why Japanese teachers readily participate in and are able to maximise their learning from LS.

This study of Japanese teachers doesn't offer direct evidence in relation to shedding light on the possible tensions that may arise when introducing LS to a different national context. Nevertheless, the very clear relationship between the key elements of LS and what the sampled Japanese teachers endorse, alerts us to consider what is likely to happen in a different national context that is more hierarchical, short-term oriented and less uncertainty avoiding.

When LS is implemented outside Japan, we cannot assume the same value orientations from the teachers, neither should we assume that the values that underpin the success of LS in Japan are themselves easily transported to other countries. Our research on Mathematics Teachers Perceptions of a Good Mathematics Lesson (MTPGML) allowed us to identify value orientations that may help or hinder success of a LS implementation elsewhere. Where there is contrariety in the value orientations, tensions, misinterpretations, misconceptions, and even resistance from other teachers may arise. This should prompt implementers of LS to either assist the teachers to transition towards valuing or to develop adaptations that teacher's values orientations can support.

References

Ebaeguin, M. & Stephens, M. (2014). Cultural challenges in adapting lesson study to a Philippines setting. *Mathematics Teacher Education and Development*, 16(1), 43–64.

Fernandez, C., & Yoshida, M. (2004). *Improving mathematics teaching and learning: The Japanese lesson study approach (Studies in Mathematical Thinking and Learning Series)*. Mahwah, NJ: Lawrence Erlbaum Associates.

Fujii, T. (2014). Implementing Japanese lesson study in foreign countries: Misconceptions revealed. *Mathematics Teacher Education and Development*, 16(1), 65–83.

Hart, L. C., Alston, A. S., & Murata, A. (2011). *Lesson study research and practice in mathematics education: Learning together*. Dordrecht, The Netherlands: Springer.

Hofstede, G. (2001). *Culture's consequences: comparing values, behaviours, institutions, and organizations across nations*. Thousand Oaks, CA: Sage.

Hofstede, G., Hofstede G. J., & Minkov, M. (2010). *Cultures and organizations: Software of the mind: Intercultural cooperation and its importance for survival*. New York: McGraw-Hill.

Inprasitha, M. (2011). One feature of adaptive lesson study in Thailand: Designing a learning unit. *Journal of Science and Mathematics Education in Southeast Asia*, 34(1), 47–66.

Lewis, C. (2002). What are the essential elements of lesson study? *The California Science Project Connection*, 2(6), 1, 4.

Lewis, C., & Hurd, J. (2011). *Lesson study step by step: How learning communities improve instruction*. Portsmouth, NH: Heinemann.

Lewis, C., & Tsuchida, I. (1998, Winter). A lesson is like a swiftly flowing river: How research lessons improve Japanese education. *American Educator*, 12–17; 50–52.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap*. New York, NY: Free Press.

Takahashi, A. (2006, January). *Characteristics of Japanese mathematics lessons*. Paper presented at APEC International Conference on Innovative Teaching Mathematics through lesson study, Tokyo, Japan.