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Key components of lesson study from the perspective of complexity: A theoretical analysis

Lesson study (LS) is a collaborative practice of inquiry in which teachers design a lesson plan and work to improve it and its execution after observing its instruction. Originating in Japan, LS is recognized in international research as a useful mechanism for teachers' training and professional development. However, research reveals that misconceptions arise when LS is adopted outside of Japan, and different authors have called for further theoretical development to increase comprehension of the process. In response, we analyse three LS' key components (phases, product and teachers' cooperation) from the perspective of the epistemology of complexity, highlighting the role of emergence, the ecology of action, and joint reflection. We suggest that viewing LS through the lens of complexity can allow teachers to gain a deeper understanding of this practice and to apply it more successfully.

Keywords: lesson study; theoretical analysis; teacher education; complex thinking; situated cognition; collaboration.

1. Introduction

Lesson study (LS), the translation of the Japanese concept 'jugyo kenkyu' (授業研究), is a practice whose roots stretch back to the last quarter of the 19th century (Makinae, 2019). Today, LS is used widely in Japan for teachers' training and professional development at different institutional and administrative levels (Lewis, 2009; 2013). LS is a cyclical, collaborative process of inquiry and reflection, carried out by a group of teachers who gather to design a lesson plan—the research lesson (RL)—implement it, and analyse

classroom instruction, with the goal of improving the RL and their teaching practices, and enriching students' learning experiences . In this way, in an ongoing feedback loop through which the outputs of the analysis of the RL are used as inputs for a new version of it, the outcomes of the LS cycle result in further analysis and revision of teaching practices and beliefs.

LS began to draw attention outside of Japan starting with Stigler and Hiebert's work (1999), which identified best practices from around the globe for improving education in the classroom. Since that time, linking the good results of Japanese students to the training and teaching culture in the country (Ingersoll, 2004), LS has been embraced and studied by teachers and researchers around the world (Lewis & Lee, 2017), including educational contexts as varied as Hong Kong (Hargreaves & O'Connor, 2018), Iran (Moghaddam, Sarkar Arani & Kuno, 2015), Uganda (Fujii, 2014), the U.K. (Dudley, 2013) and the U.S. (Akiba & Wilkinson, 2016), being these last two contexts where we find more examples of the put into practice of LS and of related studies (for the history and development of LS in the U.K., see Dudley [2011; 2015]).

LS continues to show promising results for teaching enhancement (Hiebert & Stigler, 2017) and efficacy (Chong & Kong, 2012), for the development of teachers' pedagogical content knowledge (PCK) (Coenders & Verhoef, 2018), for teachers' active (Vrikki, Warwik, Vermunt, Mercer, & Van Halem, 2017) and transformative learning (Wong, 2018), possibilities for improvement science within education (Lewis, 2015), and potential for curriculum reform (Lewis & Takahashi, 2013). However, previous studies also reveal the need to improve our theoretical foundation to understand the purpose of LS, its features and its use (Lewis, Perry & Murata, 2006; Murata, 2011; Rock & Wilson, 2005). This increasing theoretical foundation would help teachers avoid the difficulties and misconceptions revealed by different other studies (Chokshi & Fernandez 2004; Díaz

et al. 2005; Fujii 2014; Postholm, 2019; Takahashi & McDougal, 2016; Yoshida, 2012) when they put LS into practice; situations that often arise when teachers uncritically adopt a process that, even in Japan, has not always led to reflective and collaborative teaching (Sarkar Arani, Fukaya & Lassegard, 2010).

In this essay, we propose to expand the theoretical understandings of LS by observing it from the perspective of the epistemology of complexity (also known as 'complex thinking' or 'systemic thinking'). We adopt this viewpoint under the assumption that it is useful—though not necessarily required—for thinking about the cognitively complex teaching-learning processes (McAlpine, Weston, Timmermans, Berthiaume & Fairbanch-Roch, 2006) that, additionally, are executed in an educational reality that is itself unattainable and emerging.

From this unexplored angle, we make explicit tacit assumptions of LS that teachers may overlook when implementing it. When teachers don't keep in mind the underlying complexity involved in LS, they can become concerned or discouraged when their lesson plans don't develop as expected in the classroom, or when their peers' opinions sound unflattering. In contrast, recognizing the complex cognitive processes inherent to LS can help teachers carry out this process, which requires open-mindedness and the ability to tolerate unexpected outcomes. By applying the lens of complexity, teachers can capitalize on opportunities for reflection and avoid feeling overwhelmed.

Beyond its potential value to think and put into practice LS in any educational context, we propose that this perspective will be particularly useful in teaching contexts lacking any of the following habits, fundamental initial conditions for carrying out LS:

- A culture of institutional support for teachers' inquiry practices (Takahashi & McDougal, 2016).
- A routine of cooperation around creating lesson plans (Fujii, 2016).

- A systematic engagement in research-based professional learning (Akiba & Wilkinson, 2016).

2. Using the epistemology of complexity to illuminate the features of LS

Our goal is to offer a different viewpoint for reflecting on LS, seeking to understand it using the framework of complexity, which would in turn allow teachers to implement LS, while avoiding misunderstandings and maintaining their commitment to the process. In the following sub-sections, we interpret three key components and facets of LS from the perspective of the epistemology of complexity: a) its phases or steps, in 'Emergence in the LS process', b) its product (the lesson), in 'RL and the ecology of action', and c) collaboration, in 'Collaboration and joint reciprocal reflection and learning'.

2.1 Emergence in the LS process

LS consists of a standardized, cyclical process undertaken by a group of teachers. As it is put into practice in Japan and internationally (see, for example, Lewis & Hurd, 2011; Fujii, 2016; Stepanek, Appel, Leong, Turner, & Mitchell, 2007; Takahashi, Watanabe, Yoshida, & Wand-Iverson, 2005), the teachers carry out the following phases or steps:

- Set goals for the RL according to the subject, topic and students' knowledge gaps or 'learning challenges' (Cajkler & Wood, 2016). The goals can differ depending on where LS is implemented (Lewis, 2015) and where the focus is set (students' learning, teachers' training, curriculum development, etc.). In Japanese schools, for example, lesson goals often arise from transferring an institution-wide objective to the context of a particular subject.
- Design the RL (instruction, methodology, activities, materials, etc.) that teachers will conduct so that they can later analyse the RL. In this phase, teachers also

consider possible students' answers to the activities in order to offer them a response.

- Implement the RL (usually one teacher), while the rest of the group observes to collect data according to the proposal of inquiry.
- Reflect collaboratively in a post-lesson discussion (Takahashi & McDougal, 2016) to analyse the RL based on what teachers have experienced and observed so that it can be improved and implemented in a different class—something that does not always happen (Lewis, 2009)—and disseminated to the educational community.

LS is a cycle of phases in which an original RL (and the forms of pedagogical and content-based knowledge connected to it) is created, deconstructed and reconstructed. We can imagine LS as following a spiral path. If resources permitted, this path would be infinite, since teachers could always return to observe the RL, reflect on it, reformulate it and teach it again, cooperating with its contextualized evolution.

We argue that to implement LS successfully, participants must tacitly acknowledge the unattainability of reality, recognizing the existence of classroom dynamics beyond their control and of weak emergence, phenomena and properties that, in organized systems, arise unexpectedly (Chalmers, 2006). These elements will affect their work and the design of the RL, especially because of two of the features of emergence referred by Goldstein (2016) (author who, however, considers the notion inadequate and, under a different logic of emergence, refers to 'self-transcending construction' [2016: 48]): a) radical novelty, the unpredictability of phenomena from the initial conditions and perspective, and b) 'ostensiveness' (Goldstein, 2016: 40), the impossibility to foresee these phenomena until they happen.

Recognizing these features is key to implementing LS, because the continuity of its structural stability as a process is tied to the emergence of unpredictable events that take place and are observed in the classroom. Still, it also runs the risk of making LS seem even more challenging than it already is and thus diminishing teachers' commitment. However, we suggest that we can overcome the perception of difficulty by adopting other elements from the epistemology of complexity and situated cognition, a way of thinking in which knowledge arises as a means for coordinating an activity from within the activity itself, articulated with the social context in a specialized population niche and transformed through processes of assimilation and interpretation (Robbins & Aydede, 2009):

- On one side, classrooms are complex systems occupied by human beings whom Morin (2007) understands to be non-trivial machines (analytically unpredictable and indeterminable [von Foerster, 1984]). However, these features do not mean that it is ineffective to try to anticipate behaviours in complex contexts. To the contrary, attuning oneself to a complex system does not only occur by accident; at a cognitive level, it also occurs through conscious reflection (Robbins & Aydede, 2009).

  LS practitioners should not confuse unexpectedness with nondeducibility. As Chalmers (2006) states, phenomena can be both unexpected and, yet, deducible in principle. This idea reinforces the significance of two of LS's phases that involve aligning the RL with the behaviour of the class as a system: 1) planning, as in Schön's (1987/2002) 'reflection for action' and van Manen's (1991) 'anticipatory reflection', and 2) revision, as in Schön's (1987/2002) 'reflection on action' and van Manen's (1991) 'recollective reflection'.

- But, if students are non-trivial machines, how can teachers who carry out LS 'pre-decode' their actions and possible answers during the instruction of the lesson?

Complex thinking and situated cognition help to respond this question. On one hand, teaching actions can be understood as strategies (Morin, 1999/2010), adaptable to the situation more than immutable decisions. On another, teachers—especially experienced ones—can make use of their PCK that offers them ideas on common answers and difficulties that students face in relation to a particular content or activity. This anticipation of students' responses is considered a core practice for teaching (Grossman, Hammerness, & McDonald, 2009) and it is tightly connected to the practice of pressonance, a process that enables a contextualized anticipation of future states, based on the ability to experience situations vicariously (Robbins & Aydede, 2009). It is not that students' behaviours (individual or as a group) are entirely predictable and analytically determinable, as is the behaviour of trivial machines (von Foerster, 1984). Rather, teachers draw on professional knowledge that grants them a general idea of what to expect when presenting students with a given input (topic, activity, etc.). This awareness helps them to design the RL, foreseeing situations that might emerge, and increases their confidence in an RL that, in the end, is based on students' hypothetical performances.

- On the other side, during LS teachers need not anticipate all possible outcomes that an RL could have nor how every individual student reacts to it. Despite an infinitude of situations that could arise during the lesson, only some of them are highly probable and even fewer will actually become a reality. Even natural systems balance order and chaos (Crutchfield, 2012) and in them too we find patterns, self-organization and specific points to which they seem to propel themselves (Boeing, 2016).

- Finally, reflecting on the design of the RL helps teachers locate—at a cognitive level—critical 'pressure points' from which small changes can generate a great impact in terms of students' learning. In terms of content, an example of potential pressure points that teachers could more easily locate reflecting on the design would be the threshold concepts (Walker, 2013), concepts that, when understood, transform how students think about a topic.

Unpredictability and structured disorder, rather than being obstacles to LS, actually form the basic premise that allows LS to function. Teachers tacitly assume that in the dynamic of the class system, non-linear interactions will occur, in turn provoking unexpected behaviours that may be amplified by a self-reinforcing feedback loop. Without unpredictability and disorder—if everything in the classroom were foreseeable regularity—the processes of observation and reflection in LS would become unnecessary. Conversely, accepting that things will surely not play out exactly as we expected allows teachers to analyse what happens and re-design the RL accordingly. In short, we can only carry out LS successfully if we accept the emergent properties of classroom experience and understand that the RL is, at best, a method of experimentation.

2.2 The RL and the ecology of action

In LS, teachers witness and participate first-hand in the ecology of human actions; once these are set in motion, they are taken over by the environment, weakening our control over them and limiting our ability to understand them (Heath & Luff, 2013). From the moment the RL enters the classroom, we can imagine it as a raft floating downstream. The teacher takes actions to steer it and tries to navigate its way into the port making continuous adjustments as unforeseen currents alter the raft's path. After the RL has been taught and gets to port, the teachers reflect and discuss the necessary modifications to

make it more likely to sail the waters they have experienced. Thanks to this feedback, the RL regains a temporary state of equilibrium, ready to sail again. Still, the waters it will navigate next time will be different and might probably offer new challenges. For this reason, even if the RL finds in its path moments when it recovers its stability, as long as it continues being taught in new contexts with new students, it will continue being taking over by the environment, facing disequilibrium and the need of receiving new adjustments.

As seen, the RL itself is a stable system, but it is mobile and subject to an irreversible flow, without which it cannot operate. We find in this process an example of 'endo-exo-causality' (Morin, 2005: 37), a feedback loop of causalities between the RL and the phenomena that influence it: the RL is designed for a specific context, but the RL itself brings about unexpected events, which in turn affect it and make it possible to continue the process of LS. Students, their relationship to what teachers prepare (contents, methods, etc.) and the circumstances all affect the RL, as teachers observe and analyse these elements in creating a modified version. This process is an example of how, through interaction with the environment, both a system overall and the product of the system experience self-organization.

When teachers remain open to unpredictability, they participate in uncertainty, incorporating it into the logic of the RL using rationality (which we understand, following Morin [1990], as a quality that draws on dialogue between our logical structures and reality, without pretending—unlike rationalization—that our logical structures encompass reality). In so doing, they consider not only the present choices, but also the decision tree they lead to, as Schön (1983/1998) pointed out for reflection in action. Thus, in trying to anticipate contingences that might appear when the RL is implemented,

teachers construct design networks of great complexity, as if drawing what in physics (Nolte, 2010) would be a map of trajectories intersecting the phase space.

Acknowledging that not all paths and problematic situations can be identified a priori, LS participants do not envision the RL as determining a linear and immovable course of action. The RL is, on the contrary, a space of possibility; it is a product—'biodegradable' in the action and the surrounding context—in which LS practitioners are invited to embrace uncertainty as something productive (Mintz, 2016) and act as an attentive audience, ready to learn from any possible divergence from the expected.

2.3 Cooperation and joint reciprocal reflection and learning

LS is a collaborative process, but its collaborative practices and structures are sometimes left behind when LS is transferred to contexts outside Japan, revealing misconceptions in its practice (Chokshi & Fernandez 2004; Díaz et al. 2005; Fujii 2014; Yoshida, 2012) and the need of adaptations encouraging collaboration to respond to this situation (Takahashi & McDougal, 2016). When carried out in its full form, LS involves several teachers who are part of an epistemic community (sharing the same subject or a similar disciplinary field) and are subject both to a general normative framework (legal, institutional, curricular, etc.) and to their own system of (often implicit) rules, making of their collaborative process a complex system that evolves (Yuan, Zhang, & Yu, 2018).

LS is a practice originating in Japan, where educational institutions and teachers meet different initial conditions that contribute to put it into practice and that should be taken into consideration when introducing LS in other contexts. On one side, in Japan professionals are regularly involved in *kaizen*—continuous improvement (Sarkar et al., 2010)—a work philosophy that involves the willingness to unlearn thinking schemes and construct new ones with the help of colleagues. For this reason, we find in Japanese schools a culture of institutional support for teachers' inquiry practices (Takahashi &

McDougal, 2016) and a tradition of engaging in research-based professional learning (Akiba & Wilkinson, 2016). On the other side, the LS group is shaped as a setting that favours self-contemplation. In Japanese, we find the concept of *hansei* to describe a practice of continual critique of our prior actions with the goal of learning from mistakes and improving our behaviour in the future (Rohlen & LeTendre, 1998). The LS group, as a setting, also favours openness to joint self-inspection as a path toward comprehension and toward reconsidering what was previously known; together, teachers co-construct knowledge through dialogue and observation, under the assumption that there is no single correct way to create and conduct an RL. In this sense, LS is an intimate practice (Lewis & Hurd, 2011) that requires teachers to reveal themselves professionally by contributing their knowledge, practical experience, judgments and educational ethics and values.

At the same time, LS in Japan is put into practice in a culture where cooperation around creating lesson plans is common (Fujii, 2016). This way, teachers collaboratively apply their reasoning and combine their different forms of knowledge to reach a consistent group vision of what to teach and to whom. The RL is developed from this point of overall—though not necessarily complete—consensus; teachers must be willing to accept critique (of the work more than of the person who performs it) and to pursue self-evaluation. This process requires that participants develop a type of communication that allows them to cognitively place each other in the world, in order to coordinate their joint efforts (Robbins & Aydede, 2009). Through this joint reflection, interpersonal knowledge is engendered from the shared experience of a socially situated process (van Dijk, 2016), which has different representations in the mental models of the individual participants. This is yet another case in which the part (individual knowledge) and the whole (group knowledge) mutually influence each other, generating interactive learning paths for both the individual and the group.

It is useful to think of the LS working group as a system in the form of a learning community. This system is a perceived whole whose parts remain united, because, while continuously affecting each other, they operate for a common purpose. Despite resistance to change, by engaging in dialogue and regulating the relations and interactions that happen in and arise from the system, the community evolves in codependence with the context. The group and its work are flexible and sensitive to the development of the RL. These traits make it possible for the group to face needs that emerge beyond what was planned and tolerate circumstances related to mistakes and liminal spaces (areas or states of transition and ambiguity where meanings and learners' subjectivity are transformed [Land, Rattray & Vivian, 2014]), typical facets of any learning situation.

We need to understand LS as a practice that, due to its original conditions in Japan, both requires and promotes a culture of cooperation among groups of teachers and at their institutions more broadly. In Japanese schools, for example, LS groups specify broad institutional goals within their subjects through the RL; this task of specification involves connecting systems at different levels, contributing to develop a more organic perspective of the organization by recognizing teachers as driving forces for educational change and improvement. LS groups are then spaces guided by cooperation rather than competition, where the principles of solidarity and flexibility are applied. Practitioners strive to understand the inevitable diversity and contradictions that arise as signs of the group's vitality. And this very diversity provides teachers with access to other viewpoints, allowing them to avoid self-deception and to use contrast to analyse their own standpoints, knowledge and methods.

3. Conclusion

We have attempted to present complex thinking as a cognitive attitude that can allow teachers to make sense of and carry out the process of LS. The goal of our theoretical

analysis has been to make LS more understandable, therefore helping to confront the challenges that have arisen when teachers have tried to apply it outside of Japan.

Along the same lines, we have referred to LS as a practical and reflective process that helps teachers implement and analyse sets of knowledge, abilities and actions to address the complex relationships between objectives, policies, resources and methodologies. The entire LS cycle revolves around the RL, a product tailored to a specific context and to specific groups of students, assuming their features are unique. This approach avoids over-simplification by paying attention to the local and particular, while simultaneously recognizing its embedding in a global context. The educational needs of the current context set the LS working group in motion, and those needs also shape its course and determine its end point. LS' continuity depends on change, observation and critical reflection and, through them, the original RL progresses. We have suggested that LS, even in the face of the impossibility of anticipating every classroom circumstance, makes a good case for continuous planning and reflection. In LS, teachers forget about mechanical certainties and accept approximate knowledge and partial comprehension as starting points. From there, discoveries and learning happen, thanks to inaccurate predictions.

LS can contribute immensely to teachers' professional development, as it presupposes openness toward mistakes. It asks of them to be willing to shape their practices by taking advantage of emergence, boosting pressonance and operationalizing their own wisdom and knowledge. This process faces the complexity inherent in classroom systems by encouraging teachers to reflect on what they have experienced, embracing their own and others' reflective critique to devise strategies for improving the RL. In doing so, participants in LS relate to each other as a collective of competent

professional researchers, cognoscente subjects in the creation of the RL and their learning processes as teachers.

Earlier, we suggested that LS is based on more an ecological than a mechanistic conception of reality. In this sense, LS is a process for constantly seeking an RL befitting a context, goal and topic. The pursuit of an unreachable ideal—the perfect RL—is also the only way to bring teachers closer to achieving an envisioned archetypical lesson for a specific moment and situation. LS proceeds, and the RL evolves, as teachers engage in collaboration and tolerant dialogue to problematize previous ways of doing (benefited from the original Japanese cultural features), as they make use of strategy and situated thinking to attend to unforeseen situations and compare alternatives, and as they remain aware that they can only have ephemeral control over the actions that they carry out and the product that they create. And, as all of this happens, the RL itself stops being the main goal (Stepanek et al., 2007) or an end in itself. Instead, it becomes a window on a wider perspective of education (Lewis, 2009) through a process that should be explored in future theoretical and empirical research.

Deleuze said that '(…) there is no other method for finding other than a long preparation' (Deleuze & Parnet, 1977/2007: 7). We propose that—viewed from the perspective of the epistemology of complexity—LS is in fact a form of long preparation in which teachers move forward by developing tentative answers that lead to subtler questions.

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