Chapter 4
The Change Laboratory in Practice

Abstract This chapter provides a thick description to make the reader understand the field research, which was carried out in an Italian secondary technical institute. This context was selected for the Change Laboratory, the issue being a dramatic fall in the number of enrolments for a course in surveying over the years. The teaching staff had not fully understood the changes in surveying caused by the crisis in the building sector and the school reform and were still training students to specialise as the pre-reform surveyor, with a curriculum centred on the construction of new buildings. Instead, the school reform and the job market called for a transformation of the curriculum towards the renovation and maintenance of already existing buildings, the environment and territory. The chapter describes the seven Change Laboratory workshops and the three follow-up workshops with the learning actions being triggered, the mirror materials and the topics of discussion. The idea being developed is that in the Grade 5 classes teachers teach around a common interdisciplinary hands-on project entailing the construction of a canteen in a parking lot close to the school. The project is designed around traditional technical topics but is dealt with as it was real, allowing students to make connections between subjects and to understand in depth the core concepts of surveying, and it is coordinated by the workshop assistants.

Keywords Thick description · Change Laboratory · Field research
Double stimulation · Expansive learning · Interdisciplinary project

In Cultural Historical Activity Theory (CHAT), the potential and limitations of an activity system can be better understood against its history. This chapter makes a detailed description of the workshops and field research to make the reader understand the research. The first section makes a historical contextualisation of the field research conducted in a secondary technical school located in Northern Italy. The school reform of 2008 had transformed the school, originally an institute for surveyors, into a technical institute with three courses: surveying, graphics and communication and logistics. After this shift, the course in graphics and communication had consistently boomed with enrolments increasing most in most years, while the course in surveying shrank from four classes in 2008 to only one class in 2015. The section explains how

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I carried out field research in the school and how the course in surveying taken as activity system was selected for the Change Laboratory intervention.

The second section portrays the eight Change Laboratory workshops with the surveying teachers and technical assistants held from February to April 2016. The description seeks to connect practice with theory described in Chap. 3. To do so, it shows the most useful stimuli for triggering specific learning actions and the participants' topics during the discussion and reflection. The following section describes three follow-up workshops held from May 2016 to March 2017, with the development of the idea of an interdisciplinary and hands-on project (in Italian *area di progetto*), and its implementation throughout the school year.

4.1 Historical Contextualisation

This chapter makes a thick description of the workshops and field research to make the reader understand the significance of the context. In qualitative research, thick descriptions portray a research context in writing, and the aim is to thoroughly and accurately describe the relevant contextual circumstances such as the context of the study, participants and connected experiences (Merriam, 2009; Ravitch & Carl, 2015). A thick description allows a sufficient understanding of the context so that the reader can form their own opinions on the research quality and researchers' interpretation. In line with Ravitch and Carl (2015), this chapter will be written in first person to emphasise that this study has been a qualitative research, a unique study conducted in a specific context and historical moment.

According to the CHAT framework, the possibilities and limitations of an activity system can be better analysed by knowing its history (Engeström, 2001). To do so, it is necessary that the researcher engages in extensive field research. This study was conducted from December 2015 to June April 2017, in an Italian technical technological institute in a small city located in the Lombardy region. Previously an institute for building surveyors, since the school reform of 2008 it has three courses: graphics; logistics; CET an acronym for construction, environment and territory (surveying). A fourth course, Geotechnics is part of CET. These upper secondary courses are 5 years long, classifying each year of progression from Grade 1 to Grade 5, and have a final state examination to obtain a diploma, the completion certificate. The major subjects are technical, but there is also a wide range of other subjects that explicitly focus on literacy, numeracy, science, as well as the study of a foreign language (Polesel, 2006). The institute that hosted the research was founded in 1970 as an institute for building surveyors, and since then it has had roughly 500 students with an average of 4 Grade 1 classes. The school reform of 2008 had transformed the school into a technical institute with three courses: surveying, graphics and communication and logistics. Figure 4.1 shows the number of enrolments of Grade 1 surveyors from 2007 to 2016, for 2016 the figure concerns the pre-enrolments (the same figure was used during the Change Laboratory).

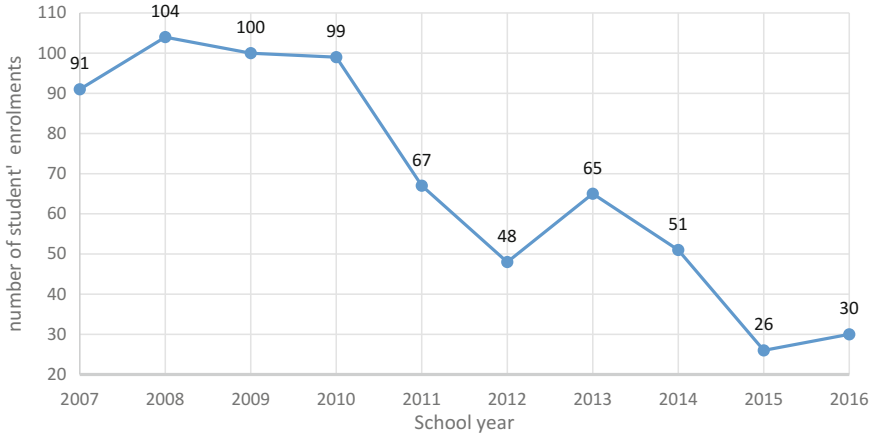

Fig. 4.1 Number of enrolments in surveying from 2007 to 2016

Since a Grade 1 class must have roughly 25 students to be run as part of the curriculum, a drop of enrolments meant that the number of classes of a specific course progressively shrinks up to 1 in 2015. This is not felt as a threat for general education teachers, who are employed in other courses of the school, or more rarely in other upper secondary schools to teach the same subject. By way of contrast, the shrinking of the number of classes for technical teachers is a catastrophe since it leads to their redundancy. If technical teachers want to continue teaching, they have to move to lower secondary schools and teach more general subjects such as math or science. In the context of Italy, however, technical teachers have a private practice and consider themselves professionals rather than teachers. While teaching provides a safety that the private practice cannot give, being forced to teach in general subjects in lower secondary school is considered humiliating by them.

The fall of enrolments in surveying has been observed throughout Italy and has been caused mainly by two phenomena: the crisis of the estate sector since 2007 and the changing role of the surveyor. Architects and engineers have taken over many of the surveyors' functions, to the degree that surveyors can only design small buildings. The fact that a tertiary degree is needed to work as engineer or architect, professions closely related to surveying and which surveying leads to, often makes families opt for general education studies in the lyceum, which is considered more high quality than technical education. Furthermore, the crisis in the estate sector caused a fall in the new buildings constructed where surveyors could be employed. As the teachers will discuss in the fourth workshop, the market transformation imposed by the crisis in the estate sector has called for a new type of self-employed and specialised surveyor who works in close cooperation with other professionals. In line with the European regulations, the Italian School Reform of 2008 was swift to adapt to these changes. Surveying changed into the acronym CET, in English construction, environment and territory. CET implies a diminished importance of building new constructions

towards the renovation and maintenance of buildings, while simultaneously placing an increased importance of the competences related to the environment and the territory. In short, surveying has historically evolved with new opportunities for self-employed professionals: estimations, appraisals, certifications.

The reform, however, did not anticipate that both the school curriculum and people's perceptions take time to understand changes to professions. In the school selected for the study, the technical teachers admitted they were still teaching for the old professional. To make an example, construction teachers taught how to design a bridge, but such a blueprint could only be made by a structural engineer. Topography teachers taught how to design a mountainous road, but the city is located in a plain and it would be more useful to teach the students how to design a roundabout. This resulted in a job mismatch for surveyors. Although the teachers already knew what the new professional could do, their curricula had substantially remained the same after the school reform. Writing a programme and preparing new lessons take time, and most of the technical teachers have a second job. Many are also close to retirement, and these are good reasons to continue teaching the old curriculum in the old way.

For the school director, the drop of the enrolments in surveying was a sign of the times with increasing importance attributed to the social media and Internet. From her point of view, the shrinking of classes in surveying was not a problem, as it had been more than compensated by the increase in graphics and communication. The overall number of enrolments in the school had continued to increase steadily year after year up to 6 new Grade 1 classes. This evidence was interpreted by her as confidence that she had done well in her job. Instead, she considered the fact that the surveying teachers had continued to teach the same curriculum as one of the causes that had contributed to the drop of enrolments in their course.

4.1.1 The Field Research

In December 2015, I started conducting field research in the school. My goal was to find important problems that could persuade the teachers to engage in a Change Laboratory. In an interclass council on 11 February 2016, I shared the results of my 2 months' field research with the whole teaching body of Grades 3, 4 and 5 of the school. The presentation focused on two issues. The first problem concerned the students' employment outcomes after school diploma. With the help of a young technical teacher who later took part in the Change Laboratory, I had screened with telephone interviews with all the 132 school students who had taken their high school degree either the previous year or two years before. This approach allowed the graduates before the school reform (18 months after diploma) to be compared with the graduates after the school reform of 2007 (6 months after diploma). In summary, the surveying course appeared to have generated more NEET alumni (not engaged in education, employment or training) after the reform. Furthermore, more graduates seemed to have chosen a different work path than surveying, and less graduates were

undertaking practice to enrol in the surveyors' register. My provocative question to the teachers was: "Is it worth to train surveyors if the graduates do not become surveyors?".

The second problem I hypothesised was the unattractiveness of the school open days compared to the competing technical institute, which was located in the same city. School open days are days where families who are deciding which school to apply for their child come over to visit the premises and meet the teachers. To make a comparison, I had visited the school open day of the competing institute. Besides having been built recently and having new classrooms for innovative didactics, the competing technical institute projected a much better image of itself. The families were collected in a conference room, and the school director presented all the courses and the school initiatives, giving the idea that the teaching body acted as a team. Only then were the families shown around, especially the newly built rooms for innovative didactics and the workshops. By way of contrast, the institute hosting this study had been built during the 1930s and had old rooms and furniture. During the school open days, the parents were first gathered in the hall for few minutes, and then they were sent in different rooms representing the courses. The resulting message seemed to communicate competition between the different courses.

After having presented these issues, we initiated a discussion to decide which course would have benefitted most from a formative intervention. The choice was for the surveying course with the goal of increasing the number of enrolments. The participants were 14 teachers and workshop assistants: one humanities teacher, one math teacher, three workshops assistants, nine technical teachers, one of them being also the vice director. Other people occasionally participated in the workshops; these are the school director, the local representative of the industry confederation of the building sector and the local representative of the surveyors' register. The environment chosen for the workshop was the teacher room (with an old furniture, the same as the 1970s) and a classroom that had a smartboard with Internet access to show models and the mirror materials.

4.2 The Change Laboratory Workshops

This section provides a thick description of the seven Change Laboratory workshops. For each workshop, I will mention the learning action I sought to trigger, and how I used the writing surfaces both in the continuum, concreteness abstraction with mirrors, ideas/tools, visions and according to time with past, present, future. I will show the content of the writing surfaces in terms of tables or diagrams and to trace the concept of interdisciplinary project I will report how many times it was used in each meeting.

By comparison with other Change Laboratory interventions, the reader might feel that the workshops run too smoothly. This intervention was, however, carried out within a European project in a formal environment and was supported by the school director. The use of a video recording system contributed to make the participants

more cautious about criticising each other, and the process made the participants were aware that they had to work side by side with their colleagues. There were, however, critiques towards the management and disagreement among the teaching staff with expression of resistance. I will quote some of these speaking turns to give a vivid idea of the dialectics going on during the workshops. To show the process of idea generation in vivo, I will also quote some speaking turns where the interdisciplinary project is debated. Another issue is that the participants tended to interrupt each other, so the quotations are sometimes incomplete. All the quotations are translated into English, with substantial changes in the structure and in the wording.

From the methodological point of view, the Change Laboratory and follow-up workshops were video recorded and fully transcribed, and the descriptions here are just a summary of the discussion. The full body of data anonymised (in Italian) is available on *OpenAIRE* (https://zenodo.org/record/838015). For validity purposes (Ravitch & Carl, 2015), the workshops were planned and later discussed with two experts of the Change Laboratory through Skype meetings.

4.2.1 First Workshop, 23 February 2016

The first Change Laboratory workshop had two objectives: familiarising with the conceptual tools and start *questioning the present state of things.* The workshop was joint between surveying and logistics. I first explained them the way the Change Laboratory works and its concepts: cycle of expansive learning, triangular model of human activity (Engeström, 2015). I then showed the participants the figures of the students' enrolments for the school year 2016–2017 *as mirror material of the present.* Table 4.1 represents the first stimulus; I divided the participants into two groups (surveying and logistics), and the task was to find the reasons why we have come to this point.

The two groups had 30 min to perform the task. An idea did not have to be necessarily shared by all the participants to be written on the surface. The following are the reasons of the students' drop in surveying that we put in the 'ideas and tools' of the present:

1. As the overall number of hours concerning technical subjects had decreased, the school reform determined a type of surveyor who is less professionalised.

Table 4.1 Mirror material of the present used during the learning phase of questioning

Course	Enrolments in 2015	Pre-enrolments in 2016
Graphics	More than 60	50
Surveyors	27	30
Logistics	10	14

2. As a consequence of the crisis in the building sector, families enrolled their children to other courses with better employment outcomes.
3. Families may have found other courses more attractive or 'fashionable'; the course in graphics was a competitor of surveying, since both dealt with drawing, and unlike surveying it did not entail complicated metrical computations. For some the fact that the overall number of students in the school has remained steady means that students aimed to enrol in the school due to its reputation, before choosing a course. In CHAT terms, the participants are blaming the course in graphics and communication for the drop in enrolments of prospective surveyors.
4. The lowering of the course goals during successive years which discouraged high achievers from enrolling in surveying.
5. The course in surveying was promoted ineffectively with poor guidance to students for what the course involves, with open days and school tours with little public exposure.
6. The prospective student likely did not perceive the school as providing positive opportunities for their working life. This point is more related to the fact that some students do not care about their school achievement.
7. The technical curricula were not up to date.
8. Some teachers were still anchored to an old view of teaching in the classroom. For example, they were reluctant to cooperate and give up their teaching hours for visits outside the school to learn up-to-date surveying technologies. These visits would have been useful for informing students about industry conditions, but also to promote surveying within the broader community outside the school.
9. Interdisciplinary projects were lacking, which had an impact on the visibility of surveying outside the school.
10. Over the years in Italy, the birth rate has declined, which has led to the overall number of students shrinking.

These ideas are not necessarily compatible one another, yet they represent the different points of view of the participants. Some, such as number 6, are expressed at rather general and are therefore of little use. Others such as the number 5 concern the school and course, and would need more discussion. After having presented the results of the discussion of the two groups, we compared the findings to find shared issues and issues that differ. The common issues were the need for better promotion of the courses outside the school, understanding the conditions graduates would face once they finished their courses, as well as appropriately calibrating the learning outcomes of the courses. While nobody disagreed on the similarities, there was more discussion about the differences and not everybody agreed on the conclusions. However, the participants agreed on the need to update the equipment of the workshops in surveying, and the need for workshops spaces in logistics. The discourse then moved to the need to adopt common rules among the teachers to educate students to behave at school.

During this discussion, the topography teacher openly questioned the present state of things. For her some were shallow in finding the causes of the present state of things:

82	*I wouldn't say that enrolling in other courses is simply a passing trend. I think it's about the students looking for something else. I wouldn't reduce it to blaming regional or industry factors, we can't continue hiding ourselves […] otherwise we'll not get to any point*

Later she criticised the lack of cooperation between colleagues, since her initiatives are made difficult by the other teachers (bullet 8 above):

146	*We should be more flexible. Yesterday (when I asked my colleagues to bring my class to the University) I was told "I don't know how I can do this". We should consider ourselves very lucky that the University gives us spaces and time. Instead you make such important initiatives more difficult …*

In another instance, she questioned the choice of the new courses to be activated after the school reform, which was eventually made by the school director against the suggestions of by the committee she had appointed.

221	*As a consequence of the school reform, we had to make a steering committee of technical teachers to find the new courses to be launched in the school …*
223	*The committee members were discussing which courses were better to match with surveying. After many meetings the members chose the course in agronomy. Of the proposals coming out from this committee, none was eventually considered [by the school director]. Nothing, but logistics and graphics and communication*

4.2.2 Second Workshop, 2 March 2016

The second workshop aimed at making the *historical analysis* of the course of surveying. It started with the summary of the results of the previous meeting. Following this initial stage, in the writing surface representing the ideas/tools of the past, the participants drew a timeline with the important events characterising the history of the school: teaching staff, school directors and courses taught. To retrieve such precise data (the mirror of the past), the participants used an old publication of the 1990s on the surveying course that lay in the teachers' room.

Firstly, the participants wrote their name and year when they started teaching in the school. Five participants had been students in the school in 1970s, and eight started teaching there in the 1980s. Only seven of the teaching staff, mostly

workshop assistants, started recently working in the school (since 2013). As second task, the participants wrote in the timeline the various' school directors: five ran the school from 1970 to 1975, while one was in charge for a long period—from 1975 to 2006—followed by a temporary regency of a couple of years, and the present school director has been in the role since 2007.

Third, we plotted school reforms and course changes on the timeline. The course runs since the start of school in 1970 to the school reform of 2008 was the traditional course in surveying. Another course named *Cerere* in agronomy was run between 1984 and 1995, in large part because it was considered the ideal match with surveying. Since 1985–2008, there were two surveying courses: one being the traditional form and the experimental version (called *Sirena*). Since the *Sirena* course had more technical teaching hours than the other, it was more geared to professionalising students. In 2000 another change occurred, the technical institute merged with the lyceum next to it. However, it was the school reform of 2008 which marked the milestone between the old and the new. From 2008 to 2010, working groups were established to find out which of the courses allowed by the school reform could be launched besides surveying. In 2010, the new surveying CET course started with a subcourse in Geotechnics specialising in environmental skills, but this course did not prove popular. The course in graphics and communication also started in 2010, while the year later it a course in logistics was initiated. The school reform has also determined the arrival of two new school professionals: the workshop assistant introduced between 2010 and 2012, and a supplementary teacher for 'students' enhancement' since 2014.

I then invited the participants to distinguish periods in their school history. They found three. The first period was with the school director between 1975 and 2006; the second was the transition between 2006 and 2008; and the third was from 2008 up to present. Interestingly, this period is characterised by both the latest school director and the school reform. The first period lasted almost 30 years and is considered by the participants as the golden era of surveying, which the school capitalised on by having a capable yet controlling school director. The participants wrote on the surface that this period is characterised by organisation, severity, responsibility, valorisation of teachers and authoritarianism. The second period represented a transition between the first and the third period and was characterised by a community of teachers who sought to cooperate. The third period was opposed to the first; it was the period of 'charting a new way' and is characterised by discomfort caused by the reform, divisions, lack of coordination and collegiality.

Figure 4.2 illustrates the historical analysis made with the help of a timeline in the surface of 'ideas and tools' of the past. This banner was entirely written by the participants.

It was clear that the experienced teachers preferred when they were administered by the tyrannical school director who had controlled the school for almost 30 years. A design teacher comments:

This consequence means that, by contrast, the present school director has a defensive attitude towards the students. Moreover, the participants seem to blame her for

Fig. 4.2 Timeline drawn by the participants during the historical analysis

365	*Notwithstanding that he was a centraliser, he had a protective attitude towards the teachers. If a teacher made a mistake, he would first defend him or her from the parents, and only then tell him or her off privately*

the present state of things. The topography teacher tells me about the previous school director:

540	*He was an engineer (like us). He liked the same things we like, he cared … do you understand?*

The participants also criticise the school reform, another design teacher comments:

605	*I think that the best word to characterise the reform is disorientation. Many of us do not agree with the school reform and think it worsened the previous curriculum. The fact that the new course is not designed to prepare a full technician but rather to continue towards tertiary studies makes many of us upset*

The reform has also caused the lack of cooperation among the teaching staff. Implicitly, the school director is blamed again for not having coordinated the new curricula. The same design teacher contends:

711	*This discomfort has been caused by the reform. We had to understand the reform and each of us was required to autonomously interpret it and apply it in an individualistic way [rather than having a whole-school vision]. Nobody in the school helps us understand the reform and the changes to adjust the programs are carried out individually*

Interestingly, in this meeting, the idea of interdisciplinary project already appeared four times, and it was suggested by the topography teacher as possible solution to overcome teachers' isolating individualism:

731	*There is the issue of time. We have to perform the same things in much less time, therefore we are all rushing. Concerning (the teaching staff's) team work, the interdisciplinary project has always been an interesting activity, but it took time, and we are now rushing so much*

4.2.3 Third Workshop, 8 March 2016

The third workshop aimed at performing the *empirical analysis*. It started with the summary of the previous meeting. To make an empirical analysis based on facts rather than on the participants' memories, we used the curricula of surveying before and the school reform (the mirror of the past and the present). Based on the historical analysis which had identified the school reform as the main difference between the past and the present, the task was to draw a table to compare the surveying course before and after the reform. The participants decided to use colours to emphasise the differences: green for positive changes, black for negative changes and grey for areas that could be potentially positive but need improvement. Such grey areas could be potential areas of development as a springboard for change. Table 4.2 translates the empirical analysis made by the participants in the surface of 'ideas and tools' of the present.

Overall, for the participants the school reform brought more teaching hours connected to general education subjects (literature, second language, ITs) and less hours connected to technical subjects (from 33 to 26 h), but this was partially compensated by the increased duration of a teaching hour (from 50 to 60 min). The unintended result of the analysis was that the strengths led by the reform outweighed the drawbacks. The participants agreed that many changes had been positive for students, the main being: the improvement in teaching hours in literature, English skills and ITs; a new technical subject dealing with the management of the building site; improved didactics leading to a competence-based approach. Moreover, there are potentially positive areas that should be better developed, such as the full exploitation of the professional figures introduced by the school reform (workshop assistants and teachers for enhancement); work experience; the final state examination which should be competence-based. The only real shortcoming was that the subject law disappeared in the new curriculum, which was counterproductive because it prevented future professional surveyors from acting as intermediary between public administrations and private citizens.

In the final part of the workshop, I explained the theory of mini-sized, medium-sized and large expansive learning cycles (Engeström, 2015) to help the participants consider the implementation of the reform as a cycle of expansive learning. When asked to place their course on the larger cycle, the participants said they were *reflecting on and evaluating the process*. Six years after the reform, the participants could reflect on the effect of the reform on the students who had freshly graduated with the new programme. The participants suggested that the following meeting would be employed to hear the voices of the building industry and the local register of surveyors.

Table 4.2 Empirical analysis, comparison on the surveying course before and after the reform

Navigating without map (many containers lacking content)	**Before the reform**	**After the reform**
Subject Law in the triennium	Present	Absent
Subject literature over the 5 years	19 hours	20 hours
Technical Subjects overall in the triennium (without the subject "Management of the building site" below)	33	20
Subject Management of the building site	Absent	6 hours
Workshops and Workshop assistants Co teaching between teacher and ITP	Absent Absent	Present ~~(To be developed)~~ Present, 27 hours ~~(To be developed)~~ ~~(Leasing of laptops for studs)~~ More "forced team work" between ITPs and teachers
Subject English in the triennium	Present in the Sirena Absent in the Traditional	Present in the CAT (plus 1 hour)
IT subject in the biennium	Not present	3 hours in first year
Students' external and internal mobility from the biennium to the triennium	More difficult	Easier
Work experience	Short work experience (2 weeks)	Work-experience (400 hours) ~~(To be developed)~~
Formative approach	Based on disciplines	Based on competences ~~(on going)~~
Teacher for "enhancement"	Absent	Present ~~(To be developed)~~
~~Final exam to obtain high school diploma~~	~~Based on disciplines~~ ~~(area of project – interdisciplinary project)~~	~~Based on competences~~ ~~(multidisciplinary simulation)~~
School books Electronical register	paper made absent	Also digital books Present
Duration of 1 teaching hour	50 minutes	60 minutes
Didactics	More (stand-alone) disciplines	More multidisciplinarity
Communication between school and work	Less enhanced	More enhanced
Legend Black: negative Green: positive ~~Grey and crossed out: critical, potentially positive but to be worked out~~		

In this meeting, 'interdisciplinary project' was used seven times to refer to practices that were viewed as good practice. A design teacher, for example, said:

649	*We organised a interdisciplinary project around a common theme. I worked on it, the land valuation teacher worked on it, law (teacher worked on it). It was called "area di progetto"*

4.2.4 Fourth Workshop, 15 March 2016

This meeting was a mirror of the present oriented to better understand how the surveying profession had changed after the financial crisis (and consequent fall of the estate sector) as well as the school reform. To do so, the meeting involved the local representative of the *Confindustria* building sector and the president of the register for surveyors. The meeting started with a summary of the previous workshop made by a design teacher to illustrate the two representatives what the group had discussed so far.

The register's president told the staff about modern surveyor's opportunities, such as he/she can potentially open a private practice, thus making an entrepreneurial choice or work as employee. The financial crisis and the school reform, which occurred almost at the same time, represent the landmark between the old and the new: the surveyor is no longer the professional working in the construction of new buildings. There is a wide range of activities he/she can now perform, which constitute mainly maintenance and renovation of existing buildings; role of intermediary between public administrations and private citizens or companies. He/She is a professional with niche specialisation, and this could be accident prevention, energetic certification, or the consolidation of foundation in historical buildings. Such a professional, who most of the times is self-employed, is characterised by their problem-solving and teamwork skills.

The representative of *Confindustria* completed the picture. While the register's president was concrete in their description, the representative of the building sector was quite general, so that the discussion tended to drift away from the actual problems that the participants were tackling. As an employed professional, the surveyor has to be knowledgeable about all types of issues around construction. He/She is a problem-solver, able to spot a problem and to contact the right professional to solve it. School should therefore educate students for working ethics and responsibly when they enter the industry, so as not to be afraid to be highly involved in the building sites or to stay at work until the issues they face are resolved.

However, when the two representatives left a more focused discussion started. A significant observation that one of the participants made was that some students did not have a holistic view of surveying because at school every subject is dealt with as detached from the others. Another reflection point was that work experience should be more qualifying for the students. Additionally, teachers in school should have taught the students how to work productively in groups, since this capacity was at the core of current surveying work. Finally, the teaching staff did not act as an educating community; they send contradictory messages to the students, since they did not agree on common rules such as coming on time to school, handing homework by the deadline, denying permission to leave school before the regular end for petty reasons such as playing soccer. The discussion moved to didactics, and the difficulty of ensuring that students are able to work in groups productively.

The interdisciplinary project was mentioned seven times referring to the past but also to the present. A design teacher suggested that a interdisciplinary project as done many years later in the school could be a solution to move towards a competence approach where students have a holistic understanding of surveying.

227	*I believe that the methodology of the interdisciplinary project that we carried out years ago, and now unfortunately we don't do [this activity] any more, [since it] could be an instrument for the student to have a full-field vision of surveying*

The farm valuation teacher, however, deems it unfeasible:

243	*Since the interdisciplinary project cannot be done, we could try to find few teaching hours to make transversal lessons: starting from a question we move (across subjects). (For instance), we could start from city planning and move to topography, without the need of an interdisciplinary project. It will be difficult but possible. I find it problematic that each time I ask students a question beyond my subject they remain silent*

A few speaking turns later, the design teacher put forward an initial idea of an interdisciplinary project managed by the workshop assistant:

250	*I don't think there is a need for extracurricular time to implement a interdisciplinary project. I [will] explain what I mean: the class council decides to implement a project and makes a plan. Then the workshop assistant coordinates the project and connects with the subject teachers involved*

This idea met resistance by the topography teacher:

268	*Yes, but there are practical problems we have to deal with. For example, we don't have hours where two teachers can teach in the same class. In any case, the subject teacher could carry out a small project with his or her workshop assistant by having the students tackle a practical problem in groups*

Lastly, the vice director pointed out that in the Geotechnics small Grade 4 class he and another teacher helped by the workshop assistant were carrying out a small interdisciplinary project on the transformation of a quarry into a cultivated land. The students were enjoying this project as it was hands-on.

4.2.5 Fifth Workshop, 22 March 2016

This meeting aimed to *model the new solution* to identify the basic contradiction of the course in surveying. The meeting was held close to Easter holidays and conse-

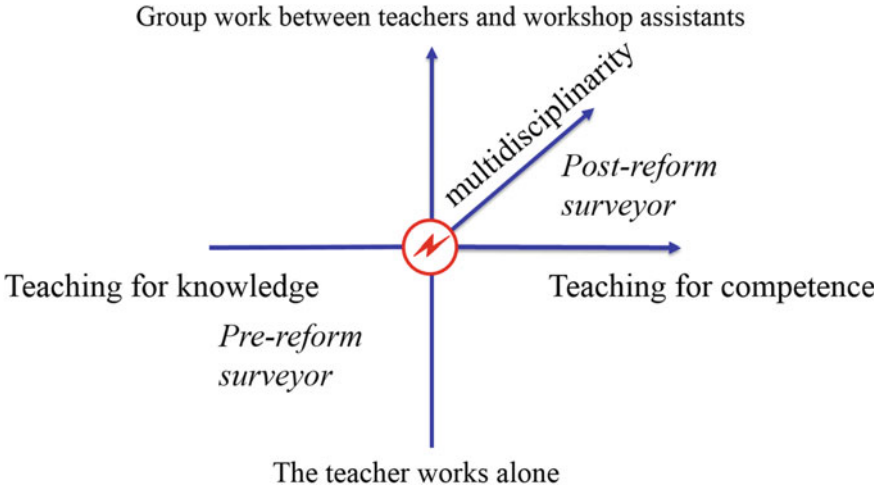

Fig. 4.3 Identification of the main contradiction of the activity system of the surveying course

quently only six participants attended the workshop. I started by making a summary of the previous meeting with the representatives of the industry. According to the participants, this previous workshop did not reveal any information that was new to them about what the surveyor should be like in current industry conditions. In the introduction, I also drafted the main contradiction and I hypothesised as a model explaining the present, as from Fig. 4.3.

The hypothesis I had made was shared through a Cartesian plane. The main contradiction was that the teachers were still teaching for the pre-reform programme, and this clashed with the need to train the new surveyor as called by the reform and the job market. The bottom left area represented the teacher's work before the reform, and the upper right part the teacher's work as it should be after the reform. The horizontal arrow displayed the tension between teaching from disciplines and teaching for competence; the vertical arrow showed the tension between teaching alone and teaching as group—including the workshop assistants. The crossing of teaching for competence and teachers' group work would lead to interdisciplinarity. The red circle with the arrow inside shows the clash between the two fields: teaching for the pre-reform instead of teaching for the post-reform surveyors, which had contributed to decrease the enrolments year after year.

This did not rouse any discussion. The small group where still considering isolated problems and discussed the following topics: (1) students do not have mature social skills, for example, it is hard for them to conduct group work; (2) students' work experience should be connected to specific projects to improve their professionalism; (3) it is difficult to teach surveying when students lack basic notions of how law works, due to this subject having disappeared from the school reform; (4) the common people perceive the surveyor in the old way, and it is difficult to convince them about the

new role of surveyor; (5) the external image of the school is negative, and teachers should learn how to market their course better, putting more care in organising the open days; (6) it is difficult to educate students for self-control; (7) the teachers work isolated from one another, and an agreement of co-responsibility would be necessary to work as team and educate as community; (8) the school lacks workshops and equipment.

Towards the end of the meeting, it was clear that the problems had been discussed, and it was time to start thinking of a solution. This was suggested by a design teacher:

520	*I don't believe we can continue discussing on our lacks, from the next time we have to consider concrete proposals or instruments. At this stage I think that we have already performed the analysis*

Given that I had the feeling that the discussion had reached a stalemate, I gave the teachers a task for homework, that is, to think about the future of surveying in their institute. The proposals would be discussed in the following meeting.

In this workshop, the concept of interdisciplinary project was used once by the design teacher:

43	*I think it not enough to make a interdisciplinary project within the technical subjects. A cooperation with the literature it is necessary to create a positive atmosphere and work on relationships*

4.2.6 Sixth Workshop, 5 April 2016

This workshop aimed at *modelling the new solution* and started with the participants sharing the home assignment on the ideas about the future of surveying in their school.

The first proposal came from a humanities teacher. She proposed to start from the students' needs and not from what the teachers know or want to teach. She then stated that teachers should agree on specific cross-curricular competencies (for instance, teamwork) to be developed in the students, and all teachers should modify their programmes to teach such competencies. Students could put together a portfolio to show how they acquired such competence, and this portfolio would be useful once in the world of work.

The second proposal came from a design teacher who made related proposals: organising an interdisciplinary project with the help of the workshop assistants; using workshops to teach student's group work; working by implementing projects in each subject with periodical team meetings; developing a programme on sustainable architecture in the triennium; differentiating work experience; improving the educational climate in the school by establishing and adopting common rules; improving the way the course was designed.

Before the third proposal was presented, the discussion of the interdisciplinary project took over. A first proposal was launched by the topography teacher, the same that in the fourth meeting had opposed it (speaking turn 268):

96	*Let's say 6 teachers, 3 in A and 3 in B. Let's think about Construction, Surveying, and Appraisal of Farmland agree to carry out a common project. The workshops assistants coordinate that project work. We agree on a common project before the beginning of the next school year*

The third proposal came from another design teacher who suggested unrelated proposals: establishing continuity in didactics; that is, the same teacher follows the same students over the years; finding a specific person who liaises with the companies for organising work experience; improving the visibility of the school; activating a course on sustainable architecture in the triennium (this proposal had been already approved in previous years but had been never implemented); choosing only one workshop assistant for each discipline or workshop instead of having each workshop assistant dealing with three different disciplines and corresponding workshops.

The fourth teacher, the vice director, presented a draft paper with the idea of interdisciplinary project:

176	*Here is my project. I propose to resume the old interdisciplinary project I used when I taught the course of Agronomy and that now I teach in Geotechnics. In Agronomy I have much more experience. I propose 3 h per week in the same subject, but we could do it in a different way, for example 2 h of Design and 1 h of Land Valuation. In any case in cooperation with the other teachers and with a workshop assistant as coordinator. The students could present the interdisciplinary project at the state exam instead of the usual pretty long-essay. The topic could be the renovation of a building, but it could be something different, we have to decide this together. In my draft you can see knowledge, competences, contents, and where the various disciplines come into play. Not only technical disciplines but also English, since the technical reports would be written in English. In the case of the subject History of Landscape, the landscape depends on natural shape and on history, therefore the humanity teacher could also be involved). Building to be renewed, 3 h per week, here we should also change our teaching timetable, which won't be easy. Each teacher teaches his/her subject related to the interdisciplinary project, and is coordinated by the workshop assistant. Each teacher evaluates the project according to the subject s/he teaches. This is my proposal, I wrote it in half an hour. We have to proceed with a very concrete proposal, as I see it*

Notably, the last sentence of the vice school director reinforces the method; that is, participants have to come with a concrete proposal. For the topography teacher, who earlier resisted this idea, the interdisciplinary project would be "fully feasible".

177	*To me this would be fully feasible, we just have to plan well when I could come into play with my subject, for example I could appraise the land in October while in November …*

The discussion moves to the role of workshop assistants who is supposed to manage the interdisciplinary project and have the students group work. The workshop assistants, however, felt they could not be the coordinators of this intervention as teachers do not take them into consideration:

221	*We have to start from a simple consideration, I believe that the other workshop assistant would have the same issue. If I ask the design teacher: 'Can we make this interdisciplinary project?', he agrees. Then I ask the topography teacher the same question and he answers: 'Sorry I'm busy this week'. I ask the economy teachers: 'I'm sorry I'm busy'. When I find opposition, I can do anything but giving up. I put my commitment, but if other teachers are against there is nothing I can do*

However, the topography teachers affirmed the concept:

226	*Can you please let me speak? I was proposing a different thing. We (the teachers), who will also be teaching here the next year, propose a project which is given to you (the workshop assistants) to be managed. It won't be you who propose to the teachers "I would like to do this", I will be the one who organises the project*

The fifth proposal is made by another design teacher who suggested reconsidering from scratch the outcomes of the course because the learning outcomes are not in line with the market needs. To do so, a teacher should give up teaching and design the new course in surveying. This proposal was immediately trashed:

331	*I am sorry, but it is useless to talk about the book of dreams, we can only take from our teaching time one or two hours a week*

Eventually, the idea chosen during the workshop is a hands-on interdisciplinary project that builds on the traditional technical topics, allowing students to make connections and to deepen the understanding of surveying. The project should be basic enough to be manageable for students.

Towards the end of the workshop, the school director joined the meeting. The teachers illustrated the idea of the hands-on interdisciplinary project led by the workshops assistants, and the school director agreed it was feasible. She gave two suggestions. The first was to detail the role of the workshop assistant:

331	*Talking about workshop assistant, can I be clear? Many teachers come to me and say that workshop assistants are incompetent, the average one is not useful, I am not talking about you (to the workshop assistant present in the workshop). […] It is you (the teachers) who must tell them what to do. Two years ago I wrote this point in the agenda of a council, do you remember? You must tell them "please prepare these instruments so that I can perform this experiment or experience" […] These are things I have told you individually for the first 5 years I was here, and at least 10 times each, then I gave up. You still have time to change*

This speaking, in turn, evidences that there have been long-standing disagreements between these group of teachers and the school director. The second advice was to have the interdisciplinary project approved by the institute council, since this action could allow for changes in the teaching hours. The overall number of times used to mention the interdisciplinary project was 35 times.

4.2.7 Seven Workshop, 5 April 2016

The goal of this workshop was to continue with *modelling the new solution*. In the interdisciplinary project, there were two needs. While some teachers focused on the contents to be taught and how to coordinate the topics within the interdisciplinary project, others were concerned with the didactics that a interdisciplinary project would imply. My proposal as facilitator was to help include active didactics in the interdisciplinary project. To achieve this goal, I proposed a reading group open to anybody, employing the flipped classroom and group work. Volunteers would carry out planned experiments on the active didactics, and in the first follow-up meeting on May 31, the participants would discuss the results. I proposed the flipped classroom because I knew that previous courses on cooperative learning had been organised with no success. In the flipped classroom, students prepare for the lesson by watching videos at home. This appeared good to introduce IT and to free the class from lectures, thus leaving time for active didactics. My proposal was to match the flipped classroom with in-class group work.

Back to the workshop, I introduced a competence approach with its components: knowledge, skills and habits and briefly discussed the SOLO taxonomy and the theory of constructive alignment (Biggs & Tang, 2011) to find the possible learning outcomes for the interdisciplinary project. The starting point was the draft that the vice director had shared the previous workshop. The discussion sought to find the practical arrangements and targeted the workshop assistant' role: although they are often the same, their position was not permanent. A first arrangement had to be made with the school secretary, who would hire them as soon as possible at the beginning of the school year. The other condition was to have one workshop assistant for each Grade 5 class, so that the same person could follow the project across the subjects.

The interdisciplinary project would initially be limited to 99 teaching hours. It would have to deal with surveying in a rigorous way, so that the students could present it at the state examination. The teachers would work on basic concepts rather than enlarging the subject, allowing students to recapitulate, make connections across different topics and subjects and deepen their understanding of the basic surveying concepts. The interdisciplinary project would be hands-on to show in practice what the students already studied in theory, the goal being to develop a holistic view of surveying. Having experts from outside could prove difficult from the organisational point of view. Although based on technical subjects, the interdisciplinary project would also involve general education subjects: humanities with the study of landscape and English with the abstract of the technical report in English.

The group discussed a physical place where to implement the interdisciplinary project, an area that would make the project real. The group found an unresolved area: a parking lot close to their institute. It would be easy to organise school visits, for example to survey the parking lot. The project would have to appear meaningful to the students but also basic to be feasible without pretending. In the following speaking turns, teachers discussed whether to keep it or not:

290	*Even though few years have passed, I remember students finding it difficult to deal with the interdisciplinary project*
291	*Indeed it is difficult, let's come down to earth*
292	*We have to keep it compact*
293	*Good, very good!*

These speaking turns show that the constructive and positive atmosphere during the workshop. Designing a canteen that simply warms up the food prepared in another venue would keep the interdisciplinary project both simple and realistic. Moreover, as the school has no bar or canteen, this topic matches a student's need.

The last issue discussed concerned how to involve the teachers of the course who did not attend the workshops, but who should nevertheless be included in the interdisciplinary project. The other teachers would adjust to the majority's will, who approved of the project. However, while some of them will be happy to participate, it will be difficult to involve others. The interdisciplinary project in two Grade 5 classes could differ according to the teachers who participate. In any case, the first step would be to obtain the approval of the class councils and the department council.

The words ' interdisciplinary project' were used 23 times during the workshop. Appendix A shows the description of the interdisciplinary project as designed by the teachers in an intermediate version dated on May 2016. The model, however, was continuously updated by the participants as it developed, in line with the theory of expansive learning (Engeström, 2011; Virkkunen & Newnham, 2013) discussed in Chap. 3.

4.2.8 Department Council, 10 May 2016

The department council is composed of the group of technical teachers in surveying. While this was not a proper Change Laboratory, the teachers and workshop assistants discussed the implementation of the interdisciplinary project and continued to *examine the new solution.* This meeting represented a turning point: if approved, the project would have to be implemented. Two teachers who had not attended the Change Laboratory were present. This workshop I was present demonstrates that expansive learning progressives outside the Change Laboratory, and once the new idea is generated, it is continuously discussed and developed in the practical implications, with practitioners who had not participated in the Change Laboratory joining the effort (Engeström & Sannino, 2010).

A teacher read the features of the interdisciplinary project, and it was approved. The first query was about the city's regulation plan, whether it would allow for the construction of a canteen. For the students, it is important that the interdisciplinary project would be doable in reality, and the best projects could be presented to the municipality, while simultaneously giving the school more visibility within this broader community.

At this point, the agency was totally transferred to the participants (Sannino, Engeström, & Lahikainen, 2016; Virkkunen & Newnham, 2013). In the following quotations, they claim the ownership of their interdisciplinary project:

222	*(…) The most important thing now is that the Department council approves this idea, which was born during the course (the Change Laboratory), but which is extended to all of you gentlemen*
223	*Indeed, we had had regrets (for not setting up an interdisciplinary project) that we had expressed many times*
224	*Precisely, we do believe in it*

The group continued discussing the timeline of the project and how many hours per subject. Another issue was competence-based assessment for the interdisciplinary project at the state examination. After having discussed such issue with the school director who had called in, the participants concluded it was too early to turn the state examination into competence based with real-world problems to be tackled.

4.3 The Follow-up Workshops

4.3.1 First Follow-up, 31 May 2016

Since the implementation of the interdisciplinary project would start at the beginning of the following school year, and the interdisciplinary project had been already

planned; this workshop discussed the innovative didactics that would be useful to implement the interdisciplinary project. After having organised reading group on the flipped classroom and having experimented with new practices, the workshop aimed to *reflect on the new practices*. The volunteers were a construction teacher and a literature teacher who carried out the planned experiments on the flipped classroom with in-class group work. Most of the follow-up was dedicated to watch and discuss these videos as mirror materials of the future. The school director and a representative of the surveyors' register were also present. While in the classes of literature, it had been more difficult to deliver a module with the flipped classroom, the thought experiments in the construction classes had been successful, and students had been enthusiastic.

In design, the flipped classroom allowed for a drop in the number of students who failed the test, from 39 to 12% in a Grade 3 class and from 44 to 17% in a Grade IV class. During the discussion, it was acknowledged that such difference in the success rate was not due to the final mark which also accounted for group work ability. The students acknowledged that watching the video at home and having peer-tutoring in class had risen the understanding of the topic. Based on these observations, the flipped classroom was a promising didactic for the interdisciplinary project, and that didactics to enhance inclusion and success could be used to promote the school outside and attract new enrolments.

4.3.2 Department Council, 14 October 2016

In this meeting, the participants *reflected on the new practice. The implementation of the model* started in September 2016, at the beginning of the school year, with one of the two classes going to survey the selected area. Two technical teachers joined the workshop for the first time, with two newly employed workshop assistants and the responsibility for education at the local surveyors' register.

The interdisciplinary project had started in the two Grade 5 classes. We presented the interdisciplinary project and its aim to the workshop assistants. In the two classes, the project was proceeding in slightly different ways both in the timeline and in the delivery of content. In both classes, the students had to work in groups to share the workload in tasks requiring them to produce documents such as blueprints, layouts, contracts and metrical computations. We discussed the basic methods to have students teamworking productively and fairly. The two new teachers were not convinced about the interdisciplinary project and expressed resistance. One of them, a land valuation teacher, said:

189	*I see many problems in this interdisciplinary project. Firstly, we are professionals coming from different parts of Italy and have different ways to organise our discipline. Secondly, if we look at the time I have to dedicate to this project, I have to take many hours from the regular program. Third, there are always accidents during the year and this project is extremely multifaceted. If I think that I have to wait for data from my colleagues, since all this looks far from simple*

The land valuation teacher raises the tension between the interdisciplinary project and the regular curriculum that will be discussed at length on Chap. 7. The final part of the meeting was spent in budgeting the interdisciplinary project: materials, other professionals, etc.

4.3.3 Second Follow-up, 22 March 2017

This meeting aimed at *reflecting on and evaluating the process.* I shared with the participants the results of the focus groups in the two Grade 5 classes and the interviews with teachers and workshop assistants. Since this follow-up discussed in depth the interdisciplinary project, the next chapter will be entirely dedicated to analyse the features, challenges and potentials of the interdisciplinary project with the words of participants.

From a CHAT point of view, this chapter displayed how the participants are mastering the expansive learning process. It started with the historical conditions that created the need for a formative intervention, and the Change Laboratory on the filed with its multi-voicedness and dialectics. During the workshops, the main contradiction emerged was that the teachers had endured the school reform without understanding it. They had also lost the object of their activity; that is, they did not know what type of surveyor they were training and blamed the others for the situation: the students, their parents, the other courses in the school, the school principal, the ministry of education. Although already carried out at the end of the 1990s, the interdisciplinary project represents a possible germ cell, a practice that is brought back to life with new contents to tackle the issues emerged during the workshops: how to revitalise enrolments, how to work as team, how to improve the teaching methods and embed competence-based approach into the programme, how to improve the image of the surveying course outside the school.

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