Erasmus+

elite Enhancing learning in teaching via e-inquiries

An overview of the ELITe project "*Learning in teaching via e-inquiries*" approach for STEM teachers' professional learning

The "***Learning in Teaching via e-inquiries"*** approach for STEM teachers' professional learning ***steps on the principle that the teacher teaches in such a way in which he/she was taught.*** Inquiry-based learning (IBL) has been identified as a powerful innovative teaching approach, providing opportunities to develop the scientific literacy of all learners. In the same time, teachers meet difficulties to implement it in the classroom, due to missing experience in it, as, usually, the teachers' professional development courses are conducted in a traditional way via lectures. ***The main assumption of the ELITe project is that the implementation of the IBL methodology in teachers' competence development courses will provide them with real situation experience and know-how as well as with a reflection from 'students' point of view'***. Something more – the IBL has a very poor explored potential as ***an effective teacher training method, which can contribute for effective STEM teachers' competence development***.

Challenges and implicit requirements

The ELITe's approach is informed by current challenges and the aligned to them implicit requirements on STEM teachers' professional learning for competence development, outlined here below:

		Challenges	***Implicit requirements***
Perspectives	***Contextual***	Variation in terms of teacher competence requirements among and within EU countries	Place-based approach, taking into consideration national policy requirements and practice needs
	Methodological	Teachers' practice is influenced by the way they have received training themselves	Modernization of teacher training methodology
	Content related	Thematic that facilitates addressing STEM broader aims	Relevance of the thematic to STEM broader educational aims
	Outcome related	Need for more rigorous evidence of the impact of competence based frameworks on teachers' professional learning	Need for evidence-based framework for STEM teachers' competence development

Main elements of the approach

On the basis of the above-mentioned challenges and implicit requirements, the ELITe project's approach for STEM teachers' PL bears the following elements, which should be interpreted as assumptions underpinning our approach.

The ELITe project's "***Learning in Teaching via e-inquiries***" approach for STEM teachers' competence development:

- *adopts a **place-based approach** for STEM teachers' professional learning, taking into consideration national policy requirements and practice needs*

  According to EC (2013) report conclusions, *"teacher competence frameworks, when devised and implemented in ways that are relevant to each national context and consistent with other educational*

policies, can be powerful tools to improve educational quality" (p.43). In addition, "CPD provisions should respond to each teacher's specific needs", while among the key factors in the successful development and implementation of a competence approach to teaching is "the process of bringing stakeholders discussing these issues (…) especially if it leads to an increased sense of ownership of the results" (p.43).

- *propagates the **adoption of the inquiry-based learning (IBL) methodology in professional learning activities**, under the assumption that STEM teachers' training via IB methodology supports the development of teacher competences*

  Good practice increasingly views both teachers and students as lifelong learners: teachers should in the same time '*learn how to teach*' and '*teach how to learn'*. IBL has long been recognized in science learning as a successful and promising approach for achieving science education goals - see for example "Science Education: A renewed pedagogy for the Future in Europe" (EC, 2007). In recognizing the qualities of IBL as a means of promoting better engagement and motivation in STEM subjects and skills development, we also need to recognize its effectiveness in teachers' professional development. In this context, in order to support STEM teachers' professional learning, we advocate the need to apply to teachers the same principles of learning as they are expected to employ with their students. Our approach ("Learning in Teaching via e-inquiries") foresees teachers' learning activities taking place through an online platform embedded on an IBL model (developed in the frame of the weSPOT project) which support personal and collaborative inquiry learning

- *proposes as thematic for STEM teachers' professional learning **content areas that reflect current policy orientation on the broader aims of STEM education**, so as to facilitate teachers to model key competences required (knowledge, skills and attitudes) in order to help students acquire them*

  STEM teachers need to be supported to meet current STEM education challenges and aims. The new STEM education imperative is to ensure that – on the one hand - future citizens have a better understanding of science and technology (if they are to participate actively in informed decision-making and knowledge-based innovation), and – on the other hand – future researchers are equipped with the necessary knowledge and tools to fully participate in and take responsibility for the processes of research and innovation (European Commission, 2015). STEM teachers, therefore, need to strengthen their competences to meet the challenge of ensuring that all students are scientific literate, able to apply science knowledge to improve their own lives, deal with an increasingly complex technological world and making science-related decisions as responsible citizens (European Commission, 2015).

- *Is oriented towards facilitating the development of **an evidence-based framework** for teacher's competence development through IBL methodology*

  Teacher training activities under the "Learning in Teaching via e-inquiries" approach aim to provide evidence for the development of the main tangible outcome of the project, namely an evidence-based framework for STEM teachers' competence development via inquiry methodology - aiming to inform curriculum design for STEM secondary teachers' continuous professional development.

Theoretical framework

The ELITe's approach for STEM teachers' professional learning foresees teachers training activities taking place through the weSPOT inquiry based learning (IB) model.

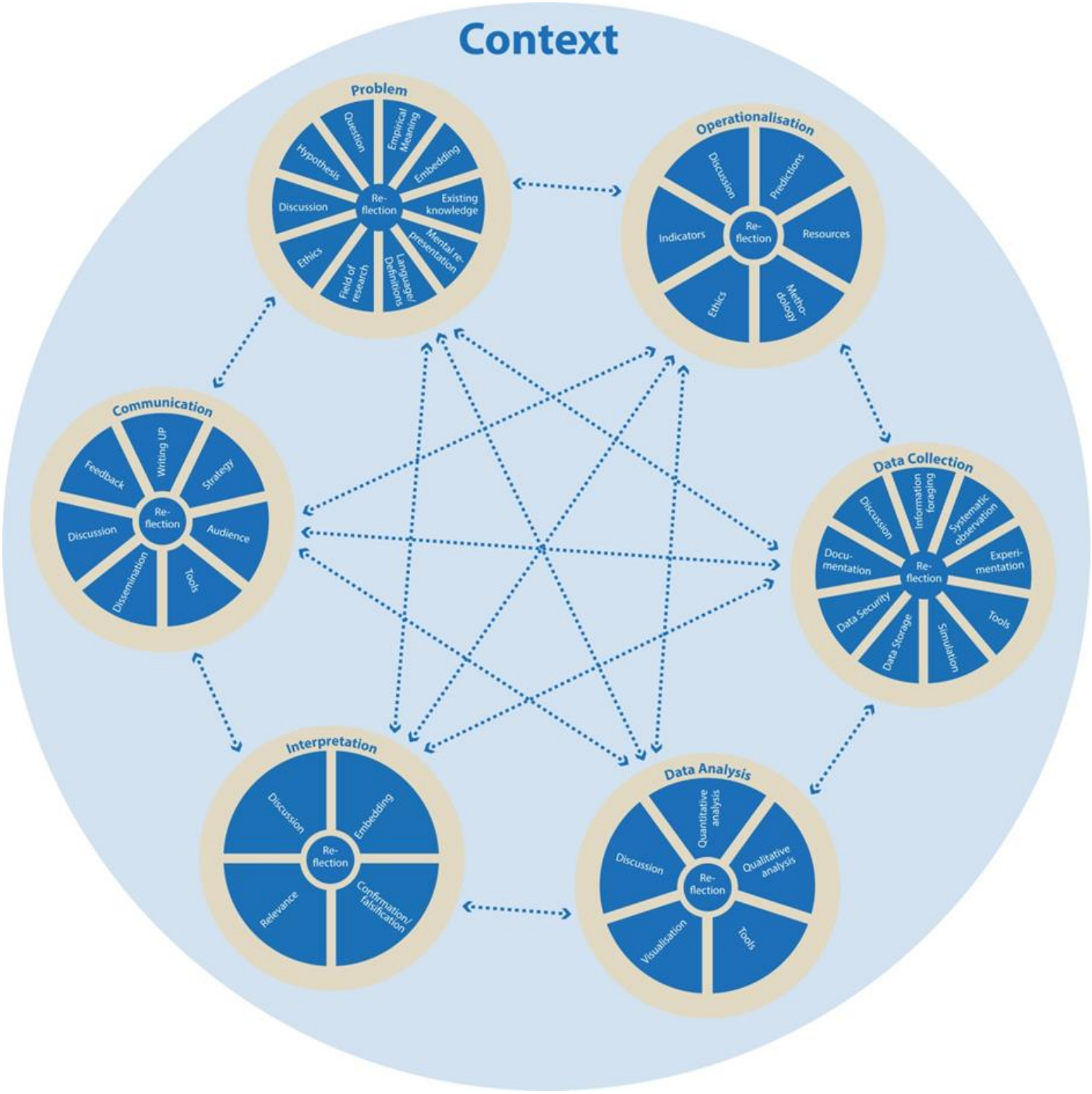
The weSPOT IB model on which the ELITe's training activities are based

The weSPOT model moves on from the simplistic cyclical models steps required for good research, steps described in scientific literature (Crawford & Stucki, 1990; Hunt & Colander, 2010) such as, data collection, data analysis, hypothesis forming, communication and dissemination of findings etc. and it is closely related to the inquiry model by Mulholland et al. (2012). It shares many of the phases that Mulholland et al. (2012) described in their model, such as create a

question or a hypothesis, collect data, analyse data, share finding etc., but it is more elaborate regarding the sub-phases providing a detailed description of things that teachers and students should consider when doing inquiry.

The weSPOT inquiry-based learning model presented in figure 1, consists of six phases, placed within the context, that mirror the phases that researchers need to go through in order to conduct their research, since inquiry is an integral feature of science. Each phase also consists of a number of activities ranging from six to eleven. Activities in each phase are outlined here below:

Figure 1: *The weSPOT IB model on which the ELITe professional learning activities are based on*



Problem/Topic: Embedding; Existing knowledge; Mental representation; Language/definitions; Field of research; Ethics; Empirical meaning ; Discussion/Argumentaion; Question; Hypothesis; Reflection

Operationalisation (realisation of idea with the aim to measure): Indicators; Predictions; Resources; Methodology (of data collection and processing); Ethics (Ethical issues); Discussion/Argumentaion; Reflection

Data collection: Information foraging; Systematic observation; Experimentation; Tools; Simulation; Data storage; Data security; Documentation; Discussion/Argumentaion; Reflection

Data Analysis (processing): Quantitative analysis (Statistical methods/analysis); Qualitative analysis; Tools; Visualisation; Discussion/Argumentaion; Reflection

Interpretation: Embedding (Embedding into existing theories/results/domain knowledge (classification)); Confirmation/falsification (of the initial question/hypothesis); Relevance (of the results); Discussion/Argumentation; Reflection

Communication: Strategy; Audience; Tools; Dissemination (Events/Presentation/Publication); Discussion/Argumentaion; Feedback (Receiving and reacting); Writing up; Reflection

All the IBL model phases are placed in the context where the different aspects of inquiry can take place.

The weSPOT inquiry-based learning model places reflection at the centre of each inquiry phase, see it as an integrated process throughout the inquiry activity and not as an independent phase that comes at the end of the process. The reason is that reflection is vital at every stage of the process even at the very beginning when the student needs to develop a question or a hypothesis. He/she needs to reflect upon the question, and evaluate it before they decide to proceed. The evaluation can either be individual or collaborative.

Additionally, there is bidirectional communication between the different inquiry phases, meaning that students and teachers can move from one phase to the next depending on their needs and their focus without needing to complete a phase. A more detailed description of the model can be found on the report: Deliverable D2.3.1: Pedagogical and Diagnostic Framework (available in: http://wespot.net/).

IBL skills & competences practiced through weSPOT IBL learning activities

Skill is seen as a goal oriented and well organised behaviour which is developed through practice and gradually becomes automated. Skill is a much narrower term compared to competence and focuses on the ability to use the knowledge to accomplish a task. **Competence** on the other hand is defined as a set of observable performance dimensions, including individual knowledge, skills, attitudes, and behaviours, as well as collective team, process, and organizational capabilities, that are linked to high performance.

Skills related to the IB learning activities as identified in the WeSPOT project -and adopted by the ELITe project - are the following:

- Analytical skills to research a topic, develop a project plan and timeline, and draw conclusions from research results.
- Science skills to break down a complex scientific system into smaller parts, recognize cause and effect relationships, and defend opinions using facts.
- Comprehension, read and understand scientific and technical materials.
- Experimentation skills to know the different methodologies and processes required.
- Mathematic skills for calculations and measurements.
- Attention to detail to follow a standard blueprint, record data accurately, or write instructions.

- Technical skills to troubleshoot the source of a problem, repair a machine or debug an operating system, and computer capabilities to stay current on appropriate software and equipment.
- Presentation skills
- Cooperation skills to listen to others needs or interact with project partners.
- Creative skills/abilities to solve problems and develop new ideas.
- Leadership skills to be able to lead a team.
- Organization skills to keep track of lots of different information.
- Metacognitive skills

Competencies related to the IB learning activities as identified in the WeSPOT project -and adopted by the ELITe project - are the following:

Research competence: To have research competence one should be able to apply a variety of analytical skills, mathematical and technical skills, experimentation skills and knowledge, sometimes to apply creative skills to obtain a solution, presentation skills, collaboration and communication skills especially if working within a team and so on.

Problem solving: Problem solving is a competence that requires several skills, knowledge and behaviours to be performed well. For example, to solve problems effectively one must have the skill to define the problem, have knowledge of all possible solutions, and exhibit behaviour that enables him or her to make a decision. Problem solving competence can be applied to technical as well to non-technical tasks/areas.

Communication: Communication is really a competency that relies on a combination of certain skills, behaviour and knowledge. To communicate effectively, for example, a person may need to understand cultural diversity, have advanced language skills, behave with patience have technical skills regarding different presentation media etc.

Critical thinking: Critical thinking includes a wide range of cognitive skills and intellectual dispositions needed to interpret, analyse, and evaluate arguments, problems and systems, and then to synthesize, evaluate, and explain an appropriate response. This response may be innovative and go beyond standard conventions.

For more information on how the ELITe project approach for STEM teachers' professional learning has been applied for building scenarios that demonstrate and exemplify the approach, read the document "IO4: Sample digital scenarios for STEM teachers' competence development via inquiry methodology"(http://www.learning-in-teaching.eu/index.php/en/intellectual-outputs/io4).

The ELITe consortium

IACM FORTH Educational Research & Evaluation

Open University Netherland

FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

SOFIISKI UNIVERSITET SVETI KLIMENT OHRIDSKI

UNIVERSITAT DE BARCELONA

EPA EUROPEAN PARENTS' ASSOCIATION

learn EUROPEAN DIGITAL LEARNING NETWORK