Negotiating tension points in the Bulgarian educational system towards a new model for STEM professional learning

A report on the processes and outcomes of the ELITe project Multiplier Event E7 "Toward professional development of ELITe STEM teachers"

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1. Introduction

The aim of the Multiplier Event E7 "Toward professional development of ELITe STEM teachers" is to present the main outcomes of the ELITe project in front of the main stakeholders – policy makers and mediators, STEM teachers' educators and STEM teachers, as well as to evaluate validity of the achieved results.

The focus is on the **Methodological dimension** of the ELITe framework. The aim is to *take a picture* of the different stakeholders' points of view on how relevant for teachers and teachers' educators trainings the ELITe methodology is and to negotiate with educational stakeholders the validity of the project's methodology for Science, Technology, Engineering and Mathematics (STEM) teachers' competences enhancement through inquiry based learning (IBL) methodology. The aspects of the **Methodological dimension**, interesting to be evaluated, are its *usefulness*; *feasibility for adoption*; *challenges & recommendations for adoption*. As a satellite goal, the other dimensions are partially validated in terms of their relationships with the **Methodology dimension** - the *possibility / ways of transfer* to other practices related to the STEM teachers' professional competence development.

The focus area is selected because the National regulatory framework expresses a lot of new requirements for STEM teachers' professional competences. From other hand, the different stakeholders (policy-makers, policy mediators, teachers' educators, and STEM teachers) have different understanding on how to achieve the regulatory framework requirements and how to implement in practice innovative methodologies for professional development of teachers' competences. In practice, the traditional approaches still prevail in teachers' trainings, even on innovative methods of teaching. The E7 multiplier event's focus is on negotiating stakeholders' understanding on the *ELITe* innovative approaches in teachers' education, on validation of the methodology from different perspectives, and on finding a relevant ways for its adoption in practice.

The leading questions directing the validation and negotiation process are:

- Recent changes in the National policy regulation in relation to STEM teaching
- What are real needs from different stakeholder's point of view
- How we (different stakeholders together) can response to them
  - What thematic areas mostly needs intervention?
  - What are the innovative aspects of the ELITe methodology and how they can contribute to adequate teachers' competence development?
- How / in what context / with what added value the particular ELITe components / tools / outcomes could be used by different stakeholders in their specific practice

2. Implementation of the event

2.1. Participants

The Multiplier event E7 "Toward professional development of ELITe STEM teachers" was held on the 20 June 2019 in the Mirror Hall of the Sofia University. There were invited 65 people, representing the following

groups: policy makers (representatives of Ministry of Education and Regional Inspectorates), policy mediators (STEM faculty deans, STEM teachers' educators, responsible for curricula / content development, school headmasters, school STEM main teachers), teachers' educators (representing academic institutions and NGOs), and STEM teachers. Some of them are in more than one role – for example, the school STEM teachers and deputy headmasters are STEM teachers by themselves, but they are also responsible for identification of the STEM teachers' professional development needs, choosing or organizing local professional development training activities. The situation is similar with the teachers' educators – most of them take also a role of policy makers and / or policy mediators, as they are responsible for the design and delivery of their courses. The invitation was accepted by 43 people – the actual participants in the ME 7. The event was moderated by 5 ELITe team members. Approximately one forth (12) of the participants were familiarized with the ELITe project during the first multiplier event (ME 3) or as participants in the implementation phase. There were also 2 Albanian invited guests – Dr. Bederiana Shity and PhD student Diana Starja, working in the area of STEM teachers' development in the University of Elbasan, Albania. In addition, two teachers' educators – prof. Maritona Mermeva and prof. Eleonora Serafimovska from University of Skopje (UKIM), North Macedonia, has joint the event at the last minute.

The event provides added value for each participant's group, as follow:

- For policy makers and mediators: to take a picture of the results, to form constructive relationships with teachers' competence providers, to be able to choose relevant courses for teachers they are responsible to, to become familiar with innovative tools, helping them to identify the needs, to evaluate teachers' competences.
- For teachers' educators: to enhance their practice with innovative ideas, tools, components or the complete ELITe methodology.
- For teachers: to be introduced with innovative methodologies and courses accessible for them, to form a network and friendships with other innovative STEM teachers, to form personal relationships with institutions providing teachers' education, to become familiarized with self-evaluation tools, helping them to identify their needs and to choose relevant teachers' competence development courses.

2.2. Event structure

The Multiplier event 7 "Toward professional development of ELITe STEM teachers" was implemented in a workshop format with the following structure:

1. Plenary session: **ELITe framework**
   a. ELIte framework brief presentation
   b. ELITe IBL & Reflective teaching methodology presentation
   c. A good practice of application of the ELITe scenario template for scenario design: **#3: Neither sees nor hears, but succeeds** scenario development process
2. Work in **focus groups** (policy maker and mediators, teachers' educators, and teachers) with the aim to evaluate if and how different groups could use the ELITe tools and outcomes in their practice.:
   a. **Policy makers and mediators** - hands-on work on *Comparative insights on national requirements for STEM teachers' competence development*, *Critical factors affecting STEM teachers' professional learning in my country*, *Process indicators for inquiry skills development in professional learning activities*, *Outcome indicators for assessing the impact of STEM professional learning activities on competence development*, and *Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development*

    b. **STEM Teachers' educators** - hands-on activity on *Guidelines for STEM teachers' inquiry and reflective practice*, *Sample digital scenarios for STEM teacher training under an inquiry based learning (IBL) methodology*, *Process indicators for inquiry skills development in professional learning activities*, *Outcome indicators for assessing the impact of STEM professional learning activities on competence development*, *Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development*

    c. **STEM Teachers & other stakeholders** - hand-on working on *Guidelines for STEM teachers' inquiry and reflective practice*, *Sample digital scenarios for STEM teacher training under an inquiry based learning (ILB) methodology*, *Process indicators for inquiry skills development in professional learning activities*, *Outcome indicators for assessing the impact of STEM professional learning activities on competence development*, *Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development*

3. Plenary session: **ELITe best practices**

    a. Presentation of the Bulgarian ELITe best practices: **#1: "Dream" and Reality (*Space Safari*), #4: Open air lessons – myth or not…** and **#8: Overcoming personal bad experiences of parents for STEM success of their children**

    b. Sharing experience of transferability of the ELITe scenarios to own practice by participants in the ELITe implementation phase.

4. *World café*'s style **group work**: best practices – work in small heterogeneous groups on presented best practices. Sharing own innovative experience, underlying the common aspects with ELITe elements / inspirations / challenges.

    Aims: To find out if / how the ELITe methodology and experience could enhance participants own practice. To develop ideas for collaborative STEM teaching scenarios, following the experience shared by the teachers who already have been participated in the ELITe courses modules

5. **Plenary session**:

    a. Groups results presentation

    b. Gathering feedback on advances and challenges of application of the ELITe approach in the stakeholders practice:

    c. Event summary and evaluation

2.3. Event implementation

The event started with a welcome coffee for ice breaking.

During the first plenary session: **ElITe framework**, Nikolina Nikolova has presented the ELITe framework, its components, developed IBL & Reflective practice methodology, and the main ELITe outcomes. She was followed by Temenuzhka Malcheva, a teachers' educator participated in the ME 3 and in the implementation phase, who shared her experience in the use of the ELITe scenario template for development of the **#3 Neither sees nor hears, but succeeds** ELITe scenario (Figure 1).

Figure 1. Introducing the ELITe framework

The **focus groups** hands-on work was dedicated on the evaluation of different ELITe outcomes and tools. Each group has discussed the relevance, usefulness and feasibility for adoption of the ELITe methodology and accompanying instruments in its practice in correspondence with the participants' responsibilities. The session finished with the groups' work overview (Figure 2).

Figure 2. Homogeneous focus groups discussions

During the second plenary session: **ELITe best practices**, the implementation of the three scenarios and results - **#1: "Dream" and Reality (*Space Safari*)**, **#4: Open air lessons – myth or not…** and **#8: Overcoming personal bad experiences of parents for STEM success of their children;** were presented. After that two of the participants there shared their own experience in the transfer of the scenarios to their own practice:

- Diana Petrova (ICT teacher) and Tatiana Dimitrova (chemistry teacher) in the First Private Mathematical Gymnasium has been adapted the **#4: Open air lessons – myth or not…** scenario and implemented with their colleagues (biology, math and sport teachers) and after that, using the product created by them during the ELITe scenario implementation – organized and delivered a winter open air school with 12 – 14 year old students.
- Neli Georgieva, a deputy headmaster in the National High School of Mathematics and Science, responsible for teachers' career development in the school, has been used a school outdoor teambuilding event for transfer the **#8: Overcoming personal bad experiences of parents for STEM success of their children** scenario to the school teachers' team. She shared a powerful effect of the methodology and ready for use DojoIBL implementation for the school teachers' training (Figure 3).

Figure 3 .Best practices of implementation, adaptation and transfer of the ELITe methodology and scenarios

The workshop continued with evaluation of the ELITe teacher' and teachers' educators' professional development scenarios. The participants were regrouped in four groups according their interests in specific area, common ideas or need to form relationships with other people / institutions. The groups work has had an open format – the participants were free to move from one group to another, being oriented on the topics of discussion in different groups by the event moderators.

The session finished with the groups' ideas presentation (Figure 4).

Figure 4. World's cafe style heterogeneous groups work

As the most of ideas demonstrated ways for implementation / adoption / adaptation of the ELITe methodology in participants' practice, it passed smoothly to the final plenary session. After the multiplier event summary, the participants evaluated the event by emoticons (Figure 5).
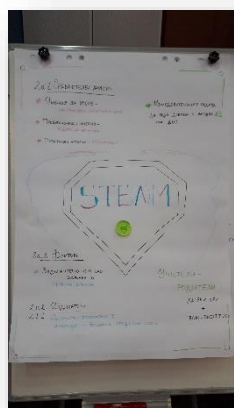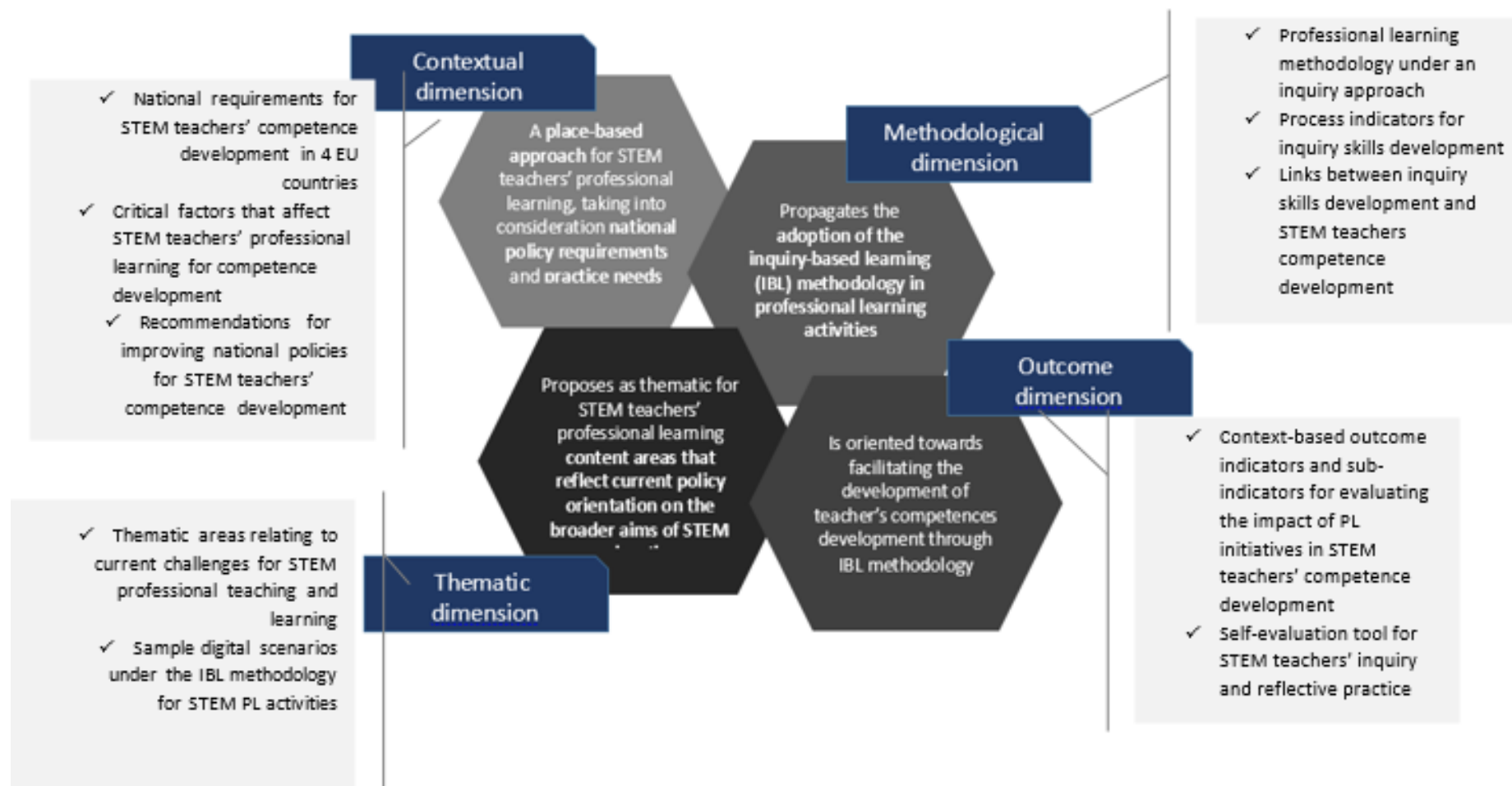
Figure 5. Multiplier event evaluation

3. Documentation of outcomes of the negotiation process

Appendix 1: Structure (dimensions and components) of the ELITe framework

Contextual dimension

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

Methodological dimension

Propagates the adoption of the inquiry-based learning (IBL) methodology in professional learning activities

- ✓ 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

Proposes as thematic for STEM teachers' professional learning content areas that reflect current policy orientation on the broader aims of STEM

Outcome dimension

Is oriented towards facilitating the development of teacher's competences development through IBL methodology

Thematic dimension

- ✓ 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

3.1 SWOT for the adoption/adaption of the ELITe approach in STEM CPD in Bulgaria

Table 1. SWOT analysis of the ELITe framework components

		STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
		Contextual			
Dimensions & components of the ELITe framework negotiated in the ME	Critical factors affecting STEM teachers' professional learning for competence development	• The teachers-participants stressed that the outlined ***Critical Factors affecting STEM teachers' professional learning in my country*** influence the professional training of STEM teachers in Bulgaria. They pointed out that there is indeed more effective training - with short breaks from the workplace (day or two), blended – with on-the-spot and online sessions (paying particular attention to online feedback and reflection), applying innovative methods that teachers themselves need to apply.	• The inquiry-based approach, applied within a distance or blended mode of learning, can lead to failure, if the teachers do not provide timely and systematic feedback to learners. • There is a poor equipment in part of the schools, which prevents the IBL implementation at school. This leads to a demotivation of teachers to develop competencies for implementing the IBL approach in student education.		
	National requirements for STEM teachers competence development	• The participating policy makers evaluate as a directly applicable the ***Comparative insight on national requirements for STEM teachers' competence***			

		STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
		development in their practice, as a: o confirmation that the national policies are developed in sync, and in some places being ahead of part of the other EU countries. o motivation for the STEM teachers about their inclusion in trainings for acquisition of relevant knowledge and skills, as required by the national regulations.			
Methodological					
	Professional learning methodology under the inquiry approach	• The methodology and the applied tools offer an easy way to learn during teacher training, especially if it is based on already implemented and described scenario. The methodology is easily transferable also in schools, even within just one learning subject, e.g. Chemistry. • The participants in the training, who followed the ELITe methodology,	• Substantial part of the school managers (principals), whose responsibility is the professional development of the teachers, are not really aware about what STEM is, what competences it requires teachers to perform, and in what direction the STEM teachers need to operate and develop themselves. Such principals are still	• The ELITe model is extremely suitable for applying in school for student career guidance. • The multiplier event provides opportunity for the establishment of a regional partner network of institutions (academia, schools, NGOs) that can work together towards real innovation implementation in education. Specifically, the people gathered	• The lack of a database(s) of ready-to-apply scenarios, lessons and examples, based on the ELITe methodology, which teachers and teachers' educators can use freely, is considered as a challenge - the existing old database is not accessible. • The innovative learning methods require more time for design and implementation than the traditional ones. In the

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
are enthusiastic and full of ideas for its implementation in the environment in which they work. The methodology creates prerequisites not only for development of personal contacts, but also friendships between the participants. As a result, many of them, when completing a module, are leaving the training with joint ideas for its implementation, including in teams, formed by different institutions. • The Instrument **Guidelines for STEM teachers' inquiry and reflective practice** is extremely practically oriented and can be applied directly in practice when preparing trainings for STEM teachers • The participants in the **Teachers' educators** group believe that the proposed methodology is	checking up STEM teachers whether they teach in the traditional way - examining 1-2 students on learned theory, then teaching new material (lecture style). There is a danger that such headmasters will not only deny to support STEM teachers, but even could oppose the introduction of innovative practices in the STEM teacher training and the subsequent transfer to the teaching process at school. • The ELITe methodology presents only the traditional model for IBL. It would be good to extend the methodology with the inverted model, i.e. the Visual Discovery.	here, we can together plan future teacher trainings based on the ELITe methodology. Because the goal is not to know much, but with little effort to achieve a lot. • The methodology, accompanying tools and best practices could be shared in the Scientix platform to make them accessible to as many interested people as possible. • Through such events it is possible to set up regional partner networks with businesses. This will allow the development and implementation of joint ELITe scenarios for teacher and pupil training that are geared directly to the development of the necessary business competencies among the pupils. • At policy level, STEM education can become a	curricula of future pedagogues in STEM, academic hours are reserved for lectures and exercises only. In this sense, it is not clear how exactly such a methodology could be in place within these curricula. There is a danger that teacher training, which strives to the implementation of the IBL model of instruction will not get (sufficient) study time. • On the Internet, there are too many web sites with fake, non-working, models of competency-based approach of instruction, which web sites offer training to teachers (e.g. https://mycompetence.bg/). Never mind of their poor quality, such "trainings" are used both by trainers of teachers, or in self-training of teachers. • Financial resources o In schools: there is no regulation for provision of funds for work in an external institution (e.g. a museum), or for

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS

applicable to teachers' trainings, but it is good to be clear that the model is flexible and every educator has an opportunity to adapt it individually to his own needs. The Teachers'-educators prefer to start from specific example towards general framework - that is, first to look at specific sample scenarios and subsequently, on the basis of these examples, to realise their own ideas following the model.
• The participants (teacher trainers) have highlighted that it takes a long time to persuade teachers to apply such an approach in their work, but once they have applied it, they find that the results are better in comparison to the classical way of teaching of the same topic (an example with the theme of structure of the atom)
		state priority, as for example in Israel.
		• The ELITe methodology and accompanying tools could be used not only for the training of teachers and teacher trainers, but also for training of specialists for modern innovative business companies, as these companies are currently looking the most for researchers with research (inquiry-based) skills.
		• The ELITe model and methodology can expand its scope so that the universities offer research internships for students and their teachers.
		• The ELITe methodology can be successfully applied to the career guidance for students through the development of appropriate scenarios, together with the local industry (Pharmacy, ICT, etc.)
			provision of resources and materials, or for organisation of an external training
			○ Teacher training:
			   ▪ Classes are strictly defined as "lectures" and "exercises"
			   ▪ There is no regulation of such field practice for future teachers; respectively, it cannot be included in the classes because there is no way to justify (report and pay)
			• Time as a resource: a heavily overloaded curriculum. Shortage of time. At university - the IBL approach requires more time for work by students, suggesting that incorporating it as a method in regular study programs will lead to changes in the curriculum - reflecting an extra

		STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
					students' self-study time, thus, increasing the number of study credits for a STEM (pedagogical) discipline. It is unclear whether the relevant units / managers will value positively the methodology, and whether they will vote for such an adjustment • Lack of policies to promote inquiry and in general - innovative teachers' training, both in universities and in-place local school trainings. Short lectures in lecture style are supported. • Breaking the stereotype of teaching / learning teachers - they are accustomed to the traditional style of listening to lectures and taking notes. They are afraid that they could become "foolish" if they engage in IBL activities, and they could be compromised in front of their students, show lack of specific skills, etc.
	Process indicators for	• Currently, research competencies are highly			

		STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
	inquiry skills development	valued not only and not primarily in the academic community, but above all by innovative business companies. In this sense, ELITe methodology is extremely strong and differs from the other teacher training and teachers' educators methodologies because it gives them also a model about how to develop the research capabilities of their students. • The tool **Process indicators for inquiry skills development in professional learning activities** is very convenient in the design of inquiry training activities for teachers and teachers' educators, and can be used directly not only in the ELITe designs of teachers' and teachers' educators' training, but also in other IBL-based trainings. • Highly measured characteristics of the teacher training			

	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
	methodology and its transferability to student education: ○ Learning through entertainment ○ Learning through co-experience and co-design ○ *Getting into the shoes of the other* ○ Application of science in practice ➜ motivation + interest			
Links between inquiry skills development and STEM teachers competence development	• The ELITe methodology is directed towards developing STEM-specific competencies, unlike the mass teacher trainings, that are primarily focused on memorising learning content			
Thematic				
Thematic areas	• Thematic areas are relevant to the school needs of teachers professional competence development			
Sample digital scenarios under the IBL methodology or	• The sample digital scenarios are directly applicable in the others institution teachers training practice.		• The presented good practices are extremely useful. It is easier to follow a model of good practice than to pursue a	

		STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
	STEM PL activities	• For teachers' trainers it is easier to design a training stepping on a provided digital scenario than just following the template structure. • The proposed scenarios are easily achievable both in the local training of STEM teachers within one school, and in international Erasmus+ projects.		purely theoretical approach to the development of a teacher training design. The multiplier event has also enabled participants to share good practices. There is an opportunity, under the protection of the Ministry of Education and Science, to create a national database with a description of good practices that are freely accessible to both teacher trainers and STEM teachers. • Another opportunity is the development of shared platforms between academic institutions to describe innovative methods and good practices in the training of teacher trainers.	
	Outcome				
	• Outcome indicators for assessing the impact of STEM professional learning	• The tools ***Process indicators for inquiry skills development in professional learning activities*** and ***Outcome indicators for assessing the impact of STEM***	• The instruments for assessing the impact of methodology and learner self-assessment lack indicators about competence assessment for spatial-oriented		

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
activities on competence development • Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development	*professional learning activities on competence development* are very convenient in the design of inquiry training activities for teachers and teachers' educators, and can be used directly not only in the ELITe designs of teachers' and teachers' educators' training, but also in other IBL-based trainings. The tools are directly applicable and the participants plan to use them both in schools (NHSMS and MG Varna), as well as in the Regional Methodological Councils (deputy directors of NHSMS and MG Varna participate in such Councils and intend to use them in an 1:1 manner). The same applies to the **Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development**.	learning, and the impact of methodology on learner self-effectiveness.		

Thoughts, shared by the participants, showing the added value of the ELITe framework and the Multiplier event #7:

- *Already here, while working, I have an idea how to apply this methodology in the work with my students on the subject of "Structure of the atom" and the methods of teaching this topic at school* (Dr. Milena Kirova, Faculty of Chemistry & Pharmacy)
- *We launched an Erasmus+ project dedicated to the application of math in everyday life. We have already planned to transfer, with little adaptation, the* **Open Air Lessons** *scenario together with teachers and students from partners' countries* (Vyara, Project Manager, 144 General School)
- *During the trainings in which I took part, together with colleagues from Sofia University, we decided to initiate a national event "Scientist for a Day", to bring together university and school STEM lecturers and teachers in the creation of a inquiry atmosphere, environment and design of pupils' immersion scenarios for pupils from the country into a research environment for discovering the beauty of the scientist's profession.* (Diana Petrova, Senior Teacher, First Private Math Gymnasium /FPMG/, Sofia)

3.2 Critical issues for the adoption/adaption of the ELITe approach in STEM CPD

Discussing the critical issues for the adoption / adaptation of the ELITe approach, all of the participants approved the validity of the IO1 issues, updated during the Multiplier Event 3. They shared their own experience (see SWOT analysis) in support of the critical issues described in the IO3, related to the **content**, **forms**, and **assessment** of the teachers' training courses. The updated list includes more opportunities for thematic areas, while the form of delivery is more narrow and defined as required:

Content of teacher training courses:

- **STEM subject matter** – new science achievements as well as changes in the students' curricula.
- **The use of ICT's in STEM disciplines education** – special attention, dedicated to the use of ICT's in STEM disciplines education in terms of simulations of phenomena and dependencies, giving possibilities for students to experiment and generate hypothesis, reasoning, and conclusions, has raised and was shaped a an independent thematic area for teachers' training courses.
- **Interdisciplinary** and **holistic** educational approach– practical trainings combining different STEM subject matter and relationships, in collaboration with other STEM subject teachers; learning design, implementation and evaluation of students' achievements. Special attention not only on the interdisciplinary, but on the holistic approach in STEM education.
- **Innovative teaching methods** – interactive methods of teaching / learning, design and implementation of student's inquiry, group work management, use of innovative ICTs in education, etc., focused to STEM education.
- **Work with special students' groups**, tailored to the specifics of the subject and the educational need – involving students with special educational needs, work with talented students, and work with students with learning disabilities.
- **Work with parents** – effective communication and collaboration with parents, involving parents in school live, 'school for parents'.
- **Work / networking / negotiation with different institutions**, able to provide administrative and/or methodological support, environment for IBL STEM learning and teaching, partnership, etc.
- **Dealing with administrative issues** - familiarizing with administrative framework and approaches for more effectively carrying out administrative work.
- **Evaluation in education** – approaches and technics for evaluation of educational process, how to implement classroom pedagogical experiment, evaluation of students'' textbooks and additional learning resources, formative and summative students assessments, etc.

Forms of teachers' training courses:

- **Face-to-face or blended learning** – Short term face to face learning out of the school, supported by distance online phase, accompanied by the regular feedback by trainers.
- **Balance between learning at work place (school) and out the door courses**- regional, national workshops as environment for sharing ideas and experience. Active practical learning process is preferred by practitioners instead of lectures and formal exams. Also, demonstration and participation of innovative teaching methods implementation is very important for the successful transfer of given teaching methodology to the classroom.
- **Online archives of courses** – as a current support, and as an archive data base for long term use and **transferability**. Training courses content online for future use is useful, as well as to have an online tool for support of the professional community, established during the course.

Transparency and assessments of teachers' training courses

The participants approved the need of a common online platform offering:

- Information about **teachers' training providers** and **information about teachers' training courses** – topic, annotation, duration.
- **Transparent information about how many teachers attended a particular course and how they evaluate it.**
- **Public ranking system** of courses and public ranking system of course providers.
- Possibility for users to **inform the course providers for their needs and expectations** of particular courses.

In addition, they underlined as a critical issue, related to the transparency of the teachers' training courses the need of:

- **Promotion of IBL** and reflective practices approach to the teachers' education providers.
- **Good practices / scenarios** for teachers' and teachers' educations trainings **database**

4. Results of the validation questionnaire

4.1. Validation dimensions

Table 2. Validation dimensions

		Dimensions of the ELITe framework			
Validation dimensions tackled in the questionnaire		Contextual dimension	Thematic dimension	Methodological dimension	Outcome dimension
Relevancy of the ELITe approach		1a	1d	1b	1c
Usefulness of the resources produced		2a	2b	2b, 2c	2d
Feasibility for adoption/adaption	approach	3A			
	resources	3Ba	3Bb	3Bb, 3Bc	3Bd
Challenges for adoption/adaption		4			

The validation questionnaire is filled in by **38** participants in total. They were divided into three groups– **policy makers and policy mediators: 10**, **teachers' educators: 11**, **STEM teachers: 17** with a different focus

on validated dimensions, although most of them share more than one role – teacher and mezzo level policy maker, teacher and teacher educator, teacher educator and policy maker (Figure 6).
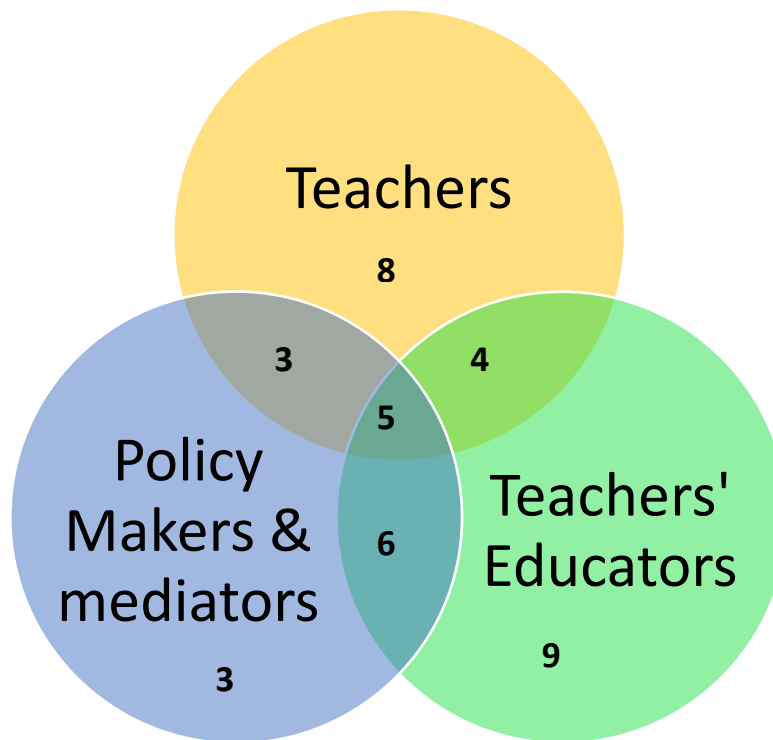

Figure 6. Roles distribution

33 female and 5 male participants filed in the questionnaire.

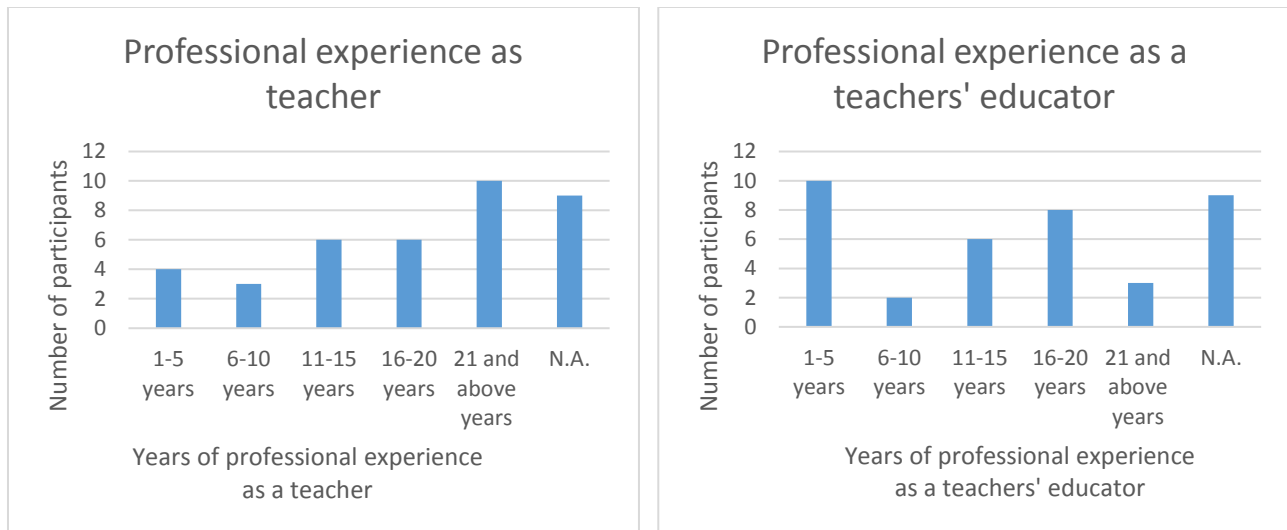The years of professional experience are distributed as follows (Figure 7):

Figure 7. Professional experience distribution

Contextual Dimension

The **relevancy** Contextual Dimension is evaluated from all of the participants while the task for validation of the **usefulness of the resources** and the **feasibility for adoption/adaption resources** in this dimension is given only to the policy makers group. Some of the teachers' educators also interested in there and

responded to the questions, so in this group the number of answers are more than the volume of the groups of the policy makers and vary. The results are (Table 3):

Table 3. Contextual dimension validation

Contextual dimension validation	1	2	3	4	5	Not answered	Mean
The development of STEM teachers'training activities should take into consideration national policy requirements and contexual factors.	0	0	3	16	18	1	**4,41**
Comparative insights on national requirements for STEM teachers' competence development	0	0	0	3	9	-3	**4,75**
Critical factors affecting STEM teachers' professional learning in my country	0	0	0	3	9	-3	**4,75**
Recommendations for improving national policies for STEM teachers' competence development	0	0	0	3	9	-3	**4,75**
Comparative insights on national requirements for STEM teachers' competence development	0	0	2	6	7	-6	**4,33**
Critical factors affecting STEM teachers' professional learning in my country	0	0	1	3	8	-3	**4,58**
Recommendations for improving national policies for STEM teachers' competence development	0	0	1	4	7	-3	**4,50**

The average rating of each aspect of the Contextual Dimension is shown on the Figure 8:
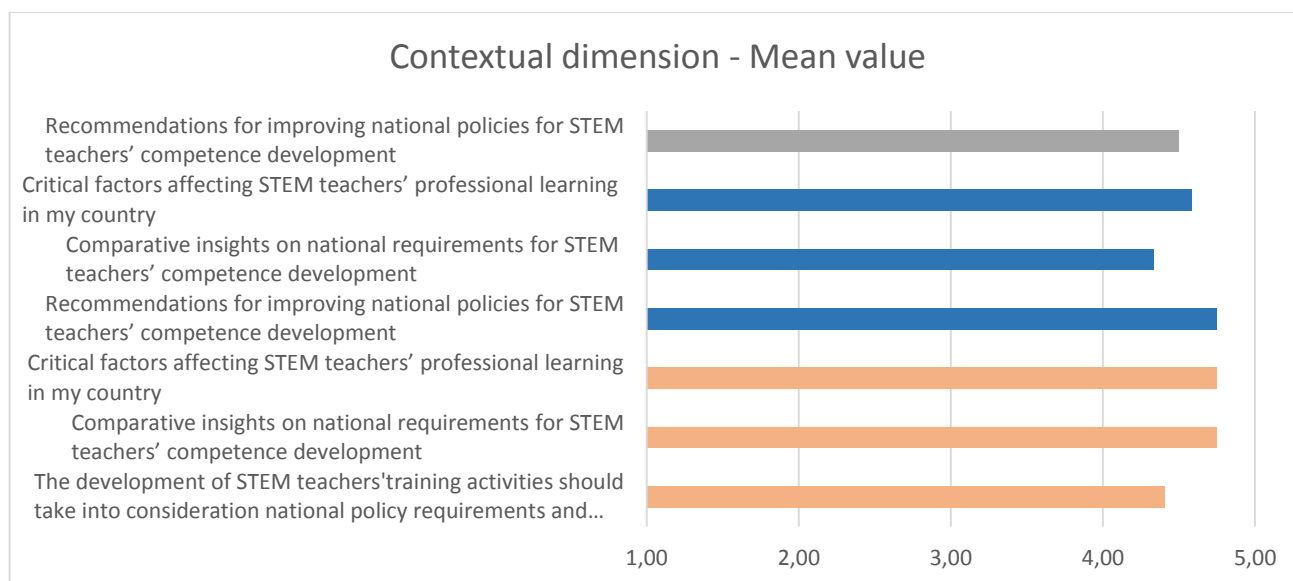

Figure 8. Contextual dimension mean values

Thematic dimension

The Figure 9 shows that all the thematic areas are relevant to the Bulgarian stakeholders; more over – most of the areas are welcome for more than 2/3 of the participants. ICT enhanced STEM learning and teaching, Innovative STEM methodologies, Opening Up school science and Teaching STEM for skill development are the most relevant for the multiplier event participants.
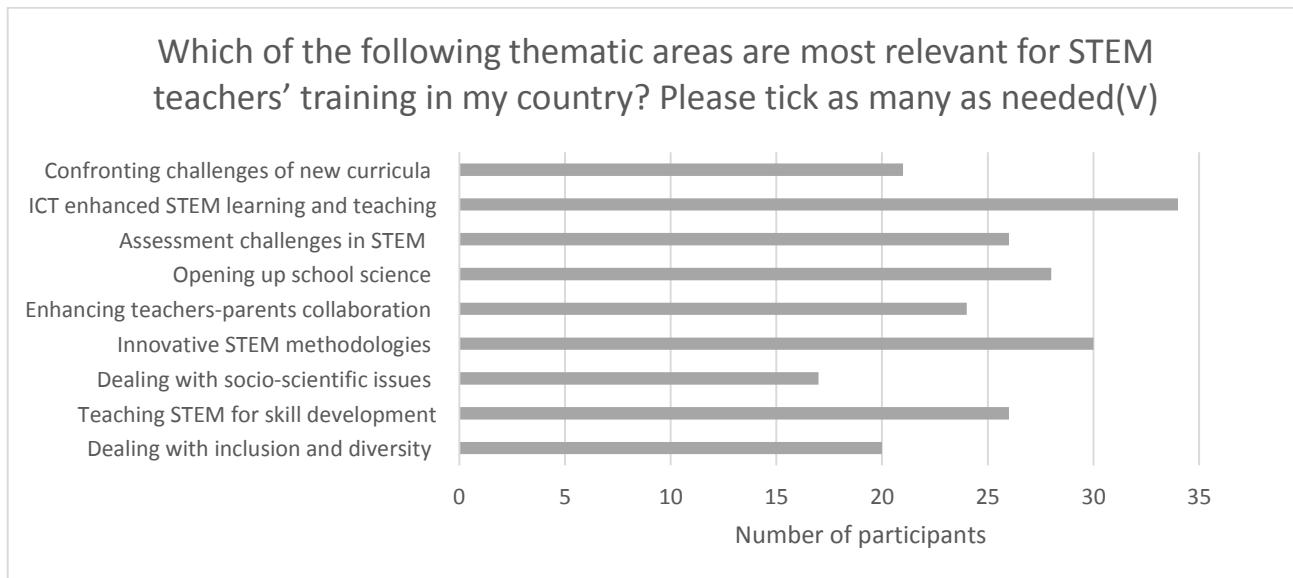

Figure 9. The most relevant thematic areas

The Table 4 represents high level of relevance and feasibility for adoption and adaptation of the scenarios by the groups of **teachers' educators** and **teachers**. The results are supported also by the participants' feedback, listed in the next section.

Table 4. Thematic dimension validation

Thematic dimension validation	1	2	3	4	5	Not answered	Mean
Sample digital scenarios for STEM teacher training under an inquiry based learning (IBL) methodology: **Usefulness**	0	0	0	6	18	14	**4,75**
Sample digital scenarios for STEM teacher training under an inquiry based learning (IBL) methodology: **Feasibility for adoption**	0	0	2	8	13	15	**4,48**

The average rating of each aspect of the Contextual Dimension is shown on the ==Error! Reference source not found.==:
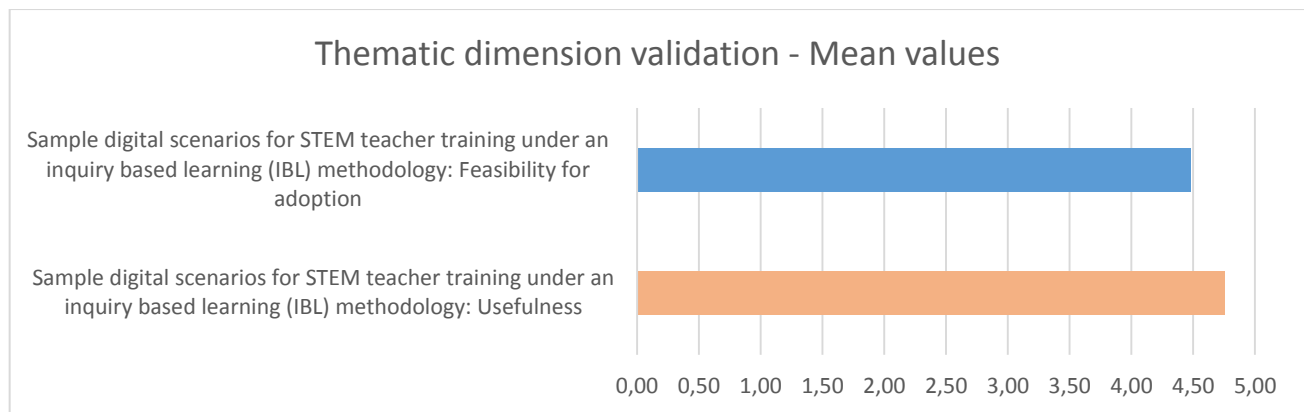
Figure 10. Thematic dimension mean values

Methodological dimension

The results of the validation of the **Methodological dimension** are listed in the Table 5. The **Sample digital scenarios, Guidelines for STEM teachers' inquiry and reflective practice,** and **Process indicators for inquiry skills development in professional learning activities**, were provided only to the groups of **the teachers' educators** and **teachers** as direct providers of trainings.

Table 5. Methodological dimension validation

Methodological dimension validation	1	2	3	4	5	Not answered	Mean
Promoting professional learning through inquiry and reflective approaches is relevant to teacher training.	0	0	0	11	27	0	**4,71**
Sample digital scenarios for STEM teacher training under an inquiry based learning (IBL) methodology	0	0	0	6	18	4	**4,75**
Guidelines for STEM teachers' inquiry and reflective practice	0	0	1	12	25	0	**4,63**
Process indicators for inquiry skills development in professional learning activities	0	0	2	13	23	0	**4,55**
Sample digital scenarios for STEM teacher training under an inquiry based learning (IBL) methodology	0	0	2	8	13	5	**4,48**
Guidelines for STEM teachers' inquiry and reflective practice	0	0	3	10	12	3	**4,36**
Process indicators for inquiry skills development in professional learning activities	0	0	2	8	15	3	**4,52**

The **Error! Reference source not found.** illustrates the high level of evaluation of different aspects of the Methodological dimension:
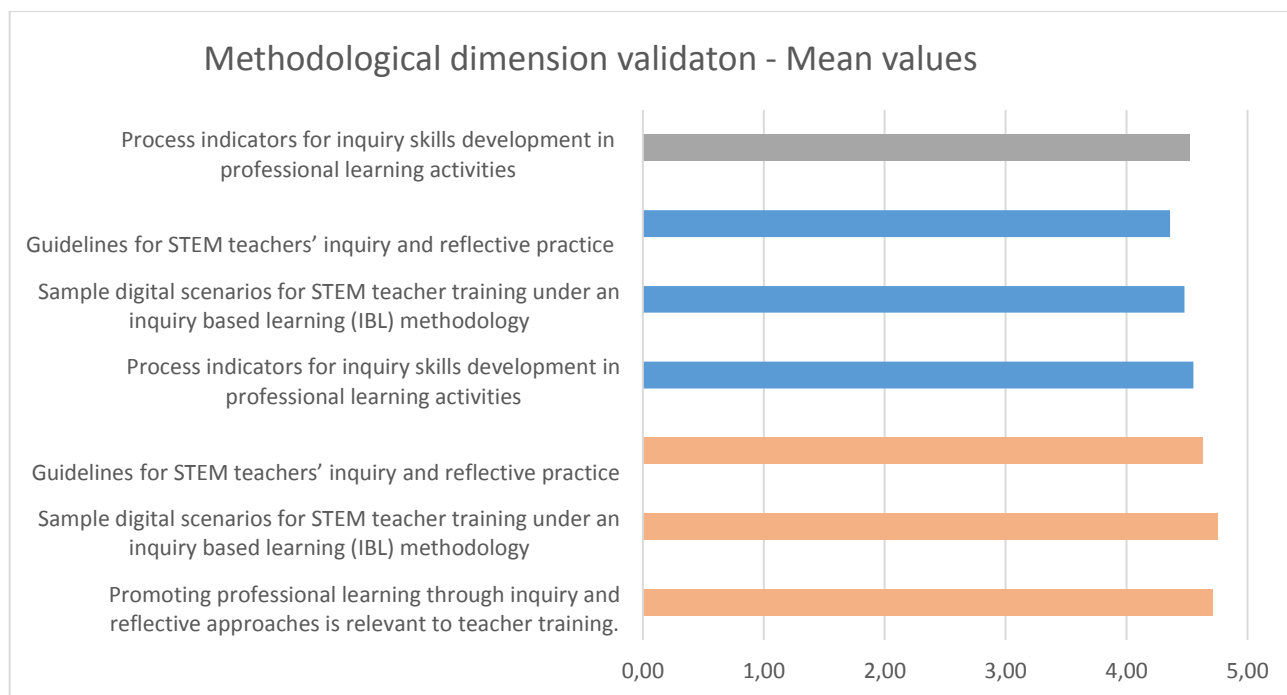
Figure 11. Methodological dimension mean values

Outcome dimension

For *Outcome dimension validation*, the **Outcome indicators for assessing the impact of STEM professional learning activities on competence development** was provided only to the **policy makers** and **teachers' educators** groups, while the other questions were provided to all of the participants. Some of the teachers have shown interest to this particular outcome and also provided an answer (Table 6).

Table 6. Outcome dimension validation

Outcome dimension validation	1	2	3	4	5	Not answered	Mean
STEM professional learning activities should aim at supporting the development of teachers' competences as lifelong learners, facilitators of learning and members of educational communities.	0	0	0	8	30	0	**4,79**
Outcome indicators for assessing the impact of STEM professional learning activities on competence development	0	0	0	5	22	-6	**4,81**
Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development	0	0	0	13	25	0	**4,66**
Outcome indicators for assessing the impact of STEM professional learning activities on competence development	0	0	1	10	7	3	**4,33**
Self-evaluation tool for assessing the impact of STEM professional learning activities on competence development	0	0	1	14	11	12	**4,38**

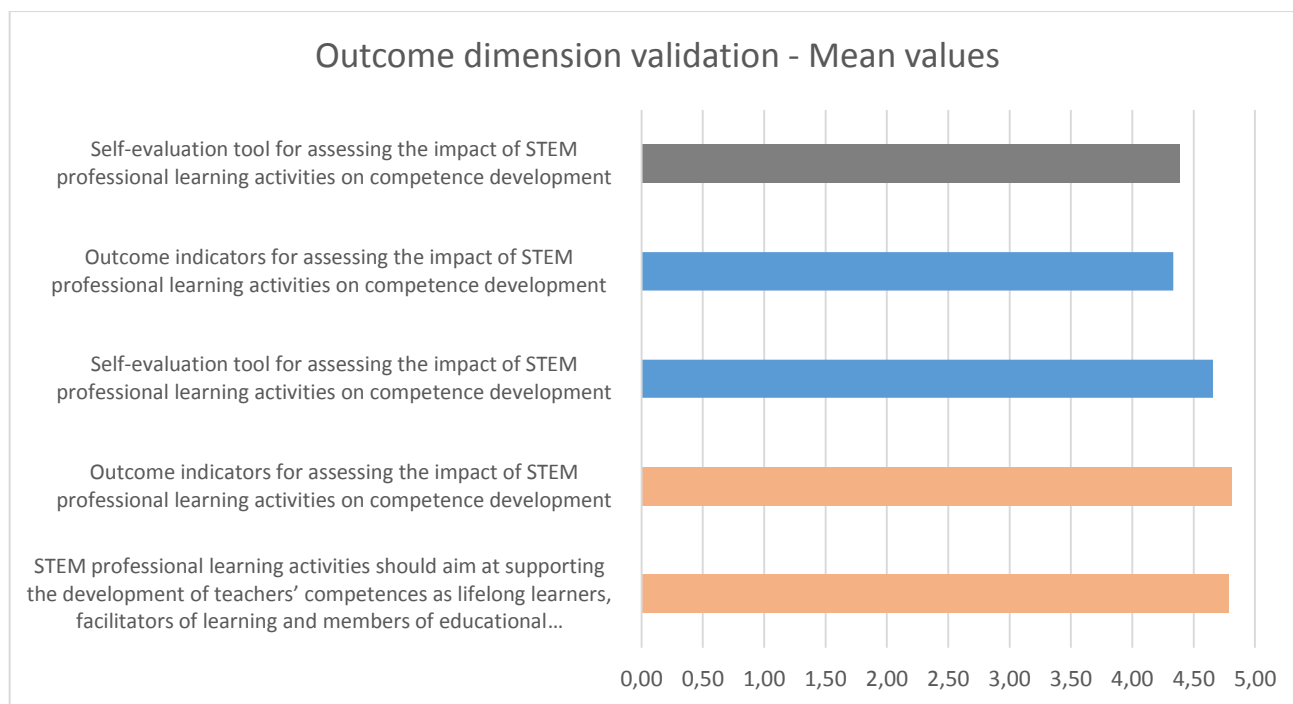The average results are shown on the Figure 12.

Figure 12. Outcome dimension mean values

Cross-dimensional validation

The cross-dimensional validation is presented by the question *How feasible is to adopt/adapt the following elements of the ELITe approach in STEM professional learning activities in your country?*, which answers are provided on the Table 7

Table 7. Feasibility for adoption of the ELITe approach and outcomes

How feasible is to adopt/adapt the following elements of the ELITe approach in STEM professional learning activities in your country?	1	2	3	4	5	Not answered	Mean
Aiming towards teachers' competence development rather than subject-oriented training	0	1	4	15	18	0	4,32
Using inquiry based learning methodological approaches rather than traditional instruction	0	0	0	4	6	0	4,60

The results shows (Figure 13) that the stakeholders are ready and value highly innovative learning and teaching methods but, thinking on the focus on the training, some of them are still bounded to the traditional subject-oriented approach.
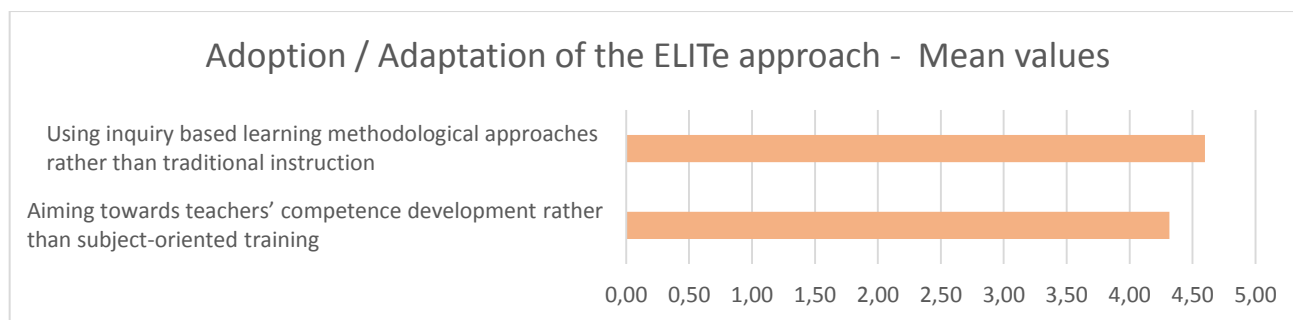
Figure 13. Adoption / Adaptation of the ELITe approach - mean values

4.1. Feasibility for adoption/adaptation of the ELITe approach - ideas for sustainable application of the ELITe framework, provided by the participants

- Ideas for direct transfer of scenarios for local teacher training. In this case, scenarios related to communications with parents:
  - National Science and Math Gimnasium (NSMG): *I am responsible for conducting an educational team building at the school. The subject of working with parents is very hot for us. Providing that I participated in the current event, and I am very impressed with the results of working on scenarios related to teacher-parent communication, I was happy to re-create it in our school.* (Nelly Georgieva, Deputy Director, NSMG)
  Note: Neli Georgieva transferred the scenario **"Let your father come to school!"**(Implementation of the scenario **#8: Overcoming personal bad experiences of parents for STEM success of their children)** to their team-building event. We received very positive feedback from her, right after the training.
  - Math Gymnasium Varna (MG Varna): *A targeted training of pedagogical staff is planned to overcome barriers to the IBL approach in STEM training. The school will apply directly the described as a good practice scenario* (Eleonora Pavlova, Deputy Headmaster, MG Varna)
- *Together, we will design and implement a scenario of a science competition during the European Scientists' Night. The competition will involve teachers and pupils together. As a basis, we plan to use the **Open Air Lessons** scenario.* (Milena Kirova, Faculty of Chemistry and Pharmacy, Sofia University, and Diana Petrova, FPMG).
- *During the presentations of good practices, it has come to our minds to realise a similar scenario for inquiry-based training of mathematics teachers by creating a pano that is an application of geometric figures*. (Daniela Dureva, FMI, SWU - Blagoevgrad, Margarita Teoharova, Director of secondary school for foreign language learning, Blagoevgrad)
- *I have an idea to apply the methodology of career guidance for our pupils. We have good contacts with the local business - Pharmacy, ICT. I am thinking of a joint development, together with business, of such career orientation scenarios.* (Eleonora Pavlova, Deputy Director of MG Varna.)
- *Idea for scenario for students according to the model of the proposed "Garden of the Herbs on the Roof" - landscaping the roof, care of the plants, conformation to the climatic conditions, etc*. (107th Primary School, Sofia)
- Development of training scenarios for organising meetings with established specialists in a given field for better motivation of learners. NHSMS has the idea to adapt its own best practices to the ELITe methodology by using its existing experience (with Chemistry class they had meetings with professionally engaged chemists; several Math classes are visiting leading IT companies).
- The Deputy Rector of the Shumen University offered an opportunity to adapt the "Space Safari" (implementation of the **#1: "Dream" and Reality** scenario) example with by providing opportunity

for remote access and time-slots reservation to the telescopes of the Astronomical Laboratory "Shumen Plateau", led by him.

4.2. Main challenges for adopting the ELITe approach and outcomes in Bulgarian national context

- Regulation at national level of the out-of-lecture halls / fieldwork training to all students prepared for STEM teachers (and in Bulgaria - from the specialties with the code **1.3. Pedagogy of the training in <subject domain>...**).
- Introducing a **metric to measure** the different competency groups of STEM teachers. It is also possible to do this through the students' STEM external assessment
- For the teachers' training institutions – **expanding curricula themes** by including:
  - o Developing basic digital competencies for STEM teachers.
  - o Developing competencies for participation in IBL research processes.
  - o Developing competencies for conducting negotiations (between different stakeholder groups, between different institutions, etc.)
- Support of national initiatives for **collaborative research activities** between universities / academic units and schools with academic facilities - laboratories, equipment, appliances. Such trainings could be used both in teacher trainings and in pupils' education under the guidance of university lecturers.
- The Ordinance № 12 (about the teachers' professional development) needs an update by allowing the acquisition of Professional Qualification Degrees (PCD) through design, experimental training and analysis of results of application the IBL approach at schools.
- **Mixed/Blended training** is recommended as a form of teacher training - short (1-2 days of face-to-face sessions) followed by a longer distance/e-learning form.
- The application of **IBL & Reflective practices** in teachers' trainings has an extremely powerful effect and should be promoted and supported by regulatory documents.
- Targeted **creation of connections / relationships**:
  - o **Among various institutions** that offer teachers' trainings (universities, schools, NGOs) and institutions that can offer an environment for applying the ELITe methodology - museums, laboratories for young people, observatories, etc.
  - o Creating bridges / synergies **between projects at European level** to see how they complement and enrich each other.
  - o Visible, publicly communicated links to different **ELITe's implementation options** for other innovative teacher training approaches, as well as sample scenarios, with the aims to be easily available to MSc and PhD students, and young scientists as a good practice or material for use in their scientific works.
- Changes, based on the ***Comparative insights on national requirements for STEM teachers' competence development***, are proposed at the national policies, adding requirements for:
  - o professional skills - **negotiation skills** (considered necessary in forming partnerships with other institutions as well as in working with parents and students)
  - o **positive attitudes** – performance effectiveness
- The knowledge, mastering and application of **IBL** should be included as a **requirement** (at least for STEM teachers and for acquiring First and Second Professional Qualification Degrees /PCD/) in Ordinance № 12 (The Teacher Qualification Regulation).
- An important aspect of the implementation of the IBL approach is to provide appropriate training for teachers to implement new curricular programmes by clearly showing the places where the IBL implementation is appropriate and possible.

4.3. Policy recommendations – added value

- To the Regional Councils for Methodology: direct use of the scenarios related to school-parent communication for trainings of school managers (two of the headmasters have already made such proposals in their regions - Sofia and Varna).
- In the official STEM teachers' training programs - to have a regulated number of training hours to apply such innovative practices, as they require more time for design and implementation, as well as the provision of the necessary number of credits for out-of-lecture halls study and work for learners and trainers.
- The dissemination of the project results - it is important that the results, achieved by the project, and the created materials and scenarios, will reach as many potential users, since the created materials and practical examples are very useful. It is important to make them available to the public, to have a place where it is possible to share freely experience in this domain.