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Using the didactical contract to untangle the complex dynamics of a lesson study group in initial teacher education

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This paper addresses the issue of understanding the dynamics between the participants of a collaborative setting like lesson study (LS) in an initial teacher education program. The case study presented is a LS course held for prospective mathematics teachers at secondary level at Lausanne University of teacher education, in Switzerland. The changes in the didactical contract and in the postures of both the educator and the preservice teachers are analysed using qualitative methods. Results show a gradual change in the group dynamics through the process, and the progressive reinforcement of clauses of the didactical contract that are characteristics to LS.

Keywords: Lesson study, initial teacher education, didactical contract, facilitator, role.

Introduction

At the beginning of the 2010s, Krainer and Llinares (2010) literature review identified the social dimension and the reflective practice as key features for mathematics teacher education, as well as new challenges for the future. Since then, the interest towards collaborative settings in this field has significantly increased (Borko & Potari, 2020), especially regarding initial teacher education (ITE). Due to its features, *lesson study* (LS) is one of such settings. This form of professional development, founded upon the Japanese practice of *jugyou kenkyuu*, gained popularity outside of the Asian continent at the end of the 1990s. Although in Japan LS is used for both in-service and preservice training, outside this country, preservice implementation has taken place only at a later stage. The reason of this late development is that LS is subject to several constraints and challenges when practiced in ITE, like time limitations or the difficulty of access to real classes (Ni Shuilleabhain & Bjuland, 2019). In this context, the task of teacher educators is particularly challenging, as the imbalance of power and experience between the participants may hinder the establishment of truly collaborative relationships (Ponte, 2017). Moreover, they are at the same time facilitators, experts and educators to the LS group, which implies a different approach to knowledge depending on the role they chose to take.

For these reasons, in order to explore LS potential for ITE, it is important to better understand how its implementation affects the interactions and the dynamics between the members of the program. The study presented here is part of a broader doctoral research (Presutti, 2024) addressing two main issues regarding LS in ITE. On the one side, it seeks to examine the conditions and adaptations that affect LS key features, in the context of an ITE program held at Lausanne University of Teacher Education, Switzerland. On the other side, it aims to explore the possible contributions of LS and the learning outcomes for its participants. This paper addresses the first aspect, providing a follow-up to a precedent study presented at CERME13 (Presutti, 2023), with a specific focus on the evolution of a LS group dynamics through the analysis of its didactical contract.

Theoretical background

The main object of study of this research is, as previously stated, LS. This process is based on the collaboration of a group of teachers trying to solve a teaching or learning problem. To achieve this, they engage in an action-research process: they study the problem and analyse the curriculum, then plan a lesson and collectively observe its outcomes. Subsequently, they discuss their observations and either disseminate the results to the professional community or re-engage in the first phase of the process, giving it a cyclical structure.

LS is usually coordinated by a *facilitator*, who helps the flowing of the process by involving all participants and promoting the dialogue (Lewis & Hurd, 2011). During some phases, and particularly the post-lesson discussion, the group's work can be supported by an external expert, or *knowledgeable other*. These two figures have hence different attitudes towards the knowledge at stance, with the former potentially retaining some of it, while the latter is invited to state it explicitly. It is although important to note that in countries where LS is not yet well-established, these two roles may overlap, since the facilitator should possess knowledge about the LS process, as well as pedagogical and disciplinary expertise (Hourigan & Leavy, 2021). To account for this complexity, some authors have modelled the facilitator as a figure with multifaceted roles (Clivaz & Clerc-Georgy, 2020). The picture is even more complex when LS takes place in ITE, as the role of educator come into play. According to Clivaz and Clerc-Georgy (2020), whose research was on LS with in-service teachers, all the roles can coexist and evolve throughout the LS, depending on the relationships within the participants, but also the subject of the LS and the facilitator's expertise in it. Using the framework of Brousseau's Theory of Situations (1997), it is possible to interpret this evolution as changes in the *didactical contract*.

The didactical contract is in fact a set of norms, mostly implicit, that regulate the mutual expectations of the teacher and the students concerning the mathematical knowledge at stake (Hersant & Perrin-Glorian, 2005). It encompasses two dimensions: one epistemological, related to the mathematical knowledge, and one social, concerning the reciprocal expectations between the stakeholders in the production of knowledge. Hersant and Perrin-Glorian (2005) developed Brousseau's concept of didactical contract by considering four aspects that characterize it at different scales. The first one, acting on a *macro-level*, is the teaching object. The second and third aspects are the didactic status of the knowledge and the existence of an adidactical potential of the milieu. These aspects characterize the contract at the *meso-level*, i.e. the realization of an activity (for example the resolution of a problem). The fourth aspect is the distribution of responsibility in the construction of knowledge, acting at a *micro-level* (at the scale of an episode: the set of interactions around a unit of knowledge). According to this framework, the complex interactions between the participants of LS in ITE influence both the epistemological and the social dimensions, particularly in the distribution of responsibility, i.e. at the micro-level.

With respect to this theoretical framework, the research question may be stated as follows: *how does the (micro)-didactical contract of a LS group held in a ITE program evolve through the process?*

Data and method

The case study presented in this paper concerns a university course based on LS that took place at Lausanne University of Teacher Education during the autumn semester of 2021. The LS group was composed by five preservice middle-school mathematics teachers. It was facilitated by a university educator with experience in LS, who was also in charge of their evaluation, while two experienced schoolteachers participated to some of the sessions. The LS consisted of two cycles, with one mock-up research lesson and one lesson held in the class of one of the schoolteachers. The total was of 12 sessions of 1.5 hours each, plus one 45-minutes lesson. As a researcher, I designed the LS and each session with the teacher educator, and I observed their implementation without intervening. The LS subject was decided in advance during the design of the course, to better anticipate the teaching and reading material. The chosen topic was the teaching of integers at grade 7, a pivotal moment for the extension of the number system and the passage to algebra (Rezat, 2019). During LS, the preservice teachers decided to focus on integer multiplication and its mathematical justification, one of the first examples the pupils encounter where the justification relies only on intra-mathematical arguments, namely Henkel's permanence principle[1]. For the teacher educator, the goal was for the preservice teachers to acquire mathematical knowledge about the permanence principle, and to be able to justify their decisions regarding its didactical transposition to the class.

Data collected for this part of the PhD research consist in video recordings of all the meetings. Other data consist in texts written by each participant at the end of the course, the lesson plan, and all the documents and the artefacts produced during the process. All the video recordings were summarized in a synopsis, and arranged according to three levels (macro, meso, micro), following Hersant and Perrin-Glorian (2005) method (see Presutti, 2023, 2024 for further details). Macro-level consisted of LS phases. Meso-level consisted of training tasks proposed by the educator to the preservice teachers. Micro-level consisted of episodes. To grasp the interactions and the evolution of the didactical contract, each episode involving the permanence principle or its didactical transposition was qualitatively coded according to the knowledge at stake, the elements of the milieu, the kind of micro-contract[2], the preservice teachers postures (namely pupil, student-teacher, teacher, and researcher-practitioner, following Guille-Biel Winder et al., 2018), and the educator's posture.

Coding of the teacher educator's posture required a specific procedure, since very little research is done about his role in the ITE case. The first step consisted in theoretically defining and separating the *roles* from the *postures*. The educator's *roles* stem from the institutions to which he or she is subjected. *Postures*, on the other hand, depend on his or her positioning within the roles and influence how the educator acts, thinks or speaks in a given situation, as well as his or her attitude towards knowledge. All postures hence coexist, but for each episode it is possible to identify a predominant

[1] The idea that algebraic operations should be consistent in all number systems, particularly in the development of their extensions.

[2] Hersant and Perrin-Glorian highlight seven kinds of micro-didactical contract, depending on whether the teacher retains full responsibility (four), shares it with the whole class (two) or with each student in the class (two)-see Table 1.

one based on the educator's actions and speech. The second step was the creation of a list of roles and postures. This was made according to a literature review, from which all the possible roles and postures were listed (most of the articles didn't differentiate between the two terms). The first list, L_0, comprehended 20 terms. Step three was the refining of L_0 by associating similar terms, e.g. *koshi*, external expert and knowledgeable other. During step four, the terms indicating institutional roles were extracted: educator, facilitator, and teacher. The resulting list was then tested on the data set and refined by taking away the remaining ambiguous terms. The retained roles and postures are shown in Figure 1.

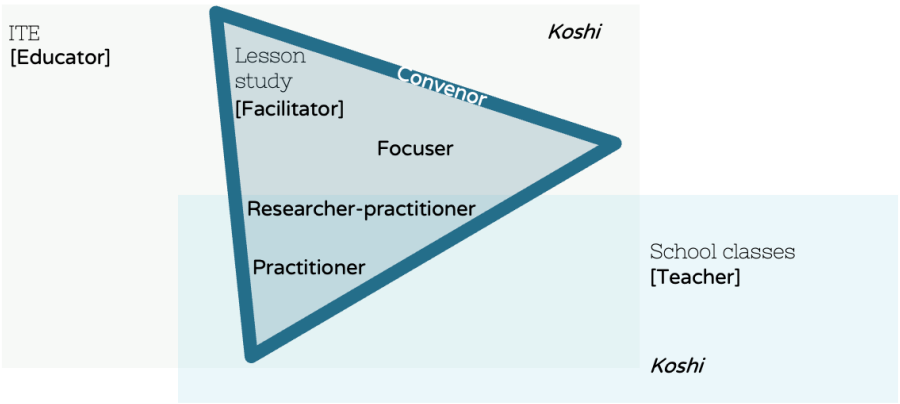

Figure 1: Institutional roles [in brackets] and postures of an educator doing LS in ITE

The analysis at the micro-level highlighted some particular moves of the educator on the didactical contract and on the milieu (presented in Presutti, 2023), as well as some key moments in LS process with regard to the knowledge at stake. Those key moments were analysed at the meso-level to better understand the dynamics of the interactions between the participants during the mathematical and didactical activity. Some results of these analysis are presented in the following section.

Results

A first result concerns the evolution of the micro-contract of distribution of responsibility with respect to the construction of the knowledge at stake.

Table 1: Frequence of the micro-contracts of distribution of responsibility

Micro-contract category	Type of micro-contract	Number of episodes identified (total=161)
The educator retains full responsibility	Information	4
	Assumed ostension	34
	Disguised ostension	4
Responsibility is shared between the educator and the group of preservice teachers	Adherence	28
	Collective production	83
Responsibility is shared between the educator and each preservice teacher	Individual production	8
	Tutoring	0

In total, 83 out of 161 episodes were coded with the micro-contract of *collective production*, more than each of the other kinds of contract. Most of these episodes (63) are distributed in the second part

of the LS course, between session 6 and session 12. Besides, in sessions 5, 10 and 11, many episodes show a didactical contract of explicit ostension of knowledge: these episodes are marked by the presence of the schoolteachers, who undertake the posture of *koshi*, or experts, in most episodes.

To get a closer look of the evolution of the social and epistemological dimension of the didactical contract, three training tasks have been chosen from the beginning, the middle and the end of the LS course. Task 4 took place at the beginning of the LS process, during session 2 (00:40:39-1:05:35). This session was the beginning of the study phase and aimed at understanding the mathematical reasoning behind the sign rule through the analysis of some textbook tasks. After a discussion about textbooks, Thomas, one of the preservice teachers, directedly asked the educator why (–1)·(–1)=+1. The educator first proposed to the group to look for some common answers (Figure 2, E01), to which the preservice teachers answered by suggesting a pattern explanation (E02). The repeated moments of silence and hesitation during this episode led the educator to propose a task found in a lesson plan of a previous LS group (E03). The preservice teachers' expectation of an answer from the educator led him to take an expert posture (*koshi*) and to set up a kind of dialogue lesson in which he finally stated the concept of the permanence principle. In E03, preservice teachers assumed a pupil posture. This kind of move of the educator on the didactical contract, named M1, has been presented in a previous study (Presutti, 2023).

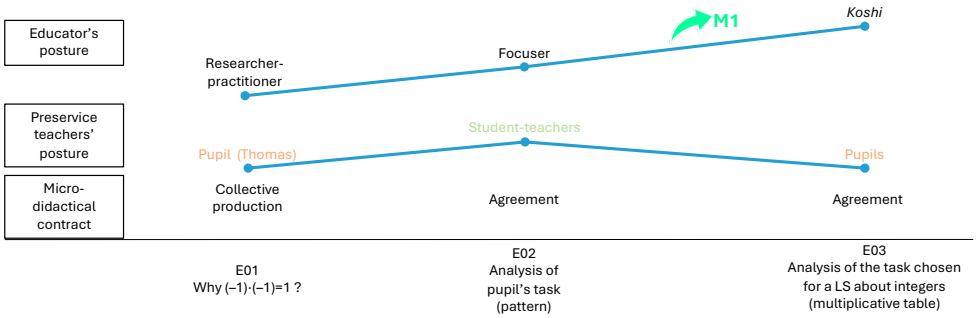

Figure 2: Educator and preservice teachers' posture changes in session 2, task 4

Task 3 (0:35:56-1:17:12) took place in session 6, devoted to the planning of the first research lesson. During this task, the LS group discussed the first part of the lesson, in which an illustration of the integer multiplication is shown through the use of arrows made of cardboard representing vectors on the number line in four different cases. After the discussion upon the first case, 2·3, the group analysed the two multiplications (–2)·3, 2·(–3) and their respective representations with the arrows. During the discussion, in episode 2 the educator took a researcher-practitioner posture by saying that he *really* didn't know the best way to present it to the pupils, and the group could only make assumptions and validate them during the research lesson. With this move (M2) the educator took a participant perspective and strengthen the didactical milieu, as it was the only way to validate the mathematical and didactical knowledge at stake. In episode 3, the prospective teachers took themselves a researcher-practitioner posture and produced hypothesis about the vectorial representations of the multiplication, which led in episode 4 to the emergence of knowledge about the commutative property of the multiplication, the "symmetry" of the representation and the minus

sign as an opposite operator. After M2, the micro-didactical contract turned to one of collective production of knowledge for the rest of the training task (Figure 3).

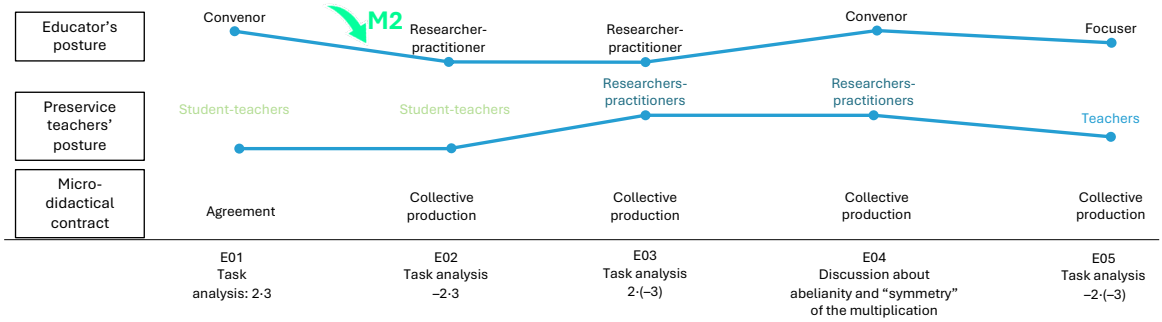

Figure 3: Educator and preservice teachers' posture changes in session 6, task 3

Task 3 (0:48:26-1:22:51) of session 11 took place during the analysis of the second research lesson. Session 10 was devoted to a first debriefing, while session 11 was devoted to a deeper analysis of the observations. One of the schoolteachers, Yves, joined the meeting. During this task, the preservice teachers assumed a teacher posture and put into perspective their observations about the timing, the place for "mathematics theory" during the lesson (episode 1, Figure 4), or pupils' activity (episode 2). During episode 3, Yves was invited to express his thoughts on these topics. He explained that when he taught integer multiplication, he made different choices, questioning the group's will to tackle the mathematical justification of the sign rule. In this case, the educator felt it appropriate to regain his *koshi* posture by taking explicitly his "teacher educator hat" (Presutti, 2023) and mediate between the positions. This move (M3), together with Yves intervention, marked the micro-didactical contract as one of explicit ostension of the knowledge at stake (in this case, didactical knowledge). During episodes 3 and 4, the preservice teachers maintained their teacher postures by drawing parallels with their previous teaching experiences and analysing classes similarities and differences. In episode 5, the educator finally asked the participants how they would redo the research lesson, taking a convenor posture. Eventually, each participant answered with a different version of the lesson. All but one preservice teacher maintained their teacher posture, while one of them took a research-practitioner one by directedly linking her lesson to the LS issue. It is important to observe that in this phase of the LS, the teacher posture was predominant over the researcher-practitioner one. Episode 5 was also the only episode in which the schoolteacher took a practitioner posture.

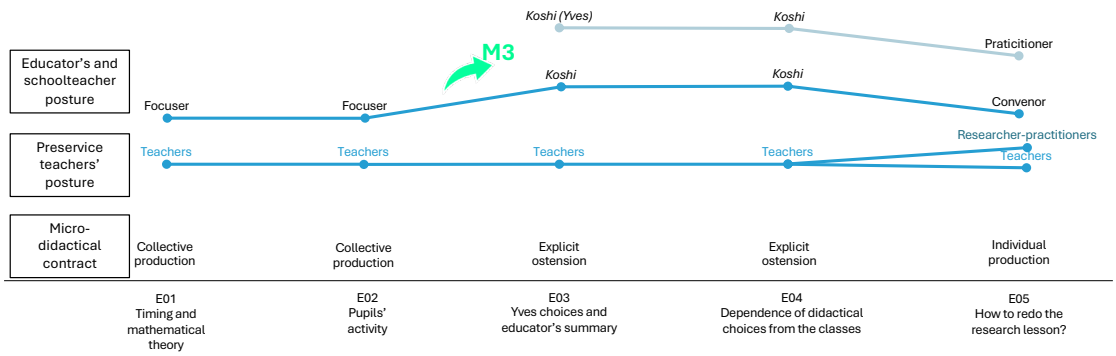

Figure 4: Educator and preservice teachers' posture changes in session 11, task 3

Discussion

The focus of this case study was the understanding of the dynamics between the participants of a LS set in ITE through the theoretical lens of the didactical contract. For this purpose, the analysis of the changes in the micro-didactical contract was enriched by the study of the postures of both the teacher educator, the preservice teachers and, when present, the experienced schoolteachers. The observation of the evolution of the didactical contract shows that there is a significant shift in the second part of the LS from the point of view of the sharing of responsibility in the construction of knowledge, which is more and more a collective effort instead that an initiative of the teacher educator. This aspect is also illustrated by the comparison between the training tasks in sessions 2 and 6. In fact, in session 2, the educator's move (M1) led to the assumption of an expert posture, ending up in an explicit clarification of the attended knowledge. On the contrary, in meeting 6, the educator move (M2) consisted of the assumption of a researcher-practitioner posture, resulting in a change in the epistemological and social dimensions of the didactical contract and in a stronger interaction of the preservice teachers with the milieu. Besides, the distribution of these two moves during the LS course (Figure 5) show that M1 is more present in the first half of the LS process, while M2 in more present in the last half.

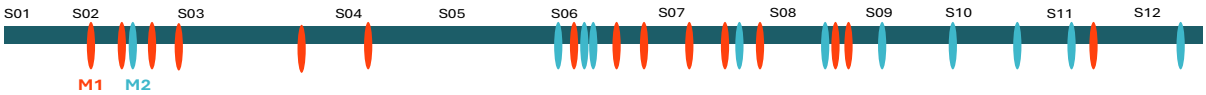

Figure 5: Distribution of M1 and M2 during LS

Session 2 and 6 also show a "mirror effect" between the educator and the preservice teachers' postures, resulting in a distancing of the postures (M1) or an approaching (M2). This can also be read as a more teacher-student dynamic (M1), or a researcher-researcher one (M2). Interestingly, this mirror effect is no longer present at the end of the LS, as shown in session 11. In this case, the assumption of an expert posture by the educator (and the schoolteacher) doesn't end up with preservice teachers taking a pupil or student-teacher posture. They persist instead in their teacher posture. This may suggest a "maturing" of the teacher posture over time, which also assumes a more reflective standpoint, but doesn't become a researcher-practitioner one.

In conclusion, this study shows a significant evolution of the group dynamics during LS, marked by the transition from a more traditional university training to a LS one (i.e. a collective, teacher-led activity). These analyses also highlight the fact that, in ITE, adapting to LS might require significant time for the participants to adjust to the "LS clauses" of the didactical contract. Regarding this aspect, it might be insightful to test other forms of LS in ITE, such as practicum-based. Finally, it is important to note that in this study the posture of the prospective teachers and of the educator are not symmetrical, as they come from different frameworks. Further work is needed on investigate these postures and their consequences on the actual effectiveness of LS in ITE.

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