Let me do it: towards the implementation of sustainable instructional patterns

***Abstract*—We present the design of an online environment that provides mechanisms for the exploitation of school ICT infrastructure by empowering teachers to discover and comment on educational activities (patterns, scenarios, experience reports) that can be implemented in their schools. To this end, our design approach will make explicit the linking between the patterns, the learning scenarios and other contextual information. The online environment will not only serve as a repository of educational activities but will help schools to analyze their infrastructure, to select proper scenarios that effectively exploit it and, potentially, to enrich these scenarios by commenting on them.**

Keywords- pattern; scenario; experience report; school ict infrastructure

I. INTRODUCTION

This paper discusses the approach of a collaboration project with schools and academic partners from three European countries called eSIT4SIP (Empowering the School IT infrastructures for the implementation of Sustainable Instructional Patterns, Erasmus+ project, Key Action 2: Cooperation for Innovation and Exchange of Good Practices, Strategic Partnerships in the field of Education and Training, School Education, 2015-2018).The eSIT4SIP project aims at better utilizing school ICT infrastructures through their analysis and subsequent mapping of their affordances with the educational context. Based on this mapping, schools should be in a position to analyze their infrastructure and decide on the possibility of the application of learning scenarios that effectively exploit the school ICT facilities and, potentially, to enrich the scenarios. The mappings will be anchored to design patterns [1], that, for the purposes of the eSIT4SIP project, will provide general solutions for recurring problems with respect to the relevant aspects of the school ICT infrastructure when implementing learning scenarios. Our design approach will make explicit the linking between the patterns, the learning scenarios and other relevant information. The project will also provide a platform to access these patterns online and extend them or make comments on them. In other words, this specific approach represents an extension of the classical design patterns [1] containing not only abstract descriptions of general solutions for recurring problems in the educational field, but also links to required ICT infrastructure. This includes possible variants of the scenario conforming to variations in the infrastructure.

The tools that we are developing in the eSIT4SIP project will allow teachers and other stakeholders to search for relevant teaching materials and inspiration at different levels of abstraction. The rationale of providing such distinct levels of abstraction, and the appropriate connections between them, is to facilitate the discovery of relevant information. Giving teachers the autonomy to search based on their own initial framing will not only help the searching but it might also foster new models of thinking about the topics that they are interested in. The question now becomes how to provide such search mechanisms and what scaffold is needed in order to truly facilitate the finding and adoption of learning practices. The constituent components of our approach are a) the description of educational activities, b) the Knowledge Base that captures and disseminates domain knowledge and c) the matching algorithm that maps patterns to school infrastructure.

II. DESCRIBING EDUCATIONAL ACTIVITIES

Pozzi & Earp [11] mention that a scenario is "a sequence of phases within which students have tasks to do and specific roles to play" (p. 281). It defines the activities performed by students and tutors, their sequencing, as well as, the learning objects and tools that are provided to the different actors. A scenario that integrates ICT involves the application of effective teaching strategies with the aim of achieving learning objectives through the use of an appropriate computerized environment [6].

Defining design patterns is challenging, since it is tempting to think of them as a catalogue of templates or metaphors [10]. Besides that, there are several challenges mentioned in the literature that revolve around their creation, their usage and their evaluation, including: lack in educational theory or epistemology [7], not being used by educators and too abstract as they describe problems in a very broad way [3], as well as, achieving a striking balance between abstraction and complexity [14], and fit-for-purpose granularity [10]. Regarding abstraction, "it is generally accepted that a pattern must be an abstraction based on at least three concrete cases" around essential practices in the domain of interest [4].

A number of projects have focused on the mining of best practices in learning design and teaching in terms of instructional design patterns. Examples of such projects are the Pedagogical Patterns Project [2], the Kaleidoscope Network of Excellence [12], the TELL (Towards Effective network supported collaborative learning activities, https://www.gsic.uva.es/proyectos.php?lang=en&pId_p=3) project, and the PCeL pattern repository [4]. Results from several initiatives on the collection of such patterns can be found in the recently published compendium [8]. The problem is that they typically lack a link to a description of the suggested ICT infrastructure. This makes it difficult for teachers to foresee which demands and changes to the infrastructure are required to implement them. Hence, our approach will produce guidance notes, scenarios and patterns for the effective use of the existing ICT infrastructure and equipment available in the educational institutions.

III. THE KNOWLEDGE BASE

The eSIT4SIP project will deliver a Knowledge Base (KB) that allows teachers to plan for the technical realization of learning scenarios within their premises. To this end, knowledge of the feasibility of the scenarios is needed. It is based on the knowledge of the ICT facilities of the schools, that is, the infrastructure required to achieve the functions described in each of the scenarios. The infrastructure descriptions are meant to be used in two processes:

- When a teacher plans a lesson, he or she selects existing scenarios or at least design patterns. This selection will be successful if the scenarios are realizable by the school's ICT infrastructure or if the teacher can adjust the scenario to only include feasible functions.
- When a media specialist or school principal plans the purchase of new ICT facilities, he or she will want to know the achievable patterns and scenarios so as to guide the choices.

For these processes to happen automatically, the eSIT4SIP project thus requires a description language for infrastructure that will allow to categorize and describe each school's infrastructure. Knowledge structures of facilities such as Common Information Model (CIM) [5] or the Internet's Network Markup Language [6] could be applicable. However, these encodings appear to be oriented to technical purposes such as the network services' management and not to represent a widespread standard yet.

The eSIT4SIP KB employs knowledge encoded in three distinct but interconnected ontologies:

- The "functions" ontology, which describes the functions described in the scenarios. The concept of function here is referring to the ability to perform a certain work provided by tools made available, where this work can be any process that manipulates information, such as creation, communication, information, calculation and so on.
- The "educational practices" ontology, which requires knowledge on scenarios, instructional patterns and experience reports. An instructional pattern can be applied to a learning scenario. After the scenario is implemented in real-world settings, it can be instantiated by an experience report which aims to capture the specificities of this particular implementation of the learning scenario. Experience reports are implementations of a scenario which can be adapted for reuse in accordance with individual needs (i.e. scenarios in action).
- The "school infrastructure configurations" ontology, which requires knowledge on the configuration of the school infrastructure. This, in turn, entails knowledge about the hardware, the software, the network, the services and the physical space.

The organization of the knowledge in the form of ontologies allows us to create a knowledge base system that is valid long term and that can be adjusted by the use of axioms or rules. A UML class diagram describing the knowledge structure is represented in Figure 1.

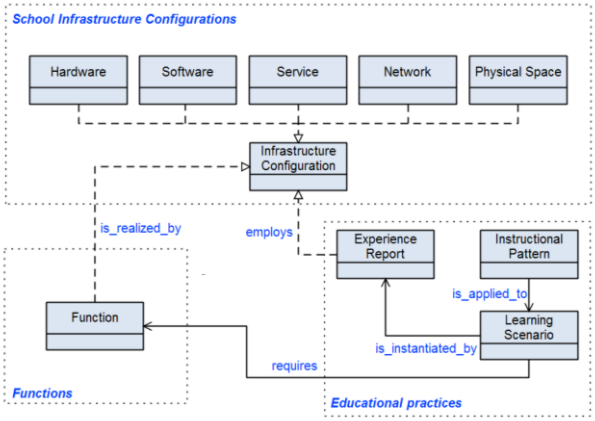

Figure 1. UML class diagram of the Knowledge Base model

IV. THE MATCHING ALGORITHM

A question that applies to our problem is about the appropriate level of abstraction for describing educational activities employing ICT if they are to be transferable to schools with different ICT infrastructure. Clearly, a high degree of abstraction fosters the adaption to different contexts. On the other hand, it hinders the transfer in cases where the similarity of objectives and context would allow for an easy transfer of the scenario. In our approach, we would like to support the use of different levels of abstractions by the application of design patterns and scenarios in combination with the linking to concrete infrastructure descriptions. In order to map patterns to school infrastructure we conceptualised an algorithm which is briefly described below:

- Step 1. From the scenario we extract a timeline of didactic sessions, each of which has some elementary ICT didactic requirements. 'Parallel' time lines express concurrent requirements. An example: session 1 involves a lecture which requires the equivalent of a video projector, then session 2, involves supervised groupwork which requires the equivalent of a workstation per group of students, plus a communication functionality for teacher supervision of the groupwork and finally, in session 3, student groups report their work to the whole class and that requires the equivalent of a common data repository plus a video projector.
- Step 2. This is the basic (sequential) checking step which aims to answer "Can I do that?" This basic checking step provides a "Yes/No" answer and in the case of a positive answer, alternative lists of computing resources which can be used for this; some resources may be needed exclusively, others are shareable, still others are consumed by usage.
- Step 3. This is the parallel use checking step. When a didactic session includes more than one sets of elementary ICT didactic requirements, to check whether they can be satisfied in parallel, we repeatedly apply Step 2, each time subtracting the

resources exclusively needed from the infrastructure available and doing the next step with the remaining infrastructure. Since Step 2 may result in several alternatives, the algorithm may have to backtrack

V. THE PROJECT APPROACH

The project involves 15 schools in Cyprus, Germany, and Sweden (five schools per country) with students aged 7 to 18, in collaboration with the experts of the academic partners involved. The project workers are visiting the schools so that, for each school, they: a) develop an appropriate infrastructure description, b) elicit practice descriptions in the form of experience reports, c) synthesize scenarios and instructional design patterns and, finally, d) combine them in the KB by classifying patterns, scenarios, and infrastructure descriptions based on the ontologies developed in the project. Supplementary to this input, the KB will contain selected patterns and scenarios from the literature and the repositories.

This system will be made available to teachers of the participating schools. In the first phase, selected teachers will be coached and observed in their use of the KB. Based on these trials, the planning workflow and the KB toolset will be refined in order to make them more effective to use, and the KB itself will be extended to cover more cases and resources.This refinement will be done interactively and collaboratively, including the integration of new experience reports, scenarios and patterns. The final trial round will involve teacher training, as is common in several countries, where any teacher will be guided and observed at the planning phase. This iterative process will enable the eSIT4SIP project to deliver a methodology to create, use and dynamically enrich the ensuing integrated knowledge-based system and the educational activities included.

VI. DISCUSSION

The technical feasibility of a learning scenario which indicates whether the school infrastructure is sufficient to implement the scenario is a crucial factor for its adoption by the teachers [9]. In addition, teachers need to be able to assess relevance of the scenario to their local context using their professional knowledge, and then identify possible variations of a scenario for its implementation with their own school infrastructure. Furthermore, the adaptability of a scenario to the local context contributes into creating sustainable scenarios. Few approaches aim at supporting the teachers' in assessing these values. Although the implementation of proposed approach is still a work-in-progress, it caters for these requirements. We believe that it will contribute to the increase of efficient technology enhanced learning practices in schools. After the completion of the project the KB along with the educational activities will be freely accessible online.

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