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The dynamic of implementation of adapted Lesson Studies in France

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The implementation research reported here studies the dynamic of the implementation of adapted Lesson Studies (LSa) in France, a process initiated in 2016-2017 at the IREM of Rouen. Drawing in particular on the systemic and ecological approach offered by the anthropological theory of the didactic, we show how a hybrid object combining the LS and the IREM cultures of teacher professional development has emerged and consolidated. We identify an original, essentially bottom-up dynamic that exploits curricular and institutional changes, and mobilises an increasing diversity of contexts and actors. We question its potential and its limitations, in the light of the current state of implementation research, and reflect on the most appropriate models for it.

Keywords: Adapted lesson study, teacher professional development, implementation research, graph theory, anthropological theory of the didactic

Introduction

The research study reported in this paper is part of an ongoing implementation research comparing teacher professional development (hereafter TPD) devices implemented in France over the last decade to support the collaborative work of teachers. More precisely, we study the dynamics involved in their implementation and gradual expansion, the factors that condition these dynamics, in order to identify their potential and limitations. If we refer to the categories identified by Century and Cassata (2016), regularly referred to in contributions to TWG23 at CERME conferences, this research therefore falls primarily into the second category – “understand relationships between influential factors, innovation enactment, and outcomes” – but, with a particular interest in the process dynamics.

In France, TPD is mainly the responsibility of the regional education authorities, the Rectorates of the 30 *Académies*, although the Ministry of Education sets national priorities and organises training sessions itself, particularly for its executives. Since their creation, more than 50 years ago, the IREMs (Institutes for Research on the Teaching of Mathematics) have played an important role in the TPD of mathematics teachers, with an original model of TPD activities based on the action-research and experiments carried out in IREM thematic groups involving teachers, teacher educators and university researchers, and also making use of the many resources produced by the IREM network¹.

However, it is unanimously recognised that TPD in France is insufficient and affects only a small percentage of teachers if it is not compulsory, which is mostly the case. The Noospherian discourse

¹ For more detailed information on the IREMs, teacher education and the French education system, we refer the reader to the document produced for the French national presentation at ICME-14, available on the CFEM website: http://www.cfem.asso.fr/icmi/icme-14/NP_France_ICME14English.pdf

increasingly highlights these shortcomings, the need to strengthen TPD, to promote strategies based on the collaborative work of teachers and guided by the results of research, particularly didactic research. This is evidenced by the report produced, after extensive consultations, by the Villani-Torossian Mission set up in 2018 by the then Minister of Education (Mission Villani-Torossian, 2018), and the resulting Mathematics Plan (<https://www.ih2ef.gouv.fr/le-plan-mathematiques>).

This is the context of our implementation research. In this paper, given the 8-page limit, we focus on a specific device created at the IREM of Rouen in 2016-2017. There are several reasons for this choice. The device is based on the IREM tradition of TPD, but it also incorporates the Lesson Study (hereafter LS) culture, hence its name LSa (adapted Lesson Study). It has gradually been extended to new actors, both at regional and national level, and new *problématiques*. Its dynamic, mainly bottom-up, is original in the French educational context, highly hierarchical, and also when compared to many implementation projects reported in mathematics education research. Hence the interest in understanding it better, and the research questions precisely addressed in this paper: What characterises the dynamic of this device and conditions its ecology? How can this dynamic be modelled? What are its potential and limitations?

Theoretical background and methodological choices

Implementation research in general mobilises both theoretical resources from within and outside the didactic field (Artigue, 2021). This is also the case in this research. We recognise the need to approach the processes under study in a systemic way, taking into account the diversity of actors and institutions involved and their interactions, paying attention to the ecological disturbances that these processes generate and how they are managed. For this reason, we draw on the institutional and ecological perspective offered by the anthropological theory of the didactic (ATD), which has already been used productively in implementation research (see for example Helenius, 2022). Implementation is not only a matter of numbers (Koichu et al., 2021) and, in order to analyse the progressive extension of the device, we also take into account the four dimensions introduced by Coburn (2003): depth, sustainability, spread, ownership, while adapting Coburn's criteria to our context. Thus, we consider the nature of the changes promoted and induced by the practice of LSa in terms of teaching practices, professional development of teachers and facilitators; the strategies developed to make LSa sustainable and their effects; how the expansion of the system is organised, the actors involved, their interactions and their respective responsibilities, and how this device, more generally, takes into account the issue of ownership. Our theoretical background also includes resources related to the LSa object itself. These deal with the collaborative practices of TPD in general and LS in particular, from which the device is inspired, the French didactic tradition that influences it (Artigue et al., 2019), and modelling which is a major theme in the LSa developed so far. Some of these resources, for instance (Blum & Leiss, 2007; Lewis & Hurd, 2011), are mobilised by the LSa designers, others are called upon by us for the needs of our research on the device, such as those provided by the ICMI Study 25 dedicated to the collaborative working and learning of teachers (Borko & Potari, 2020).

This theoretical background and the research questions at stake imply methodological requirements, in particular a large collection of data. Thus, we have collected the list of all the LSa organised with their respective contexts and themes, participants, tools and related productions used/developed face-

to-face or remotely on the dedicated platform. In addition, we have collected the minutes of the meetings of the IREM group that manages the project, notes and email exchanges on the interactions with the academic authorities and the various actors, the documentation of the actions organised to publicise the LSa and to support the acculturation of new facilitators. We have carried out interviews with five teachers who, after having participated in LSa as teachers, are now facilitators. The analyses of these data, mainly qualitative, have been triangulated. We also draw on publications related to LSa, in particular (Masselin, 2020; Masselin et al., 2023).

Analysis of the device and its dynamic

Against this theoretical background, this section summarises the main results of the analysis of the LSa device and its dynamic over the period 2016-2022. The presentation is divided into four subsections. The first two deal respectively with the emergence phase of the device and its consolidation-expansion; the last two focus on dimensions that implementation research has shown to be highly important to document and analyse, as illustrated by the activities of the dedicated TWG23 at CERME conferences or special issues of journals such as (Koichu et al., 2021): the device's relationship with research and the strategies developed to recruit and train new facilitators.

The emergence and characteristics of LSa

The LSa were created in the 2016-2017 academic year within the Activities Group of the IREM of Rouen (hereafter AG), whose work was focused on the relations between mathematics and everyday life. The group had participated in the production of a national curricular resource on this topic, within a partnership between the IREM network, the General Inspectorate of Mathematics and the Ministry of Education. This resource was intended to support the implementation of the 2016 reform, covering grades 1 to 9 (primary school and middle school). One AG member, the second co-author, was then preparing a PhD on TPD in probability at the LDAR. In this context, contact was made with Stéphane Clivaz, a researcher at the HEP (higher pedagogical school) in Lausanne who had adapted the LS concept to the context of this Swiss canton. His seminar at the LDAR, to which the AG members were invited, revealed interesting similarities with the work of AG and prompted the latter to start adapting LS for its TPD activities. The LSa object thus emerged as an object combining elements of the IREM and LS cultures, while being shaped by the strong constraints imposed on TPD in France. In fact, the LSa are organised over three days, the maximum possible duration (one day for the presentation of the device and the preparation of the lesson to be observed, one day for its implementation and the a posteriori analysis, and one day for the feedback of the participants who have adapted it to their own context, for didactic complements and to start the collective writing of a LSa notebook). LSa are aimed at teachers who volunteer to work on the relationship between mathematics and daily life, and on modelling. They are based on situation seeds collectively developed and experimented by AG members (LS within the group), and on a bank of commented videoclips resulting from these experiments. These are intended to support the a priori analysis of the situation seed by the participants and to help them to complete the preparation of the lesson. This lesson is taught by one of them, the others being observers, in a “borrowed” classroom. Additional tools have been developed: a grid to support a priori analyses, intervention grids for the experimenting teacher and for the facilitators, observation grids, etc. One researcher is systematically associated

with each LSa and participates for all three days (researcher-in mode); others can contribute remotely (researcher-off mode). An institutional platform is used to manage the participants' distance work, and to collect all the documents related to the LSa. This TPD device is supported by the Regional Mathematics Inspectorate, because of its convergence with institutional needs (theme and teacher collaboration). In the first three years, until June 2019, 12 LSa were organised, involving 22 then 42 and 72 teachers, the five AG members plus two new facilitators and nine researchers. Five situation seeds have been developed and used.

The phase of consolidation-expansion

The consolidation of the device and its expansion were partly the result from new institutional opportunities: the need for more effective TPD to cope with institutional transitions, in particular with the new organisation of the cycle 3, which includes the last two years of primary education and the first year of secondary education; the emphasis placed on modelling in the new curriculum; the Mathematics Plan launched in 2019, which sets up a specific TPD device for primary school teachers based on their collaborative work within constellations of eight teachers, each accompanied by a RMC (district mathematics referent), who also had to be trained. Other factors played a decisive role: the institutional recognition of the LSa beyond the Rouen area, through the IREM network, presentations at national symposiums and to educational stakeholders, a dedicated page on the IREM of Rouen website allowing the sharing of the resources produced, various publications including a book (Masselin, 2020); the creation of LSa referents to increase the pool of facilitators and the national seminar organised in May 2021 in hybrid mode, attended by 211 teachers, LSa referents, teacher educators, researchers and inspectors. However, in order to take advantage of these opportunities to consolidate and extend the LSa device, it was necessary to adapt it to new needs, new constraints and operating conditions, and to the increasing number and diversity of the actors involved. For instance, the device was adapted for the RMCs, combining the experience of LSa as a participant with the preparation for the role of facilitator, during the three days allocated. Such adaptations, and the risks of distorting the spirit of the original device that they entailed, created tensions that were evident in the minutes of the AG meetings. In addition, for more than a year from March 2020, there were difficulties due to the pandemic, although the hybrid organisation of the national seminar in May 2021 probably increased the number of participants. Nevertheless, the expansion of the device is clear, as shown in Figure 1. By the end of 2022, the LSa had reached about 60 prospective teachers and more than 200 teachers; the LSa training courses organised for teacher educators within the Mathematics Plan had reached 70 RMCs at regional level and more than 167 teacher educators at national level. 16 inspectors for primary and secondary education and three general inspectors, 24 researchers had been involved in the device. The momentum would increase in 2022-2023, with the end of the restrictions, and also the extension of the device to new regions and to physical sciences.

The changing relationship with research

As mentioned above, the relationship with research is an essential dimension of the quality of implementation processes in mathematics education. For the LSa, the data collected show that the device was linked to research from the outset: regular contacts with the HEP team in Lausanne, use

of the device in Masselin's PhD, participation of researchers as resource persons. However, the data collected show that this link with research was too much limited to seriously study and understand the dynamic of the device and its effects, to outline an explicit theory of change underlying it, and to identify its potential and limitations. A notable step forward was taken in 2021 with the creation of a specific research project on the LSa device supported by the LDAR, the IREM and the National Institute for Teacher Education (INSPE) in Rouen, and involving nine researchers. The project has three axes: the impact of LSa on the professional development of teachers who have participated in the device for several consecutive years; the place of modelling in the training and PD of LSa facilitators; and the dynamic of the device, in particular how the transition from the position of participating teacher to that of facilitator is organised within it, the subject of the next subsection.

The transition to the role of facilitator

The expansion of the device requires an increasing number of facilitators. To this end, the AG's local strategy so far has been to ask teachers who have been actively involved in LSa to become facilitators. The change of position is gradual, with the new facilitators first running one or more LSa in pairs with an experienced facilitator, before taking on full responsibility for running a LSa with a novice facilitator. In addition to this on-the-job support, there are a number of collective working sessions each year, combining feedback, proposal and discussion of new situation seeds, and didactic training on jointly agreed topics. In order to evaluate this strategy, we designed a questionnaire supplemented by interviews with five facilitators who had experienced this transition. We cannot go into the details of the analysis, but it shows that the transition is by no means self-evident for the teachers involved, especially for those who were not already involved in TPD activities as teacher educators. However, the support offered, which allows a gradual entry into responsibility and is supported by the IREM's collaborative culture, is unanimously judged to be very effective. Questionnaires and interviews also show that the need for support varies according to the teachers' professional history, but that the first LSa that they experienced as teachers was a revelation for all of them.

Discussion and perspectives

Returning to our theoretical framework, the data collected and their analysis show that, in Coburn's terms, the depth of the change is real, not only in terms of teaching practices (group work, inquiry based practices, modelling activities), but also in terms of TPD practices. Indeed, LSa break with the usual models of TPD in France by some important features, notably the time devoted to the in-depth and collective preparation of a single lesson, its implementation and observation actively involving all the participants, the collective writing of an LSa booklet incorporating the results of the experiments carried out by the participating teachers in their own classrooms or in small groups.

LSa are in fact hybrid objects combining the affordances of two cultures, different but compatible as assumed by the AG members and also pointed out by some LS experts (see for example Clivaz, 2015). The influence of the LS culture is particularly visible in the global structure of the device and the sharing of responsibilities between the different actors. The rejection of hierarchical relationships carried by the IREM culture also contributes to this shared ownership, in Coburn's terms, in the LSa, in the acculturation of new facilitators, and in the relationships with researchers. The IREM culture is also reflected in the influence of the French didactic tradition on the device, with, for example, the

importance given in LSa to the *a priori* analysis of situations and to the careful choice of their didactic variables. This hybrid character certainly contributes to the sustainability of LSa. Another important feature for the sustainability and a controlled spread of the device is the importance given to the creation of a bank of videoclips, its progressive refinement and its use. We can see here the influence of the Master program for teacher educators created in Paris in 2000, and supported by both the IREM of Paris and the LDAR.

The data collected and their analysis also show that the LSa device is shaped by the constraints and priorities of the French education system at the various levels of the ATD hierarchy of codetermination. These condition its ecological viability, as we have tried to show in the previous section, and shape its dynamic. This dynamic is of the swarming type, gradually involving new groups and institutions. These see in the device a means of responding more effectively, and in line with their values, to national institutional demands such as those of the Mathematics Plan, or to the perceived shortcomings of current TPD practices. The interviews show this clearly, for example, in the case of LSa focused on institutional transitions, particularly the transition between primary and secondary education. In this dynamic, AG plays a central role, as do the multiple institutional positions and connections of its members. The LSa device can thus rely on the institutional recognition of the IREM network and the LDAR at the national level, and on that of LS as an effective TPD practice at the international level (note that LS are mentioned in the influential Villani-Torrossian report). These institutional supports are all the more important for the legitimacy and ecological viability of the device that the LSa dynamic is a bottom-up dynamic developing in a highly hierarchical education system.

The leading role played by the AG in the implementation and expansion of the LSa device, and in the acculturation of new facilitators also seems, in the light of the data collected, to guarantee the maintenance of a certain control over the fidelity of the objects that are developed under the LSa label, despite the increasing diversity of the contexts of use and of the actors involved. This fidelity also seems to be facilitated by the corpus of situation seeds and associated resources that characterise this adaptation of LS. LSa facilitators draw on this corpus and, in turn, the adaptations they make to it contribute to its enrichment. The vision that emerges is therefore one of a bottom-up dynamic that demonstrates flexibility and adaptability in order to respond pragmatically to emerging needs or new institutional priorities, and whose growth is gradual and controlled. This bottom-up character, the efforts developed to ensure shared ownership among the various actors involved, is coupled with a constant search for institutional support at different levels of the hierarchy of codetermination, which is facilitated by the multiplicity of the institutional connections of its key actors. However, this dynamic also has its weaknesses: its dependence on AG, whose strengths and resources are limited; the institutional constraints imposed to TPD and the pressure of institutional hierarchies; the still limited number of resources, in terms of situation seeds and videoclips; the depth of the changes intended. Questionnaires and interviews show, for example, the difficulty met by most facilitators in maintaining a culture of collaborative work in the local communities created, beyond the participation in LSa. Today, only a slow process of expansion seems possible, unless coalitions with other sufficiently similar TPD devices are envisaged.

Our research also asks what are the most appropriate models for understanding and accounting for such a dynamic. Its characteristics lead us to models used to represent network dynamics. We therefore started with a graph-based model as already done in implementation research (Misfeldt et al., 2021). However, although well suited to the first phase of the device, it seems inadequate to represent an increasingly complex dynamic involving the imbrication of many structures (Figure 1).

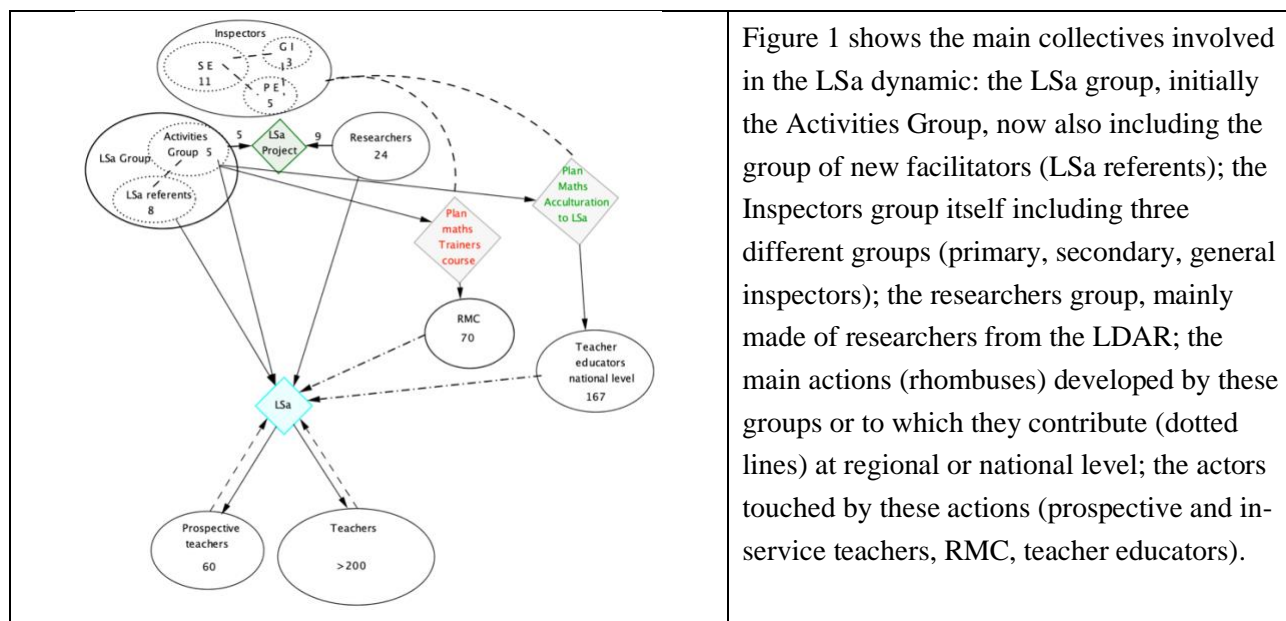


Figure 1 Representing the dynamic of the LSa device

For this reason, we plan to use hypergraphs, which make it possible to represent such imbrications and the associated interactions. Hypergraphs have already been used in ecology (see for example Salone, 2020). Unlike graphs where edges can only connect two vertices, hypergraphs accept edges connecting more complex entities. Figure 1 is an attempt in this direction, but it only partially represents the complex imbrication of institutions at stake. Moreover, at this stage we have not explored the conceptual potential of this domain at the interface of mathematics and computer science. Different research perspectives thus emerge. They can contribute to a better understanding of the dynamic diversity existing in implementation projects and of its effects. The comparative study of the dynamics of different devices, as envisaged in the overall project, should also be very enriching.

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