SUPPORTING STEM TEACHERS INQUIRY AND REFLECTIVE PRACTICE

The ELITe project's framework for STEM teachers' competence development under an inquiry approach

Briefing Document

learning-in-teaching.eu

ELITe is concerned with supporting Science, Technology, Engineering and Mathematics (STEM) teachers' development of knowledge, skills and attitudes so that they can effectively address their roles as lifelong learners, facilitators of students' learning and members of educational communities. It aims, on the one hand, to highlight the links between inquiry skills practicing and STEM teachers' competence development, and, on the other, to inform curriculum development in STEM teachers' education.

Project: Enhancing Learning in Teaching via e-inquiries (ELITe)

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Extended document available in:

http://learning-in-teaching.eu/index.php/en/intellectual-outputs/io9

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Challenges and Implicit Requirements on STEM teachers' professional learning

The starting point for the development of the ELITe project framework was the identification of current challenges and implicit requirements on STEM teachers' professional learning (PL) for competence development:

Perspectives	*Challenges*	*Implicit requirements*
Contextual	Teacher competence requirements among and within EU countries	Place-based approach, consistent with national policy requirements and practice needs
Methodo-logical	Teachers' practice depends on the way it is developed by trainings	Modernization of teacher training methodology
Content related	Thematic addressing STEM broader aims	Relevance of the thematic to STEM broader educational aims
Outcome related	Evidence of the impact of competence based frameworks on teachers pro-fessional learning	Need for definition of indicators for STEM teachers competence development

The ELITe project approach for 21st century STEM teachers' professional development

The ELITe approach for STEM professional development calls for ***a reconsideration of professional learning provisions under the perspectives*** of:

1. ***Adopting place-based approaches***, taking into consideration national policy requirements and practice needs;

2. ***Utilizing the potential of the Inquiry Based Learning (IBL) methodology***, as a means for inquiry and reflective skills practicing and teachers' competence development.

3. ***Modernizing the thematic of STEM teachers learning provisions***, addressing content areas that reflect current policy orientations on the broader aims of STEM education and teachers' practice needs;

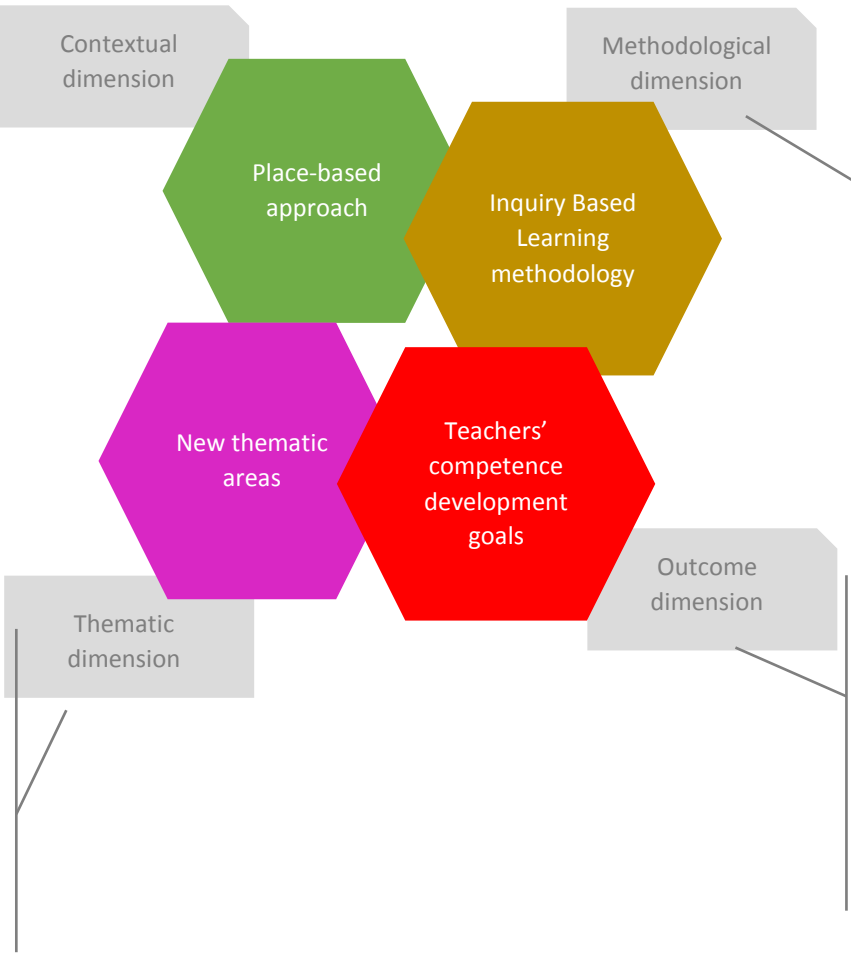
4. ***Targeting towards continuous development and assessment of STEM teachers' competences***, needed for their challenging roles as learners, teachers and menders of educational communities;

The process of developing the ELITe framework for STEM teachers' competence development under an inquiry approach

Stage of development	Stage 1 >>	Stage 2 >>	Stage 3 >>	Stage 4
Scope	To identify the space of intervention in four national EU contexts (namely Greece, the Netherlands, Bulgaria and Spain) for supporting STEM teachers' professional learning for competence development	To define outcome indicators and sub-indicators for evaluating the impact of professional learning activities targeting competence development	To develop the ELITe project "learning –in – teaching via e-inquiries approach" though the Inquiry Based Learning methodology	To evaluate the effects of the ELITe approach through pilot implementation on STEM teachers' competence development and provide evidence on the links between inquiry skills practicing and competence development
Methods	→Documentary analysis of policy documents, STEM teachers training curricula, STEM students' curricula under the EC (2013) competence framework for the national contexts of GR, NL, BG, ES →Negotiation and validation of documentary analysis outcomes with more than 120 educational stakeholders in one day EAEW workshops in GE, NL, BG and ES →Consolidation of results for identifying critical issues for STEM teacher's competence development and articulating recommendations for improving policies	→ Definition of expected outcomes of STEM PL activities, on the basis of Deakin & Crick (2008) →Identification of outcomes indicators and sub-indicators, by clustering and translating the aspects of competences defined in EC (2013) framework into indicators and sub-indicators for evaluating the expected outcomes-linking with national requirements →Operationalizing the indicators through the development of a self-evaluation tool for STEM teachers competence development	→ Adaptation of the weSPOT model for Inquiry Based Learning for STEM professional learning activities →Identification of thematic areas for STEM professional learning through large scale international studies review and negotiation with educational stakeholders → Developing sample scenarios for STEM teachers professional learning under the identified thematic areas →Structuring the scenarios in the Dojo-IBL digital platform for on-line implementation	→Implementation with more than 280 STEM teachers from GR, NL, BG, ES of the sample scenarios developed at stage 3 → Analysis of data in terms of the effects of the approach on STEM teachers' competence development → Analysis of data in terms of the links between inquiry skills practicing and teachers competence development
Outcomes	✓ Comparative insights on national requirements for STEM teachers competence development in 4 EU countries ✓ Critical factors & Recommendations for improving national policies	✓ Outcome indicators and sub-indicators for evaluating the impact of PL initiatives in STEM teachers' competence development ✓ Process indicators for inquiry skills practicing ✓ Self-evaluation tool for STEM teachers' inquiry and reflective practice	✓ The ELITe project "learning –in – teaching via e-inquiries approach" ✓ Thematic areas for modernizing STEM PL provisions ✓ 26 sample digital scenarios for STEM PL under IBL methodology	✓ Effects of the approach on STEM teachers' competence development ✓ Links between inquiry skills development and STEM teachers competence development

The ELITe project framework for STEM professional development under an inquiry and reflective approach: Overview of dimensions & components

- ✓ National requirements for STEM teachers' competence development in 4 EU countries
- ✓ Critical factors that affect STEM teachers' professional learning for competence development
- ✓ Recommendations for improving national policies for STEM teachers' competence development



- ✓ Professional learning methodology under an inquiry approach
- ✓ Process indicators for inquiry skills development
- ✓ Links between inquiry skills development and STEM teachers competence development

- ✓ Thematic areas relating to current challenges for STEM professional teaching and learning
- ✓ Sample digital scenarios under the IBL methodology for STEM PL activities

- ✓ Context-based outcome indicators and sub-indicators for evaluating the impact of PL initiatives in STEM teachers' competence development
- ✓ Self-evaluation tool for STEM teachers' inquiry and reflective practice

CONTEXTUAL DIMESNION Components

Knowledge & Understanding

	Aspects of **knowledge & understanding** required in the national contexts of:							
	Greece		Netherlands		Bulgaria		Spain	
	Explicitly	Implicitly	Explicitly	Implicitly	Explicitly	Implicitly	Explicitly	Implicitly
Subject matter knowledge		✓	✓		✓		✓	
Pedagogical content knowledge		✓	✓		✓			✓
Pedagogical knowledge	✓	✓	✓		✓		✓	
Curricular knowledge	✓		✓		✓		✓	
Educational science foundations	✓		✓		✓		✓	
Contextual, institutional, organizational aspects of educational policies	✓		✓		✓		✓	
Issues of inclusion and diversity	✓	✓	✓	✓	✓		✓	✓
Effective use of technologies in learning	✓	✓	✓	✓	✓	✓	✓	✓
Developmental psychology	✓	✓	✓		✓		✓	✓
Group processes and dynamics, learning theories, motivational issues	✓	✓	✓	✓	✓		✓	
Evaluation and assessment		✓	✓		✓		✓	

CONTEXTUAL DIMESNION Components

Skills

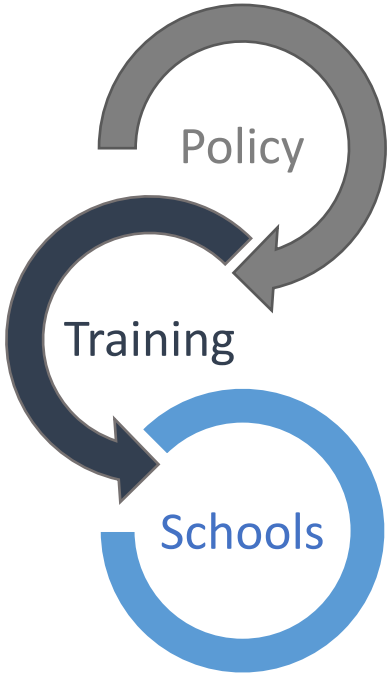
	Aspects of skills required in the national contexts of:							
	Greece		Netherlands		Bulgaria		Spain	
	Explicitly	Implicitly	Explicitly	Implicitly	Explicitly	Implicitly	Explicitly	Implicitly
Planning, managing and coordinating teaching	✓	✓	✓	✓	✓	✓	✓	
Using teaching materials and technologies	✓	✓	✓	✓	✓	✓	✓	
Managing students and groups		✓	✓	✓	✓	✓	✓	
Monitoring adapting and assessing teaching/learning objectives and processes	✓		✓	✓	✓		✓	
Collecting, analyzing, interpreting evidence and data for professional decisions		✓	✓	✓	✓			✓
Using, developing and creating research knowledge to inform practices	✓		✓	✓	✓		✓	✓
Collaborating with colleagues, parents and social services			✓		✓			
Negotiation skills (social and political interactions with multiple educational stakeholders, actors and contexts)								
Reflective, metacognitive, interpersonal skills for learning individually and in professional communities	✓			✓	✓		✓	
Adapting to educational contexts				✓	✓		✓	

CONTEXTUAL DIMESNION Components

Dispositions & Attitudes

	Aspects of **dispositions & attitudes** required in the national contexts of:							
	Greece		Netherlands		Bulgaria		Spain	
	Explicitly	Implicitly	Explicitly	Implicitly	Explicitly	Implicitly	Explicitly	Implicitly
Epistemological awareness	✓				✓	✓	✓	
Teaching skills through content		✓	✓		✓		✓	
Transferable skills				✓	✓			
Dispositions to change, flexibility, ongoing learning and professional improvement, including study and research	✓			✓	✓		✓	
Commitment to promoting the learning of all students	✓	✓	✓		✓		✓	
Dispositions to promote students democratic attitudes and practices as European citizens	✓	✓	✓	✓	✓			✓
Critical attitudes to one's own teaching	✓		✓	✓	✓		✓	
Dispositions to team working , collaboration and networking	✓		✓	✓	✓			✓
Sense of self-efficacy								

CONTEXTUAL DIMESNION Components



- ***At macro level (policy),*** major aspect of teacher competences (knowledge & understanding, skills, dispositions & attitudes) as defined in EC (2013) framework are emphasised in all national contexts of GR, NL, BG and ES.
- ***At meso level (mediating mechanisms),*** disparities are evident among the countries: In the Netherlands, the regulatory framework has been long been in place and has been adopted and implemented by teacher education institutes; in Spain, there is a lack of consensus on the acceptance of the new policies among regions, local authorities and educational councils and as such implementation is being challenged; in Greece and Bulgaria, on the other hand, currently there is uncertainty on how providers of teacher education and training will respond to and implement the new regulatory framework.
- ***At micro-level (teaching practice),*** in all national contexts, a high level of coherence is evident between teacher competences required/envisions by policy and the skills that students are aimed to develop via STEM studies.

- The above indicate that ***in the national contexts of Greece, Bulgaria and Spain the main challenge identified in respect of STEM teachers' competence development lays on the grounds of policy mediation,*** i.e. on how teacher education institutions and providers implement policy envisions and requirements.
- *In* ***the Dutch context***, on the other hand, given that the regulatory framework for teachers' competence development has long been established and implemented by mediating mechanisms, ***the main issue identified for further exploration and discussion is on the impact of teacher learning for competence development on the school practice***

CONTEXTUAL DIMESNION Components

Recommendations to policy for improving STEM professional learning provisions for STEM teachers' competence development

Greece

- ✓ **Enhancement of communication** of policy priorities, towards facilitating policy implementation and policy ownership from teacher trainers and practitioners
- ✓ **Promotion of partnerships** among STEM teachers' education providers that can foster networking, practice-sharing and programmes co-development for supporting teachers' capacity building
- ✓ **Develop a 'partnership approach'** under the 'learning communities' paradigm for professional learning within schools in which parents, informal science providers and community stakeholders become real partners in school life
- ✓ **Ensuring that continuous professional development and learning becomes a requirement** and a right for all teachers throughout their teaching career
- ✓ **Modernizing STEM teacher training provisions** from content and methodology perspectives

Netherlands

✓ ***Policy level: Alignment with the national framework is both relevant and necessary***

-All learning activities need to be part of the national professional learning requirements (lerarenregister) to realize this alignment

✓ ***School level: School management should be responsible for facilitating learning, allocating time for it and creating pre-requisites***

-School boards are partner in the organization of learning activities and are responsible for facilitation learning at the workplace

✓ ***Practice level: Introduction of new technologies and approaches should be part of both learning and teaching practice. Support is needed in both***

-Learning events should be linked to teaching practice or be easily transferrable to it

-Teachers are owners of their designs that they can develop in the learning situation and try out in their own practice.

-Exchanges with other teacher on their hands-on experiences is a valuable part of learning for teaching.

Bulgaria

- ✓ ***Building teacher competences by the teacher trainings***: STEM learning content should be provided to spread widely the approach

-Policymakers at national, regional and local level need to organize work together of traditional training providers (holding the methodology knowledge) and new one (holding concrete practical skills)

-Policymakers and all levels need to create conditions IBL approach to be embraces by new teacher trainings providers (business, publishing houses, etc.) and teaching materials to be relevant to them

-Content providers need to respond to the new requirements of schools and teachers with new curricula and updated learning content interweaving the approach into it, and to be flexible for permanently changing requirements.

- ✓ ***Focus on schools management strategy, curricula and teaching approaches:*** Building stable relationships between different disciplines teachers and environment for common work, design and delivery of interdisciplinary projects, and effective application of ICTs in STEM education.

-School authorities need to manage autonomy and freedom for decisions, and respectively – more responsibilities, so to use it to develop environment and space for application of the IBL

-School managers need to support relationships with different institutions – museums scientific labs, observatories, high-tech centers, etc.

-School managers need to support relationships between STEM teachers and interweaving of different disciplines during STEM education.

- ✓ ***Teacher competence are needed to design IBL activities in the class implementing inclusive education for students with special educational needs.*** Teachers need support for IBL day-to-day application.

-Teachers need to build competences to design the education in IBL manner, to develop IBL scenarios and introduce them into day-to-day practice.

-Teachers needs support to design IBL activities. Teachers need to be supported to deliver, manage and assess students' achievements during the IBL approach implementation.

-Teachers need to be supported to include students with special educational needs in fully valuable STEM learning process.

CONTEXTUAL DIMESNION Components

Spain

At policy level

-The administration should work together with other institutions for providing realistic STEM teachers training paths, including online delivery.

-Researchers in the area of STEM should participate in the institutional plans, providing advice on contents and methodology, as well as on impact evaluation of the STEM programmes.

-As with respect to plans for introducing STEM innovation the educational policymakers, need to coordinate with all key players, as e.g. universities (as providers of both pre-service and in-service), science centres, publishing houses, other local training institutions, practitioners, etc.

At policy mediation level

-The teachers' timetable should be organized taking account the time and the space necessary in order for those of different disciplines (but with the same students) being able to work together in organising IBL activities.

-It would be very important that school managers support the introduction of the IBL methodology in the study program, adjusting and/or adapting the learning objectives to the stages needed to implement STEM this way (considering the flexibility of the local curricula).

-School authorities should promote the communication between teachers and parents on the potential and the benefits of the IBL methodologies for STEM education.

-Teachers need more opportunities for in-service training. Give the timetable limitations, online teacher training (or a combination of online and face-to-face) is a good approach in many cases.

At practice level

-Teacher's need more support to design and implement IBL activities in the class. Teachers need to master IBL methodology, so they can feel confident to implement IBL activities in their class.

-For beginner teachers, a database of best resources and learning units can facilitate the STEM take up, and the design and the implementation of IBL activities. These resource should be innovative, combining traditional content and STEM current themes been able to raise the interest of students.

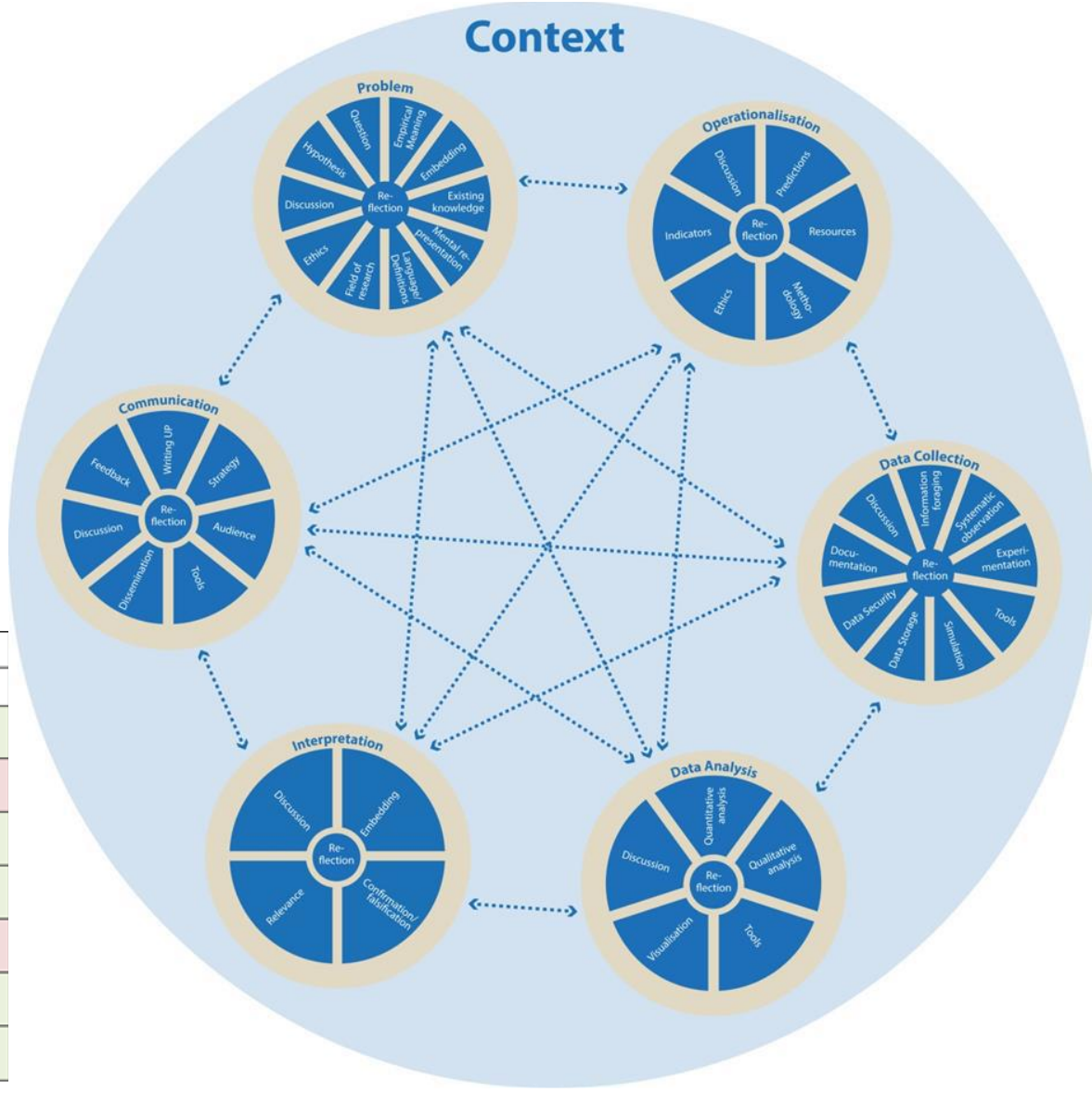
-Teachers require seeing STEM in a more integrated way, then going beyond the traditional subjects and combining contents through project-based learning. This requires many time the understanding of parents, reducing their anxiety in front of innovation learning results

METHODOLOGICAL DIMESNION Components

The ELITe ***Learning in Teaching via e-inquiries*** teacher competence development approach builds on the weSPOT IBL cyclic model, designed especially for successful inquiry-based learning supported by free ICT tools.

The weSPOT model 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. The model creates an environment for practicing inquiry skills & competences.

The weSPOT IBL model on which the ELITe professional learning activities are based on



Cause and effect relationship between IBL activities and inquiry skills practicing

Believed practices skills in the course	Contributed activities in the course				
	questioning	planning the method	review and analyze data	hand-on activity	communication
critical thinking	✓	×	×	✓	✓
information literacy	×	×	×	✓	×
analytical skills	×	×	✓	×	✓
communication skills	×	×	×	✓	✓
digital skills	×	×	✓	✓	×
metacognitive and reflection skills	×	×	✓	×	✓
other research skills	×	✓	✓	×	✓

Process indicators for inquiry skills practicing/development

Process indicators for inquiry skills practicing

Inquiry skill/competence	IBL phase	Process indicators (Indicating whether an IB skill /competence has been practiced by learners when performing IB activities)
Critical thinking (argumentation skills, comprehension skills, evaluation skills and inferring)	Questioning	➢ Providing a wonder moment ➢ Developing a concept map ➢ Concept defining ➢ Describing what we still need to know ➢ Understanding different kinds of scientific questions and examining and evaluating this aspect of the learning experience thinking (evaluation)
	Hands-on-activity	➢ Interpreting findings in light of previous knowledge ➢ Judging evidence and counterevidence ➢ Checking the interpretation (process) and coming up with alternatives, and examining and evaluating this aspect of the learning experience
	Communication	➢ Discussing the findings in a critical manner (implications, limitations, lessons learned) ➢ Checking the method of communication and coming up with alternative approaches, and examining and evaluating this aspect of the learning experience
Information literacy (existing knowledge and learning)	Hands-on-activity	➢ Interpreting findings in light of previous knowledge ➢ Judging evidence and counterevidence ➢ Checking the interpretation (process) and coming up with alternatives, and examining and evaluating this aspect of the learning experience
	Communication	➢ Discussing the findings in a critical manner (implications, limitations, lessons learned) ➢ Checking the method of communication and coming up with alternative approaches, and examining and evaluating this aspect of the learning experience
Analytical skills (classification, quantitative & qualitative analysis and statistical skills)	Review and analyze data	➢ Make sure that data are relevant to the problem ➢ Clustering data ➢ Checking the analyses and coming up with alternatives, and examining and evaluating this aspect of the learning experience
	Communication	➢ Discussing the findings in a critical manner (implications, limitations, lessons learned) ➢ Checking the method of communication and coming up with alternative approaches, and examining and evaluating this aspect of the learning experience
	Hands-on-activity	➢ Interpreting findings in light of previous knowledge ➢ Judging evidence and counterevidence

METHODOLOGICAL DIMESNION Components

Communication skills (presentation, language, writing skills)	Communication	➢ Checking the interpretation (process) and coming up with alternatives, and examining and evaluating this aspect of the learning experience ➢ Discussing the findings in a critical manner (implications, limitations, lessons learned) ➢ Checking the method of communication and coming up with alternative approaches, and examining and evaluating this aspect of the learning experience
Digital skills	Review and analyze data	➢ Make sure that data are relevant to the problem ➢ Clustering data ➢ Checking the analyses and coming up with alternatives, and examining and evaluating this aspect of the learning experience
	Hands-on-activity	➢ Interpreting findings in light of previous knowledge ➢ Judging evidence and counterevidence ➢ Checking the interpretation (process) and coming up with alternatives, and examining and evaluating this aspect of the learning experience
Metacognitive and Reflection skills	Review and analyze data	➢ Make sure that data are relevant to the problem ➢ Clustering data ➢ Checking the analyses and coming up with alternatives, and examining and evaluating this aspect of the learning experience
	Communication	➢ Discussing the findings in a critical manner (implications, limitations, lessons learned) ➢ Checking the method of communication and coming up with alternative approaches, and examining and evaluating this aspect of the learning experience
Other research skill (experimentation, observation, organisation and planning skills)	Planning the method	➢ Coming up with resources and ways how to measure/ instruments (qualitative and quantitative) ➢ Coming up with indicators for concepts that can be measured to develop or test ideas [and relationships among them] ➢ Formulating hypotheses and coming up with alternative hypotheses ➢ Setting up experiments to test hypotheses or set up other inquiry procedure ➢ Showing ethical concern within research setup ➢ Discussing the phase in a critical manner (e.g. implications, limitations of approach, lessons for future studies) by providing arguments
	Review and analyze data	➢ Make sure that data are relevant to the problem ➢ Clustering data ➢ Checking the analyses and coming up with alternatives, and examining and evaluating this aspect of the learning experience
	Communication	➢ Discussing the findings in a critical manner (implications, limitations, lessons learned) ➢ Checking the method of communication and coming up with alternative approaches, and examining and evaluating this aspect of the learning experience

Effects of IBL methodology on STEM teachers' competence development

STEM teachers roles	Teachers' competences developed: Knowledge & Understanding	Skills	Dispositions & Attitudes
Lifelong learners	-Pedagogical content knowledge -Curricular knowledge	-Use, Develop and create research knowledge to inform practices -Reflective and metacognitive skills	-Flexibility ongoing learning -Critical attitudes on own learning
Facilitators of students learning	-Pedagogical knowledge -Innovative STEM methodologies -Evaluation and assessment -New technologies	-Plan, manage coordinate teaching -Use teaching materials and technologies -Manage students and groups -Monitor, adapt and assess teaching objectives -Collect analyze and interpret data	-Teaching skills through content -Transferable skills
Members of educational communities	-Contextual, institutional & organizational aspects of educational policies	-Collaboration skills -Negotiation skills	-Positive dispositions to team working collaboration and networking

Thematic areas proposed by ELITe for STEM CPD and relevancy to the national contexts of GR, NL, BG and ES

Thematic areas for STEM CPD	Relevancy to the national contexts			
	GR	NL	BG	ES
Dealing with inclusion and diversity	O		O	O
Teaching STEM for skill development	O	O		O
Incorporating RRI in STEM education	O			O
Innovative STEM methodologies	O	O	O	O
Opening up school science	O	O	O	O
Assessment challenges in STEM	O	O	O	
ICT enhanced STEM learning and teaching	O	O	O	O
Confronting challenges of new curricula			O	
Enhancing teachers-parents collaboration	O	O	O	O

SCENARIOS on Innovative STEM methodologies

- Design and delivery of an interdisciplinary STEM project (GR)
- Self-directed learning for professionals in Education (NL)
- Computational thinking in STEM classrooms and beyond (NL)
- Detectives in the classroom IBL approach in STEM discipline -how to design, deliver, conduct and evaluate IBL education in STEM (BG)
- Overcoming key difficulties of Inquiry Based Learning for STEM teachers (ES)

SCENARIOS on Dealing with inclusion and diversity

- Reflective practice for tackling inclusion and diversity issues in STEM classrooms (GR)
- Neither sees nor hears, but succeeds /researchers with SEN in school/ Creating a learning design for successful learning through Inquiry based learning approach of pupils with SEN (BG)
- Dealing with diversity in education: gender differences, learning styles, personalisation,etc. (ES)

SCENARIOS on Teaching STEM for skills development

- Promoting students' achievement in STEM: Changing perspectives from knowledge acquisition to skills development (GR)
- Learning to design Inquiry-based learning with DojoIBL: an exploration (NL)
- Design of good IBL activities based on DojoIBL for teaching and learning (ES)

SCENARIOS on RRI in STEM education

- Dealing with controversial socio-scientific issues in contemporary science (GR)
- Strategies for introducing socio-scientific issues in the classroom: dilemmas, controversies, conversations (ES)

THEMATIC DIMESNION Components

SCENARIOS on Opening up the STEM classroom

- Opening-up science education: Taking advantage of the potential of informal science education (GR)
- Learning and teaching in a seamless way (combining classroom learning with learning in the outside world: an introduction (part 1) and designing seamless learning experiences (part 2) (NL)
- Open air lessons – myth or not… Design of the open air field IBL education in STEM (BG)
- Approaching STEM in collaboration with scientific centres, and science museums and other local institutions (ES)

SCENARIOS on Assessment challenges in STEM

- Confronting challenges on IBL from implementation and assessment perspectives (GR)
- Assessment of 21 century skills with technology: how do you do that in practice? Viewbrics, a tool for assessment of 21st century skills (NL)
- Measure three times, cut once: Assessment for success (methods, techniques and tools for assessment IBL project work and team work) (BG)

SCENARIOS on Enhancing teachers-parents collaboration

- Overcoming personal bad experiences of parents for STEM success of their children (GR, NL, BG, ES)
- Supporting gender-neutral approaches to STEM at home (GR, NL, BG, ES)

SCENARIOS on ICT enhanced STEM learning and teaching

- Challenges of Inquiry based learning and how to tackle them using DojoIBL. A design-oriented course for teachers of secondary vocational education (in STEM related domains) (NL)
- Dream or Reality: Combining "dreams" (online tools, virtual reality, augmented reality and others) and "reality" (real places for educational visits (BG)
- Emerging ICT technologies in STEM education: computational thinking, robotics, and game-based learning (ES)
- Open Science resources: use , adaptation and design of digital resources for the STEM classroom (ES)

SCENARIO on Confronting challenges of new curricula

- The challenges in the new ICT curriculum for 8- th grade The scenario is dedicated to familiarize trainees with new challenges there and to prepare them for teaching under its framework (BG)

Scenarios descriptions, outline structure and access to the digital scenarios in:

Sample digital scenarios for STEM teachers' competence development via inquiry methodology http://learning-in-teaching.eu/index.php/en/intellectual-outputs/io4

OUTCOME DIMESNION Components

Outcome indicators for evaluating the impact of Professional Learning initiatives on STEM teachers' competences

Outcome Through the participation in initiatives for STEM teachers' competence development, STEM teachers are expected to :	Outcome Indicators STEM teachers participating in initiatives for their competence development should demonstrate:	Sub-indicators STEM teachers participating in initiatives for their competence development can document the following types of evidence:	National contexts in which the sub-indicators are relevant to:	
			Explicitly	Implicitly
Develop **knowledge & understanding** on learning & teaching  **"I have knowledge & understanding on this"**	**Enhanced knowledge and understanding on STEM related & teaching and learning content**	***Demonstration of enhanced STEM knowledge*** *(knowledge in specific content areas)*	NL,BG,ES	GR
		Demonstration of enhanced Pedagogical Content Knowledge (knowledge of tasks, learning contexts & objectives; knowledge of students' prior knowledge & subject specific learning difficulties; strategic knowledge of instructional methods & curricular materials)	NL,BG	GR, ES
		Demonstration of enhanced Curricular Knowledge *(knowledge of STEM curricula- e.g. the planned and guided learning of subject specific contents)*	GR,NL,BG,ES	
		Demonstration of knowledge on issues pertaining to developmental psychology	GR,NL,BG,ES	GR,ES
		Demonstration of knowledge on issues of inclusion and diversity	GR,NL,BG,ES	GR,NL,ES
	Enhanced knowledge and understanding on methodologies and methods relating to STEM learning and teaching	***Demonstration of enhanced Pedagogical knowledge*** *(knowledge of teaching and learning methodologies* & processes; group processes & dynamics; learning theories & motivational issues)	GR,NL,BG,ES	GR,NL
		Demonstration of knowledge on innovative STEM methodologies *(e.g. inquiry based learning and teaching)*	NL,BG	NL
		Demonstration of knowledge on evaluation and assessment *(processes and methods)*	NL,BG,ES	GR
		Demonstration of knowledge on new technologies *(and their affordances as a tool for more effective learning)*	GR,NL,BG,ES	GR,NL,BG,ES
	Enhanced knowledge and understanding on contextual aspects of learning and teaching	***Demonstration of knowledge on educational sciences foundations*** *(intercultural, historical, philosophical and sociological knowledge)*	GR, NL, BG, ES	
		Demonstration of knowledge on contextual, institutional & organizational aspects of educational policies	GR, NL, BG, ES	

OUTCOME DIMESNION Components

Outcome Through the participation in initiatives for STEM teachers' competence development, STEM teachers are expected to :	Outcome Indicators STEM teachers participating in initiatives for their competence development should demonstrate:	Sub-indicators STEM teachers participating in initiatives for their competence development can document the following types of evidence:	National contexts in which the sub-indicators are relevant to:	
			Explicitly	Implicitly
Develop skills for learning & teaching  "I can do this"	Enhanced learning skills -relating to the promotion of teachers' own learning	***Demonstration of ability to using, develop and create research knowledge to inform practices***	GR,NL,BG,ES	NL,ES
		Demonstration of reflective & metacognitive skills during owns learning	GR,BG,ES	NL
		Demonstration of interpersonal skills for learning individually and in professional communities	GR,BG,ES	NL
	Enhanced teaching skills –relating to the promotion of students' learning	***Demonstration of ability to plan, manage and coordinate teaching***	GR,NL,BG,ES	GR,NL,BG
		Demonstration of ability to use teaching materials and technologies	GR,NL,BG,ES	GR,NL,BG
		Demonstration of mastery in managing students and groups	NL,BG,ES	GR,NL,BG
		Demonstration of ability to monitor, adapt and assess teaching/learning objectives and processes	GR,NL,BG,ES	NL
		Demonstration of collecting, analysing, interpreting evidence and data skills for professional decisions and teaching/learning improvement	NL,BG	GR,NL,ES
	Enhanced professional skills- relating to teachers' role as part of educational communities	***Demonstration of collaboration skills*** *(with colleagues, parents and social services)*	NL, BG	
		Demonstration of negotiation skills *(social and political interactions with multiple educational stakeholders, actors and contexts)*		
		Demonstration of ability to adapt to educational contexts	BG	NL,ES
		Demonstration of Life and Career skills *(Flexibility and adaptability; Initiative and self-direction; Productivity; Leadership and responsibility)*		BG

OUTCOME DIMESNION Components

Outcome Through the participation in initiatives for STEM teachers' competence development, STEM teachers are expected to :	Outcome Indicators STEM teachers participating in initiatives for their competence development should demonstrate:	Sub-indicators STEM teachers participating in initiatives for their competence development can document the following types of evidence:	National contexts in which the sub-indicators are relevant to:	
			Explicitly	Implicitly
Come to value learning and teaching- dispositions & attitudes  " This is important to me"	Positive dispositions and attitudes relating to teachers own learning	***Demonstration of epistemological awareness***	GR,BG	BG
		Demonstration of positive dispositions to change, flexibility, ongoing learning and professional improvement *(including study and research)*	GR,BG,ES	NL
		Demonstration of critical attitudes to one's own teaching *(examining, discussing, questioning practices)*	GR,NL,BG	NL,
	Positive dispositions and attitudes relating to the promotion students learning	***Teaching skills through content***	NL,BG,ES	GR
		Transferable skills	BG	NL
		Commitment to promoting the learning of all students	GR,NL,BG,ES	GR
		Dispositions to promote students' democratic attitudes and practices, as European citizens *(including appreciation of diversity and multiculturality)*	GR,NL,GR	GR,NL,ES
	Positive dispositions and attitudes relating to their role as part of educational communities	***Dispositions to team-working, collaboration and networking***	GR,NL,BG	NL,ES
		Sense of self-efficacy		

OUTCOME DIMESNION Components

Guidelines for facilitating teachers' educators on how to structure an evaluation tool for inquiry and reflective STEM teachers' professional learning activities

<table>
<tr><th>Aim of the tool item</th><th>Dimensions</th><th>Example of tool item</th></tr>
<tr><td>To provide data for evaluating course assumptions</td><td>- Relevance of the thematic to participants' needs
- Relevance of learning through IBL methodology
- Relevance of expected learning outcomes</td><td>How relevant are the following to my professional learning needs
(1: not at all – 5: to a great extent)
<table><tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><td>Thematic of the module</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Learning through inquiry methodology</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Expected learning outcomes as in the module outline</td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>To provide insights on participants' needs and expectations</td><td></td><td>What is your motivation for participating in this course? What do you expect to gain from taking part in it?
{open question}</td></tr>
<tr><td rowspan="2">Evaluating the impact:
To provide us with data on teachers' competence development</td><td>Knowledge & understanding</td><td>Note: Refer to outcome indicators and sub-indicators from table 5 → dimension knowledge & understanding
Example:
My knowledge and understanding on {indicative: implementing and assessing inquiry-based learning}:
(1:very poor – 5: very good)
<table><tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><td>Before the course was …</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>After the course is …</td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Skills</td><td>Note: Refer to outcome indicators and sub-indicators from table 6 → dimension Skills</td></tr>
</table>

OUTCOME DIMESNION Components

		Example: My ability to {*indicative: use and adopt existing research knowledge to inform my practices*}: (1:very poor – 5: very good) **1 2 3 4 5** **Before the course was …** **After the course is …**
	Dispositions & attitudes	Note: Refer to outcome indicators and sub-indicators from table 7 → *dimension Dispositions & attitudes* *Example*: How important it is for me (1: not at all – 5 to a great extent): **1 2 3 4 5** **{*Indicative* :To have critical attitudes to my own learning and teaching practice }** **{*indicative:* To work in teams, collaborate and network with colleagues}**
To provide data on the IBL skills developed in the course aligned to IBL activities		During the course, I believe that I used the following skills (1: not at all – 5 to a great extent): **1 2 3 4 5** **Critical thinking** **Information literacy** **Analytical skills** **Communication skills** **Digital skills** **Metacognitive and reflection skills** **Other research skills**
	Activities that the learner contributed to	During the course, I contributed to the following activities (1: not at all – 5 to a great extent): **{indicative} 1 2 3 4 5** **Formulating the question** **Planning the method** **Review and analysis of data** **Hands-on activity** **Communication** ….
Evaluation of the course	Usefulness	How useful were the following course elements to me? (1: not at all – 5 to a great extent):

OUTCOME DIMESNION Components

			1	2	3	4	5
		Learning through inquiry					
		Self-regulated learning					
		Leaning with peers					
		Hands-on learning					
		Reflection & metacognition					
	Learning outcomes	Overall, where do I believe I am in relation to my learning outcomes? Please tick					

	This is new information/experience for me and I need some time to process it
	I have connected new information to my previous learning
	I understand now how this new information fits into the bigger picture
	I am ready to share my new learning with others
	I can explain new information to others and help them understand it

Examples of self-evaluation tools that has been developed in the course of the professional learning activities implemented in the course of ELITe can be accessed in

http://learning-in-teaching.eu/index.php/en/intellectual-outputs/io6

The ELITe project framework for 21st century STEM teachers' professional development

Place-based approaches in STEM professional learning

Inquiry Based Learning (IBL) methodology

New thematic areas

Teachers' competence development goals

Read more in the ELITe project's Intellectual Outputs

- Policy envisions and requirements for STEM teachers' competence development: State of affairs in 4 EU countries.
- Context-based indicators for evaluation STEM teachers' competence development
- Systemic opportunities and challenges for STEM teachers' competence development in 4 EU national contexts.
- Sample digital scenarios for STEM teachers' competence development via inquiry methodology.
- Handbook with guidelines for STEM teachers' inquiry and reflective practice.
- Evaluation and validation report of the ELITe's learning in teaching approach via e-inquiries.
- Framework for STEM teachers' competence development under an inquiry approach.
- Recommendations for policy and policy making towards a new model for STEM professional learning

learning-in-teaching.eu

Project: Enhancing Learning in Teaching via e-inquiries (ELITe)

Program: Erasmus +, Strategic Partnerships for school education, 2016-2019

Document title: Intellectual Output O9: Framework for STEM teachers' competence development under an inquiry approach – Briefing Document

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