Abstract: Learning scenarios are a way to plan learning and teaching activities, promoting the development of skills related to problem solving, collaboration, critical thinking and creativity. Their use as lesson planning strategy is a powerful tool that, on one hand, mobilizes teaching related scientific concepts, and on the other hand, allows involving strategies and capacities essential for teachers and students. In this text we admit that training programs and educational environments enriched with digital technologies can be an important factor in increasing the quality of teachers’ initial training programs and in their future professional practice. Thus, we present the experiences in design and implementation of learning scenarios in teachers’ initial training that has been developed within the project Technology Enhanced Learning @ Future Teacher Education Lab (TEL@FTELab), with students of teaching master degrees (e.g.: Biology, Mathematics, Computer skills, Economics), through a case study analysis. The results have been analyzed, contributing to the specification of the principles underlying the learning scenarios in initial teacher education. Therefore, the use of learning scenarios brings a set of potentialities to teacher training given its prospective nature.

Key-words: Learning Scenarios, Technology Enriched Learning, Initial Teacher Training, TEL@FTELab Project.
The use of learning scenarios, as a way of planning teaching and learning activities, has been a strategy for the promotion and development of skills related to problem solving, collaboration, critical thinking and creativity. This strategy for planning classes proves to be a tool that can mobilize scientific concepts inherent to teaching, and also enables involving capacities and strategies that are essential for teachers and students.

**Framework**

Although technology is increasingly available and accessible, its use in pedagogical and didactic activities in a school context is still resisted within the educational system, and not effectively integrated in teachers’ practices. (Brás, Miranda & Marôco, 2015). Also, the very concept of the integration of digital technologies in teaching can be relevantly questioned, as the role of digital technologies in education can be analysed and questioned outside the setting of an integrative logic (Matos & Pedro, 2011).

The analysis set out in a european report on 27 countries of the European Union (European Commission, 2013) regarding the presence of digital technologies in Education evidenced some of the main elements in the discussion of this theme. Thus, although the improvement of the technical and technological infrastructures in schools is recognized, there is a number of worrying results: i) wi-fi access in classrooms is not satisfactory, (ii) globally, teachers do not seem to to have enough ICT or confidence to integrate technologies in their teaching practices, and (iii) student evaluation methods were not revised or updated despite the presence of digital technologies in teaching activities.

On the other hand, although digital technology skills and teachers’ attitudes towards the use of technology are considered a central element for the modernization of educational practices, teacher training is not adequate to deal with the challenges faced, particularly concerning the development of innovative pedagogical practices supported by technology.

This is evidenced by different authors (Barton & Haydn, 2006; BECTA, 2004; Matos, 2004; OECD, 2009) who have noted that: (i) ICT are not regularly and systematically used in teacher training, (ii) continuous teacher training in the ICT field is not sufficient to respond accordingly, (iii) there isn’t enough research on how the institutions responsible for teacher training prepare future teachers to deal with current and future students.
In fact, most programs for adoption of digital technology in schools have been focusing essentially on primary and secondary education, and the departments responsible for teacher training (initial and continuous) in higher education are not seen as stakeholders in the innovative pedagogical practices development process (Wang, 2002). In this field, evidences show the limited integration of technologies in the higher education curriculum (Kay, 2006; Matos & Pedro, 2008; Swan, 2006; Sutton, 2011). As an example, Sutton (2011) identified the national tendencies relative to the integration of teacher training in 14 different countries, reaching some worrying conclusions. In a significant number of countries, the use of technologies in initial teacher training is not mandatory. In Portugal, as in other countries, the legislation that frames Professional Teacher Training (DL nº 79/2014) does not consider ICT skills as one of the essential dimensions for the teaching profession: (i) scientific area, (ii) general education area, (iii) specific didactics, (iv) cultural, social and ethical knowledge and, (v) professional practice. In this sense, entities responsible for initial teacher training have generally ignored research on this subject, which emphasizes the role that initial teacher training holds in structuring teachers' positive attitudes regarding the use of technologies and innovative methodologies in their teaching practices. Different studies have pointed out how teachers in the first years of their career who had contact with innovative pedagogical practices and the use of technology in their initial training have shown a positive self-efficacy in the use of technologies in the classroom (Brown & Warschauer, 2006; Hammond, Fragkouli, Suandi, Crosson, Ingram, Johnston-Wilder, Kingston, Pope & Wray, 2009; Paraskeva, Bouta & Papagianna, 2008).

For a significant appropriation of technologies in the classroom context, impacting students’ learning, teachers must structure the scientific contents of their subjects to the different transversal activities developed in technology enriched pedagogical practices. However, initial teacher training programs don’t reach a significant student (future teachers) immersion in practices that use technology. These institutions merely offer isolated subjects relative to technologies, where technical competences are developed (Brown & Warschauer, 2006; Mishra & Koehler, 2006).

**TPACK Model**

One of the models relative to the integrated development of technological knowledge in teaching practices has been laid out by Koehler, Mishra e Cain (Mishra & Koehler, 2006; Koehler & Mishra, 2009; Koehler, Mishra & Cain, 2013) - TPACK model (Technological
Pedagogical Content Knowledge). This framework emphasizes the complex relationship between the teacher's three bodies of knowledge: content, pedagogy and technology (Figure 1).

The TPACK model is based on the work developed by Shulman (1987), where the teaching process as combination between content, knowledge and pedagogy is advocated, the teacher's responsibility being to adapt his or her knowledge to the student's level of comprehension and interest. Considering this model, Mishra and his collaborators (2006; 2009; 2013) have suggested including a new technology related factor, integrating the three structural bodies of knowledge for the teachers who use technology in their academic, methodological and educational practices.

The intersection of knowledge in these three levels (knowledge of curricular content, pedagogical methods and technological competences) translates into pedagogical practices that appropriately integrate technology.

According to this model, the success and efficiency of pedagogical practices is based on the development of a complex intersection between the three domains of knowledge,
considering the context where the teacher is integrated: Pedagogical Content Knowledge (relative to the capacity to select technological resources that are adequate to curricular contents); Technological Content Knowledge (relative to the ability to select adequate technological curricular contents); and, lastly, Technological Pedagogical Knowledge (related to the capacity to use technological resources in the teaching-learning process). Thus, this framework allows for an understanding of each individual teacher's need for developing these different types of expertise, that, being intrinsic and indissociable, have an interactive relationship. Each of these dimensions of knowledge, both individually and collectively, will play a structural role in teacher development (Koehler et al., 2013), entailing that whenever there is a change in one of them, the rest will be influenced (Mishra et al., 2006).

Teachers and teacher trainers' perception of these dimensions of knowledge will allow for a better understanding of (i) the different levels of technologies' integration, (ii) the teacher's necessary skills for an effective integration, (iii) the design of innovative and motivating pedagogical practices (Pedro, Matos & Pedro, 2014). We then consider that teacher training (initial and continuous) sets its activities on work strategies and methods that contribute to the development of transversal technological skills for the twenty first century.

Learning Scenarios

Learning scenarios have been used in different scientific areas (e.g. marketing, software development, medicine, game development, economy and others) as a way of structuring and reflecting on the future, thus anticipating problems and producing possible solutions for identified future problems. The use of learning scenarios in education can be a way of promoting the development of skills for the 21st century, namely those related to problem-solving, communication, critical thinking and creativity.

TEL@FTELab project adopts the idea of learning scenarios as key to planning teaching activities in technology enhanced learning spaces. Matos (2010; 2014) defines learning scenarios as “a hypothetical situation of teaching-learning (purely imagined or with real substance, widely changeable) composed of a set of elements that (i) describe the context in which learning takes place, and (ii) structures the environment in which learning happens” (p.3). Learning scenarios are “… stories of what might be. Unlike projections, scenarios do not necessarily portray what we expect the future to actually look like. Instead scenarios aim to stimulate creative ways of thinking that help people
break out of established ways of looking at situations and planning their action.” (Wollenberg, Edmunds and Bucke, 2000, p.2). On the other hand, Tetchueng, Garlatti and Laube (2008) see learning scenarios as a powerful tool to plan and “describe the learning activities to acquire knowledge domain and know-how to solve a particular problem”. Along the same line, Misfeldt (2015) defines a learning scenario in education as a “newly developed framework or approach to understanding educational situations building on scenarios, understood as real or artificial situations that are used to create context, experience of relevance and immersion, in educational situations” (p.3).

Carroll (2000) pointed out five reasons to adopt a scenario-based design in the design of new technological applications: 1) scenarios evoke thought; 2) scenarios are at once concrete and flexible; 3) scenarios afford multiple views of an interaction; 4) scenarios can also be abstracted and categorized; and 5) scenarios promote work-oriented communication. Based on those reasons Matos (2010) pointed out a set of structuring elements of a scenario: a) the organizational environment design; b) roles and actors; c) plot line, strategies, actions and activities; and d) reflection and regulation.

The design and implementation of a learning scenario is conditioned by numerous factors: subject area, knowledge domain, roles played by the different agents (students and teachers) and sequences of learning activities. Matos (2014) defines a set of six guiding principles for learning scenarios design. These principles are represented in figure 2.

Figure 2. Guiding principles for the design of learning scenarios (Matos, 2010; 2014)
Exploring each of the principles:

- **Principle 1: Learning scenarios should be built based on the idea of participative design**
  Designing learning scenarios should involve several participants and actors in the conception of the scenario, to promote meaningful learning. Whenever possible, the actors such as teachers, students, researchers and specialists, should be involved in designing the scenario and activities.

- **Principle 2: Learning scenarios should be based on the context and needs of their users.**
  Learning scenarios should be closely connected to the teachers’ and students’ classroom pedagogical practices. The scenarios should reflect the teachers’ needs (what do students need to learn? how can I enhance their learning? what activities should be designed? what is the role of digital technologies?) and should count on the students' involvement and collaboration in the search for concrete answers.
  On the other hand, they should also contemplate the students' interests and needs, allowing them to access ways of learning that are closer to the ones that characterize the digital world in which they were born and live, making learning experiences more authentic and significant.

- **Principle 3: Learning scenarios should stem from a dynamic process of experimentation and reflection**
  The scenario design should be thought as something that is developed over a long period of time, including several developmental phases. Starting with an initial prospective idea (for instance, a narrative that describes a certain problem that may arise in the future), it is possible to build and provide tools and materials, test their application, assess the impact of their use in the classroom, adjust the whole process and start the cycle over when considered pertinent. This way, learning scenarios should be thought as something that can be altered and adjusted as the actors’ motivations and contextual needs change.
  This way, the scenarios should go through a process of continuous evaluation and reflection, which allow identifying the need for improvement and change in order to increase their quality as well as that of the activities and products to be developed.

- **Principle 4: Learning scenarios should help to learn and to think**
Learning scenarios should give students and teachers challenges that will allow them to develop new habits of thinking and learning. The access to digital technologies should support teachers and students in transforming their usual learning practices. The technological artefacts introduced should propose challenges and intice the need for problem solving. Students and teachers should be involved in experimenting, exploring and in creating new learning products. Based on these ideas, it is important to include the access to different types of digital technologies: a) specific applications and technologies for a certain area of knowledge, and b) learning management platforms, collaborative environments and tools for synchronous and asynchronous communication.

- **Principle 5: Learning scenarios can include suggestions to complement the use of digital technologies**
  In the learning scenarios’ design process, examples of digital technologies that can be mobilized in the different phases can be presented as a suggestion. Similarly, suggestions for activities, resources and materials that could be mobilized for exploring the themes and concepts that are being studied, can be included.

- **Principle 6: Learning scenarios should propose new challenges and allow for the consolidation of others**
  Learning scenarios can include diverse activity proposals and methodological suggestions that appeal to project development or problem solving, allowing students to engage with new challenges and the development of new knowledge. This type of challenge tends to take longer. They can also allow for consolidation of expertise through more focused and structured activity proposals, usually of shorter duration.

A learning scenario also admits a set of characteristics that can work as catalyst for the development of the skills for the 21st century, previously mentioned. Matos (2014) listed the following as characteristics of a scenario:
Methodology

Trying to analyse how technology enriched practices can contribute to change the pedagogical practices of teachers and future teachers, the TEL@FTELAB project has admitted that the immersive use of technologies can impact the way people learn and how they teach. In this sense, the project has been developing activities with future teachers of Biology, Computer skills, Mathematics and Physics, having so far structured 30 learning scenarios for the different courses.

In order to structure these learning scenarios and to perceive in what way they are applied to classroom context by the future teachers, we have adopted a working methodology based on the Guidebook for development of Learning Scenarios (TEL@FTELab, 2018).

The Guidebook for development of Learning Scenarios is an online tool that aims to support teachers and instructors in the process of developing learning scenarios. It is organized in four dimensions, structured according to the previously listed principles.

Initially, brief descriptions are presented, both of the tool’s purposes and the learning scenario’s concept, as well as listing resources on the latter. In a specific menu, you can...
find examples for learning scenarios for different scientific areas, with the option to download for further use (with a creative commons license). Finally, in the introductory component, you can find videocases\(^1\) developed in the TEL@FTELAB project.

In order to support the process of learning scenario development, the tool is organized according to four phases, based on the principles defined for learning scenarios: planning, production, implementation and evaluation.

![Figure 4. Phases of a learning scenario cycle](image)

Planning a learning scenario is an activity that includes a thinking process by the future teacher and the team of teachers and supervisors.

Typically, conceiving or adapting a scenario to a specific group of students involves a clear identification of the idea, the addressed theme or the problem to be solved.

In the planning process, when specifying a theme to address, the teacher will tend to immediately start formulating objectives (even if general by nature) for the activity to be developed.

Thus, adopting a pedagogical approach that values the students' role, suggests a participatory design strategy, holding students responsible for their contribution in all stages of the activity since its planning. This idea requires creating and developing a culture of responsibility by the students that should constitute a general purpose in education and should be systematically laid out to students in work propositions.

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\(^1\) By videocase, one should understand the description and presentation of a learning scenario, through a video animation that contains a set of data on the implementation of said scenario (e.g. identifying school, students, scientific area, STEM, teacher, etc.), short and long versions of LC and interviews with the participants. Available at [http://ftelab.ie.ul.isboa.pt/tel/gbook/cenarios-de-aprendizagem/](http://ftelab.ie.ul.isboa.pt/tel/gbook/cenarios-de-aprendizagem/).
Identifying the situation, idea or problem to solve should then be acknowledged by all involved and analysed as a group by brainstorm methods - again making students responsible for their role in this stage of the activity.

The future teacher's role is to articulate the activity design and its goals with the themes and curricular objectives, as well as the curriculum of specific subjects (if there is more than one subject involved). However, it is important that the starting point for the articulation between activity and curriculum is the very idea or problem identified. This will make it the activity’s mobilizing element, placing the curricular themes as tools to engage with the idea or problem identified. We should underline that this viewpoint doesn’t underestimate curricular themes, on the contrary, it gives them full relevance, demonstrating their power and application potentials. At this point, constructing a conceptual map can be relevant; one that associates the curricular concepts and techniques to the predicted tasks for the student activity, as well as the representation forms that will be put to practice (e.g. data registry, producing short activity reports). This conceptual map, associated to the predicted set of tasks in the scenario, constitutes a crucial element for a successful implementation, as it will serve as the activity’s script within the scenario. Adjacently, it might be relevant for the scenario’s implementation to take note of the skills that students are to develop or strengthen in tight connection with the formulated specific pedagogical goals. In parallel, the future teacher’s reflection should contemplate an analysis of the competences which preparing and implementing the scenario may develop towards an awareness of the activity’s contribution for his professional development. This is a challenge the future teacher should embrace, while preserving the complexity of his teaching activity - keeping in mind the ultimate goal which is to create circumstances for students to develop competences or acquire clearly specified concepts. Anticipating his set of required competences in developing and implementing the scenario, the teacher becomes aware of the necessary steps and prepares himself for the roles of supervisor, facilitator and interlocutor amongst students.

In the production or design stage of the learning scenario, and using a model or template, the future teacher organizes the ideas drawn in the planning stage. Thus, considering the principles associated with the learning scenario design, as well as it’s constituting elements, the future teacher will try to define the narrative, learning goals, methodologies and strategies to be mobilized, work proposals, resources, actors and respective roles, and the regulation and self-regulation rules.
After constructing the scenario, the teacher may proceed towards its licensing, using creative commons norms and, therefore, defining the conditions for its possible use by a third party in other educational contexts.

In the Implementation phase - using educational strategies, methodologies and resources -, the future teacher and his students will foster a group of learning activities, stemming from the developed learning scenario (in the Planning and Production phases).

This process can be developed, for instance, from active learning/strategical methodologies that are mobilized to the practice: a) Project Based Learning; b) Problem Based Learning; c) Inquiry Based Learning; d) Flipped Classroom; e) Gamification; or f) Pair Programming.

The evaluation role corresponds to a careful analysis of the achieved student learning vs the planned student learning; this will be translated into a description that will inform teachers and students about the achieved goals and the ones where problems arose. It’s an essential process that enables making decisions that regulate the teaching and learning process, contributing towards an effective learning and, consequently, better results.

In the learning scenario implementation, evaluation mechanisms should be present throughout the whole process, contributing to a critical reflection and learning self-regulation. In the evaluation process, the future teacher should consider the different evaluation purposes: diagnostic, formative and summative.

The evaluation should be carried out in the scenario implementation, considering collaboration, interaction, developed products and subproducts, as well as their development process by students. Mechanisms to guarantee self-evaluation and hetero-evaluation processes - both individually and collectively - should be considered.

Feedback is an essential part of evaluation. An immediate and relevant feedback promotes student autonomy and the self-regulation of their own learning processes, allowing the teacher to reflect and promote the adaptation of strategies and methodologies according to students’ needs.

In order to be fully effective, it should be detailed, carefully developed, orientating and as immediate as possible, to allow students to act upon it, promoting timely interventions in the teaching-learning process. The more descriptive it is, the more autonomy and self-regulation capacity it promotes. The guiding function, also known as feedforward, is associated to students’ suggested actions after receiving feedback. If feedback focuses
on current performance, feedforward focuses on the next task, offering constructive
guidance on how to improve future works. The combination of the two guarantees that
the evaluation has an effective impact on the learning process development.

The case study

The case reported in this article refers to the implementation of a learning scenario within
the Program of Initial Teacher Education in the area of Informatics at the University of
Lisbon. The students of this Program already hold a degree in Informatics or Computer
Science and are taking a Master’s degree which in Portugal is compulsory in order to
become a teacher in junior and high school. In the second year of the Master’s Program,
the student is immersed as a teacher in a real classroom where he/she must plan and
implement a set of classes for about 2 months. The topic to be taught and the period of
implementation, as well as the strategies and resources to be used, are negotiated with
the teacher responsible for the class in the cooperating school. The student-teacher
spends at least one month observing the class where teaching will take place and
profiling the group of pupils in order to adapt pedagogical options to the reality of the
class.

Daniel was a mature student aiming to complete his Master’s degree in Teaching
Informatics in the 2017/2018 school year. He was supervised by the authors of this article
as well as by a teacher of the department of informatics at the University.

In negotiation with the school’s regular teacher, the topic chosen to be taught was the
‘dynamic web pages’ module which is part of the Communication Networks course in a
secondary school near Lisbon. Daniel was rather critic regarding the aims and contents
of the course as it focuses mainly on the topics to be taught putting aside important skills
that, according to the report produced by Daniel, should not only be included, they should
guide all the activities, concepts and topics to be addressed.

The topic indicated in the syllabus was Basic concepts of Hypertext Preprocessor
Programming Language (PHP) and included Structure of Decision, Loops, Arrays and
Development of scripting languages. A set of common difficulties was identified by Daniel
in addition to the information provided by the teacher of the class.

It was decided to construct a learning scenario based on the idea of system of
recommendation. In the first session chaired by the student-teacher, the pupils put
forward several ideas and domains where they could apply the idea of system of
recommendation. Finally, they voted for the best idea to implement the system of recommendation: what smartphone should one buy. The implementation was done by pupils in groups of 2 or 3 each in two phases. Firstly, they created a web page including a form with the elements that constitute the predictive attributes of the recommendation system. Secondly, they represented the decision tree in an array structure and the dynamic generation of the remaining web page with the suggested recommendations and the target-attributes.

The student-teacher Daniel played a major role as adviser and reminder of the aims of the activity, helping them to conceptualize ways of implementing the ideas and the specific recommendations. In addition, as pupils were asked to present the final product at the end of the set of classes, the teacher coordinated this part of the implementation and acted as evaluator of the solution they developed.

The pupils were induced to take the responsibility for their own decisions regarding the development of the prototypes and were placed within a framework of Project-based learning. Pair programming (McDowell, Werner, Bullock, & Fernald, 2006) was selected as a form of organization of the work of the pupils while implementing the recommendation system.

The sessions took place at a computer room at the school that included 15 computers, projector and Wampserver64, Classflow and NotePad++,. Classflow was used mainly during the moments of explanation, allowing a quick participation of all the students in reply to the questions of the teacher and having immediate feedback. In order to allow for executing dynamic pages offline Wampserver64 was used, which contains a PHP interpreter and MySQL database server. NotePad++ was used for code edition and was already familiar to most pupils.

The learning scenario was implemented aiming to construct webpages with resource to a language of scripting server-side and client-side, to understand different methods and types of data, to determine the dynamic construction of the web page according to the several parameters and to understand the production of HTML in a dynamic webpage.

Assessment was planned in order to involve all the students in the process using a peer review structure. The results of the implementation show that pupils tend to be fair in their assessment of their colleagues, valuing different aspects of the products developed. On the side of the teacher, the assessment of the presentations by the groups took place following a matrix that included a number of criteria such as clarity, oral mastery, capacity of synthesis, concordance, reply to questions. Final grades varied between 14 and 17
(on a scale of 0 to 20) with an average grade of 16. In addition, the teacher provided very complete feedback assessing several dimensions of the product: coherence, utility, structure, innovation, functionalities, quality.

From the point of view of Activity Theory (see Figure 5, the student-teacher acted upon a learning situation constituted by the anticipated phenomenon: the student-teacher understands that he will address pupils in the classroom in order to teach them a set of concepts and processes. He reflects upon the forms of pedagogy that can be used with the pupils and uses as a key mediational tool the structure of the learning scenario idea. Included in the mediation artefacts we can also position the available technology, the ideas and suggestions of the supervisors, etc. – there are many artefacts (both physical and conceptual) present in the mediation process that takes place when a teacher is planning a class.

The transformed situation that the student-teacher aims to achieve is progression of pupils learning (in the specific scientific area of Informatics). This is the (dynamic) outcome of the activity and is also the student-teacher’s motivation. At the same time, the crucial mediation role of the syllabus is apparent in the way the student-teacher conceptualizes and defines the kind of pedagogical approach he would use – with relevant implications in the learning scenario design. Daniel and his supervisors decided to put forward a learning scenario where pupils would be immersed in a challenging project, explicitly addressing concepts and processes related to dynamic web pages and systems of recommendation. But the way Daniel designed the learning scenario also took into consideration (or was mediated by) what is currently legitimate and accepted in a public secondary school by its community of teachers, principal, pedagogical council, etc. Even if the school’s internal pedagogical rules are not totally mandatory, teachers tend to comply with the rules of practice (e.g. the teacher is expected to deliver the contents to the pupils).
The supervisors and the teacher responsible for the class act as mediators as referred above. However, it is their hierarchical power that frames the options that the student-teacher makes regarding the pedagogy and the teaching methods to be used in the classroom.

Daniel acted within the system of activity described above, but it should be underscored that, at the same time, he operates within an academic system: his activity is also mediated by the rules of the University and the Master’s program, while acting upon a phenomenon or situation characterized by the need to design, implement and assess a set of classes in a school (and guided by a clear motivation which is to obtain his Master’s degree in teaching Informatics). Participation in different, although connected, systems of activity is a point of entry for external contradictions that the subject faces and eventually resolves, and therefore learns. The contradictions emerge from the different visions and structures of the academic system of activity in face of the school’s academic system. Daniel operates in both systems of activity and it is clear that: the rules (e.g. norms for the production of a Master’s dissertation or final report to be submitted to a jury and discussed in a viva); the community (e.g. teachers and members of the academic staff, colleagues of the Master’s program); and hierarchic positionings, are points of entry to the emergence of contradictions. These explain the changes and
advances which produce learning. In the words of Engeström (2016) “Contradictions are not just inevitable features of activity. They are the principle of its self-movement and the form in which the development is cast. This means that new qualitative stages and forms of activity merge as solutions to the contradictions of the preceding stage or form” (p.223).

The expansive learning cycle in this case study was apparent during the first phase of the learning scenarios. Following the steps of questioning, analyzing and modeling, an imagined implementation took place (common among teachers while preparing their lessons) and ultimately, returning to the questioning step.

Daniel was able to make the several steps of the learning scenario design explicit and to identify and analyze the contradictions inherent to the model of teacher education that is in place at the university.

To conclude
From the point of view of Activity Theory, a learning scenario can be seen as a structure that acts as a mediation artefact used by the student-teacher while immersing in the school system of activity. A learning scenario has a role of orientation and support that proves useful in initial teacher education. The quality of the learning scenario is ultimately assessed against the quality of actions and operations that pupils display. On the level of operations, as most of them are automatic and unconscious, any learning scenario faces the challenge of change and innovation. But, as a learning activity is always object-oriented (regardless of the nature of the motives involved), it integrates social constitutive elements (e.g. pupils’ previous experiences) revealing itself as a systemic structure.

Within the elements of the activity system in which pupils are involved, there are multiple processes of mediation. In particular, pupils (both as individuals as well as a collective / class) acted upon their previous ideas and concepts, transforming them into ‘better’ ideas – i.e. ideas and concepts that are conceptually situated closer to what computer science accepts as legitimate.

To conclude, we underline the following key dimensions that are useful for a better understanding of learning in the activity carried out during the learning scenario implementation:
**Systemic structure**

The student-teacher designed a plan in the form of learning scenario, aiming to lead pupils to act upon previous concepts and processes within the school system of activity. The mediation role of the syllabus and norms of assessment were clear in the learning scenario designed. Looking at the activity through a systemic structure provided opportunities to understand the way the student-teacher planned and behave.

**Contextual Phenomenon**

Crucial to understanding pupils and student-teacher in the class activity was considering the socio-historical context in which the activity unfolds. The community (which includes mainly the pupils, but also teachers, parents, principal) mediated the plan’s design process by the student-teacher, shaping the way concepts and processes were addressed in the learning scenario. This was apparent in the moments of formal assessment, when the student-teacher presented his plan to the group of colleagues and teachers, but also during the classes, when the pairs of pupils developed their activity. There is an ecological dimension of learning within the learning scenario that should be valued.

**Dynamic character**

Learning as an expansive participative transformation assumes a dynamic character, through creative and expanding movements resulting from a conceptual reconstruction – both individually as well as collective. In the activity system where the student-teacher is situated, relationships between elements evolve, leading to changes in the system’s structure. Central to the movements and processes of expansive transformation (as source of human learning and development) is the notion of contradiction (Engeström, 1987). Internal and external contradictions constitute the driving forces of change in human activity, as learning is linked to the dynamic resolution of emerging contradictions in activity. Contradictions are not directly displayed, but appear as disturbances, disruptions, innovations and changes in activity systems. Within the scope of the activity implemented through the learning scenario it is possible to identify items that show potential to be seen as attractors of (external) contradictions, such as the source of decision while facing the need to solve an issue or problem. Even if pupils are encouraged to take responsibility and risk, there is a strong expectation that the teacher (on this case, the student-teacher) is supposed to ‘advise’ and reduce the probability of ‘error’.
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