weSPOT: A cloud-based approach for personal and social inquiry

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***Abstract*—Scientific inquiry is at the core of the curricula of schools and universities across Europe. weSPOT is a new European initiative proposing a cloud-based approach for personal and social inquiry. weSPOT aims at enabling students to create their mashups out of cloud-based tools in order to perform scientific investigations. Students will also be able to share their inquiry accomplishments in social networks and receive feedback from the learning environment and their peers.**

Keywords-social learning, scientific inquiry, personal learning environment, cloud learning environment

I. Introduction

Seely-Brown and Adler [1] describe learning as "based on the premise that our understanding of content is socially constructed through conversations about that content and through grounded interactions, especially with others, around problems or actions". In addition, learning is facilitated and triggered by one's individual interaction with objects in an (real) environment, constructing meaning and testing 'hypothesized' constructs while facing and (re)acting upon unexpected phenomena or problems [2].

Nonetheless, students in secondary schools and universities assume mostly a passive role within the classroom, whilst the mentoring role is often exclusively held by the teacher. Students are seldom motivated to take initiatives within their learning and extend it outside school settings, motivated by their curiosity. In an Inquiry-Based Learning (IBL) approach learners take the role of an explorer and scientist as they try to solve issues they came across and that made them wonder, thus tapping into their personal feelings of curiosity. It supports the meaningful contextualization of scientific concepts by relating them to personal experiences. It leads to structured knowledge about a domain and to more skills and competences about how to carry out efficient and communicable research. Thus, learners learn to investigate, collaborate, be creative, use their personal characteristics and identity to have influence in different environments and at different levels (e.g. me, neighbourhood, society, world).

Learners can go through IBL workflow processes at various levels of autonomy and complexity, consequently with various degrees of support [3]. At the highest level, called 'Open Inquiry' they are only guided by self-reflection, reason and they make sense of phenomena individually or collaboratively, organize and orchestrate their (shared) activities and construct and disseminate knowledge. At the lowest level, they are completely guided by the teacher when defining a problem, choosing a suitable procedure (method) and finding a solution.

In addition, students are not sufficiently supported by technology for conducting their inquiries and investigations in their everyday environment and in a social and collaborative way. weSPOT will employ a learner-centric approach in secondary and higher education that will enable students to:

1. Personalize their inquiry-based learning environment.
2. Build, share and enact inquiry workflows individually and/or collaboratively with their peers.

Thus, weSPOT aims to lower the threshold for linking everyday life with science teaching in schools by technology.

From the European teachers' perspective, the project will enable teachers as well as students to adopt methodologies for inquiry based science learning based on experiments conducted outside schools in a real environment. Such experiments could be backed-up with computer simulations and 3D images and video, which will enable students to go deep to the science subjects. This in turn will enable new models of learning and teaching to emerge, bringing students close to the research, and creating new bridges to business usage of science results.

The remainder of this paper is structured as follows. We will first explain how we plan to support personal and social inquiry based learning processes. Than we elaborate on the role of technology and its merit to support these processes. We conclude with future steps that need to be taken in order to support IBL.

II. Personal and Social Inquiry in weSPOT

weSPOT will develop a reference model for inquiry skills as well as a diagnostic instrument to measure the individual performance on inquiry skills. The reference model and diagnostic instrument are based on the five inquiry skills areas described by the US National Research Council [4]:

- engaging by scientifically oriented questions
- giving priority to evidence in responding to questions
- formulating explanations from evidence
- connecting explanations to scientific knowledge
- communicating and justifying scientific explanations to others

The reference model will define the skills and competence levels in inquiry and these are translated in observable indicators in the diagnostic instrument.

Based on the reference model, inquiry workflows will be defined, which can be build, shared and (en)acted individually or collaboratively. The role of the teacher as well as the peers can vary when a learner follow these workflows, based on the level of support needed by the learner(s), the need to reflect and/or to provide feedback and the need to collaborate to acquire an inquiry competence. So, the instructional strategy will vary, dependent on the learner, the context and the targeted inquiry competence level. However, learners are in most cases stimulated to go through the whole inquiry process, although the level of complexity of the inquiry tasks guiding their activities will vary [5].

Inquiry workflows can be described by graphical representations, whose aim is to help users visualize and orchestrate their inquiry projects. They are key to personal as well as social inquiry based learning. Learners can link diverse steps of their investigation as well as represent their scientific reasoning by integrating graphically their questions, hypothesis, concepts, arguments and data. Inquiry workflows play an important role as visual strategy and mediating tools in scientific reasoning. As knowledge mapping strategy, they enable users to connect and make their conceptual and procedural knowledge explicit. As reflective aid, they provide visual guidance for users rethinking and reasoning through their graphical representations. As visual language, they support users to make their argumentation clear for generating a coherent document outline.

When learners have acquired a certain level of inquiry competence, they are awarded badges, which make their performance visual for others and which may be used in their personal profiles within social networks.

III. Inquiry-based Learning and Technology

Inquiry-based learning can occur with or without technology. But technology can play a special role in supporting inquiry-based learning and in transforming the learning process. To better understand the context in which technology can support inquiry-based learning, two important aspects should be considered: technology can be viewed as the subject or tool for instruction, and can transform and enhance traditional practice. This is how technology is seen within the context of the weSPOT project.

To answer the question however, "Will technology has significant effect on learning?" one needs to determine the models of teaching and learning that underlie the instruction in the classroom. Pedagogy is the key element in applying the use of technology effectively. Looking at the interaction between pedagogy and technology so far, one can conclude that traditional pedagogy has not improved much by the addition of technology. Good pedagogy, on the other hand, can be made significantly more effective by appropriate uses of technology.

weSPOT adopting this approach does not recommend a one-size-fits-all inquiry-based learning model, but it takes the pragmatic view that the optimal level of inquiry is actually variable and it might differs between individual learners or groups. It has to reflect key factors in the learning situation, including the content, context, skill of the student, knowledge of the teacher, and the materials available. Students when compared to scientists are novices in scientific inquiry. When their current knowledge of the topic is limited, the intellectual demands of fully open inquiry may not generate effective learning and may even hinder learning by adding intrinsic or extraneus cognitive load. weSPOT's model will provide teachers and learners support and the technology tools to work 'up the ladder' to reach competence, progress and become able to find the optimal inquiry level to match the needs at hand.

IV. Related Work

The Personal Learning Environment (PLE) and the Cloud Learning Environment (CLE) have shown evidence of facilitating learning and addressing the current limitations of Learning Management Systems (LMS). Compared to a typical LMS, like Moodle or Sakai, where the learner is restricted by the lack of adaptability and responsiveness of the learning environment, the PLE follows a learner-centric approach. It allows the use of lightweight services and tools that belong to and are controlled by individual learners. Rather than integrating different services into a centralised system, the PLE provides the learner with a variety of services and hands over control to her to select and use these services the way she deems fit [6-8].

The Cloud Learning Environment (CLE) extends the PLE by considering the cloud as a large autonomous system not owned by any educational organisation. In this system, the users of cloud-based services are academics or learners, who share the same privileges, including control, choice, and sharing of content on these services. This approach has the potential to enable and facilitate both formal and informal learning for the learner. It also promotes the openness, sharing and reusability of learning resources on the web [9, 10].

Self-Regulated Learning (SRL) comprises an essential aspect of the PLE and the CLE, as it enables learners to become "metacognitively, motivationally, and behaviourally active participants in their own learning process" [11]. SRL is enabled within the PLE and the CLE through the assembly of independent resources in a way that fulfils a specific learning goal. By following this paradigm, learners are empowered to regulate their own learning, thus greatly enhancing their learning outcomes [12, 13].

In weSPOT, we are planning to apply at new level our experience from previous research projects. For example, in the Innovative Didactics for Web-Based Learning - IDWBL [14] project web-based learning comprised five forms: web referral, web quest, web exploration, e-mail project and collaboration. In such a way students were put in a situation to explore new methods and techniques, guided by teachers. They shared their innovative approaches which peers and teachers and in such way they enriched the traditional work in class. The teachers reported an improvement of the thinking process of their students and an increase in their motivation for learning.

In order to apply inquiry-based science education, teachers need to develop new practical methodologies, approaches and tools in their day-to-day practice. To address this need, an useful experience was the I*Teach methodology [15], which is based on active learning methods, with the student at the centre of the learning process and the teacher as a guide and a partner in project work based on didactic scenarios encouraging the creative thinking of learners [16]. This methodology focuses on the development of specific skills in the context of the ICT education: work on a project, teamwork, presentation skills, and information skills. This methodology was integrated in the TENCompetence pilot project [17], Share.TEC pilot teachers' training [18], and in the training of 750 VET teachers in Innovative Methods and New Technologies. It was integrated in the textbook for Information technologies teaching, used actively in the training of teachers for IBSE in Fibonacci project (http://www.fibonacci-project.eu/). In 2009 the I*Teach project has been awarded for best products results.

Another useful idea can be borrowed from WebLabs**,** European project focused on the development of a Virtual Learning Environment (VLE) and WebLabs learning model [19]. The VLE allowed students, teachers and geographically dispersed researchers to be involved in science and math learning and explorations. Students developed an understanding of mathematics as a science through partnerships in research activities. Additionally, students shared their results and collaborated with peers, thus gaining specific social experience [14].

On the base of all our experience from these projects we formulated the prerequisites for the successful implementation of inquiry-based science education (IBSE) in schools [20]: change teachers attitude and provide stronger support to students (at micro level), provide schools management support, form teachers team to share experience and best practices and provide the needed ICT support (at mezzo level) and national curriculum reform, constant training for teachers and provide rich set of resources based on ICT infrastructure (at macro level).

V. Technology Facilitating Personal and Social Inquiry

As we have learned from the European project ROLE (Responsive Open Learning Environments - www.role-project.eu), what is often missing from the PLE and the CLE, is not the abundance of tools and services, but the means for binding them together in a meaningful way. weSPOT will address this issue by providing ways for the integration of data originating from different inquiry tools and services.

We plan to realize this with the use of standard integration technologies, such as OpenSocial, which has become one of the de-facto protocols for data exchange between social applications on the web. Linked Data methodologies will also be employed in order to represent and connect the semantics of inquiry workflows. Most importantly though, weSPOT will enable the cognitive integration of inquiry tools by connecting them with the student's profile, as well as her social and curricular context. Individual and collaborative student actions taking place within different inquiry tools will update the learning history and learning goals of the student, thus providing them and their tutors with a cohesive learning environment for monitoring their progress.

The Web 2.0 paradigm offers new opportunities for social learning by facilitating interactions with other learners and building a sense of connection that can foster trust and affirmation [21]. Social learning, according to Hagel, et al. [22], is dictated by recent shifts in education, which have altered the ways we catalyze learning and innovation. Key ingredients in this evolving landscape are the quality of interpersonal relationships, discourse, personal motivation, as well as tacit over explicit knowledge. Social media offer a variety of collaborative resources and facilities, which can complement and enrich the individual's personal learning space, as shown in Figure 1.

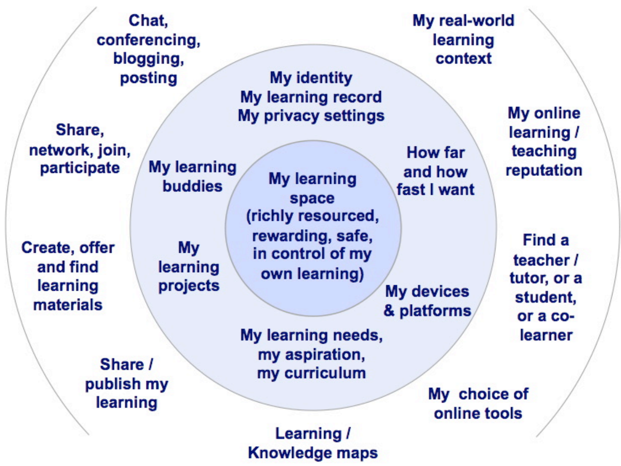

Figure 1. Personal learning space, resources, and social interactions [23]

weSPOT will provide students with the ability to build their own inquiry-based learning environment, enriched with social and collaborative features. Smart support tools will be offered for orchestrating inquiry workflows, including mobile apps, learning analytics support, and social collaboration on scientific inquiry. These offerings will allow students to filter inquiry resources and tools according to their own needs and preferences. Students will be able interact to with their peers in order to reflect on their inquiry workflows, receive and provide feedback, mentor each other, thus forming meaningful social connections that will help and motivate them in their learning. From a learner's perspective, this approach will offer them access to personalized bundles of inquiry resources augmented with social media, which they will be able to manage and control from within their personal learning space.

It should be noted though, that there is a significant distinction between the user-centric approach of the Web 2.0 paradigm and the learner-centric approach of weSPOT. This is because a social learning environment is not a just a fun place to hang out with friends, but predominantly a place where learning takes place and it does not take place by chance but because specific pedagogies and learning principles are integrated in the environment. Quite often, what students want is not necessarily what they need, since their grasp of the material and of themselves as learners, is incomplete [23].

In order to transform a Web 2.0 environment into a social learning environment, students need to be constantly challenged and taken out of their comfort zones. This raises the need of providing students with the affirmation and encouragement that will give them the confidence to proceed with their inquiries and investigations beyond their existing knowledge. weSPOT will address this issue through a gamification approach, by linking the inquiry activities and skills gained by learners with social media. In particular, this approach will define a badge system that will award virtual badges to students upon reaching certain milestones in their inquiry workflows. Students will then be able to display these badges in their preferred social networks. This approach will enhance the visibility and accrediting of personal inquiry efforts, as well as raise motivation, personal interest and curiosity on a mid-term effect.

Piloting the weSPOT inquiry tools with students and teachers in real-life scenarios in secondary education will be essential for collecting requirements and feedback from the end-users. The "Energy Efficient Buildings" pilot will concern the use of guided discussions to help students to identify disadvantages of the current building from the energy-efficiency point of view. Students will try to predict (providing evidence) future energy problems. Working in teams, they will develop reasonable ideas for future energy-efficient buildings. Teachers will be able to provide help by asking questions like:

- *What type of new materials for new energy efficient building components with reduced embodied energy to use?*
- *What technologies will ensure a high quality indoor environment, keeping in mind Ecology?*

In this way, students will learn better concepts and skills from the domain area, but will also learn new inquiry skills and competences.

VI. Mobile Support

Mobile technologies enable the integration of inquiry project support into everyday life situations of learners. To support their individual or collective inquiry projects, several mobile services are foreseen within weSPOT:

1. A **mobile personal inquiry manager** supporting a self-directed approach for creating and managing inquiry projects and (the representation of) acquired competences (in badges).
2. A **context-aware notification** system that enables the contextualized sharing and notification of real world experiences. Learners can link inquiry projects to certain locations, physical objects, or combinations of contextual factors, i.e. the weather at a certain location at a specific time of the year. Furthermore, notifications can trigger the collection of data dependent on several parameters (location, time, social context, environment). This enables learners to easily link objects and locations of daily life to inquiry projects.
3. A **mobile data collection system** supports the direct submission of sensor data and manual measurements into the workflow system, to collect data to test a hypothesis. It also supports submission of annotations and multimedia materials, to enable reflection, peer support and collaborative inquiries.
4. A **mobile inquiry coordination interface** supports inquiry coordinators by giving them access to on-going multi-user inquiries and the contributions of all participants. It allows central dispatching of messages and management of tasks and data. In case of formal settings, teachers may use this service to keep an overview and to provide feedback, in informal settings

learners may use it to coordinate their self-initiated collaborative inquiry efforts.

VII. Conclusion

The weSPOT project will investigate IBL in secondary and higher education, aiming at supporting students in their scientific investigations through a cloud-based approach for personal and social inquiry. The project will explore technological ways towards lowering the threshold for linking everyday life with science teaching and learning. The specific added value in lowering this threshold will be investigated through pilots in real-life learning settings within secondary and higher education.

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