Enhancing Learning in Teaching via e-inquiries

Intellectual Output 1

Policy envisions and requirements for STEM teachers' competence development:

the case of Greece, Netherlands, Bulgaria and Spain

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Intellectual Output:	O1: Policy envisions and requirements for STEM teachers' competence development in 4 EU countries
Output description:	This document aims to enhance understandings on the state-of-affairs in terms of STEM teachers' competence development in Greece, the Netherlands, Bulgaria and Spain. Presented are the processes and outcomes of the exploration of the national contexts, under the scope of identifying the space of intervention for supporting STEM teachers' professional learning for competence development. The national contexts are explored via documentary analysis of policy documents, STEM teachers training curricula and students' STEM curricula in each country. The analysis allows to provide insights on the dimensions and aspects of competences (knowledge & understanding, skills, dispositions and attitudes) that are explicitly and implicitly evident at policy, policy mediation and teaching practice levels in each country. As an outcome of the exploration of the national contexts, prominent issues for consideration in each country are identified and presented. Complementing the analysis of four national contexts from the perspective of parents, the document "Teacher competences for parental engagement in STEM secondary schools" is presented - providing ground for discussion and reflection among STEM education stakeholders on how to improve teacher training and competence development.
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The background and the scope of the document

The work reported in this document is predicated on the premise that teachers' competence development is crucial to educational reform and school improvement focused on enhancing students' learning outcomes and achievement. This proposition has been highly acknowledged in current educational discourse across Europe (OECD, 2010) and is supported by research findings that indicate the significant, positive correlations between teacher quality and student achievement (Caenna, 2011).

Science, Technology, Engineering and Mathematics (STEM) teachers' competence development, in particular, has been a prevailing area of policy discourse focus, in the view of the challenging roles of STEM teachers to equip both future citizens and future researchers to understand socio-scientific issues, to apply scientific knowledge and skills so as to form evidence based opinions (EC, 2015).

Against this background, this document explores the state-of-affairs in terms of STEM teachers' competence development in four European countries – namely in Greece, the Netherlands, Bulgaria and Spain – as conceptualized and expressed at the levels of policy envisions, policy mediation and practice in each national context. The scope of the exploration of the national contexts is to identify of the space of intervention for supporting STEM teachers' professional learning for teaching competence development.

The role of the document within the ELITe project

This document stems from work developed in the frame of the EASMUS+ ELITe (Enhancing Learning in Teaching via e-inquiries) project. The overall goal of the project is to support teachers' professional learning for competence development, targeting specifically in-service teachers the STEM domain. The ELITe's approach for professional learning propagates the adoption of the inquiry-based (IB) methodology in professional learning activities, under the assumption that teachers' training via IB methodology supports the development of teacher competences. The main tangible outcome of the project is be the development of an evidence-based framework for STEM teachers' competence development via inquiry methodology aiming to inform curriculum design for STEM secondary teachers' continuous professional development and learning. Teacher leaning activities -that inform the development of the framework- take place in 4 countries of the ELITe consortium, namely: Greece, the Netherlands, Bulgaria and Spain, via an online platform, which facilitates personal and collaborative inquiry learning.

For the accomplishment of the ELITE's overall goal, the project adopts a place-based approach for stimulating teachers' competence development through professional learning opportunities. This is deemed necessary in the view of the wide variety prevailing across European countries both in the conceptualization of teaching competences (EC, 2013) and in the form, content and context conditions of teachers' professional development (Caenna, 2011). Under a place-based approach on professional learning for developing teaching competences, the initial project's activities focus on the exploration of the national contexts of Greece, the Netherlands, Bulgaria and Spain in terms of STEM teachers' competence development. The scope of the exploration of national contexts is to develop a thorough understanding of policy envisions and actual practice in STEM teachers' professional learning for competence development, in order to inform the development of the project's leaning in teaching STEM teachers professional development approach via e-inquiries.

Methodological considerations - Framework for the analysis of the national contexts

From a methodological point of view, the exploration of the national contexts in terms of STEM teachers' competence development is based on the Engaged Theory, which is situated among the broad tradition of critical theory. Engaged Theory is a methodological framework for understanding social complexity, which moves from detailed empirical analysis about things, people and processes of the world, to abstract theory about the constitution and social framing

of those things, people and processed (Cooper, 2002). Engaged theory has guided the structure of the analytical framework developed for the investigation of the national contexts, in the respect that the framework's contents are organized under the presupposition that the themes/areas of focus selected are the most relevant in relation to the aims that the framework seek to achieve.

The framework for analysis on the national contexts in terms envisions and requirements of STEM teachers' competences has been informed by current literature relating to definitional and conceptual issues in terms of teachers' competences and considers the following elements:

- ***Focus on teachers' competences (rather than teaching competences) under a systemic analytical approach:*** Current literature distinguishes between teaching competences and teacher competences. Teaching competences are focused on the role of the teacher in the classroom, directly linked with the 'craft' of teaching - with professional knowledge and skills mobilised for action (Hagger & McIntyre, 2006). Teacher competences*,* on the other hand, imply a wider, systemic view of teacher professionalism, on multiple levels – the individual, the school, the local community, professional networks." (EC, 2013. p10). The focus of our work is on the exportation of teacher competences following a systemic approach for investigation: the framework for analysis of the national contexts in terms of STEM teachers' competences considers three levels of systematic analysis: *1. the macro-level* regarding wider policy envisions and requirements, *2. the meso-level* – relating to the way teacher training institutions and initiatives mediate the implementation of policies and *3. the micro-level* – regarding classroom implementation requirements. Such an approach is deemed necessary as it allows the identification prominent issues relating to policy priorities, managing/mediating mechanisms and actual implementation, which will facilitate the identification of the space of intervention for supporting STEM teachers' professional learning.

- ***Exploration of both explicit and implicit policy envisions/requirements on STEM teachers' competences:*** As documented in EC (2012, p10) in terms of the responsibility for the definition of teachers' competences in EU countries, the levels at which key decisions are taken about the competences required to be employed as a teacher vary. In a few Member States (e.g. Cyprus, Estonia, Slovenia, Germany and UK) the decision is centralised and taken by ministries or other government bodies. In a large number of countries (e.g. Austria, Belgium, Bulgaria, Denmark, France, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden) competence requirements are outlined at national level, but are adapted or further defined at a lower level by teacher education institutions. In few other Member States (e.g. Finland, Czech Republic, Greece, and Malta) the competence requirements are only set by teacher education institutions. Those countries where the decision is taken at national level tend to have more explicit and detailed descriptions of the competences that teachers are required to possess. In the countries where teacher education institutions have the autonomy to decide, the definitions of competences of teachers tend to be more diverse. Given this diversity, the objects of the analysis will be: official policy documents referring to (STEM) teachers competence development & initial and CPD curricula from STEM teachers training providers (allowing the identification on whether aspects of the competence are evident) & also STEM curricula for students (allowing the identification of competences which are implicitly evident/required).

- ***Teachers' competences defined as a combination of knowledge, skills and dispositions & attitudes***: Recently, international scholarly consensus seems to converge on the definition of competences as requirements for teaching, articulated in knowledge, skills and dispositions and attitudes. Such a definition focuses on the potentialities of continuous development and achievement, associated with aims and objectives in a lifelong learning perspective. The ELITe's framework for analysis of national contexts considers three dimensions of teachers' competences, namely: knowledge, skills and dispositions & attitudes - adopting Deakin & Crick (2008) definition of competence - according to which a competence is best described as *'a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied*

human action in the world, in a particular domain'. Competence is therefore distinguished from skill, which is defined as the ability to perform complex acts with ease, precision and adaptability.

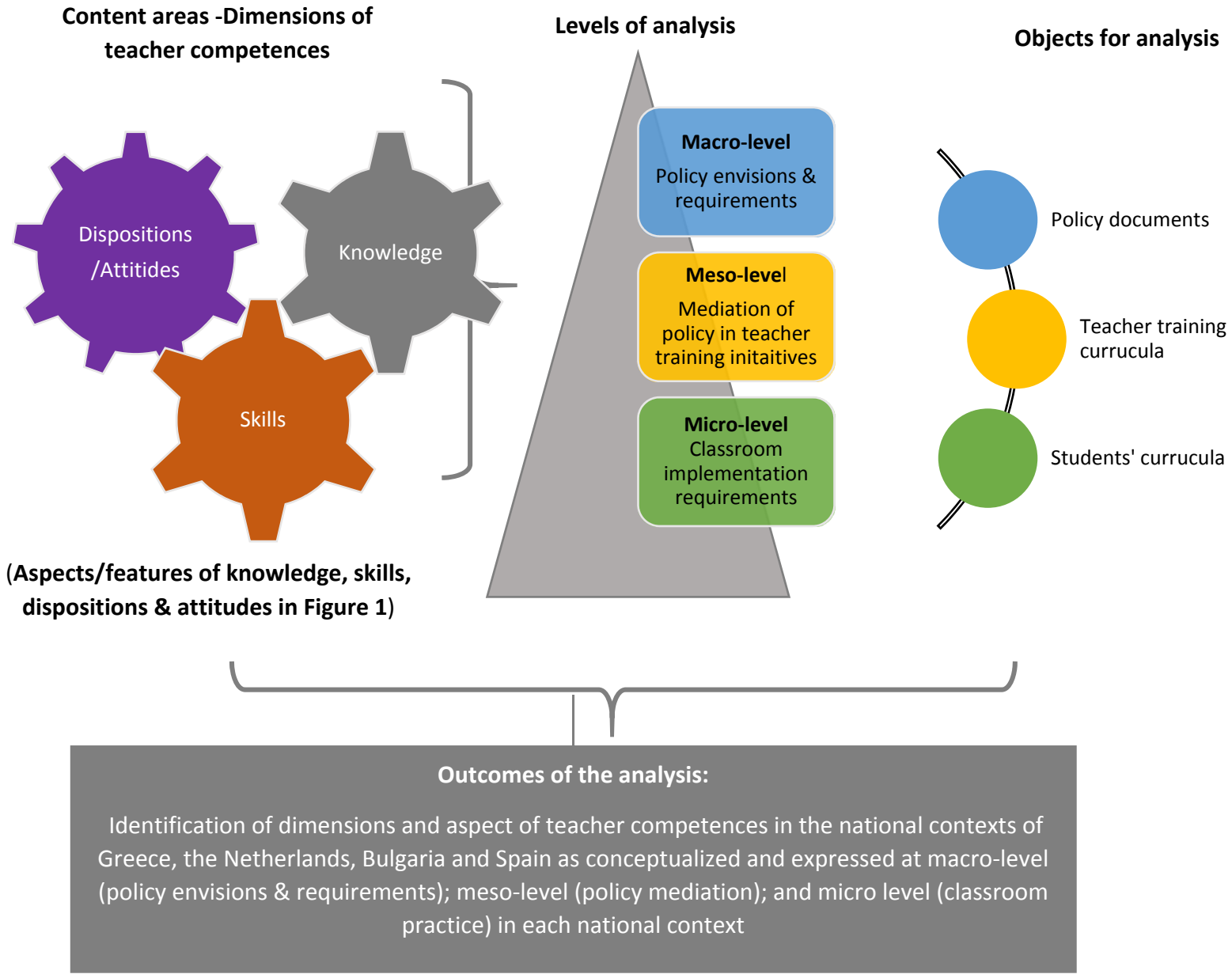
- **Aspects of competences – requirements for knowledge, skills and dispositions & attitudes teachers' professional development**: The ELITe framework adopts aspects of teacher competences as defined in EC (2013, p45-46). These encompass perspectives from policy and research and have been proposed under the scope of being "useful references for a shared discourse between stakeholders and experts, as well as a starting point for further developments in international arenas of educational policy and practice - as suggested in the Commission Staff Working Document 'Supporting the Teaching Professions for Better Learning Outcomes' ". The breaking down of teacher competences – which are essentially dynamic and holistic - into separate areas and components only serves the analytical purpose of understanding the implications and assumptions that underlies them. The following figure outlines the aspects of teachers' competences that have adopted by EC (2013, p45-46) and incorporated in the ELITe framework for the analysis of the national contexts.

Figure 1: *Aspects/features of teachers' competences (EC, 2013) that have informed the framework for analysis of national contexts in terms of teacher competence requirements*

Knowledge	Skills	Dispositions/Attitudes
•Subject matter knowledge •Pedagogical Content Knowledge •Pedagogical knowledge •Curricular knowledge •Educational sciences 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	•Planning, managing and coordinating teaching •Using teaching materials and technologies •Managing students and groups •Monitoring, adapting and assessing teaching/learning objectives and processes •Collecting, analysing, interpreting evidence and data (school learning outcomes, external assessments results) for professional decisions and teaching/learning improvement •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	•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 (including appreciation of diversity and multiculturality) •Critical attitudes to one's own teaching (examining, discussing, questioning practices) •Dispositions to team-working, collaboration and networking •Sense of self-efficacy

To sum up, the framework of the analysis of the national contexts in terms of STEM teachers' competence requirements within the ELITe project consists of the following elements: a) it examines 3 areas/dimensions of teachers' competences -namely knowledge & understanding, skills and dispositions & attitudes; b) it considers aspects/features in the dimensions of knowledge & understandings , skills, dispositions & attitudes as identified in EC (2013); c) it considers three levels of systematic analysis: *1. the macro-level* regarding wider policy envisions and requirements, *2. the meso-level* – relating to the way teacher training institutions and initiatives mediate the implementation of policies and *3. the micro-level* – regarding classroom implementation requirements; d) it defines as objects of the analysis official policy documents referring to (STEM) teachers competence development & initial and CPD curricula from STEM teachers training providers (allowing the identification on whether aspects of the competence are evident) & also STEM curricula for students (allowing the identification of competences which are implicitly evident/required; e) it is embedded on the concern to identify of the space of intervention for supporting STEM teachers' professional learning for teaching competence development.

Figure 2: *The framework for analysis of the national contexts in terms of STEM teacher competences*



Procedural methodology

The exploration of the national contexts of Greece, the Netherlands, Bulgaria and Spain in terms of STEM teachers' competence development was conducted with the aid of the analytical framework presented above. Researchers from FORTH (Greece), OUNL (the Netherlands), UNISOFIA (Bulgaria) and UB (Spain) collected relevant documents (policy documents, STEM teacher training curricula and students STEM curricula) for their national context and conducted a documentary analysis with an aim to explore: recent changes/reforms in the country in terms of policy envisions for STEM teachers competence development; dimensions and aspects of STEM teachers' competences that are explicitly evident in policy documents and in STEM training providers curricula; dimensions and aspects of STEM teachers' competences that are implicitly required in teaching practice (as evident in students STEM curricula). Four national reports were then developed providing insights on the state-of affairs on STEM teachers' competence development in each country at macro-level (policy envisions and requirements), meso-level (as evident in teacher training providers curricula) and micro-level (implicitly required in teaching practice). The exportation of the national contexts allowed the identification of prominent issues for consideration in terms of STEM teachers' competence development in each country, presented in the form of four concise "key-messages" documents (one for each national context). The European Parents Association (EPA) reviewed the outcomes of the exportation of each national context, and developed a document on Parents Association' response to state of affairs in the 4 counties. The purpose of the document is to highlight the need for the development of STEM teachers' competences for engaging parents in all aspects of school work.

An overview of the state-of- affairs on STEM teachers' competence development

Insights on the state-of affairs on STEM teachers' competence development in Greece, the Netherlands, Bulgaria and Spain are provided in this document in detail in Appendix 1 (in the form of four national reports). Presented here below is an overview of-the-state of affairs in each country (executive summary of the national reports).

The case of Greece

Prospective STEM secondary teachers in Greece have been traditionally and are currently being trained and qualified for the teaching profession in the undergraduate programmes of study offered by the university departments of sciences. The pedagogical training of prospective secondary teachers in the university departments has been a longstanding issue in the country. Until very recently the curricula of the undergraduate programmes in science, mathematics and technology departments were not oriented in educating prospective teachers, but concerned mainly the special scientific field with few references to education and pedagogy.

Recently, the discourse articulated at EU policy level on improving teacher quality and teacher education (expressed for example in EC, 2005) has been one the basic drivers of educational change in Greek context of secondary teachers' education and training. The issue of improving teachers' competences is inscribed in both the rhetoric of contemporary political discourse on education (expressed for example in the frame of the establishment of the "*Certificate of pedagogical & teaching competency for secondary teachers*"), and the recent attempted reform initiatives (New school and Social school reforms). Major aspects of competences (knowledge and understanding, skills and dispositions and attitudes) that are identified in the Greek reform for teachers' initial training and professional development include: Knowledge & Understanding: Subject matter knowledge is less emphasised as it is considered as a prerequisite for attending the Programme for acquiring the "Certificate of pedagogical & teaching competency for secondary teachers"; most focus is given on building "professional knowledge", constituting of PCK, Pedagogical knowledge and curricula knowledge; issues of inclusion and diversity. Skills: Most emphasis is given on: using, developing and creating research knowledge to inform practices; reflective, metacognitive and interpersonal skills for learning individually and in professional learning communities; inquiry skills, collecting, analyzing and interpreting evidence and data for teaching/learning improvement; using teaching materials and new technologies. Some emphasis is given on collaboration and negotiation skills with colleagues and parents. Dispositions, beliefs and

attitudes: Most emphasis is given on: dispositions to change, ongoing learning; critical attitudes to one's own teaching; transferable skills; epistemological awareness. Some emphasis is given on collaboration and team-working.

The new Law on secondary teachers' certificate for pedagogical and teaching competency - accompanied with the regulatory framework for secondary teachers' training programmers- is expected to be established in summer 2017; as such currently, STEM teachers education curricula operate in conditions of uncertainty. There is currently lack of information about how the different universities and other institutions have started to and will respond to the new law on teachers' professional development. New curricula are currently being developed. Efforts so far neither provide evidence on competence oriented learning outcomes nor give any insights on innovative methodologies that have the potential to support teachers' competence oriented objectives.

With the focus being turned on students STEM curricula, there seems to be a high level of coherence between the competences required by teachers and the competences that students are aimed to develop via STEM studies. Major skills emphasised in students curricula under the current education intended reform are: Lifelong learning skills; Skills for Responsible citizenship; Reflective and metacognitive skills; Critical thinking; Creativity; Problem solving skills; Risk estimation; Decision making ; Team working; Digital skills. Identified aspects of teachers' competences implicitly required in teaching practice –as evident in STEM curricula- are: In relation to knowledge and understanding: subject matter knowledge; pedagogical content knowledge; pedagogical knowledge; issues of inclusion and diversity; effective use of technologies; developmental psychology; group processes & dynamics, learning theories, motivational issues; evaluation and assessment. In relation to skills: planning, managing and coordinating teaching; using teaching materials and technologies; managing students and groups; collecting, analyzing, interpreting evidence and data for professional decisions and learning/teaching improvement. In relation to dispositions and attitudes: teaching skills through content; commitment to promote learning of all students; dispositions to promote students' democratic attitudes and practices as European citizens.

The case of the Netherlands

Teacher professional development is part of the national agenda in the Netherlands as a warrant of the quality of Dutch education. From 2006 till July 2017, a general teacher competence framework as a 7 competence areas structure functioned as a backbone for curriculum development in pre-service teacher education and in-service teacher professional learning activities.

Recently the teacher competence framework has been updated, and formulated three generic competence areas/pillars: subject matter, teaching and pedagogical expertise. For each pillar relevant knowledge and skills are defined. In specific in terms of knowledge: Up-to date domain knowledge; relations with adjacent areas; learning and instructional theories; development and behavioural sciences; instructional psychology; learning sciences; pedagogical science; inclusive education; personalised learning. In terms of skills: can explain, give an overview, demonstrate and present both the theoretical frameworks as practical applications; can position and relate to other disciplines within the curriculum; can make links to daily practice and possible further educational trajectories; can give feedback; can explain content; can stimulate learners to learn actively; can realize outcome-based learning; can lead, monitor, steer group process; can win trust; can create safe pedagogical climate; can create a climate that stimulates learning, including making mistakes. As for dispositions and attitudes, emphasized are: disposition to reflect on one's own knowledge, to learn from each other in school and outside, individually and in teams.

Specifically for secondary education in STEM disciplines the teacher competence framework lays emphasis on design and development perspective including the ability to effectively utilize existing curricular resources to design instruction and to interact with tools and resources; making sense of and using tools/resources to design and enact instruction and to adapt curricula, resources, and learning environments to new insights and new teacher roles as coaches and facilitators of learning.

Dimensions and aspects of STEM teachers' competences evident in teacher education curricula in the country are: In relation to knowledge: discipline specific subjects, educational science and pedagogy, pedagogical content knowledge; In-depth domain specific knowledge, knowledge of educational science; pedagogical content knowledge; design aspects for STEM-subjects. In relation to skills (a large component of all curricula) – in-service or internship at schools; Dispositions: development of reflective and inquiry habit of mind (a new emphasis); profession related skills are

trained during internships in schools. *Education design skills* – develop, apply and evaluate. *Research skills*: developed and demonstrated through a Master thesis, an independent research project conducted in the educational practice. In relation to dispositions: professional dispositions (functioning in a team, in the school as a professional organization and acting as an academically trained professional; critical thinking.

At the classroom/students' curricula level, in the context of teacher competence development the following developments are relevant: the introduction of "Studiehuis", guided and independent (project based) learning in the lower secondary school with the teacher positioned as a coach instead of the exclusive source of knowledge and "a sage on the stage"; "Tweede fase", or the second (upper) school phase curriculum innovation with a focus on development of generic skills, cross-disciplinary and higher order skills like information problem solving and research skills in secondary school curricula and examination & assessment programs. As a consequence, a mayor applied task of conducting an independent inquiry or design project has become a constituent part of the final examination program and school curriculum. Both developments implied mayor shifts in the organization of the teaching process from instruction and knowledge transmission to guidance of independent and group work and monitoring student learning within school disciplines and in cross-discipline learning activities, including stimulating independent learning (inquiry) skills in children. A STEM-specific development concerns the curriculum of Technasium with high requirements for both domain knowledge and pedagogical and didactical skills of the teachers. Thus, the core subject of Technasia, R & D, requires besides in-depth discipline related knowledge, the ability to design project-based activities and design skills and organization of curriculum. Functioning in regional networks requires social networking skills.

The case of Bulgaria

During the last decades, Bulgaria was faced with the need of dramatic changes in educational system and regulatory framework. The reform has started in 2010 and since 2016 it is in the effective use. The educational reform defines new profile of the teacher as a main actor in the educational process. The change of the in-service teachers' knowledge, skills and attitudes, as well as professional life habits and behavior in parallel with accepting of new understanding of teachers' responsibilities is a big challenge not only for teachers themselves but also for supporting institutions.

The national policy documents, influenced by relevant European policy documents provide evidence for requirements for covering each of three key dimensions of teachers' competences - knowledge and understanding, skills, dispositions and attitudes. The basic aspect of required knowledge is the deep knowledge of subject matter. In addition, special attention in the policy documents is dedicated to inclusive education. The use of innovative teaching methods in all teaching disciplines is also emphasised. Another aspect evident is knowledge and understanding of evaluation and assessment methodologies and technics. In relation to required skills, planning, teaching, evaluation and assessment, class/group management skills are emphasized. Among required skills are communicative skills (including team working skills and skills for collaborating with parents and stakeholders) and administrative skills. In relation to teachers' dispositions and attitudes, current legislation pays special attention to the commitment to promoting the learning to all students. The ordinances accompanying the new law emphasises teachers dispositions to change, flexibility, ongoing learning and professional improvement, including study and research. The promotion of students' attitudes and practices as European citizens is also part of the national policy agenda.

The Low of pre-school and school education and accompanied regulatory framework is quite new – it is in effect from the 2016 and as such at the moment the institutions, responsible for teacher's education and development are in process of development new educational plans and curricula. For this reason there is currently a lack of information about how the different universities and other institution will respond to the new rules in teachers' development. Noted should be that the separate faculties (preparing teachers in different disciplines) have their academic autonomy in in decision what subjects to teach, under which curricula, how deep and what content to include. Currently, STEM teachers' education curricula are structured in terms of a subject matter course, dedicated to the new curricula in specific subject and class; innovative methods of teaching and applications of ICT in specific subject education.

At the classroom/students' curricula level, in the context of teacher competence development, the national standards for STEM education require STEM teachers to be very well familiarized with the subject matter. Skills implicitly evident in students' curricula relate to teachers ability to lead inquiry based processes so as to facilitate the development of research skills to the students. Teachers' competences implicitly evident in students' curricula are also critical thinking, creativeness, team working skills and work on a project skills.

The case of Spain

The National Policy focusing currently on teacher competences is reflected on the "Strategic Framework for Educators' Professional Development". This is a holistic framework whose goals are: (1) to structure initial and in-service teacher training around a new competence model of education professionals from the 21st century, (2) to explore new training modalities that facilitate collaboration among teaching professionals and (3) to establish a common regulation framework which allows for professional competence certification and certification of activities which show evidence of an effective professional development for teachers and trainers. The framework is composed by three main pillars: Professional teacher competences (aiming to redefining the profile of the teaching professionals through a competence framework for educational professionals, which should allow teachers to develop and assess students' competences); New training modalities: (aiming to incorporate learning which takes place in online communities of practice and other innovative learning opportunities into certified teacher training programmes); Regularisation of training (concerned with updating regulation about certification of teacher training around professional competences).

Currently universities have undergone an important challenge on creating Master programs (Masters' degree in secondary education) under a competence oriented approach (focusing on learners' promotion of knowledge, skills and attitudes). Competences emphasized in the Inter-University Masters' Degree programs for teachers accreditation in STEM-related subjects are: In terms of knowledge and understanding: subject matter 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; learning theories and motivational issues; evaluation and assessment. In relation to skills, emphasized aspects are: planning, managing and coordinating teaching; using teaching materials and technologies; managing students and groups; using, developing and creating knowledge to inform practice; reflective, metacognitive skills; adapting to educational contexts. In relation to dispositions and attitudes: epistemological awareness; teaching skills through content; disposition to change, flexibility; commitment to promote learning of all students; dispositions to promote students democratic attitudes; dispositions to team working.

At a teaching practice level, the Educational law to enhance the quality of the educational system, emphasizes the development of students' competences. Competences are present in the curriculum development and assessment of all educational levels and modalities. Moreover, the Law states that cognitive abilities must be accompanied by students' acquisition of transversal competences such as critical thinking, management of diversity, creativity and communication skills. In 2007 basic competences were introduced for the first time in the Spanish National Curriculum for Secondary education, bearing strong similarities with those set in the European Reference Framework (European Commission, 2008): linguistic communication, mathematic competence, competence in knowledge and interaction with the physical world, digital and information processing competence, social and citizenship competence, cultural and artistic competence, learning to learn, and personal autonomy and initiative. The Curriculum states that students must acquire the appropriate level of the competences by the end of compulsory education. Moreover, it explains how each subject such as Spanish Language, Mathematics, Physical Education, etc. contributes to the acquisition of the aforementioned competences. A review of students' STEM curricula in the country provides evidence that the following aspects of teachers' competences are implicitly required by STEM teachers in the country: In relation to Knowledge & Understanding: Pedagogical Content Knowledge; Issues of inclusion and diversity; Effective use of technologies in learning. In relation to skills: Collecting analyzing, interpreting evidence and data for teaching/learning improvement; Using, developing and creating research knowledge to inform practices. In relation to Dispositions &

Attitudes: Dispositions to promote students' democratic attitudes and practices as European citizens (including appreciation of diversity and multiculturality); Dispositions to team working, collaboration and networking.

Issues for consideration in terms of STEM teachers' competence development in Greece, the Netherlands, Bulgaria and Spain

The exportation of the national contexts allowed the identification of prominent issues for consideration in terms of STEM teachers' competence development in each country, presented in the form of four concise "key-messages" documents (see Appendix 2 of the document). As evident in these documents:

In Greece, current policy initiatives and reforms relation to teachers; competence development are in line with EU policy frameworks on the issue (EC, 2005; EC, 2013). In addition, there seems to be a high level of coherence between the competences required by teachers and the competences that students are aimed to develop via STEM studies. However, there is a lack of coherence between was is envisioned in policy rhetoric and what is evident in teacher training curricula. The role of innovative training methodologies – as a means towards supporting teachers' competence oriented objectives - should be re-considered by teacher training institutions, as a step towards bridging the gap between what is envisioned in theory and is implemented in practice.

In the Dutch context, a regularity framework for teachers' competence development has long been in place and has recently been updated, while teachers training curricula are competence-oriented. Main issues for further exploration and discussion identified are: the pre-requisites for sustainable teacher learning and competence development against the newly defined teacher competence quality standards and beyond them; the question of how school boards ensure that innovation and teacher professional learning innovate and transform the current school practice and vice a versa how innovative practice insures sustainable teacher learning; the impact the new trends in students' STEM curricula implicate for teacher professional learning and competence development and the implications they have on the school practice.

In the Bulgarian context, the educational reform defines a new profile of the teacher as a main actor in the educational process. The change of the in-service teachers' knowledge, skills and attitudes, as well as professional life habits and behavior in parallel with accepting of new understanding of teachers' responsibilities is a big challenge not only for teachers themselves but also for supporting institutions. Identified challenges in the national context are: The academic, pedagogical, communicative and administrative teachers' competences needed to be developed and supported all together; Teachers need to act as a researchers and innovation providers in the classroom; Schools and teachers are more flexible to reflect to the users' expectations and economy changes, and they need to manage their own strategy, curricula and teaching approaches; the teaching training institutions needs to respond to the new requirements of schools and teachers with new curricula and updated learning content, and to be flexible for permanently changing requirements; Institutions and organization, eligible to provide short-term thematic training courses, need to be prepare for their new role and for understand of such a responsibility; The application of IBL in STEM subject teaching should be interweave in development of competences, curricula, training and practice in all level and institutions. The above are not only a challenge for all the stakeholders but they also provide a set of possibilities for new way of communication and collaboration between institutions.

In Spain, competence-based education is supported by law in all level of compulsory education and baccalaureate. Key competencies are part of the evaluation of the effectiveness of the educational system. Furthermore, the Spanish reform recommends methods to facilitate methodological strategies that allow for classroom competencies work. Among the most prominent issues for negotiation and discussion identified are: Weariness in front of the continuous legal changes and budget cut-outs; Lack of coordination among the national, regional CPD providers in terms of policies and strategic plans for STEM CPD that respond to these changes. At a policy mediation level, among the most prominent issues are: Teacher education programmes need to get used to work according to a competence-based

approach, working co-ordinately in all subjects with other key competencies (e.g. digital competencies); CPD programmes need to integrate those methodologies and innovations that favour the acquisition of STEM competencies, as e.g IBL, PBL, OSR, ICT, Gender; need to provide STEM training paths for in-service teachers in collaboration with different types of institutions, e.g. science centres, research centres, universities and governmental initiatives. At a teaching practice level: For teachers, there is a surplus of subjects and contents, obsession for finishing the programs, as well as a tendency to use summative evaluation; for students, there is a lack of interest on contents because students do not find their connections with reality; parents need more information on the importance of implementing STEM innovations in the schools, so they can be involved on the decision-making on their particular centres.

Teacher competences for parental engagement in STEM in secondary schools

Position of the European Parents' Association on STEM teachers' competence development in reaction to the state-of affairs-reports

Official EU policy has recognised the importance of engaging parents and learners in all aspects of education since the early 2010's. A need to assess and improve teachers' collaboration and negotiation skills has also been identified as an important development field to transform European education systems to meet the needs of 21st century learners, and thus also help to achieve the EU2020 headline target of reducing early school leaving. The lines here below aim to complement the analysis of four national contexts from the perspective of parents, to provide ground for discussion and reflection among STEM education stakeholders on how to improve teacher training and competence development – both pre- and in-service.

Recognition of parents as primary educators: Legally and de facto parents are the primary – first, but also most impacting at all ages - educators of their children. In teacher trainings, this is not used as a starting point, parents are often shown and thus seen as a burden, an extra task. Innovative approaches must include this as a starting point, empower teachers in innovative training for parental engagement and cooperation. Necessary methodology is to be offered to teachers to empower parents.

Parental engagement & teacher training: prominent issues for consideration

- teacher training does not aim at understanding that parental engagement is an obligation for both the school and the parent, and does not offer methodology to make parents also understand this – parents staying away and not 'interfering' are still considered a positive role model, while they it is a legal obligation of the parent to be involved in designing elements of the right educational pathway for their children
- teachers in Europe confront difficulties in making parents understand the need for innovation – although parents want the best for their children, the vast majority of them has no other reference point than their own schooling and experiences, but they bring real life and realistic future needs to the school that could be used as a basis
- teacher training does not consider co-designing curricula building on personal experiences and professional knowledge of parents
- teacher training does not offer methodology to support STEM-at-home

The role of parents in teacher training: It is still seen as unusual, happens very rarely that parents or parents' associations are invited to offer part of training for teachers, and co-training of teachers and parents is also nearly unheard of. This should be considered as a necessary element, to include the parents' associations' experiences and expectations on cooperation.

Make transitions smooth – have knowledge about and cooperate with tertiary education: The content of STEM curricula is a very delicate one. When designing local and individualised curricula, teachers should be able to make the right choices to include knowledge for everyday life, but also to prepare students for their respective career pathways, not teaching tertiary curricular content in secondary.

Gender: Early childhood links are crucial also for balancing the gender bias happening early. Secondary teachers' training should include elements that help parents in avoiding gender bias with their younger children and also to help other parents in it.

Need to change general public opinion: For strengthening a balanced approach to STEM there is a need to change general public opinion and bias towards arts subjects (that considers it 'normal' that somebody is bad at maths, not interested in chemistry, etc.). Innovative teaching methodologies and media (including social) presence have led to changes of general attitudes. Innovative methodologies for this should include real life connections, a holistic approach to STEM, to decrease subject segregation (and to stop it in primary) and to put emphasis on soft skills necessary for lifelong learning and future life-success (as an employee, a citizen and in private life),

Use of digital technology: When using digital technologies in training and also in STEM teaching, the digital divide should be considered. Internet penetration and the use of smartphones, tablets, etc. is different in different countries. Digital technology is a great asset in STEM, so teachers should be prepared for exploring individual access of students, and also to encourage the use of public offer (libraries, internet centres, and school access). Digital technology use at home and at school can help make the real-life connection as well as increase attractiveness. Teachers' awareness levels are to be raised of resources, teacher communities on the internet, but they should also be able to use digital technologies for parental engagement in a way comfortable for everyone – taking into consideration parents' schedules, but without too much intrusion into their private lives.

Ensuring the children's voice: In most cases, it falls on parents to ensure that they are given a real voice and decision-making power with regards to their own personal learning pathways as well as the STEM offer of the school. Child rights, the best interest of the child and their impact on school life is often missing from training.

A key to ensuring education reform for a 21st century education we need to put the learner in focus and offer learning pathways individualized enough to be relevant and attractive for each and all. This is crucial in education in general, but even more so in STEM education, an area still not held at high enough esteem by many, but an absolute necessity in present and future labor markets. This needs a collaboration of all stakeholders, but especially students, parents and teachers, and must be based on new approaches to training, empowerment and teaching. In this document, reflecting on the state of play in four very different European countries and feedback from parents, the aim was so draft an ideal scenario and highlight areas to tackle in training of STEM teachers, most of them not traditional, subject-specific areas, and to offer a starting point for training development.

Concluding remarks

This document aimed to enhance understandings on the state-of-affairs in terms of STEM teachers' competence development in Greece, the Netherlands, Bulgaria and Spain. Presented were the processes and outcomes of the exploration of the national contexts, under the scope of identifying the space of intervention for supporting STEM teachers' professional learning for competence development. The national contexts were explored via documentary analysis of policy documents, STEM teachers training curricula and students' STEM curricula in each country. The analysis allowed to provide insights on the dimensions and aspects of competences (knowledge & understanding, skills, dispositions and attitudes) that are explicitly and implicitly evident at policy, policy mediation and teaching practice levels in each country (presented in national reports in Appendix 1). As an outcome of the exploration of the national contexts, prominent issues for consideration in each country were identified and presented concisely (in key-messages documents in Appendix 2). Complementing the analysis of four national contexts from the perspective of parents, the document "Teacher competences for parental engagement in STEM secondary schools" was presented - providing ground for discussion and reflection among STEM education stakeholders on how to improve teacher training and competence development.

Concluding, the work reported in this document provides evidence that in Greece, the Netherlands, Bulgaria and Spain STEM teachers' competence development is currently a prominent issue in the policy agenda as a warrant of quality

in education, in line with the priorities of the EU policy agenda for education and training. Major aspect of teacher competences (knowledge & understanding, skills, dispositions & attitudes) as defined in EC (2013) framework are emphasised in national policy documents. In the Dutch and the Spanish contexts policy frameworks for teachers' competence development are in place from 2006 and have recently been updated. However, while in the Netherlands the regulatory framework 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, the establishment of a regulatory framework for teacher education under a competence development orientation is a part of very recent reform initiatives; as such, currently there is uncertainty on how providers of teacher education and training will respond to and implement the new regulatory framework. 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.

From an ELITe project specific perspective, outcomes of the work reported in this document aim to inform subsequent project's activities in two respects: on the one hand, the four national reports constitute the background documents, the synthesis of which will enable the identification of context-based indicators for evaluating STEM teachers' competence development (which will be reported in Intellectual output O2); on the other hand, the four key messages documents will be communicated to and negotiated with educational stakeholders during the Multiplying Evens in the 4 countries, under the scope of identifying systemic opportunities and challenges for STEM teachers' competence development in the 4 countries of the consortium that will implement training activities (which will be reported in Intellectual output O3). As such, the work reported in this document contributes to the accomplishment of the overall goal of the project, by providing the basis under which the project's learning in teaching approach via e-inquiries will be developed, implemented and evaluated.

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Appendix 1 – National Reports on state-of-affairs on STEM teachers competence development

Key Action 2 – Strategic Partnerships for school education

ELITe: Enhancing Learning in Teaching via e-inquiries

Agreement No. 2016-1-EL01-KA201-023647

Policy envisions and requirements for STEM teachers' competence development: State of affairs in GREECE

by Foteini Chaimala[1]

Recent changes in Greece in terms of policy envisions for STEM teachers competence development

Prospective Science, Technology, Engineering and Mathematics (STEM) secondary teachers in Greece have been traditionally and are currently being trained and qualified for the teaching profession in the undergraduate programmes of study offered by the university departments of sciences - with subject specialisms in mathematics, physics, chemistry, technology etc. Each university department has the autonomy and the responsibility to decide on the training and qualification programmes. The recruitment of STEM secondary teachers in public schools is based – from 1998- on competitive national examinations organized by an independent personnel selection authority (ASEP). Entitled to participate in these exams are STEM graduates - who are tested on: a) subject matter knowledge, b) pedagogical knowledge and c) pedagogical content knowledge. Candidates who pass the exams are employed by central or regional education authorities and become career civil servants.

The pedagogical training of prospective secondary teachers in the university departments has been a longstanding issue in the country (Sarakinioti & Tsatsaroni, 2015). Until very recently the curricula of the undergraduate programmes in science, mathematics and technology departments were not oriented in educating prospective teachers, but concerned mainly the special scientific field with few references to education and pedagogy (Gordon et al., 2009). Teacher competence requirements – where evident in the training and qualification programmes for prospective teachers - were defined by each university department, without being outlined by the ministry of education or other government bodies. As a result, in Greece the definitions of competences that teachers are required to possess were until recently neither explicit nor being detailed described, and tended to be diverse (EC, 2012).

The issues of learning outcomes and competences in teachers' education in Greece begun to appear on the official political agenda very recently in the country, mainly due to EU pressure to develop National Qualification Framework (NQF). Before the decade of 2000s curricular knowledge, educational qualifications and skills were not central issues in the public debate on the universities (Sarakinioti & Tsatsaroni, 2015). The changes promoted to the university study programmes in the 2000s were mainly linked to the implementation of the Operational Programme for Education and Training II (OPEVEIT II, 2000-2006), and in specific to the 2nd priority action line of the programme referring to the

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promotion and enhancement of education and vocational training within the framework of an integrated system of lifelong learning.

Recently, the discourse articulated at EU policy level on improving teacher quality and teacher education (expressed for example in EC, 2005) has been one the basic drivers of educational change in Greek context of secondary teachers' education and training. The issue of improving teachers' competences is inscribed in both the rhetoric of contemporary political discourse on education, and the recent attempted reform initiatives of the 'New School-Student First' (ministry of Education, 2009) and the 'Social School' (Ministry of Education, 2014) - aiming at an open, more inclusive, innovative and efficient school, as well as exerting pressures to make teachers more competent, productive and effective.

From 2009 onwards, the objective of "being accountable to others" has been spreading as a dominant element in the reformative discourses about institutions delivering teacher education. Policies and practices of accountability were deemed to be an imposition of external criteria of evaluation, attempting to regulate the pedagogical context of knowledge organisations (Sarakinioti, 2014). The legislation (Law 3848/2010) has been crucial in policy developments because it specified key competencies for teachers and leaders in education, and introduced evaluation and quality assurance for primary and secondary teachers and schools. In addition, in 2013 (Law 4142/2013) teachers found themselves at a crossroad of deep reforms regarding their qualifications and competencies, as well as their effectiveness to respond successfully to the demands and new standards of education quality. During the last five years, controversies and resistance has evolved, emanating from the academic community and various social, political and professional groups, leading in January 2015 to the abolition of Law 4142/2013, relating to teachers' qualifications and required competencies.

Currently, teacher education curricula operate in conditions of uncertainty, caused by an absence of a governmental framework for teachers' education and training. Most recent policy initiatives on training and continuous development of teachers – among which STEM teachers- are concerned with the establishment of the "Certificate of pedagogical & teaching competency for secondary teachers" - expected to be established by law in the summer of 2017.

Dimensions and aspects of STEM teachers' competences that are evident in policy documents in Greece

The most recent policy document concerned with secondary teachers education and training in Greece was released on May 2016 by the Educational Committee of the Greek Parliament (White paper, 2016). The document formulates recommendations towards educational reform, among others concerning a) the establishment of the "Certificate of pedagogical & teaching competency for secondary teachers" and b) the systematic and continuous professional development of secondary teachers. The paper defines specifications for teacher education and training curricula, under a learning outcomes and teacher competence orientation. According to the document, university departments are recommended to develop specific programmes for their graduates that would like to follow teaching careers that will provide them with "*the necessary knowledge, skills and attitudes, so as to be able to respond with integrity and accountability to the educational work and to the mission of educating tomorrow citizens*" (White paper, 2016, p 55). On the other hand, continuous professional activities should be mainstreamed aiming at "*the up-dating and upgrading the knowledge and skills of the teachers*" (White paper, 2016, p 55).

As in the White paper (2016), the prospective teachers learning outcomes from the participation in programmes for acquiring the Certificate of pedagogical & teaching competency are:

- learn to critically review the multiple ways of linking theory to practice;
- to explore and transform existing beliefs and practices;
- to balance the cognitive and pedagogical aspects of their work;

- to interpret and exploit the experiences with the help of theory;
- and to build professional knowledge.

Major aspects of competences (knowledge & understanding, skills and dispositions & attitudes) that are evident in the policy document for teachers' initial training and professional development include:

In relation to knowledge & understanding

- *"Learn the theories and the outcomes of research on development and learning (cognitive, psychosocial, moral development of students) and to acquire methodological tools for effective use in teaching practice***". *Aspects of competence evident: Pedagogical Knowledge & Developmental psychology***
- *"To recognize the theories embedded in the students' curricula".* ***Aspect of competence evident: Curricular knowledge.***
- ***"***Familiarize themselves with the various theoretical approaches relating to the role and the importance of education at individual and social levels, the basic functions of education, school as institutionalized organization and as a space of social interaction, as well as the dimensions of both professional and social role of the teacher". ***Aspects of competence evident: Educational sciences foundations; Contextual, institutional, organizational aspects of educational policies***
- *"To have knowledge on the management of the educational units and the management of human resources".* ***Aspect of competence evident: Contextual, institutional, organizational aspects of educational policies***
- *"Use of new technologies".* ***Aspect of competence evident: Effective use of new technologies.***
- *"Critically understand the principles on which the different pedagogical approaches on Heterogeneity (interculturalism, gender, religion, etc.) are based".* ***Aspect of competence evident: Issues of inclusion and diversity***

In relation to teachers' skills development

- *"Be able to associate developments in relation to epistemology with teaching objectives, decisions and practices*". ***Aspect of competence evident: Reflective and metacognitive skills***
- "To develop skills of systematic observation, monitoring and critical review of the didactical practice". ***Aspect of competence evident: Monitoring, adapting and assessing teaching/learning objectives and processes***
- "*To develop the ability to recognize the theories embedded in the students' curricula and the skills to transform them creatively through experimentation via the didactic practice.* ***Aspect of competence evident: Reflective and metacognitive skills***
- "Acquire the competence to investigate the suitability of various theoretical perspectives for teaching and learning, and the aligned to them methods in relation to the specific, learning environment (subject, teaching purposes and objectives, age of students, network of relationships and interactions, etc.)" ***Aspect of competence evident: Using research knowledge to inform practices***
- "Be able to responsibly design and realize lesson plans, and to experiment for renewing dynamically the didactic practice. This renewal may be relevant to the production and new educational material, alternative teaching methods, new types of interaction with pupils, use of new technologies, etc." ***Aspects of competence evident: Planning, managing and coordinating teaching; Using teaching materials & technologies***

- *"Be able to recognize behind the didactic practices teachers' assumptions on teaching and learning."* ***Aspect of competence evident: Reflective and metacognitive skills***

In relation to teachers' dispositions & attitudes

- "*To learn about developments in relation to the epistemology of the teaching/learning subject".* ***Aspect of competence evident: Epistemological awareness***
- "Acquire the ability to critically understand the principles on which the different pedagogical approaches on heterogeneity (interculturalism, gender, religion, etc.) are based". ***Aspect of competence evident: Appreciation of diversity and multiculturalism***
- "Be able to responsibly design and realize lesson plans, and to experiment for renewing dynamically the didactic practice. This renewal may be relevant to the production and new educational material, alternative teaching methods, new types of interaction with pupils, use of new technologies, etc." ***Aspect of competence evident: Dispositions to change, flexibility, ongoing learning and professional improvement, including study and research***
- *"Be able to recognize behind the didactic practices teachers' assumptions on teaching and learning."* ***Aspect of competence evident: Critical attitudes to ones' own teaching***
- *"Encourage the collaboration between colleagues, so as to reinforce a collaborative culture".* ***Aspect of competence evident: Dispositions to team-working, collaboration and networking***
- *"Take into consideration aspects of differentiation in teaching/learning, special education, multiculturalism".* ***Aspect of competence evident: Promoting learning of all students***

In short, aspects of competences (knowledge, skills and dispositions and attitudes) that are evident in the policy document for teachers' initial training and professional development are summarized in Figure 1 below.

Figure 1: *Aspects of competences (knowledge & understanding, skills, dispositions & attitudes) that are evident in policy documents for teachers' initial training and professional development in Greece*

Knowledge & Undestanding	Skills	Dispositions & Attitudes
•Pedagogical Knowledge •Developmental psychology •Curricular knowledge •Educational sciences foundations •Contextual, institutional, organizational aspects of educational policies •Effective use of new technologies •Issues of inclusion and diversity	•Reflective and metacognitive skills •Monitoring, adapting and assessing teaching/learning objectives and processes •Using research knowledge to inform practices •Planning, managing and coordinating teaching •Using teaching materials & technologies	•Epistemological awareness •Appreciation of diversity and multiculturalism •Dispositions to change, flexibility, ongoing learning and professional improvement, including study and research •Critical attitudes to ones' own teaching •Dispositions to team-working, collaboration and networking •Promoting learning of all students

Dimensions and aspects of STEM teachers' competences that are evident in teacher training curricula in Greece

Initial training for secondary education teachers falls under the Higher Education University or Technological sector, while all teachers hold at least a first cycle degree. With regard to conditions of service and terms of employment, as of school year 2010-2011, Law 3848/2010 "Upgrading teacher's role – establishment of assessment and meritocracy rules in education and other provisions" came into force establishing the acquisition of a pedagogical training certificate for teachers of the above mentioned levels and introducing a new standing and objective appointment procedure with the successful participation in the Supreme Council for Civil Personnel Selection (A.S.E.P.) examination being the necessary condition for permanent teachers' appointment or substitute teachers' recruitment under a fixed term employment contract governed by private law, when there are vacant posts to be filled. In particular, teachers' appointment/employment is based exclusively on ranking lists including the names of those who have successfully participated in the above mentioned examination, while academic qualifications, social criteria and actual prior teaching service are taken into consideration. In the context of the said law, emphasis is placed on issues pertaining not only to the education and assessment of the teaching staff but also to self-assessment/ school assessment (Education for All 2015 National Review Report: Greece, p.34). Continuous professional development for STEM teachers is provided by the Institute of Educational Policy (IEP) and the Peripheral Teacher Training Centres (PEK) in each region. The programme currently being implemented for teachers' continuous professional development is: Training of Teachers for the Exploitation and Implementation of Digital Technologies in the Teaching Practice (Level 2 Training).

The new Law on secondary teachers' certificate for pedagogical and teaching competency - accompanied with the regulatory framework for secondary teachers' training programmers- is expected to be established in summer 2017; as such currently, STEM teachers education curricula operate in conditions of uncertainty. A number of university departments have already started to implement programmes for secondary teachers' pedagogical competence development; however, such programmes are at an early stage of implememation by the relevant departments and at present there is no research on the rate of expansion of such courses (Sarakinioti & Tsatsaroni, 2015). Noted should be that not only the universities, but also the separate faculties (preparing teachers in different disciplines) have their academic autonomy in deciding what subjects to teach, under which curricula, how deep and what content to include. For these reasons there is currently lack of information about how the different universities and other institutions have started to and will respond to the new law on teachers' professional development. New curricula are currently being developed. Efforts so far neither provide evidence on competence oriented learning outcomes- as teacher curricula remain subject oriented- nor give any insights on innovative methodologies that have the potential to support teachers' competence oriented objectives.

Dimensions and aspects of STEM teachers' competences that are implicitly evident from students STEM curricula in Greece

General secondary education in Greece is divided in two tiers: Gymnasio (lower secondary school) and Lyleio (upper secondary school). Regarding Gymnasio, its aim is to promote the well-rounded development of the pupils according to their age-related capabilities and the corresponding demands of life. In particular, Gymnasio aims to help pupils: to broaden their system of values (moral, humanitarian and other); to combine knowledge acquisition with current social issues, in order to successfully deal with different situations and seek for responsible solutions to problems, amid a climate of creative dialogue and collective effort; to cultivate their linguistic expression, formulating their thoughts clearly and correctly, both orally and in writing; to improve their physical fitness and cultivate their talents and physical skills; to become acquainted with the various art forms and create a set of aesthetic criteria useful for their own cultural expression; to realize their capabilities, disposition, skills and interests, acquire knowledge of various professions and pursue their further improvement in the context of cultural, social and economic life in order to evolve

in harmony as individuals and future employees, fully aware of the equal contribution of spiritual and manual work to social progress and development (Education for All 2015 National Review Report: Greece, p.15). Regarding Lykeio, its aim is: to provide a high level of general knowledge, to develop the students' abilities, initiative, creativity and critical thinking, to offer the pupils the knowledge and abilities necessary to continue their studies on to the next level of education, to cultivate pupils' skills which will, after specialisation or training, facilitate their access to the labour market (Education for All 2015 National Review Report: Greece, p.20).

In relation to recent and current initiatives and developments aiming to promote quality in education, the "New School - Student First' reform (ministry of Education, 2009) has aimed at serving certain educational strategic objectives, such as:

- promotion of lifelong learning;
- quality improvement of education; promotion of social cohesion and active citizenship;
- enhancement of innovation, creativity and entrepreneurship.

Current education reform initiative 'Social School' (Ministry of Education, 2014) emphasizes the following objectives for students learning and skills development:

- Lifelong learning skills;
- skills for responsible citizenship;
- reflective and metacognitive skills;
- critical thinking;
- creativity;
- problem solving skills;
- risk estimating;
- decision making;
- team working;
- digital skills.

In relation to STEM secondary education, according to the national framework of studying programmes for secondary education (DEPPS), STEM teaching and learning aims to contribute towards students developing competences (knowledge, skills and attitudes) necessary for their future role as informed citizens in a knowledge-based society. In specific, STEM teaching and learning in secondary education should contribute towards:

- the acquisition of knowledge about theories, laws and principles related to individual subjects so that the students are able to "interpret" phenomena and processes and their relations with the environment in which they live;
- developing the personality of the students, by promoting independent thinking, motivation to work, ability to reasonably handle situations, and the ability to communicate and collaborate with other people;
- acquiring the ability to recognize the unity and continuity of scientific knowledge in science, as well as the ability to recognize the relationship that exists between them;
- familiarizing students with scientific thinking, scientific methodology (observation, concentration - use of information, hypothesis, experimental control, analysis and interpretation data, conclusions, generalization and modelling) and the use of information technology, so as a future scientist to be capable of research and technology design;
- developing the ability to evaluate scientific and technological applications, so the student, as a future citizen, be able to critically address them and decide on the positive or negative effects their individual and social health, the management of natural resources and the environment;
- acquiring aesthetic values in relation to the environment;
- determining the contribution of the Natural Sciences to improving the quality of human life;
- acquiring knowledge of the organization and processes of the environment (natural and social) and the acquisition of the ability to participate in efforts to solve social problems by exploiting knowledge and the skills it has acquired;

- acquiring the ability to communicate, to collaborate with scientific and social actors, to collecting and exchanging information, presenting the thoughts or conclusions of his studies;
- acquiring basic knowledge, specialized information, methods and techniques that contribute to understand the structure of the geographical space, understand and interpret interdependencies and relationships interactions of geophysical and social factors, and to justify the need for harmonic coexistence of man and the environment.

Reviewing the above information with the aid of EC (2015) teachers' competence framework, it becomes evident that the following aspects of teachers' competences mentioned in the framework are implicitly required by STEM teachers in Greece:

In relation to knowledge and understanding:

- subject matter knowledge;
- pedagogical content knowledge;
- pedagogical knowledge;
- issues of inclusion and diversity;
- effective use of technologies;
- developmental psychology;
- group processes & dynamics, learning theories, motivational issues;
- evaluation and assessment

In relation to skills:

- planning, managing and coordinating teaching;
- using teaching materials and technologies;
- managing students and groups;
- collecting, analyzing, interpreting evidence and data for professional decisions and learning/teaching improvement

In relation to dispositions and attitudes:

- teaching skills through content;
- commitment to promote learning of all students;
- dispositions to promote students' democratic attitudes and practices as European citizens

Major issues for consideration: Proposed issues for discussion about STEM teachers' professional development in the Greece

This document aimed to provide insights in terms of teachers' competences requirements in Greece as evident explicitly in policy documents (policy level), in teacher training curricula (teacher training level) and implicitly in students' STEM curricula (practice level). Prominent issues for consideration that emerged from the exploration of the national context are outlined here below:

At macro-level, relating to policy envisions on STEM teachers' competence development: new initiatives in terms of teachers' competence development are in line with EU policy frameworks on the issue (EC, 2005; EC, 2013). Major aspects of competences (knowledge, skills and attitudes) that are identified in the Greek reform for teachers' initial training and professional development include: Knowledge & Understanding: Subject matter knowledge is less emphasised as it is considered as a prerequisite for attending the Programme for acquiring the "Certificate of pedagogical & teaching competency for secondary teachers"; most focus is given on building "professional knowledge", constituting of PCK, Pedagogical knowledge and curricula knowledge; issues of inclusion and diversity. Skills: Most emphasis is given on: using, developing and creating research knowledge to inform practices; reflective, metacognitive and interpersonal skills for learning individually and in professional learning communities; inquiry skills, collecting, analyzing and interpreting evidence and data for teaching/learning improvement; using teaching materials

and new technologies. Some emphasis is given on collaboration and negotiation skills with colleagues and parents. Dispositions, beliefs and attitudes: Most emphasis is given on: dispositions to change, ongoing learning; critical attitudes to one's own teaching; transferable skills; epistemological awareness. Some emphasis is given on collaboration and team-working.

At meso-level, relating to the mediation mechanisms from policy to practice (teacher training): until very recently the curricula of the undergraduate programmes in science departments were not oriented in educating prospective teachers, but concerned mainly the special scientific field with few references to education and pedagogy. The definitions of competences that teachers are required to possess as evident in teacher training curricula are currently neither explicit nor being detailed described, and tend to be diverse. Recent legislation concerning secondary teachers' pedagogical competence is at an early stage of implememation by university departments. New curricula are currently developed. Efforts so far neither provide evidence on competence oriented learning outcomes- as teacher curricula remain subject oriented- nor give any insights on innovative methodologies that have the potential to support teachers' competence oriented objectives.

At micro-level, relating to teaching/learning practice: There is a high level of coherence between the competences required by teachers and the competences that students are aimed to develop via STEM studies. Major skills emphasised in students curricula under the current education intended reform are: Lifelong learning skills; Skills for Responsible citizenship; Reflective and metacognitive skills; Critical thinking; Creativity; Problem solving skills; Risk estimation; Decision making ; Team working; Digital skills.

Concluding, in relation to STEM teachers' competence development & requirements in Greece, there is a need for coherence between was is envisioned in policy rhetoric and what is evident in teacher training curricula. The role of innovative training methodologies – as a means towards supporting teachers' competence oriented objectives - should be re-considered by teacher training institutions. This could be a step towards bridging the gap between what is envisioned in theory and is implemented in practice.

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Key Action 2 – Strategic Partnerships for school education

ELITe: Enhancing Learning in Teaching via e-inquiries

Agreement No. 2016-1-EL01-KA201-023647

Policy envisions and requirements for STEM teachers' competence development: State of affairs in the NETHERLANDS

by Olga Firssova[2]

Recent changes in the Netherlands in terms of policy envisions for STEM teachers competence development

Teacher professional development in the Netherlands is anchored in the Law. The Education Professions Act 2006 (Wet Bio, n.d.) states that continuous professional learning and development as a compulsory part of the teacher profession. In conformity with the Law the national Education Professional Cooperation Board developed a general teacher competence framework as a 7 competence areas structure (Onderwijscoöperatie, n.d.). This framework had functioned as a backbone for curriculum development in pre-service teacher education and in-service teacher professional learning activities in the school from 2006 till July 2017. In 2011 the Minister of Education entrusted the Onderwijscoöperatie with gauging the teacher competence framework so that it could function as a professional standard for the teaching profession in the future. Amendment to the Law was signed in April 2017 (Wet Bio, n.d.). The framework has been updated, and formulated as three generic competence areas in subject matter, teaching and pedagogical expertise. An overview of the updated framework is provided in p. 2 of this document.

The *National Teacher Register* forms an important provision of the Education Professions Act for embedding continuous professional development in the teaching profession. It is an instrument through which teachers can keep record of their professional learning activities and thus make their competence development explicit. Operational as from 2012, the Teacher Register functioned till August 2017 on a voluntary basis. Teachers could collect and keep record of professional experiences and learning activities in order to demonstrate the realized professional learning and competence growth. From September 2018 collecting and providing evidence of participating in professional learning activities through the National Teacher Register becomes compulsory. All teachers are expected to engage in professional learning and use the Register for validation purposes (Lerarenregister, n.d., Rinnooy Kan, e.a., 2007).

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While professional bachelor level is the basic requirement of teacher education in all educational sectors in the Netherlands, the Dutch Ministry of Education provides financial resources and pre-requisites for further professional learning and competence development of teachers up to professional and academic masters' and Ph.D. level. In 2008 the *National Teacher scholarship* (Actieplan Leraar 2020; 2011; Regeling Lerarenbeurs, n.d.) was introduced as a system of national bursaries that individual teachers can apply for to follow a professional or an academic bachelor or masters' program or shorter educational programs in specific professional domains. Schools are additionally financed so that teachers can be replaced for the duration of their study (Rinnooy Kan, e.a., 2007). Between 2008 and 2012 ca 19000 scholarships were granted for bachelor and masters' programs and for shorter programs. From 2012 onwards the scholarship can only be granted for an accredited professional of an academic masters'program and a restriction was introduced in the duration of the grant. A recently formulated target for teacher graduates with a professional bachelor diploma is to receive a masters' diploma within 5 years after graduation (Lerarenagenda 2013-2020, n.d.)

The national agenda on teacher professional development in the Netherlands is strongly influenced by policy envisions and discourse on new educational priorities such as development of 21st century skills, citizenship and civil society, inclusive education, education and training for yet non-existent professions (Gravemeijer, 2017; Onderwijs2032, n.d.; Thijs., 2014; Walma van de Molen & Kirschner, 2017).

Specific developments in STEM domains have been driven by the necessity to enhance and further improve education in science and technology, better equip students for further studies in highly demanding technology enhanced domains, improve the image and stop falling numbers in science and technology in higher and further professional education in the country (Nationaal Techniekpact2020, n.d.).

In 2013, The National Technology Pact 2020 and a Platform Bèta Techniek were established as joint initiative of governmental institutions and industry. Among the objectives updated in 2016, are increasing the number of students with a STEM profile in general secondary education; provision of in-depth innovative advanced level education in Science and Technology through the increase of students choosing Science specialization in upper secondary schools and the introduction of *Technasium* as a new type of secondary school. Technasium offers in-depth curricula in STEM with a particular focus on Research and Development (R&D) as a core school subject and participates in developing regional networks involving Technasia, local industry, research centres and business (Van Diggelen & van de Brok, 2013). The introduction of Technasia and new subjects in all STEM curricula stimulated professional learning initiatives at national, regional and grass roots levels such as development of shared Open Resource databases with teaching materials in a variety of subjects, including STEM, joint development of curricula for the new subject of Nature, Life and Technology in upper secondary schools, development of regional and national networks like Opeduca or Jet-Net (www.opeduca.eu; http://www.jet-net.nl/english).

Introduction of Science and Technology in primary education curricula is another important consequence of the National Technology Pact2020 with direct implications for teacher competence development and in-service teacher education for primary schools (Nationaal Techniekpact2020, n.d.)

Among other initiatives, Ministry of Education and the Platform Bèta Techniek has introduced a programme supporting several STEM teachers a year in doing fundamental research in their discipline through the system of internships. By doing research teachers get new sources of inspiration for their teaching practice and can make link between science and practice.

Dimensions and aspects of STEM teachers' competences that are evident in policy documents in the Netherlands

The recently renewed teacher competence framework is the core document that defines teacher competences through three pillars: subject matter, teaching and pedagogical expertise (Onderwijscooperatie, n.d.). In specific:

Subject matter: the teacher has and continuously updates disciplinary knowledge to stay above the school subject content and is able to design and compile learning arrangements, select and adjust material to make it learnable. Based on disciplinary knowledge, the teacher can contextualize and link the school knowledge to daily and work-related contexts, scientific knowledge and contribute to general academic forming of learners.

Teaching: the ability to make domain specific knowledge learnable to students in conformity with pedagogical standpoints and vision of the school, the ability to translate domain specific knowledge in school curricula and lesson plans and carry out instruction, taking into consideration the learning objectives, the level and individual learner characteristics, domain specific aspects, available methods and tools and the ability to evaluate the progress and results and introduce improvements based on evaluation.

Pedagogical expertise: the ability to create a safe, supportive and stimulating climate for learners, their cognitive and socio-emotional development, so that the learners are enabled to develop into independent and responsible adults and citizens and realize their potential to the full.

For each pillar relevant knowledge and skills areas are defined, as summarized in table 1.

Table 1: *Knowledge and skills in the teacher competence framework*

Pillar	Knowledge	Skills
Subject matter (discipline) specific	Up-to date domain knowledge, both at the basics as advanced level, theory and application Knowledge is above the content: Is well versed in the state of the art in the domain of teaching and relations with adjacent areas	Can explain, give an overview, demonstrate and present both the theoretical frameworks as practical applications Can position and relate to other disciplines within the curriculum Can make links to daily practice and possible further educational trajectories
Instructional	Learning and instructional theories	Can give feedback Can explain content Can stimulate learners to learn actively Can realize outcome-based learning Personalized learning
Pedagogical	Developmental and behavioral sciences Instructional psychology Learning sciences, Pedagogical science Inclusive education Personalised learning	Can lead, monitor, steer group processes Can win trust Can create a safe pedagogical climate Can create a climate that stimulates learning, including making mistakes

As for ***dispositions***, the framework sums them up as follows: "*the professional attitude involves the ability and disposition to reflect on one's own knowledge, effectiveness of knowledge transfer and skills for personal development. It is important that teacher learn from each other in the school and outside, individually and in teams*".

Specifically for ***secondary education in STEM disciplines*** the teacher competence framework lays emphasis on design and development perspective including the ability to effectively utilize existing curricular resources to design instruction and to interact with tools and resources; making sense of and using tools/resources to design and enact instruction and to adapt curricula, resources, and learning environments to new insights and new teacher roles as coaches and facilitators of learning (Eindhoven School of Education, 2016).

As an illustration of ***the required teacher graduate level competence level***, a quote. Technical University Eindhoven formulates its vision on professional STEM teachers as "*innovative experts in their subject domain who design and develop (technologically) rich contexts for learning. They evaluate their education, including their own role, and demonstrate an inquiry and learning attitude towards their subject and work as teachers. As such they are a role model for their students. In innovative contexts they act as agents of change together with colleagues inside and outside their schools and demonstrate professional leadership needed for this. ESoE educates these academic professionals in close cooperation with schools*" (Eindhoven School of Education, 2016).

Dimensions and aspects of STEM teachers' competences that are evident in teacher training curricula in the Netherlands

Teacher education curricula in the Netherlands can be clustered in four categories. Table 2 below provides an overview of the curricula by category describing dimensions and aspects of teacher competences in general and specifically, issues related to teaching STEM disciplines.

Table 2: *An overview of curricula in teacher education in the Netherlands (from primary school teacher to teachers of upper secondary schools)*

Type:	***Teacher education for primary school teachers at applied universities (hogescholen /PABO). 4 year non-university teacher education***
Specific STEM-domain related issues:	From 2014 onwards Science and Technology is included in core curricula so that to prepare teachers for the inquiry projects with Science and Technology
Teacher competences (knowledge, skills and dispositions): developments and challenges	**Knowledge**: there is renewed focus on knowledge base. Aspirant students have to pass basic knowledge exams in core subjects (language, mathematics) All curricula include developmental psychology, general pedagogy, specializations in young children. From 2014 onwards Science and Technology (Wetenschap en Techniek) has been included in core curricula. **Skills** development constitutes a large component in the curricula and is implemented through in-service training and internships at schools (workplace learning) **Dispositions**: a recent focus on the development of the inquiry habit of mind (in particular in academic tracks teacher training schools)

Type:	***Teacher education at applied universities (hogescholen) (secondary school teachers) – 2nd degree [bachelor, for middle school]*** ***(secondary school teachers) – 1nd degree [professional master, high school)***
Specific STEM-domain related issues:	Diverse programs at applied universities, such as [the 2nd degree] Teacher of Physics, Biology, Chemistry, Mathematics of Teacher of Science and Technology (Exact & Techniek) with Physics & Chemistry as core disciplines
Teacher competences (knowledge, skills and dispositions): developments and challenges	**Knowledge** discipline specific subjects, educational science and pedagogy, pedagogical content knowledge **Skills** (a large component of all curricula) – in-service or internship at schools, **Dispositions**: development of reflective and inquiry habit of mind (a new emphasis)

Type:	***University teacher education and training (secondary school teachers) – 1st degree, high school [upper level]***
Specific STEM-domain related issues:	Discipline specific Master of Education programs with specialization in Biology, Physics, Chemistry and Mathematics (University of Leiden, University of Groningen) Masters programs in Science Education and Communication (TUEindhoven, TUDelft, University Twente). Graduates hold a master of science degree. 5 discipline specific specialisations: Computer Science/Informatics, Physics, Chemistry, Mathematics and a combined domain specialization in Nature, Life and Technology together with Reseach and Development A Master of Science and Education
Teacher competences (knowledge, skills and dispositions): developments and challenges	**Knowledge:** Curricula integrate two lines – a discipline related line related to the subjects the student will teach and profession related line - directed at general professional and pedagogical teacher competencies. In-depth domain specific knowledge, knowledge of educational science; pedagogical content knowledge; design aspects for STEM-subjects. **Skills:** profession related skills are trained during internships in schools. *Education design skills* – develop, apply and evaluate. *Research skills*: developed and demonstrated through a Master thesis, an independent research project conducted in the educational practice. f.e., University of Groningen requires 840 hours [half the study time] in in-service TUE program sees inquiry, doing research as part of the professional teacher development and a contribution to teacher competence as to supervising students doing inquiries. Research is practice oriented (evaluate and improve deep learning in STEM learning) **Dispositions**: professional dispositions (functioning in a team, in the school as a professional organization and acting as an academically trained professional. Reflective and Inquiry habit of mind

	f.e., University of Leiden (ICLON School of Education) offers master specializations in mathematics, physics, chemistry and biology for students of master programs in the respective disciplines, with 1 year in discipline and 1 year in teacher training including educational science, adolescent psychology, pedagogical content knowledge and skills (through internships at schools) and an independent research project. University of Groningen offers a Master of Education in combination with a disciplinary masters in Computer Science, Biology, Physics and Chemistry and the Education and Communication in Mathematics and Sciences. The curriculum includes teaching and instruction in a discipline, pedagogical knowledge and training of skills in practice, educational science and learning theories, professional dispositions (reflective and inquiry set of mind) as well as research skills

Type:	***University master of Science programs in Educational Science, Pedagogy – 1 year full time programs for candidates with a background in Education (teachers). National bursary applicable ; OU NL (distance education); University of Groningen; Utrecht University; UvA VU; University of Twente***
Specific STEM-domain related issues:	While STEM is not a specific profile, however, STEM domains can form the field of knowledge application
Teacher competences (knowledge, skills and dispositions): developments and challenges	**Knowledge:** Research methodologies, instructional design, developmental psychology, theories of learning and instruction, technology for learning, use of technology and tools in design of curricula and **Skills**: instructional design, research methods, academic writing, development of learning environment, **Dispositions** academic habitus, reflective and inquiry habit of mind, critical thinking

Some relevant facts and figures

a. Teacher training for primary education (PABO's)

A total of 27 teacher training schools for primary education (PABO) with 54 programs. Relevant developments: a focus on basic knowledge, compulsory tests in the Netherlands and arithmetics. Another important trend – introduction of Science and Technology in primary education curricula with a focus on inquiry and design based learning.

b. Teacher education at applied universities (hogescholen) (secondary school teachers)

There are 44 teacher education programs at applied universities for the 1st degree with 12 in STEM domains (around 30% of all programs).

At bachelor level there are 190 programs with 383 variants of full time and part time programs. STEM disciplines represent a third large category of HBO TT curricula and have around 500 graduates per year, see figure 3. All programs have implemented a knowledge base requirement and take part in national tests of disciplinary knowledge. Dropout rates (up to 49%) and the quality of education are seen as challenges. An important new trend is according to the Inspection, the "in-service training".

c. University teacher education and training (secondary school teachers)

There are 140 1 or 2 year full time or part time university teacher programs, in 273 variants. These programs combine teaching discipline related subjects in discipline-based groups and theories of teaching and instruction, pedagogical aspects in inter-disciplinary groups. Yearly around 1850 students enroll in these programs, 1/5 of them part time. STEM domains have stable a third place in overall enrolments and diploma's (see Figures 1 & 2).

The compulsory research component presents a challenge since the requirements are in conformity with the research requirements in other masters' programs while the teacher profession demands development of professional skills through extensive practice making one year academic masters programs a challenge. Universities are developing 2 year master of Education programs to tackle this problem.

Next to offering Master of Education programs, universities contribute to further professional development of teachers through projects and participation in regional centres of teacher professional development.

Dimensions and aspects of (STEM) teachers' competences that are implicitly evident from students STEM curricula in the country

Starting from late nineties of the last century, curricula of pre-university 6 year study tracks VWO) and general secondary 5 year study tracks (HAVO) in secondary school in the Netherlands have undergone major changes. In the context of teacher competence development the following developments are relevant: The introduction of "Studiehuis", guided and independent (project based) learning in the lower secondary school with the teacher positioned as a coach instead of the exclusive source of knowledge and "a sage on the stage". "Tweede fase", or the second (upper) school phase curriculum innovation with a focus on development of generic skills, cross-disciplinary and higher order skills like information problem solving and research skills in secondary school curricula and examination & assessment programs. As a consequence, a mayor applied task of conducting an independent inquiry or design project has become a constituent part of the final examination program and school curriculum.

Both developments implied mayor shifts in the organization of the teaching process from instruction and knowledge transmission to guidance of independent and group work and monitoring student learning within school disciplines and in cross-discipline learning activities, including stimulating independent learning (inquiry) skills in children. Conducting an independent domain-specific or cross-disciplinary research project in the last school year culminates this trajectory. A pre-vocation schools the projects of 20 study hours are conducted, the minimal volume of independent projects in pre-university education is 80 hours (source).

A STEM-specific development concerns the curriculum of Technasium with high requirements for both domain knowledge and pedagogical and didactical skills of the teachers. Thus, the core subject of Technasia, R & D, requires besides in-depth discipline related knowledge, the ability to design project-based activities and design skills and organization of curriculum. Functioning in regional networks requires social networking skills.

Introduction of context-based curricula in Science subjects like Physics or Chemistry is an important trend initiated in 2003 (https://www.leraar24.nl/vak-scheikunde-chemie). The most important characteristic in context-based curricula is that appealing contexts for students are used as a starting point for learning (Coenders & Terlouw, 2015). The Dutch National Steering Committee, responsible for the development of context-based curricula in Science disciplines involves teachers in the design of student learning material through participation in teacher development networks. Participation in these networks is seen as a way of increasing teacher ownership of the context-based curricula that would lead to changes in knowledge and beliefs of these teachers, stimulating teacher professional development (Driessen & Meinema, 2003).

Another relatively recent development that is worth mentioning is the application of an innovative teaching method known as the *Lesson Study* approach, a method of teacher led curriculum and lesson design and research which originated in Japan and involves team work in design activities, thorough evaluation and explicit reflection on the outcomes (De Vries, Roorda & Van Veen, 2007). In the last decade Lesson Study method has been actively applied in

Dutch primary education, in particularly for design of new Science and Technology lessons (Schot & van Vugt, 2016) and in secondary education, in STEM subjects in particular (School-aan-zet.nl).

Major issues for consideration: Proposed issues for discussion about STEM teachers' professional development in the Netherlands

Teacher professional development is part of the national agenda in the Netherlands as a warrant of the quality of Dutch education. The Ministry of Education and Culture and national teacher agency (Onderwijscoöperatie) take care of the pre-requisites and the general framework by formulating the general quality standards and by financing teachers' professional development. At meso level school boards facilitate teacher professional development by allocating time and facilities for learning activities, intervision and network learning and support of innovation at grass-roots level. Support of participation in regional, national and international networks of schools contributes to teacher learning as well. Pre-service teacher education, publishing houses, non-governmental educational agencies and university research centers contribute to teacher learning by offering live, online and blended courses and programs and conducting research of teacher professionalization. It is however, the teachers themselves who retain responsibility for and who have the lead in making continuous professional development an integral part of the teacher profession in the ever changing and increasingly demanding world of education.

Proposed issues for discussion on STEM teachers' professional development in the country –identified via the exploration of the Dutch context at policy, policy mediation and practice levels as presented in this document – are:

At macro level, relating to policy envisions on STEM teachers' competence development: Balance between societal demands of innovation, the national core curriculum requirements and the organization of pre-service and in-service teacher learning and permanent competence development [in STEM domains]. The trigger for discussion [can be]: the pre-requisites for sustainable teacher learning and competence development against the newly defined teacher competence quality standards and beyond them.

At meso level, relating to the mediation mechanisms from policy to practice (teacher training): Transition from pioneer work, experiments, projects and lessons learned from them to integration of innovative approaches at schools into mainstream school daily practice against the background of the current practices of teacher learning facilitation by school boards. "From sowing to harvesting". The trigger for discussion [can be] the question of how school boards ensure that innovation and teacher professional learning innovate and transform the current school practice and vice a versa how innovative practice insures sustainable teacher learning.

At micro level, relating to teacher/learning practice: Integration of 21st century skills with (STEM) domain knowledge and skills, connecting learning in and out of school with ubiquitous ICT (seamless learning idea), integration of subjects, learner directed curricula - numerous trends meet in the school of today and make active teacher involvement in designing and shaping his/her lessons, courses and curricula for and with learners a necessity. Insights in what works and why are needed to underpin design decisions, therefore the inquiring mind as an attitude comes into picture. Teacher as designer and teacher as inquirer /researcher of his/her own practice are two important trends in the teacher profession nowadays. The trigger questions for discussion could be on the impact these two new trends implicate for teacher professional learning and competence development and the implications they have on the school practice.

Given that in the Dutch context the regulatory framework for teachers' competence development has already been in place 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.

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Key Action 2 – Strategic Partnerships for school education

ELITe: Enhancing Learning in Teaching via e-inquiries

Agreement No. 2016-1-EL01-KA201-023647

Policy envisions and requirements for STEM teachers' competence development: State of affairs in BULGARIA

by Nikolina Nikolova[3]

Recent changes in Bulgaria in terms of policy envisions for STEM teachers competence development

During the last decades, Bulgaria was faced with the need of dramatic changes in educational system and regulatory framework. The low level of functional literacy of Bulgarian students, the high percentage of drop-out students, old and cumbersome regulatory framework in education, economic development, labour market and business needs, etc., are just some of the factors, determining the need of educational reform in the country.

The reform has started in 2010 and since 2016 it is in the effective use. The new **Law for pre-school and school education** defines the education as a national priority. It keeps the balance between regularity and autonomy (authority) of the players. It delegates more rights to the schools, teachers, parents and students to take decision and respective responsibility about their relationships. The simpler framework guarantee the transparence and predictability of the policies in the educational system.

The main goals of educational reform are:

- Change of the educational system.
- Increasing the quality of general education.
- Defining new educational levels and providing possibilities for more students to graduate.
- Possibility to separate students who'd like to go to the labour market after 16 years from those, who'd like to prepare for university education.
- Increasing of quality of teaching and possibilities for career development of the teachers.

The Law for pre-school and school education discusses only general education. Professional education is still in the process of reform.

The Law for pre-school and school education offers new understanding about educational standards focused on the achievement of the educational goals and outcomes, national qualification framework and competences which should be developed at pre-school and school age, regulation of inclusive education as a part of human educational rights,

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etc. The Law provide more flexibility and freedom in curricula, providing autonomy to schools to develop their own curricula for extensive and addition learning courses. It governs also validation of competences, developed by informal or non-formal educational process. The Law ensures possibility for implementing individual, distance or blended forms of education.

The law takes special attention on qualification and career development of the teachers. It introduces:

- Mandatory qualification for in-service teachers (48 academic hours per attestation period), measured by ECTS credits.
- Mandatory internal institutional qualification (16 academic hours per year).
- Attestation period of 4 yours for all pedagogical specialists.
- Possibility for professional development for all pedagogical specialist.
- Opportunities to attract young people to work as teachers by introducing of new positions: trainee-teacher and mentor teacher.

Under the frame of the Law for pre-school and school education there were developed 19 National standards and other sub-law regulatory documents. The main of them, related to the general and STEM education, are:

- Ordinance on National requirement for acquiring professional qualification 'teacher' which formulates the teachers' competences and defines a model for career development of teachers.
- Ordinance #12 on the status and professional development of teachers, headmasters and other pedagogical specialists. It takes special attention on:
    - teachers' competences;
    - teachers' career development;
    - stimulating teachers' research;
    - stimulating application of innovative methods of teaching.
- Ordinance on inclusive education.
- National Educational Standards about expected results of STEM education, focused on the development of the key competences. As a consequence – the new curricula for each school subject and each grade, contacting subject learning content description as well as recommendations for appropriate teaching approaches.

Dimensions and aspects of STEM teachers' competences that are evident in policy documents in Bulgaria

The national policy documents, based on relevant European policy documents provide evidence for requirements for covering each of three key dimensions of teachers' competences - knowledge and understanding; skills; dispositions.

Knowledge and understanding

The basic aspect of required knowledge is the deep knowledge in **subject matter**: *... as a minimum, teachers should have a specialist knowledge of the subject(s) they teach* (European Commission, 2013). The requirement reflects on the main national policy document ORDINANCE #12 from 01 of September, 2016 on the status and professional development of teachers, headmasters and other pedagogical specialists (Ministry of Educaton and Science, Republic of Bulgaria, 2016f), which defines the National Standard for the pedagogical staff requirements and qualification, as

well as the way of career development of teachers, headmasters, and other pedagogical specialists. There it is explicitly numbered the initial education that the teacher should be graduated as well as additional conditions (i.e. additional courses or SDP), if any at the specific case, that should be taken to be a legal teacher in a specific subject. About STEM teacher, the requirement is to have bachelor or master degree in one of the following: science (math, informatics, physics, chemistry, biology, etc. according to the teaching subject), pedagogy of education in... (specific subjects), or engineering. The same document defines the types of qualification of pedagogical specialist:

...

2. long-life - directed to professional and personal development... through:

*- short term training courses dedicated to periodical actualisation of **subject knowledge**, to development of skills to teach key competences, to familiarizing and applying innovative approaches in education,...etc.*

The special attention in the policy documents is dedicated to the **inclusive education**. *Equal access to high-quality education, inclusion of every student and child* is a priority, defined in the Law on pre-school and school education (Ministry of Education and Science, Republic of Bulgaria, 2015a). During the educational reform, a National Standard about inclusive education (Ministry of Educationa and Science, Republic of Bulgaria, 2016d) was developed. The standard defines principles and conditions for students' inclusion in educational process, independently of their individual characteristics, special educational needs, ethnic and cultural specifics, etc. The standard recommends that teachers should be able to *apply differentiated pedagogical approaches in accordance with Interests and stimulating the motivation of the child and the student, adapted to the age and social changes in his / her life and adapted to his / her ability to apply the acquired competencies in practice*, which means at least they should have theoretical basis on the specific educational needs and variety of pedagogical approaches for differentiated education. The issues of inclusion and diversity is also a subject matter of the National requirement of the teaching profession: the teacher's responsibility is planning *and conduction of educational process in accordance to: ... encouraging achievements and providing the necessary support and assistance for their (students') full integration into the educational and social environment according to their specific needs*.

In Bulgaria, there is a good tradition for the last 10 years in the use of **ICTs in education**, reported in the Science Education in Europe: National Policies, Practices and Research, Figure 3.4, p.72 (EC, Eurydice, 2011) and Key Data on Learning and Innovation through ICT at School in Europe 2011, p. 69 (EACEA, Eurydice, 2011). These good practices are kept in the new policy documents – as it is written above, the National requirements for "teacher" qualification includes at least 30 academic hours of study how to use ICTs and digital environment in teaching process (Ministry of Education and Science, Republic of Bulgaria, 2016c).

Current policy documents focuses attention also on the use of **innovative teaching methods** in all teaching disciplines. The Ordinance #12 (Ministry of Educaton and Science, Republic of Bulgaria, 2016f) states that *the position "teacher" includes the following features ... use of effective methods of teaching...*. It stimulates teachers to gather knowledge on different modern innovative educational methods not only through formal education but also by participation in large teachers' networks (national general or thematic, Scientix, etc.), teachers forums, conferences, experience exchange events.

Other aspect of teachers' competences is focused on knowledge and understanding of the key role of **evaluation and assessment** methodologies and technics. The policy documents comment different aspects of the evaluation process:

- Students' assessment – formative and summative.
- Teachers' assessment in relevance to career development.
- Educational process / system evaluation at macro level.

The Ordinance # 11 (Ministry of Educaton and Science, Republic of Bulgaria, 2016e) describes the National Educational Standard on assessment of the students' achievements. It determines the components, types and forms of assessment of students' educational achievements; тhe terms and procedure for organization of external evaluation and maturity

exams; recognition of skills in arts and sport; etc. The document presents the different forms and types of assessments, the role and expected responsibilities of teachers, the importance of formative assessment in tracking students' progress, as well as the role of summative assessment for diagnostics, monitoring and future improvement of educational policies.

The assessment of teachers' proficiency is discussed in ORDINANCE # 12 (Ministry of Educaton and Science, Republic of Bulgaria, 2016f), where the attestation card is provided. The document treated knowledge, understanding and skills for self-assessment of the teachers' as crucial for his/her career development.

Much less of the teachers are involved in evaluation of the educational process – mainly in conduction of the evaluation procedure at operational level.

Skills

All of the policy documents treats the teachers' **academic and pedagogical** competences as a whole – all the listed above knowledge are accompanied by relevant skill for design, conduction and evaluation of the teaching process.

For in-service teachers, the **pedagogical competences: planning, teaching, evaluation and assessment, class / group management** take a special place in procedure for teachers' attestation (Ministry of Educaton and Science, Republic of Bulgaria, 2016f).

In addition, the teachers' assessment card in ORDINANCE #12, Appendix #2 (Ministry of Educaton and Science, Republic of Bulgaria, 2016f) defines two more group of teachers' competences: **communicative competences** and **administrative** competence.

Communicative competence includes **team working skills** – partnership with other pedagogical specialist and school managers, didactical support and mentoring of newly recruited teachers, leadership skills and skill for takin decisions at school policy level and corresponding responsibility, participation in institutional, out-of-school, cultural and social activities; and **skills for collaborating with parents and other stakeholders** – inclusion parents in educational process, support and stimulation of the parents of children with special educational needs, etc.

Administrative competences relates to familiarizing with National Educational Standards and skills to apply them, ethics in work with children, privacy of the personal information, work with policy documents.

Not at last place, the teacher is expected to act as **researcher** in the classroom and to develop sustainable competences in the field (Ministry of Educaton and Science, Republic of Bulgaria, 2016f):

The qualification of pedagogical specialist... is: ...

2. long-life - directed to professional and personal development... through:

*- Participation in **research**, **inquiry** and **creative** activities.*

Disposition, beliefs, attitudes

The Law on pre-school and education takes special attention on **commitment to promoting the learning to all student**. One of the main principle there is *Equality and non-discrimination when conducting pre-school and school education* (Ministry of Education and Science, Republic of Bulgaria, 2015a). The principle is expressed in:

- Equal access and inclusion of every child and student
- Humanism and tolerance
- Safety of cultural diversity and inclusion by Bulgarian language

The Ordinance of inclusive education (Ministry of Educationa and Science, Republic of Bulgaria, 2016d) regulates the public relations relating to the provision of Inclusive education of children and pupils in the pre - school system, school

education, as well as the activities of the institutions in this system on providing support for the personal development of children and students. It requires

- Unique support of personal development of each pupil in dependence of his/her special educational needs
- Differentiated pedagogical approaches in correspondence with personal interests and motivators of the student, age and social life and changes
- Acceptance and respect to the uniqueness of each child and pupil - individual needs and opportunities, personal qualities, knowledge, skills and interests to which the educational institution must respond in such a way that the child or pupil can maximize its potential.
- Systematic and holistic approach in organization and collaboration of educational institutions, etc.

The ordinances accompanying the new law contain special dispositions to **change, flexibility, ongoing learning and professional improvement, including study and research**: According to the Ordinance #12:

47. Organizational forms of long life qualification are:

..

(6) forums (conferences, contests, planers, etc.) in accordance to present research results, studies, best practices, innovative practices or achievements. (Ministry of Educaton and Science, Republic of Bulgaria, 2016f)

Promotion of **students' attitudes and practices as European citizens** is also a subject of the Law of pre-school and school education, where the next principles and goals are defined:

- Principles:
    - Humanity and tolerance
    - The preservation of cultural diversity and inclusion through the Bulgarian language
- Goals:
    - Acquisition of competences needed for successful personal and professional development and active civic life in modern communities
    - Acquisition of competences for understanding and application of principles, rules, responsibilities and rights arising from EU membership

The Law is supported by a special Ordinance on civic, health, ecological and intercultural education (Ministry of Education and Science, Republic of Bulgaria, 2016b), which states that *Civic education is aimed at forming civic consciousness and civic virtues and involves knowledge about the formation of a democratic society, the rights and obligations of the citizen, and skills and readiness for responsible civic behavior*.

Dimensions and aspects of STEM teachers' competences that are evident in teacher training curricula in Bulgaria

The Low of pre-school and school education and accompanied regulatory framework is quite new – it is in effect from the 2016. At the moment the institutions, responsible for teacher's education and development are in process of development new educational plans and curricula, so to be able to implement the new regulation since 2017/2018 academic year. This is the reason there is a lack of information about how the different universities and other institution will respond to the new rules in teachers' development. Moreover, not only the universities, but also the separate faculties (preparing teachers in different disciplines) have their academic autonomy in in decision what subjects to teach, under which curricula, how deep and what content to include.

The main regulatory framework in teachers' development is provided by the Ordinance on National requirements for acquiring professional qualification "teacher". The other main aspect of the required teachers' knowledge and understanding is on the field of **pedagogy and educational technologies** as well as the field of **psychology**. The knowledge of how to teach (in general) and how to teach specific subject are crucial for teaching profession in Europe: *Initial teacher education is an intensive experience that requires student teachers to be both learners and teachers simultaneously – being supported in learning how to teach, and supporting pupils in how to learn* (Caena, 2014). In correspondence with this need, the Ordinance on National requirements for acquiring professional qualification "teacher" (Ministry of Education and Science, Republic of Bulgaria, 2016c) suggests the minimal academic hours pre-service teacher have to learn:

- Pedagogy: 60;
- Psychology: 60;
- Pedagogy in… (specific subject): 90;
- Inclusive education: 15;
- ICT in education and work in digital environment: 30.

The policy document defines the minimum of academic hours to study basic disciplines, but it does not provide any requirements for learning content. It is responsibility of the training providers.

The Ordinance define who can teach specific school subject. For STEM teacher it is expected to have a stable base in a **specific content** (they should have basic bachelor or master degree in the field) and to have taken additional or parallel courses in **pedagogy and psychology**. The experience at Sofia University and discussion and forums with other teachers' training institutions shows a gap between subject matter education and pedagogical education – usually both groups of disciplines are led by professors with very different expertise without any concurrence. The relationship between both groups of subjects are responsibility of departments of pedagogy in… (specific subject).

The main organizations that are eligible to prepare STEM teachers are universities. Most of them prepare dual subject teachers – biology & chemistry, physics & mathematics, physics & chemistry, mathematics & informatics, chemistry & informatics, etc. There is a good practice at Sofia University to share disciplines between pre-service teachers from faculties of chemistry, physics and mathematics and informatics. In this specific case, the IBL is taught in parallel with ICT in education.

In addition to main teachers' training providers, other institutions can also provide (usually short-term) teacher training courses – Bulgarian Academy of Science (BAS), special departments for teachers' CDP, NGOs, etc. Since 2016 the National register of teachers' qualifications programs (Ministry of Education and Science, Republic of Bulgaria, 2016a) has been developed. All the courses are approved by Ministry of Education and Science and provide corresponding ECTS credits which are required for teacher' attestation and professional development. Unfortunately, only brief annotation of the course is publicly accessible. According to it, the main directions of **STEM teachers' courses** are:

- subject matter course, dedicated to the new curricula in specific subject and class;
- innovative methods of teaching;
- applications of ICTs in specific subject education.

It is a good practice that some of organizations provide European proven courses developed under a European research project. For STEM teachers special place has **Inquiry-based learning courses**, related to the corresponding EU projects and networks: Mascil (BAS), weSPOT (Sofia University), Scientix (BAS).

Dimensions and aspects of STEM teachers' competences that are implicitly evident from students STEM curricula in Bulgaria

The Bulgarian educational system determine two type of schools: general schools and professional school. STEM subjects are compulsory in both schools until graduating first level of secondary school. In general schools, second level of secondary school, there is a National standards for profiled education in STEM subject. The standards and the corresponding curricula are used by the schools, who have chosen to offer profiled education in the field.

The National standards for STEM education approve the necessity for STEM teacher to be very well familiarized with the **subject matter**. Second level, which goal is to prepare pupil for universities, requires these teachers to have much more academic knowledge than other, teaching in first level.

The National standards for first and second level of STEM learning reveals also additional teachers' competences, implicitly describe there.

The National standard about learning content (Ministry of Education and Science, Republic of Bulgaria, 2015b), App#3 – mathematics, informatics and ICTs specify the next goals for the basic education (5. – 7. grade):

- Forming of logical thinking, combinability, observability and mathematical competence;
- Empirical formation of a part of geometric knowledge,

for the first level (8. – 10. grade):

- Development the ability and desire of the individual to use mathematical methods of thinking and presentation - by means of formulas, models, constructions, graphs, diagrams - in general, "working with data";
- Taking responsibility for self-fulfillment of tasks as well as showing attitude and choice of decision and behavior according to specific problems and circumstances.

The goals implicitly shows that the teacher should be able to lead the **Inquiry-based learning process** as well as to form the different levels of **research skill** of student. The same requirement is much more explicitly stated in the National Standards in Human and Nature, Biology and Health Education, Chemistry and Environment, Physics and Astronomy, where the next goals are described:

- Ambient word (1. – 4. grade): Forming skills to study of environment changes through discovery of data, facts, and by observatory of processes and phenomena
- Human and nature (5. – 7. grade):
    - Stimulating curiosity to the nature…
    - Forming skills for research of objects, processes and phenomena in the nature
    - Using primary (observation, experiment) sources and secondary (schemes, charts, graphics, models, etc.) sources of information, related to organisms, solids, substances, natural phenomena and processes.
- Biology and Health Education (5. – 7., 8. – 10. grade)
    - Forming practical skill to work with laboratory instruments, appliances and apparatuses, observation and study of objects of the nature.

    - Development of curiosity to the life nature
    - Forming practical skills for observation and study of different levels of organization of the live matter
- Physics and Astronomy (8. – 10. grade): Development of practical skills for preparation and conduction of observations and experiments, for use of physics' instruments and apparatus, for measuring physical magnitude, and verification of physical laws.
- Chemistry and protection the environment (5. – 7., 8. – 10. grade):
    - Forming the skills for observation and comparison of objects, noticing of causal links; explaining properties of substances through their construction, aggregation of information; formulating conclusions
    - Developing self-learning skills by exploring information presented through text, tables, charts, patterns, diagrams, including using ICT; discussing the impact of the studied substances on the environment and people

The same standard and the STEM curricula implicitly reveal the also the teachers' competences in the development of **critical thinking**, **creativeness**, the **team-work skills**, and the **work on a project skills**:

Critical thinking

- ICTs (I level): development of informational culture, critical and responsible attitude to the information
- Biology and Health Education (8. – 10. grade): Forming of critical thinking and reasoning the position in solving specific cases and problems, related to the own and relatives' health and the protection of the environment

Creativeness:

- ICTs: Creative use of the possibilities of the modern technologies for elaborating information, solving problems and communication.

Team working skills:

- ICTs: Working online in team on the common problem.

Work on a project:

- ICTs: Forming skills for team work in development, presentation and documenting of group project.

The requirement of the STEM curricula on the interdisciplinarity of the learning process:

- Math (II level): development the ability for application of mathematical thinking and reasoning in solving problems in other learning disciplines
- Informatics (I level): modelling object of real word
- Ambient word (elementary): Development of integrated knowledge about ambient word…

means that the teacher should have a good base on other STEM subject as well as to act as e **team member** in local teacher's community.

The very important teacher's competence is to use the ICTs in teaching process, as in Bulgaria students use ICT in class AND for complementary activities (homework, projects, research) in Maths and Science at all grades (EACEA, Eurydice, 2011) (Figure C3: Student use of ICT by subject area according to official steering documents in primary and general secondary education, p.46).

Major issues for consideration: Proposed issues for discussion about STEM teachers' professional development in Bulgaria

The educational reform defines new profile of the teacher as a main actor in the educational process. The change of the in-service teachers' knowledge, skills and attitudes, as well as professional life habits and behavior in parallel with accepting of new understanding of teachers' responsibilities is a big challenge not only for teachers themselves but also for supporting institutions – Ministry of Education and Science, Regional Management Centers of Education, teacher training institutions and schools. Only working together, they can react to:

Key message 1: The academic, pedagogical, communicative and administrative teachers' competences needed to be developed and supported all together.

Key message 2: Teachers needs to act as a researchers and innovation providers in the classroom.

Just few years ago the schools were strongly recommended to follow the national directions on management, internal organization of school life, and development strategies according to the school type. Now a day they have more autonomy and freedom for decisions, and respectively – more responsibilities.

Key message 3: Schools and teachers are more flexible to reflect to the users' expectations and economy changes, and they needs to manage their own strategy, curricula and teaching approaches.

The teachers' training institutions are in front of the f the challenge to prepare new curricula, corresponding to the new requirements for teachers. In the same time they should to support in-service teacher to develop their competences according to new rules and methodology of teachers' assessment, providing relevant courses for CPD in appropriate forms, duration and places.

Key message 4: The teaching training institutions needs to respond to the new requirements of schools and teachers with new curricula and updated learning content, and to be flexible for permanently changing requirements.

The educational reform open the doors for business companies and NGOs to provide short-term teachers' trainings. These give possibilities for publishers to participate in the teachers' competence development process familiarizing them with knew students' textbooks and learning resources, for business companies to prepare teachers to develop particular professional skills in professional schools, for NGOs to provide support and training in inclusive education issues, etc.

Key message 5: Institutions and organization, eligible to provide short-term thematic training courses, need to be prepare for their new role and for understand of such a responsibility.

The students' curricula demonstrated the need STEM teaches' to be able stimulate pupils natural curiosity to the science and nature, and to develop students' inquiry skills - to organize different levels of experiments, to observe variety of phenomena, to make conclusions and to reason them. In addition, teachers are required to act as pedagogical researchers in the classroom and to share their experimental results, and to be able to evaluate in a critical way innovative experience of other teachers.

Key message 6: The application of IBL in STEM subject teaching should be interweave in development of competences, curricula, training and practice in all level and institutions.

All of these key messages are not only challenge for all the stakeholders but they also provide a set of possibilities for new way of communication and collaboration between institutions. The real educational reform is possible only with a common efforts of all sides together

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Key Action 2 – Strategic Partnerships for school education

ELITe: Enhancing Learning in Teaching via e-inquiries

Agreement No. 2016-1-EL01-KA201-023647

Policy envisions and requirements for STEM teachers' competence development: State of affairs in SPAIN

by Mario Barajas[4]

Recent changes in Spain in terms of policy envisions for STEM teachers competence development

Educational System at secondary and post-secondary level

In order to acquire a comprehensive understanding of the current implementation of competence-based learning in Spain in secondary and post-secondary education, it is worth considering factors related to the administrative and political structure of the country. To that goal, in this section we review relevant data from the Spanish Educational System, National Policies and Spanish curriculum.

The education system in Spain is organised into mainstream education and specialised education. Mainstream education comprises:

- Compulsory secondary education: it is divided into four years and it is usually completed at the age of 16.
- Vocational training: it offers a range of training provision that equips pupils with the necessary skills to undertake any one of various trades, have access to the labour market, and actively participate in social, cultural and economic life. It is organised into 26 professional families and divided into two stages: intermediate and advanced, which have a flexible modular structure and variable duration
- Post-compulsory secondary education: Baccalaureate, 2 years, not compulsory, generally until students are 18. Three types of studies: Scientific, Humanities and social sciences, and Arts
- University education: it is organised into three cycles, namely Bachelor, Masters and Doctorate, with different duration and a minimum required number of ECTS credits.

Secondary education comprises compulsory secondary education (4 years, free and compulsory) and post-compulsory secondary education (Baccalaureate, 2 years, not compulsory). Higher education includes university education,

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advanced arts education, advanced vocational training, advanced plastic arts and design education and advanced sports education.

Specialised education programmes are concerned with arts, sports and languages education and can be undertaken from the second cycle of primary education. Figure gives an overview of the Spanish Educational System

The Spanish Constitution addresses an essential aspect of the educational organisation in Spain, that is, the decentralisation of educational responsibilities and the distribution of educational competences between the State and the Regions. The latter may undertake the organisation and administration of the education system in their respective regions, with the exception of those powers which are exclusively central, such as the regulation of the conditions for the awarding, issuing and recognition of academic and vocational qualifications. Regions are also responsible for teaching their own co-official languages which, together with Spanish, have official status in some regions.

National Policy on competence-based learning

Review of National Policy suggests that student competences have an increasingly important role in the Spanish Educational system. At the moment, the **Education Law to Enhance the Quality of the Educational System (MECD, 2013)** demands to lower the rate of early school leaving, which is twice as high as the mean from the European Union (MECD, 2013). Other goals are to increase youth employment, modernise professional training, give more autonomy to schools and increase the use of ICT in education.

The Law gives more weight on student competences. Competences are present in the curriculum development and assessment of all educational levels and modalities. Moreover, the Law states that cognitive abilities must be accompanied by students' acquisition of transversal competences such as critical thinking, management of diversity, creativity and communication skills. To that goal, National and regional governments must cooperate so to make a link between these competences and the current contents and evaluation criteria of all the education delivered across the country.

According to current regulations, the National Curriculum is a set of goals, basic competences, content, pedagogical methods and assessment criteria of all the training provided in Spain. The goal of the National Curriculum is to guarantee a common education for all students in Spain as well as to ensure the validity of the degrees awarded all around the country.

In 2006 basic competences were introduced for the first time in the Spanish National Curriculum for Primary Education (National Agency Official State Gazette, 2006) and in 2007 for Secondary education (National Agency Official State Gazette, 2007). The competences have strong similarities with those set in the European Reference Framework (European Commission, 2008): linguistic communication, mathematic competence, competence in knowledge and interaction with the physical world, digital and information processing competence, social and citizenship competence, cultural and artistic competence, learning to learn, and personal autonomy and initiative. The Curriculum states that students must acquire the appropriate level of the competences by the end of compulsory education. Moreover, it explains how each subject such as Spanish Language, Mathematics, Physical Education, etc. contributes to the acquisition of the aforementioned competences.

According to the distribution of powers among National and Regional government, the National Curriculum in Spain constitutes a framework which is further developed by regional governments. To date, most regional governments have organized their curriculum around student competences (School Council of the Basque Country, 2008). As an example, the curriculum for primary and secondary education in the region of Catalonia links student acquisition of basic competences with traditional school subjects. Basic competences are divided into two groups, i.e. transversal and specific. Transversal competences are defined as linguistic and audiovisual communication, artistic and cultural competence, information processing and digital competence, mathematic competence, learning to learn, and sense of initiative and entrepreneurship. Specific competences correspond to knowledge and interaction with the physical

world, and social and civic competence. In order to support teachers in the implementation of competence-based teaching and assessment, the Department of Education of Catalonia has published teacher guidelines for Competence-Based learning and assessment for two subjects, i.e. Language and Mathematics, for primary (Generalitat de Catalunya, 2013) and secondary education (Generalitat de Catalunya, 2013).

Finally, the law gives freedom to schools to carry out the final development of the curriculum for the educational levels that they offer. Within this context, there are reasons to think that schools wishing to do so can make their own policies on competence-based learning and assessment provided the goals of the regional and national curriculum are met.

To sum up, review of National Policy on Competence-Based education in Spain shows that the Spanish educational system is in line with the European policies. Such change is promoted by the Spanish Ministry of Education, Culture and Sports in collaboration with the Regions.

STEM Teachers competences development

The National Policy focuses currently on competences is the Strategic Framework for Educators' Professional Development. It was announced in May 2013 by the National Institute for Educational Technology and Teacher Training (2013). It is a holistic framework whose goals are: (1) to structure initial and in-service teacher training around a new competence model of education professionals from the 21st century, (2) to explore new training modalities that facilitate collaboration among teaching professionals and (3) to establish a common regulation framework which allows for professional competence certification and certification of activities which show evidence of an effective professional development for teachers and trainers. The framework is composed by three main pillars:

- Professional teacher competences: the project aims to redefining the profile of the teaching professionals through a competence framework for educational professionals, which should allow teachers to develop and assess students' competences.
- New training modalities: The Ministry wishes to incorporate learning which takes place in online communities of practice and other innovative learning opportunities into certified teacher training programmes.
- Regularisation of training: it is concerned with updating regulation about certification of teacher training around professional competences.

The encouragement of STEM is supported by the new LOMCE curriculum for secondary education. For students age 15-16, one of the objectives is that the upper secondary education should help develop in the students the capabilities "*to understand the basic elements and procedures of the research and scientific methods*." Current changes in the enacted curriculum are in line with STEM objectives. All regional governments (in charge of the real implementation of these policies) are developing professional development programmes, including pre-service and in-service teacher education, however there is a lack of a clear general framework for STEM competencies in the line of ICT teachers competencies.

Dimensions and aspects of STEM teachers' competences that are evident in policy documents in Spain

In line with Recommendation 2006/962 / EC of the European Parliament and of the Council of
18 December 2006 on key competences for lifelong learning, the Spanish Royal Decree establishing the basic curriculum of secondary education and Baccalaureate (MECD, 2015), is based on the empowerment of competency-based learning, integrated in the curricular elements to promote a renewal in teaching practice and in the teaching and learning process. New approaches to learning and evaluation are proposed, which, according to the Law, must be a major change in the tasks to be undertaken by students, as well as innovative methodological approaches. The competence is a combination of practical skills, knowledge, motivation, ethical values, attitudes, emotions, and other social and behavioural components that are mobilized together for effective action. They are, therefore, considered

as knowledge in the practice, knowledge acquired through active participation in social practices which, as such, can be developed both in the formal educational context, through curriculum, as in non-formal and informal educational contexts. In the Spanish educational system, competences, therefore, are conceptualized as a "know-how" that applies to a diversity of academic, social and professional contexts. For the transfer to different contexts being possible is indispensable an understanding of the knowledge present in the competences, and the linkage of the latter with the practical or skills that integrate them.

Competence learning favours the learning processes themselves and the motivation to learn, due to the strong interrelation between its components: we learn a concept together with the procedure used to learn this concept. The Law adopts the name of the key competences defined by the European Union. The role of the teacher is fundamental, as he/she must be able to design tasks or situations to solve problems, the application of learning and the promotion of student activity.

In practice, the current Educational Law LOMCE, at the level of primary education refers to STEM competencies as an integrated basic competence. At the level of secondary education, although the competence approach mentioned above is used, it discriminates among the different knowledge areas, i.e. considers competences for maths, for physics, and so on. As such it lacks a holistic vision of competences, and adopts a narrow vision of the STEM competencies, separated in knowledge areas, limiting in practice an integrative view of these areas and the possibility of using new didactical approaches, as e.g. project-based learning or inquiry-based learning.

Dimensions and aspects of STEM teachers' competences that are evident in teacher training curricula in Spain

Currently in Spain there is not an official Master's Degree Program in STEM education. Conversely, pre-service teacher education for teaching in secondary schools is divided into four STEM related subjects: Maths, Physics, Chemistry and Technology. However all share communalities in terms of competences. Table 1 below presents a synthesis of the competences to achieve (knowledge, skills and dispositions) out of the Inter-University Master's Degree Programs for teacher accreditation in each of the STEM-related subjects.

Table 1: *Competences (knowledge, skills, dispositions & attitudes) evident the Inter-University Master's Degree Programs for teacher accreditation in STEM-related subjects*

Cross-disciplinary aspects of knowledge and mastery of the content
— Know the contents of the STEM subjects to teach.
— Know the history, recent developments and the future prospects of the disciplines that make up STEM in order to convey to the students a dynamic vision of these disciplines.
— Know the nature of the STEM disciplines and the specific forms of making STEM knowledge.
— Know the possible theoretical-practical developments that correspond to the teaching and learning of the STEM disciplines
— Know the epistemological perspectives that provide the knowledge of the reality that unfolds STEM disciplines.
— Have criteria for the selection and ordering of conceptual and practical aspects most relevant for the teaching of the STEM disciplines.
— A critical capacity to interpret and evaluate the socio-economic aspects and the environmental effects of the applications of STEM knowledge.

— Ability to solve problems related to the STEM subjects, qualitative and quantitative type, based on the models developed for the subject

Teaching skills

Curriculum and educational practices

— Meet all current curricular elements of the subjects that are taught, deeper into the issues that are necessary for their education (specific and transversal skills of the disciplines that have been developed).

— Know identify questions and key ideas of the different topics that are part of the curriculum.

— Ability to plan, organize, manage and explain phenomena, information, solving problems, projects and processes related to the fundamental aspects of the subjects STEM that teach.

— Know contexts and situations (historical also referred to the matter in question) in which they are used or can be applied for the various curricular contents.

— know how to design and develop individually or collectively educational projects, programming units, plans of action, environments, activities and innovative materials, that allow to adapt the curriculum of STEM subjects to the diversity of the students and promote the quality of the contexts in which the educational process.

— Have criteria for the selection and evaluation of didactic and hands-on activities that may constitute a landmark in the teaching of the subjects STEM.

— Use teaching strategies that contribute to the significant construction of knowledge and reasoning, that encourage a critical spirit in relation to STEM.

— Recognize the importance of language in the learning of the raw materials and the characteristics of the scientific language and promote STEM the use of teaching materials for students to learn science and mathematics learning to speak and write Science and mathematics.

— Assess the importance of experimental work in the teaching and learning of Sciences; Learn about different ways to integrate it into the design and implementation of educational inquiry.

— Recognize the importance of integrating information and communication technologies in teaching and learning activities of STEM. Meet models and examples of how to integrate them into the activities of teaching and learning. Ability to integrate information ICT in educational practices.

Focus on diversity

—Consider diversity issues, taking into account the resources available, supports psycho-to cater to the diversity in the centre and in the classroom, the organisation and the management of the classroom, the various forms of grouping.

— Detect learning difficulties of students. Use the knowledge of the characteristics of the development of the students, their social contexts and the motivations and interests to design and

develop the educational proposals that will enable them to continue learning throughout life , help them to reason critically and to behave autonomously, relying so tight in the personal capabilities.

— Recognize the importance that the ways of understanding and reasoning of the students are in the process of teaching and learning in the subjects STEM and identify them in specific situations.

— Transform the curriculum of various subjects STEM in activities and work adapting them to the ways of understanding and reasoning of the students, their educational levels, social context, diversity, etc.

— Design and develop learning spaces with particular attention to fairness, emotional education and values, equality of rights and opportunities between men and women, public education and the construction of a sustainable future.

Evaluation

—Know how to use strategies and techniques of evaluation. Understand the evaluation as an instrument of regulation and stimulus to the effort, as well as the promotion of the improvement of the teaching and learning of subjects STEM.

— Assess the impact of the use of technologies in the processes of development and learning of the STEM.

Dispositions and attitudes

— Understand learning as a global, complex and transcendent; self-regulate the own learning and mobilize knowledge of all kinds to adapt to new situations and connect knowledge as a method to draw up new ones.

— Carry out work related to STEM (according to their speciality) independently and responsibly.

— Apply fundamental techniques and methodologies in educational research and be able to design and develop projects of applied research and innovation in the educational intervention and to situations that are specific to the area of knowledge of STEM.

— Motivate and promote communication between students and teachers, and the same students, in order to get a good climate for learning, and developing teaching strategies that prevent exclusion and discrimination.

— Know the historical evolution of the labour market, its current situation and perspective, the characteristics of the teaching profession, the interaction between the social reality of the time, work and the quality of life, as well as the need to acquire suitable for adaptation to the changes and transformations that may require the professions.

— Appreciate the educational value of reflective practice of teachers during their working life and to promote its application in the students themselves as a way to become citizens with critical thinking. Identify information needs, find it, analyse it, process it, use it and communicate it effectively, critical and creative.

— Acquire an ethical commitment based on the ability of criticism and self-criticism and the social importance of education; critically analyse the personal work and find new resources for the

autonomous learning and professional development; take on the ethical dimension of teaching, acting with responsibility, making decisions and analysing critically the ideas and proposals on education, from both the research and innovation and the educational administration.

—Assume that teaching must improve, update and adapt to the educational, social and cultural, and scientific changes; understand the importance of participating in research and innovation projects related to teaching and learning, and to introduce innovative proposals in the classroom.

— Know and analyse the basic elements of the organizational model of the schools and its link with the political and administrative context. Meet the institutional approach of the centres, the organization of human resources, the structures of participation of the educational community, the characteristics and the forms of organization of the class groups, the organization of resources materials and of their relationships with the environment

— Design and carry out activities that contribute to make the school a context of participation in general, and participation in the evaluation, research and educational innovation in particular, in order to promote team work and teaching between teams .

Dimensions and aspects of STEM teachers' competences that are implicitly evident in students STEM curricula in Spain

By analysing students STEM curricula of both secondary education and baccalaureate, Vazquez and Massanero (2017) have identified certain competence dimensions that teachers need to master. Table 2 presents outcomes of the above mentioned study, providing insights on STEM teachers' competences that are implicitly evident in students STEM curricula in Spain.

Table 2: *STEM teachers' competencies implicitly evident in students' curricula as identified by Vazquez & Massanero (2017)*

Dimensions	***Aspects***	***Extracts of learning standards (examples)***
Related to scientific inquiry processes	Skills and strategies of scientific methodology (baccalaureate)	"Apply abilities of scientific inquiry (posing questions, identifying and analysing problems, suggesting sound hypothesis, gathering data, analysing trends based on models, designing and proposing action strategies)"
	Scientific culture (secondary education)	"Analyse a scientific text, critically appraising its content"
		"Analyse the role of scientific research as the engine of our society, and its historical importance"
	Scientific activity (secondary education)	"Recognise and identify the symbols in labels of chemical products and facilities"

Related to students' research projects	Research project (secondary education)	"Use argumentation, justifying the hypothesis posed"
		"Explain with precision and coherence both verbally and in writing the findings of the research"
Related to contents	Ecology and environment	"Compare the practical consequences in the sustainable management of resources, critically appraising its importance"

A review of students' STEM curricula in the country – with the aid of EC (2015) teachers' competence framework - provides evidence that the following aspects of teachers' competences mentioned in the framework are implicitly required by STEM teachers in the country:

Knowledge & Understanding:

- Pedagogical Content Knowledge
- Issues of inclusion and diversity
- Effective use of technologies in learning

Skills:

- Collecting analyzing, interpreting evidence and data for teaching/learning improvement
- Using, developing and creating research knowledge to inform practices

Dispositions & Attitudes:

- Dispositions to promote students' democratic attitudes and practices as European citizens (including appreciation of diversity and multiculturality)
- Dispositions to team working, collaboration and networking.

Major issues for consideration: Proposed issues for discussion about STEM teachers' professional development in Spain

Proposed issues for discussion on STEM teachers' professional development for competence development in the country – as identified via the exploration of the Spanish context at policy, policy mediation and practice levels presented in this document - are:

At macro level, relating to policy envisions on STEM teachers' competence development: Competence-based education is supported by law in all level of compulsory education and baccalaureate. Key competencies are part of the evaluation of the effectiveness of the educational system. Furthermore, STEM has more weight in the curriculum in terms of content and time. The law demands teacher education being adapted to this new situation in terms of contents and methods. In this sense, the Spanish reform recommends methods to facilitate methodological strategies that allow for classroom competencies work (ECD/65/2015). Among the most prominent issues, we can mention:

- Weariness in front of the continuous legal changes and budget cut-outs.
- Lack of coordination among the national, regional CPD providers in terms of policies and strategic plans for STEM CPD that respond to these changes.

At meso level, relating to the mediation mechanisms from policy to practice (teacher training): Universities have undergone an important challenge on creating their own Master's Degree in Secondary Education (should to be approved by a Spanish National Agency of Evaluation), with a competence approach (knowledge, skills and attitudes) that vertebrates the study programs. However, many times University teacher trainers lack experience on the reality of the school, and are more oriented to theoretical approaches. However, there is a great opportunity for the updating of both in-service and pre-service STEM teacher education programs (the new Law specifically mention 7 key competencies, including "mathematics competence and basic competencies in science and technology"). Then teacher education programmes should follow the same approach.

On the other hand, there is a persistence of providing teacher training on STEM according to the traditional subjects (physics, chemistry, technology and maths), which hinder the possibility to include methodologies that are becoming more and more popular in secondary education, as e.g., Project work. Many times University teacher trainers lack experience on the reality of the school, and are more oriented to theoretical approaches.

However, although training contents has been updated, there is a lack of EU policies insufficiently considered (e.g. OSR, STEM gender aspects, ICT, RRI, STE(ART)M), and methodological aspects (e.g. IBL, project work,) are still a challenge in teacher education programs. Among the most prominent issues, we can mention:

- Teacher education programmes need a holistic approach to STEM competencies, getting used to work according to a competence-based approach, working in coordination with all STEM related subjects, and with other key competencies (e.g. digital competencies)
- CPD programmes need to integrate those methodologies and innovations that favour the acquisition of STEM competencies, as e.g IBL, PBL, OSR, ICT, Gender, etc
- Need to provide STEM training paths for in-service teachers in collaboration with different types of institutions, e.g. science centres, research centres, universities and governmental initiatives.

At micro level, relating to teaching/learning practice: There should be a high level of coherence between the competencies required by teachers and those described for students in the Law of Education and further deployments in the regions. However, in practice this does not always happen for different reasons related to the day-to-day work. On the other hand STEM competencies imply a new role for students, more active and autonomous (conscious and responsible of their own learning). Finally, the participation of parents in the day-to-day of the educational centres is important at the time of pushing for STEM-related extra-curricular activities. Among the most prominent issues, we can mention:

- For teachers, there is a surplus of subjects and contents, obsession for finishing the programs, as well as a tendency to use summative evaluation.
- For students, there is a lack of interest on contents because students do not find their connections with reality. And considering also the gender differences in STEM.
- Parents need more information on the importance of implementing STEM innovations in the schools, so they can be involved on the decision-making on their particular centres.

In the frame of the ELIte project, the above mentioned issues will be discussed and negotiated with policy, policy mediation and practice stakeholders (in the course of a multiplier event). The focus of the event will be on the STEM policies at both national and regional level, teachers' training curricula and methods – the role of different stakeholders in the teacher teachers' competences development and the role of the teachers' competences for the development of new generation of Spanish youth.

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Appendix 2- Key messages document on STEM teachers competence development

Key Action 2 – Strategic Partnerships for school education

ELITe: Enhancing Learning in Teaching via e-inquiries

Agreement No. 2016-1-EL01-KA201-023647

STEM teachers' competence development in Greece

Key messages to be discussed at the Greek multiplier event

The background

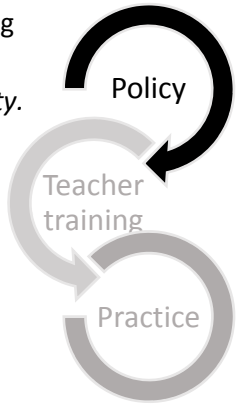
The discourse articulated at EU policy level on ***improving the quality of teacher education*** - expressed for example in EC (2005) [1] - seems to be one the basic drivers of current educational change in the Greek context of secondary teachers' education and training. The issue of ***improving teachers' competences*** is inscribed in both the rhetoric of contemporary political discourse on education (for example in the frame of the establishment of the "***Certificate of pedagogical & teaching competency for secondary teachers***"), and the recent attempted reform initiatives of the 'New School- Student First' (Ministry of Education, 2009) and the 'Social School' (Ministry of Education, 2014).

Against this background, this document reports on the ***key issues*** emerged from the analysis of the ***state of affairs in Greece in terms of Science, Technology, Engineering and Mathematics (STEM) teachers' competence requirements and development,*** conducted in the frame of the ELITe ERASMUS+ project. A ***systemic approach*** has been followed for the analysis, which provides insights in terms of teachers' competences requirements as evident ***explicitly*** in ***policy documents*** (policy level), in ***teacher training curricula*** (teacher training level) and ***implicitly in students' STEM curricula*** (practice level). Prominent issues for consideration that emerged from the analysis are outlined here below.

Prominent issues for consideration on STEM teachers' competence development in Greece

At macro level (policy), new initiatives in terms of teachers' competence development are in line with EU policy frameworks on the issue (EC, 2005; EC, 2013[2]). Major aspects of competences (knowledge, skills and attitudes) that are identified in the Greek reform for teachers' initial training and professional development include:

Knowledge & Understanding: Subject matter knowledge is less emphasised as it is considered as a prerequisite for attending the Programme for acquiring the "*Certificate of pedagogical & teaching competency for secondary teachers*"; most focus is given on building "*professional knowledge*", constituting of PCK, Pedagogical knowledge and curricula knowledge; issues of *inclusion and diversity.*

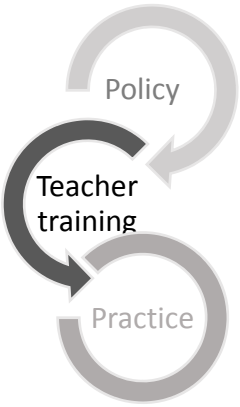


Skills: Most emphasis is given on**:** *using, developing and creating research knowledge* to inform practices; *reflective, metacognitive and interpersonal skills* for learning individually and in professional learning communities; inquiry skills, *collecting, analyzing and interpreting evidence and data* for teaching/learning improvement; using teaching materials and *new technologies*. Some emphasis is given on *collaboration and negotiation skills* with colleagues and parents.

Dispositions, beliefs and attitudes: Most emphasis is given on: dispositions to *change, ongoing learning*; *critical attitudes* to one's own teaching; *transferable* skills; *epistemological awareness.* Some emphasis is given on collaboration and team-working.

Prominent issues for consideration on STEM teachers' competence development in Greece

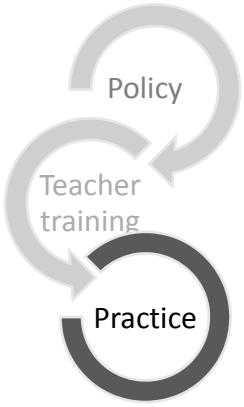
At meso level (teacher training institutions), until very recently the curricula of the undergraduate programmes in science departments were not oriented in educating prospective teachers, but concerned mainly the special scientific field with few references to education and pedagogy (Finnish Institute for Education Research, 2009) [3]. The definitions of competences that teachers are required to possess as evident in teacher training curricula are currently neither explicit nor being detailed described, and tend to be diverse (EC, 2012) [4].



Recent legislation concerning secondary teachers' pedagogical competence is at an early stage of implemeмation by university departments. New curricula are currently developed. Efforts so far neither provide evidence on competence oriented learning outcomes- as teacher curricula remain subject oriented- nor give any insights on innovative methodologies that have the potential to support teachers' competence oriented objectives.

At micro level (students' curricula): There is a high level of coherence between the competences required by teachers and the competences that students are aimed to develop via STEM studies.

Major skills emphasised in students curricula under the current education intended reform 'Social School' (Ministry of Education, 2014) are: Lifelong learning skills; Skills for Responsible citizenship; Reflective and metacognitive skills; Critical thinking; Creativity; Problem solving skills; Risk estimation; Decision making ; Team working; Digital skills.



Main theme for the Greek multiplier event

In relation to STEM teachers' competence development & requirements in Greece, there is a need for **coherence** between was is envisioned in policy rhetoric and what is evident in teacher training curricula. **The role of innovative training methodologies** – as a means towards **supporting teachers' competence oriented objectives** - should be re-considered by teacher training institutions. This could be a step towards bridging the gap between what is envisioned in theory and is implemented in practice.

Structure of the Greek multiplier event

Raising issues	Negotiating	Structuring
Opportunities and challenges in STEM teachers training and professional development for competence development	Propose recommendations for effective STEM teachers training for competence development (take advantage of opportunities and confront obstacles)	Mapping the issues and recommendations onto the onto the EC competence framework and the Greek educational reform framework

References: ***[1]*** EC(2005) Common European principles for teacher competences and qualifications ; ***[2]*** EC (2013) Supporting teacher competence development for better learning outcomes; ***[3]*** Finnish Institute for Education Research (2009) 3 studies to support School Policy Development, Lot 2: Teacher Education Curriculum in the EU, Final Report. ***[4]*** EC (2012) COMMISSION STAFF WORKING DOCUMENT Supporting the Teaching Professions for Better Learning Outcomes

Εκπαίδευση & Επιμόρφωση Εκπαιδευτικών Φυσικών Επιστημών,

της Τεχνολογίας, των Μαθηματικών και της Μηχανικής (ΦΕΤΜΜ / STEM)

για ανάπτυξη επαγγελματικών δεξιοτήτων

Θέματα προς διαπραγμάτευση στην Πολλαπλασιαστική Εκδήλωση Ε1 του έργου ELITe στην Ελλάδα

Η προβληματική και το υπόβαθρο

Τα τελευταία χρόνια σχεδιαζόμενες και ακολουθούμενες εκπαιδευτικές πολιτικές σε Ευρωπαϊκό επίπεδο εστιάζουν όλο και περισσότερο ***στη διασφάλιση υψηλής ποιότητητας διδασκαλίας μέσω κατάλληλης εκπαίδευσης των διδασκόντων***, ως βασική προϋπόθεση για να αντιμετωπιστούν τρέχουσες κοινωνικές προκλήσεις – μεταξύ άλλων το να προσφέρουν τα συστήματα εκπαίδευσης κατάλληλες δεξιότητες για την απασχόληση, την ενεργό συμμετοχή των πολιτών στα κοινά και την ενίσχυση της καινοτομίας (Education and Training 2020). Ο προβληματισμός σε σχέση με τη ***βελτίωση της ποιότητας της εκπαίδευσης και επιμόρφωσης των εκπαιδευτικών*** - όπως εκφράζεται σε ευρωπαϊκό πολιτικό επίπεδο - αποτελεί έναν από τους βασικούς μοχλούς πρόσφατων προσπαθειών για εκπαιδευτική μεταρρύθμιση ***στην Ελλάδα.*** Το ζήτημα της ανάπτυξης κατάλληλων επαγγελματικών δεξιοτήτων σε εκπαιδευτικούς καταγράφεται τόσο στη ρητορική εκπαιδευτικών πολιτικών (για παράδειγμα στο πλαίσιο της θέσπισης του «Πιστοποιητικού Παιδαγωγικής & Διδακτικής Επάρκειας»), όσο και σε πρόσφατες μεταρρυθμιστικές προσπάθειες (Υπουργείο Παιδείας: Νέο Σχολείο, 2009. Κοινωνικό Σχολείο, 2014).

Υπό το πρίσμα των παραπάνω εξελίξεων, στα πλαίσια του ERASMUS+ έργου ELITe η Ομάδα Εκπαιδευτικής Έρευνας και Αξιολόγησης του ITE οργάνωσε, συντόνισε και διεξείγαγε μια μελέτη σχετική με την ανάπτυξη επαγγελματικών δεξιοτήτων κατά την εκπαίδευση και επιμόρφωση εκπαιδευτικών σε ευρωπαϊκό επίπεδο και στα εθνικά πλαίσια της Ελλάδα, της Ολλανδίας, τη Βουλγαρίας και της Ισπανίας. Η μελέτη εστίασε στην ***εκπαίδευση και επιμόρφωση καθηγητών των Φυσικών Επιστημών, της Τεχνολογίας, των Μαθηματικών και της Μηχανικής (ΦΕΤΜΜ/STEM) για την ανάπτυξη επαγγελματικών δεξιοτήτων*** με δεδομένο τον βασικό ρόλο των ΦΕΤΜΜ στο να εξοπλίσουν με τις κατάλληλες γνώσεις, ικανότητες και στάσεις τόσο τους μελλοντικούς πολίτες, όσο και τους μελλοντικούς επιστήμονες (EC, Science Education for Responsible Citizenship, 2015). Η μελέτη υλοποιήθηκε σε τρία επίπεδα: σε επίπεδο εκπαιδευτικών πολιτικών, σε επίπεδο ευκαιριών για επαγγελματική εκπαίδευση και επιμορφωση, και σε επίπεδο σχολικής πράξης σε κάθε χώρα. Στη συνέχεια παρουσιάζουμε κύρια θέματα που αναδύθηκαν από τη μελέτη για το εθνικό πλαίσιο της Ελλάδας, με σκοπό αυτά να αποτελέσουν το εφαλτήριο για τις συζητήσεις στη συνάντηση εργασίας που έχετε προσκληθεί να συμμετέχετε.

Θέματα που αναδύθηκαν από τη μελέτη του έργου ELITe για το εθνικό πλαίσιο της Ελλάδας

- **Σε επίπεδο χάραξης εκπαιδευτικών πολιτικών,** η ρητορική που αφορά στην ανάπτυξη δεδιοτήτων των εκπαιδευτικών είναι σύμφωνη με προωθούμενες εκπαιδευτικές πολιτικές της ΕΕ (EC, 2005. EC, 2013). Σημαντικές πτυχές των δεξιοτήτων (γνώσεων, ικανοτήτων και στάσεων) που εντοπίζονται στην ελληνική

μεταρρυθμιστική προσπάθεια για την αρχική κατάρτιση και την επαγγελματική εξέλιξη των εκπαιδευτικών περιλαμβάνουν:

Γνώσεις & Κατανόηση: Η γνώση του επιστημονικού περιεχομένου θεωρείται ως βάσική προϋπόθεση για την περαιρέρω επιμόρφωση των εκπαιδευτικών. Ιδιαίτερη έμφαση δίνεται στην οικοδόμηση επαγγελματικής γνώσης (που περιλαμβάνει παιδαγωγικές γνώσεις, γνώσεις παιδαγωγικού επιστημονικού περιεχομένου, και γνώσεις σχετικά με το πρόγραμμα σπουδών) καθώς και σε θέματα διαφοροποίησης και ένταξης μαθητών με ειδικές ικανότητες και δυσκολίες.

Ικανότητες: Έμφαση δίνεται σε ικανότητες χρήσης, ανάπτυξης και δημιουργίας γνώσης μέσα από έρευνα που μπορεί να ενημερώσει τη διδακτική πράξη, ικανότητες σκέψης και μεταγνώσης, διαπροσωπικές ικανότητες για μάθηση ατομική και σε κοινότητες πρακτικής, ικανότητες διερεύνησης, ικανότητες χρήσης καινοτόμων μαθησιακών υλικών και νέων τεχνολογιών.

Στάσεις: Έμφαση δίνεται σε θετικές στάσεις στην αλλάγή, στη δια-βίου μάθηση, στην κριτική στάση απέναντι στον προσωπικό τρόπο διδασκαλίας, στην επιστημονολογική συνειδητοποίηση, καθώς επίσης και στη θετική στάση για συνεργασία και ομαδική εργασία.

- **Σε επίπεδο ευκαιριών για επαγγελματική εκπαίδευση και επιμορφωση**, μέχρι πρόσφατα τα προγράμματα σπουδών των προπτυχιακών προγραμμάτων στα πανεπιστημιακά τήματα δεν προσανατολίζονταν στην εκπαίδευση των μελλοντικών εκπαιδευτικών, αλλά αφορούσαν κυρίως τον ειδικό επιστημονικό τομέα - με ελάχιστες αναφορές στην εκπαίδευση και την παιδαγωγική (Φινλανδικό Ινστιτούτο Εκπαίδευσης, 2009). Οι ορισμοί των ικανοτήτων που απαιτείται να διαθέτουν οι καθηγητές - όπως προκύπτουν μέσα στα προγράμματα σπουδών για την κατάρτιση των εκπαιδευτικών - δεν είναι ούτε σαφείς ούτε λεπτομερείς και τείνουν να είναι ποικίλοι ανάλογα με το φορέα εκπαίδευσης/επιμόρφωσης (EC, 2012).

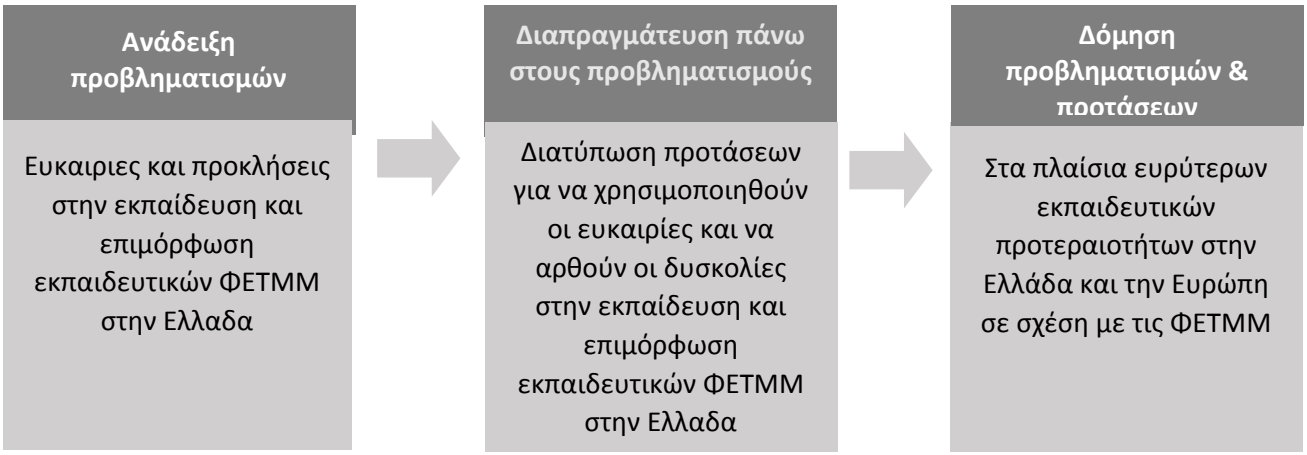
Πρόσφατες νομοθετικές προσπάθειες σχετικά με την παιδαγωγική και διδακτική επάρκεια των δευτεροβάθμιων εκπαιδευτικών βρίσκονται σε πρώιμο στάδιο υλοποίησης από τα πανεπιστημιακά τμήματα. Νέα προγράμματα σπουδών αναπτύσσονται επί του παρόντος. Οι προσπάθειες μέχρι στιγμής δεν παρέχουν αποδείξεις ότι τα προγράμματα προσανατολίζονται στην ανάπτυξη ικανοτήτων (competence oriented learning outcomes) και δεν ενσωματώνουν καινοτόμες μεθοδολογίες που έχουν τη δυνατότητα να υποστηρίξουν στόχους προσανατολισμένους στην ανάπτυξη δεξιοτήτων των εκπαιδευτικών.

- **Σε επιπεδο σχολικής πράξης**, υπάρχει υψηλό επίπεδο συνοχής μεταξύ των ικανοτήτων που απαιτούνται από τους εκπαιδευτικούς στη ρητορική εκπαιδευτικής πολιτικής, και των ικανοτήτων που επιδιώκουμε να αναπτύξουν οι μαθητές μέσα από τις σπουδές στις ΦΕΤΜΜ. Σημαντικές δεξιότητες που υπογραμμίζονται στα προγράμματα σπουδών των μαθητών υπό την τρέχουσα μεταρρύθμιση «Κοινωνικό Σχολείο» (Υπουργείο Παιδείας, 2014) είναι: Δεξιότητες διά βίου μάθησης, δεξιότητες για υπεύθυνη πολιτότητα, μεταγνωστικές ικανότητες, κριτική σκέψη, δημιουργικότητα, ικανότητες επίλυσης προβλημάτων, εκτίμηση κινδύνου, λήψη αποφάσης, ομαδική εργασία, ψηφιακές δεξιότητες.

Κύριο θέμα συζήτησης για την Πολλαπλασιαστική Εκδήλωση στην Ελλάδα

Συμπερασματικά, όσον αφορά την ανάπτυξη ικανοτήτων των εκπαιδευτικών ΦΕΤΜΜ στην Ελλάδα, παρατηρείται ***έλλειψη συνοχής ανάμεσα στην ρητορική των εκπαιδευτικών πολιτικών και στο επίπεδο ευκαιριών για επαγγελματική εκπαίδευση και επιμορφωση***. Ο ρόλος καινοτόμων μεθοδολογιών κατάρτισης - ως μέσο για την επίτευξη στόχων προσανατολισμένων προς την ανάπτυξη δεξιοτήτων- θα πρέπει να επανεξεταστεί από τους φορείς κατάρτισης και επιμόρφωσης των εκπαιδευτικών. Αυτό θα μπορούσε να αποτελέσει ένα βήμα προς τη γεφύρωση του χάσματος μεταξύ του τι προωθείται θεωρητικά και τι εφαρμόζεται στην πράξη.

Στόχοι και δομή της Πολλαπλασιαστικής Εκδήλωσης στην Ελλάδα



Αναφορές: ***[1]*** EC(2005) Common European principles for teacher competences and qualifications ; *[2]* EC (2013) Supporting teacher competence development for better learning outcomes; *[3]* Finnish Institute for Education Research (2009) 3 studies to support School Policy Development, Lot 2: Teacher Education Curriculum in the EU, Final Report. *[4]* EC (2012) COMMISSION STAFF WORKING DOCUMENT Supporting the Teaching Professions for Better Learning Outcomes

Key Action 2 – Strategic Partnerships for school education

ELITe: Enhancing Learning in Teaching via e-inquiries

Agreement No. 2016-1-EL01-KA201-023647

STEM teachers' competence development in the Netherlands

Key messages to be discussed at the Dutch multiplier event

The background

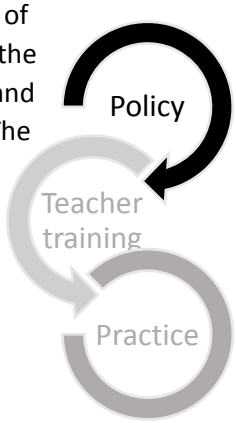
Teacher professional development is part of the national agenda in the Netherlands as a warrant of the quality of Dutch education. From August 1 2017 the Law on Teacher Profession and Teacher Register makes continuous professional learning and development a compulsory part of the teacher profession. The Ministry of Education and Culture and national teacher agency (Onderwijscoöperatie) take care of the pre-requisites and the general framework by formulating the general quality standards and by financing teachers' professional development through the system of national bursaries for masters' or Ph.D. programs for teachers.

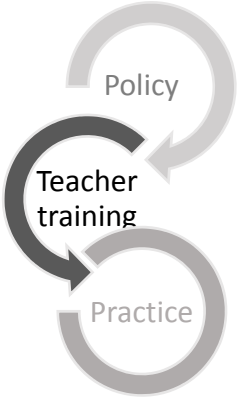
At meso level, school boards facilitate teacher professional development by allocating time and facilities for learning activities, intervision and network learning and support of innovation at grass-roots level. Support of participation in regional, national and international networks of schools contributes to teacher learning as well. Pre-service teacher education, publishing houses, non-governmental educational agencies and university research centers contribute to teacher learning by offering live, online and blended courses and programs and conducting research of teacher professionalization.

It is however, the teachers themselves who retain responsibility for and who have the lead in making continuous professional development an integral part of the teacher profession in the ever changing and increasingly demanding world of education.

Issues for discussion about (STEM) teachers' professional development in the Netherlands

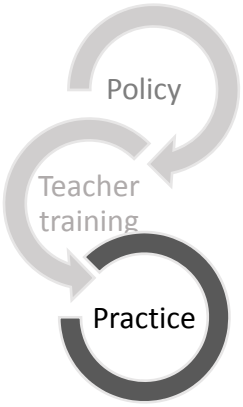
At macro level (policy): Balance between societal demands of innovation, the national core curriculum requirements and the organization of pre-service and in-service teacher learning and permanent competence development [in STEM domains]. The trigger for discussion [can be]: the pre-requisites for sustainable teacher learning and competence development against the newly defined teacher competence quality standards and beyond them.





At meso level (teacher training institutions): Transition from pioneer work, experiments, projects and lessons learned from them to integration of innovative approaches at schools into mainstream school daily practice against the background of the current practices of teacher learning facilitation by school boards. "From sowing to harvesting". The trigger for discussion [can be] the question of how school boards ensure that innovation and teacher professional learning innovate and transform the current school practice and vice a versa how innovative practice insures sustainable teacher learning.

At micro level (practice): Integration of 21st century skills with (STEM) domain knowledge and skills, connecting learning in and out of school with ubiquitous ICT (seamless learning idea), integration of subjects, learner directed curricula - numerous trends meet in the school of today and make active teacher involvement in designing and shaping his/her lessons, courses and curricula for and with learners a necessity. Insights in what works and why are needed to underpin design decisions, therefore the inquiring mind as an attitude comes into picture. Teacher as designer and teacher as inquirer /researcher of his/her own practice are two important trends in the teacher profession nowadays. The trigger questions for discussion are on the impact these two new trends implicate for teacher professional learning and competence development and the implications they have on the school practice.



Issues for discussion about (STEM) teachers' professional development in the Netherlands

Main theme for the Dutch multiplier event

Impact of teacher learning (competence development) on the school practice

Structure of the Dutch multiplier event

Raising issues	Negotiating	Structuring
Clarifying the core issues, Discussing opportunities and challenges per level (macro, meso, micro)	Negotiating over the issues, propose recommendations.	Mapping the issues and the recommendations onto EC (2013) competence framework & national agenda

De competentieontwikkeling van STEM docenten in Nederland

Sleutelboodschappen die in het Nederlandse multiplierevenement worden besproken

Docentprofesssionalisering is meer dan een relevant onderdeel van het onderwijsagenda in Nederland. Met de Wet Beroepen in het Onderwijs (Wet Bio, 2006) is professionalisering een integraal onderdeel van de professie van leraar geworden. Met deze verankering en de instrumentatie via Lerarenregister en het creëren van financiële randvoorwaarden in de vorm Lerarenbeurs heeft de Nederlandse onderwijs belangrijke randvoorwaarden voor permanente professionalisering van leerkrachten en docenten geschapen. De realisatie van de professionalisering binnen deze randvoorwaarden en ook benutten van datgene wat dankzij deze randvoorwaarden mogelijk is, ligt bij de school als organisatie, enerzijds en de individuele docent, anderzijds.

Relevante vraagstukken zijn

- **Op macro niveau:** afstemming tussen nationale interesses in innovatie en technologische ontwikkeling en de organisatie van initiële onderwijsstructuren en de structuren voor de permanente docentenprofessionalisering op de werkplek. De recent herijkte docentencompetenties dienen als een trigger voor discussie over toepkomstgericht en toekomstbestendig docentprofessionalisering.
- **Op meso niveau**: school als organisatie en werkgever is op zoek naar innovatieve aanpakken van professionalisering waarmee niet alleen individu maar de organisatie als geheel het predicaat “lerende organisatie” zou kunnen hebben. Wat betekent voor de school als organisatie het leren van docenten als een integraal onderdeel van het functioneren van deze organisatie? Hoe evalueert de school door de individuele transformaties van leraren en wat betekent de transformatie van de school in de lerende organisatie voor toekomstgericht en toekomstbestendig docentprofessionalisering?
- **Op micro-niveau** heeft het vraagstuk van docentprofessionalisering meerdere kanten. Integratie van transversale vaardigheden, de zo genaamde 21eeuwse vaardigheden, alomtegenwoordigheid van ICT, curricula die niet de vakinhouden maar de leerling centraal stellen, personalisatie van leren veranderen het onderwijs en de leerkracht. De kennis en vaardigheden opgebouwd in initiële opleidingen leggen de basis voor het carrière lang bouwwerk van docenteprofessionalisering waarbij de houding, met name de onderzoekende en reflecterende houding prominent naar voren komen en ontwerp- en onderzoeksvaardigheden steeds meer tot de basisrepertoire van de leraar beginnen te behoren.

⇨ Het centrale thema van het Nederlandse multiplayer event

Docentprofessionalisering en de impact ervan op de schoolpraktijk

Op 5 oktober 2017 organiseren schoolbesturen LVO (cluster Parkstad), SVO|PL en Citaverde (afd. Vmbo) een Dag van de Leraar voor alle betrokkenen bij het voortgezet onderwijs in Parkstad Limburg. In het theater van Parkstad Limburg komen naar verwachting circa 1200 docenten, onderwijsondersteunend personeel, schoolmanagement en andere stakeholders bij elkaar om een dag lang samen met elkaar en van elkaar te leren. Het thema van de dag is: 'Zaaien, groeien, bloeien en oogsten'. Het Parkstad Limburg Theater wordt voor deze dag omgetoverd in een soort onderwijsfestival met keynotes, good practice workshops, inspiratiesessies en netwerkplekken. Elke deelnemer zal online een geheel gepersonaliseerde route voor die dag uit kunnen stippelen.

Het Welten-Instituut koppelt een onderzoek zal aan naar de behoeften van leraren aan professionalisering aan deze dag en zal op de dag via een serie workshops de vragen die zowel op mico als op meso niveau betrekking hebben verhelderen.

Door middel van een Groep Concept mapping worden de behoeften van individuele leraren geinventariseerd.

In een gezamenlijke sessie wordt vanuit verschillende rollen naar deze expliciet gemaakte behoeften gezamenlijk gekeken.

Vervolgens worden de standpunten van de betrokken stakeholders aan de schoolbesturen voorgelegd.

De uitkomst is een overzichten van de behoeften en leerwensen van de docenten op zowel individueel als collectief niveau.

Key Action 2 – Strategic Partnerships for school education

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STEM teachers' competence development in Bulgaria

Key messages to be discussed at the Bulgarian multiplier event

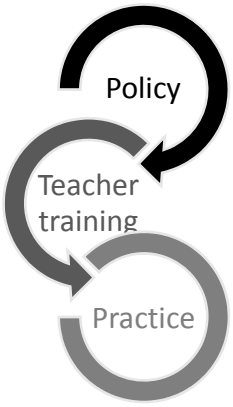
The background

During the last decades, Bulgaria was faced with the need of dramatic changes in educational system and regulatory framework. The reform has started in 2010 and since 2016 it is in the effective use. The educational reform defines new profile of the teacher as a main actor in the educational process. The change of the in-service teachers' knowledge, skills and attitudes, as well as professional life habits and behavior in parallel with accepting of new understanding of teachers' responsibilities is a big challenge not only for teachers themselves but also for supporting institutions – Ministry of Education and Science, Regional Management Centers of Education, teacher training institutions and schools.

Prominent issues for consideration on STEM teachers' competence development in Bulgaria

***At macro level*: Opportunities and challenges in building teacher competences by the teacher trainings**

- Policymakers at national, regional and local level need to organize work together with traditional training providers (holding the methodology knowledge) and new one (holding concrete practical approach).
- Policymakers and all levels to create conditions IBL approach to be embraces by new teacher trainings providers (business, publishing houses, etc.) and teaching materials?



***At meso level*: Opportunities and challenges in schools management of strategy, curricula and teaching approaches**

- School authorities 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

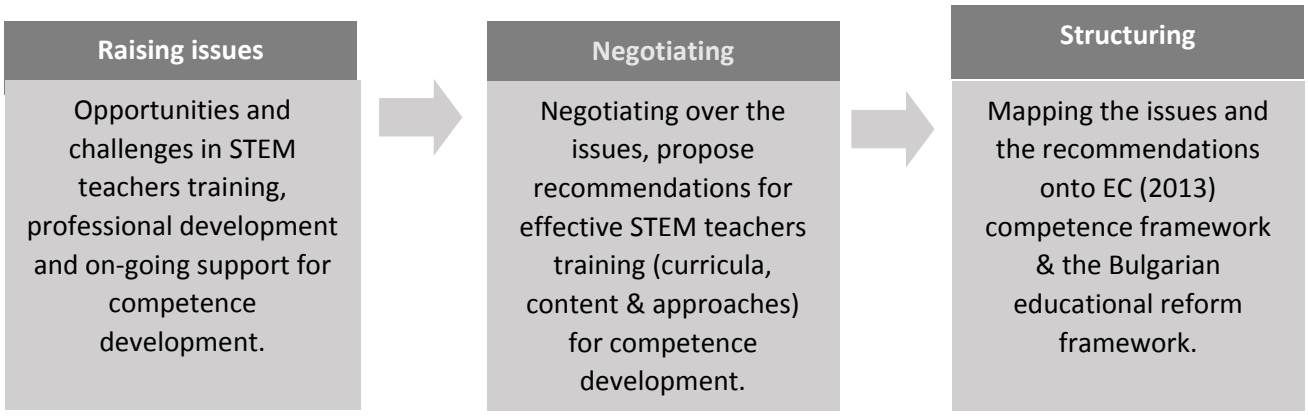
***At micro level*: Teacher competence are needed to design IBL activities in the class. Teachers needs a support for IBL day-to-day application. Content should be provided to spread widely the approach.**

- 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.
- Content providers 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.

Main theme for the Bulgarian multiplier event

Focus on the STEM teachers' training curricula and methods – the role of different stakeholders in the teacher teachers' competences development and the role of the teachers' competences for the development of new generation of Bulgarian youth.

Structure of the Bulgarian multiplier event



Ключови компетенции за българските учители по природни науки, инженерни науки и математика

Основни послания

За дискутиране по време на семинара

Описание на контекста

През последните десетилетия България се изправи пред необходимостта от сериозни промени в образователната система и основните закони в тази сфера. Последната реформа започна през 2010 г., като промените влязоха в сила през 2016 г.. Тези промени определят важна роля за учителя в образователните процеси. От друга страна се изискват сериозни промени в знанията, уменията и поведението на учителите. Това води до трудности не само за учителите, но и за всички други въвлечени институции – министерството, регионалните инспекторати, институциите подготвящи учители и училищата.

Важни въпроси свързани с развитието на компетенциите на учителите по природни науки, инженерни науки и математика в България

На ниво класна стая (микро ниво): **Учителите трябва да могат да проектират класни учебни дейности, свързани с прилагане на изследователския подход. Учителите имат нужда от помощни инструментални средства за ежедневното прилагане на този подход, както и от подходящо учебно съдържание.**

- Необходимо е учителите да изграждат и развиват компетенции за прилагане на изследователския подход в училище, да създават и прилагат сценарии, базирани на този подход в ежедневната си практика в клас.
- Необходимо е да се предоставят инструменти на учителите за по-лесно и ефективно прилагане на този подход чрез подходящи учебни дейности.
- Авторите на учебно съдържание трябва да нагодят учебния материал с цел възможност за прилагане на изследователския подход, като дадат достатъчно свобода на учителите да избират как да се случи това на практика.

На ниво училище (мезо ниво): **Възможности и предизвикателства пред училищните ръководства за по-гъвкаво прилагане на нови стратегии, учебни програми и иновативни методи за преподаване**

- Училищните управи да използват правото си на автономни решения и отговорността пред обществото за високо качество на образователни услуги, като създават условия и възможности за прилагане на изследователския подход в обучението

На национално ниво (макро ниво): **Възможности и предизвикателства за изграждане на нужните компетенции на учителите чрез повишаване на квалификация и обучение през целия живот**

- Министерството да организира и гарантира провеждане на обучения за учители на национално, регионално и локално ниво чрез привличане на компетентни преподаватели и организации, специализирани в подготовката и квалификацията на учителите

- Министерството да стимулира създаване на подходящи инструментални средства и учебни материали за прилагане на изследователския подход в образованието

⇨ **Основни теми за семинарите в България**

Основен фокус и център на внимание ще бъдат въпросите свързани с ефективното прилагане на изследователския подход в обучението в природните науки, инженерните науки и математиката. Ще се разгледат проблемите свързани с изграждане на нужните компетенции на учителите, ролята и отговорността на родителите, осигуряването на необходимите ресурси за прилагане на този метод в ежедневието.

Повдигане на въпроси и проблеми (дискусии в еднородни групи): Възможности и предизвикателства пред подготовката и развиването на компетенциите на учителите за прилагане на изследователски подход в обучението по природни и инженерни науки и математика.

Постигане на съгласие (дискусии в разнородни групи): Дискутиране на конкретни въпроси и проблеми, свързани с подготовката на учителите, постигане на съгласие и формулиране на конкретни предложения пред съответните национални органи.

Финално структуриране (пленарно заседание): Финално оформление и структуриране на повдигнатите проблеми и предложения за решения, и намиране на съответствие с европейската скала на компетенции и правната рамка на Българската образователна реформа.

STEM teachers' competence development in Spain

Key messages to be discussed at the Spanish multiplier event

The background

Spanish educational Laws have been changed several times during the last twenty years. Since 2013 and in process of deployment, there is a ***new Educational Law*** named "Organic Law for the Improvement of the Quality of Education" (LOMCE, 8/2013). Fruit of the political instability and, to a certain extent, a lack of a culture of consensus, implementation is being challenged in many levels, giving a sense of provisionality, which is reflected in the fact that regions, local authorities, and educational councils are in ***continuous negotiations with the Ministry in order to modify the law***. In this situation there is certain weariness in front of the continuous legal changes and budget cut-outs.

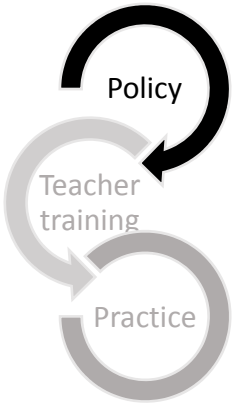
There are important changes very much in concordance with the EU policies (European Parliament, 2006/962/EC). The Law emphasises quality and employability, encouraging selecting both the professional and the academic path at earlier ages. There is ***more emphasis in STEM***, more instrumental type of disciplines, and less subjects optional. Of importance is the interest of giving the ***schools more freedom in terms of adapting the national curriculum*** (curriculum proposal) or ***introducing new methodologies*** and optional subjects (didactical programme), within their legal competencies. The ***curriculum is now organised according to a competency approach***, in which knowledge, skills and attitudes have been identified in all subjects and at all levels. Key competencies, named "basic competencies" inform the competence model. This panorama implied also ***the reform of the Continuous Professional Development (CPD) programmes***, as well as access to the teacher profession, now based on Master's Degree Programmes.

At macro level (policy):

Competence-based education is supported by law in all level of compulsory education and baccalaureate. Key competencies are part of the evaluation of the effectiveness of the educational system. Furthermore, STEM has more weight in the curriculum in terms of content and time. The law demands teacher education being adapted to this new situation in terms of contents and methods. In this sense, the Spanish reform recommends methods to facilitate methodological strategies that allow for classroom competencies work (ECD/65/2015).

Among the most prominent issues, we can mention:

- Weariness in front of the continuous legal changes and budget cut-outs.
- Lack of coordination among the national, regional CPD providers in terms of policies and strategic plans for STEM CPD that respond to these changes.



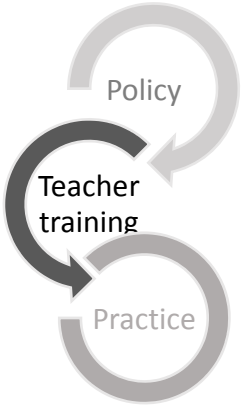
Prominent issues for consideration on STEM teachers' competence development in Spain

At meso level (teacher training institutions):

Universities have undergone an important challenge on creating their own Master's Degree in Secondary Education (should to be approved by a Spanish National Agency of Evaluation), with a competence approach (knowledge, skills and attitudes) that vertebrates the study programs. However, many times University teacher trainers lack experience on the reality of the school, and are more oriented to theoretical approaches.

However, there is a great opportunity for the updating of both in-service and pre-service STEM teacher education programs (the new Law specifically mention 7 key competencies, including "mathematics competence and basic competencies in science and technology"). Then teacher education programmes should follow the same approach**.**

On the other hand, there is a persistence of providing teacher training on STEM according to the traditional subjects (physics, chemistry, technology and maths), which hinder the possibility to include methodologies that are becoming more and more popular in secondary education, as e.g., Project work. Many times University teacher trainers lack experience on the reality of the school, and are more oriented to theoretical approaches.



Prominent issues for consideration on STEM teachers' competence development in Spain

However, although training contents has been updated, there is a lack of EU policies insufficiently considered (e.g. OSR, STEM gender aspects, ICT, RRI, STE(ART)M), and methodological aspects (e.g. IBL, project work,) are still a challenge in teacher education programs.

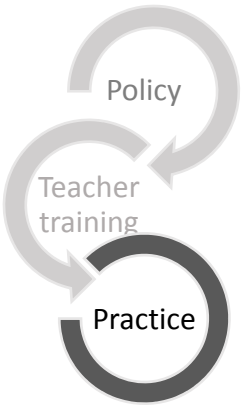
Among the most prominent issues, we can mention:

- Teacher education programmes need to get used to work according to a competence-based approach, working co-ordinately in all subjects with other key competencies (e.g. digital competencies)
- CPD programmes need to integrate those methodologies and innovations that favour the acquisition of STEM competencies, as e.g IBL, PBL, OSR, ICT, Gender, etc
- Need to provide STEM training paths for in-service teachers in collaboration with different types of institutions, e.g. science centres, research centres, universities and governmental initiatives.

Prominent issues for consideration on STEM teachers' competence development in Spain

At micro level (students' curricula):

There should be a high level of coherence between the competencies required by teachers and those described for students in the Law of Education and further deployments in the regions. However, in practice this does not always happen for different reasons related to the day-to-day work. On the other hand STEM competencies imply a new role for students, more active and autonomous (conscious and responsible of their own learning). Finally, the participation of parents in the day-to-day of the educational centres is important at the time of pushing for STEM-related extra-curricular activities.



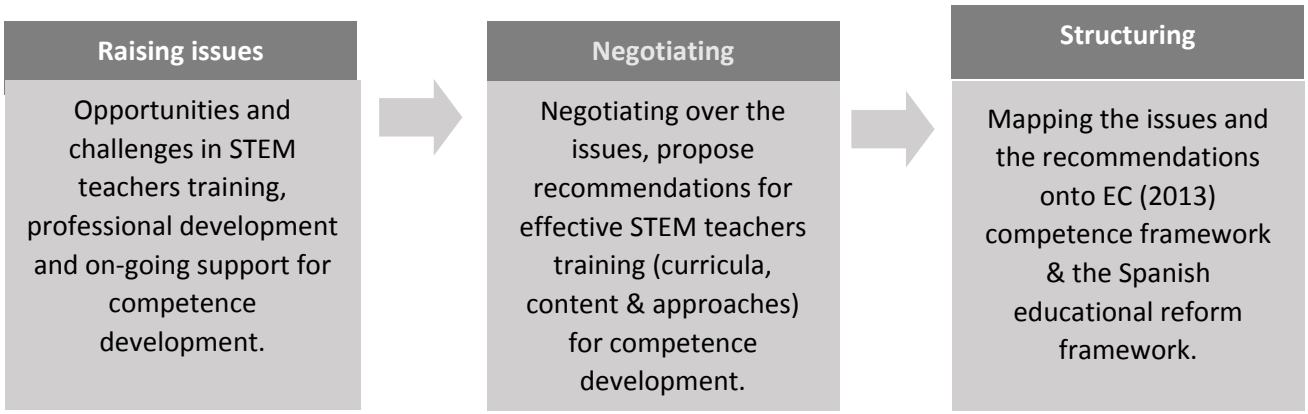
Among the most prominent issues, we can mention:

- For teachers, there is a surplus of subjects and contents, obsession for finishing the programs, as well as a tendency to use summative evaluation.
- For students, there is a lack of interest on contents because students do not find their connections with reality.
- Parents need more information on the importance of implementing STEM innovations in the schools, so they can be involved on the decision-making on their particular centres.

Main themes for the Spanish multiplier event

Focus on the STEM policies at both national and regional level, teachers' training curricula and methods – the role of different stakeholders in the teacher teachers' competences development and the role of the teachers' competences for the development of new generation of Spanish youth.

Structure of the Spanish multiplier event



Desarrollo de competencias del docente CTIM en España

Mensajes clave

para ser discutidos en un evento con diferentes actores interesados

Antecedentes

Las leyes educativas españolas han cambiado varias veces durante los últimos 20 años. Desde que el 2013 y en proceso de reforma antes de ser totalmente implementada, una nueva ley educativa denominada "Ley Orgánica para la mejora de la calidad de la educación (LOMCE, 8/2013."), ha comenzado a desplegarse con muchos recortes presupuestarios. Fruto de la inestabilidad política y, en cierta medida, la falta de una cultura de consenso, la aplicación está siendo impugnada en muchos niveles, dando una sensación de provisionalidad, que se refleja en el hecho de que las regiones, las autoridades locales y los consejos educativos están en continuas negociaciones con el Ministerio de Educación para modificar esa ley. En esta situación hay cierto cansancio en la comunidad educativa y en la sociedad en general frente a los continuos cambios normativos.

En esta ley, se aprecian cambios importantes en concordancia con las políticas de la UE (Parlamento Europeo, 2006/962/CE). Se enfatiza la calidad de la educación y la empleabilidad, fomentando la selección tanto de las futuras profesiones como trayectorias académicas a edades más tempranas. Hay más énfasis en el las **carreras CTIM (ciencias, tecnologías, ingenierías y Matemáticas**, STEM en la nomenclatura internacional), con disciplinas más instrumentales, y en la práctica, menos asignaturas optativas. De importancia es el interés en dar a los centros más libertad en términos de adaptación del currículo nacional (propuesta curricular), o de introducir nuevas metodologías y asignaturas dentro de sus competencias legales. El currículo se organiza ahora de acuerdo al enfoque por competencia, identificando conocimientos, destrezas y actitudes en todos los temas y en todos los niveles. Las competencias clave (denominadas "competencias básicas"), informan el modelo de competencia. Esta situación implicaba también la reforma de los programas de desarrollo profesional del profesorado, así como el acceso a la profesión docente, ahora basada en los nuevos programas de maestría.

Aspectos destacados para su consideración en la discusión del desarrollo de competencias del profesorado CTIM en España.

A nivel macro (política):

La educación basada en la competencia está respaldada por la ley en todos los niveles de educación obligatoria y bachillerato. Las competencias clave son parte de la evaluación de la efectividad del sistema educativo. Además, CTIM tiene más peso en el currículo en términos de contenido y horario. La ley exige que la formación docente se adapte a esta nueva situación en términos de contenidos y metodologías. En este sentido, la reforma en España hace recomendaciones para facilitar estrategias metodológicas que permitan el trabajo de las competencias en el aula (ECD/65/2015). Entre los aspectos más controvertidos a discutir, podemos mencionar:

- cansancio de la comunidad educativa frente a los continuos cambios legales y recortes de presupuesto.
- falta de coordinación entre los proveedores nacionales y/o regionales de formación inicial y permanente en términos de políticas y planes estratégicos para el desarrollo profesional del profesorado CTIM que respondan a estos cambios.

A nivel meso (la formación docente):

Las universidades han experimentado un importante reto en la creación de sus propios Másters en educación secundaria (deben ser aprobado por una Agencia Nacional Española de evaluación), con un enfoque de competencia (conocimientos, habilidades y actitudes) que vertebra los programas de estudio. Sin embargo, muchas veces los formadores de profesores universitarios carecen de experiencia en la realidad de la escuela, y están más orientados a enfoques teóricos. Existe una gran oportunidad para la actualización de los programas de formación de profesorado CTIM a nivel inicial y permanente (la nueva ley menciona específicamente siete competencias clave, incluyendo "competencia matemática y competencias básicas en ciencia y tecnología"). Es decir, los programas de formación docente deben seguir el mismo enfoque.

Por otro lado, pervive el hecho de proporcionar formación de profesorado CTIM de acuerdo a las disciplinas tradicionales (física, química, tecnología y matemáticas), que dificultan en cierta manera la posibilidad de incluir metodologías cada vez más populares en la educación secundaria, como por ejemplo, el trabajo por proyectos.

Sin embargo, aunque se ha actualizado el contenido de la formación, están insuficientemente consideradas algunas de las políticas promocionadas por la UE en sus programas de innovación educativa (por ejemplo, Recursos Educativos Abiertos, aspectos de género y CTIM, TICs, Investigación e Innovación Responsable, CTIM(Arte). Muchas metodológicas didácticas, (por ejemplo, Aprendizaje Basado en la Indagación, trabajo de proyectos) están presentes, pero siguen siendo un reto en los programas de formación del profesorado. Entre los aspectos más controvertidos a discutir, podemos mencionar:

- los programas de formación docente necesitan acostumbrarse a trabajar de acuerdo con un enfoque basado en competencias, trabajando coordinadamente y transversalmente con otras competencias clave (por ejemplo, las competencias digitales)
- los programas de desarrollo profesional del profesorado necesitan integrar las metodologías e innovaciones mencionadas anteriormente que favorezcan la adquisición de competencias CTIM,
- la necesidad de proporcionar rutas formativas en CTIM para docentes en servicio en colaboración con diferentes tipos de instituciones tales como centros científicos, centros de investigación, universidades y otras iniciativas gubernamentales y no gubernamentales.

A nivel micro (la práctica)

Debería existir un alto nivel de coherencia entre las competencias exigidas por los docentes y las que se describen para los estudiantes en la ley de educación y en el despliegue de ésta en las comunidades autónomas. Sin embargo, en la práctica, esto no siempre ocurre por razones relacionadas con el trabajo día a día. Por otra parte, las competencias troncales implican un nuevo rol para el estudiante, más activos y autónomos (conscientes y responsables de su propio aprendizaje). Por último, la participación de los padres en la cotidianidad de los centros educativos es importante en

el momento de impulsar actividades extracurriculares relacionadas con CTIM. . Entre los aspectos más controvertidos a discutir, podemos mencionar:

- para los docentes, hay un exceso de asignaturas y contenidos, la conocida obsesión por terminar los programas, así como la tendencia a utilizar, por práctica, la evaluación sumativa.
- para los estudiantes, hay una falta de interés en los contenidos CTIM porque generalmente no encuentran conexiones con la realidad que viven
- los padres y madres necesitan más información sobre la importancia de implementar las innovaciones CTIM en el currículum, para que puedan participar en la toma de decisiones en sus centros particulares

Temas claves para la discusión en el evento en España

Se pondrá el foco, siguiendo lo mencionado anteriormente, en las políticas de CTIM (a nivel nacional y regional), en los programas de formación y en la metodología docente – el papel de las diferentes partes interesadas en el desarrollo de las competencias de los docentes, y el papel de las competencias de los docentes para el desarrollo de la nueva generación de jóvenes.

Planteando cuestiones controvertidas (**en grupos homogéneos**): oportunidades y desafíos en la formación inicial de profesorado CTIM, su desarrollo profesional, y el apoyo actual recibido para el desarrollo de competencias docentes.

Negociando sobre los cuestiones controvertidas identificadas anteriormente (**sesiones de grupos heterogéneos):** negociación de temas, proponer recomendaciones para una efectiva formación del docente CTIM (currículos, contenidos y enfoques) para el desarrollo de sus competencias.

Estructurando (**sesión plenaria**): mapeo de los temas clave más controvertidos, y recomendaciones sobre el marco de competencias de la UE (publicado en el 2013) y el marco de la reforma educativa española.

Appendix 3 – Teacher competences for parental engagement- Position of EPA in reaction to the state-of-affairs reports

Teacher competences for parental engagement in STEM in secondary schools

Position of the European Parents' Association on policy envisions & requirement for STEM teachers' competence development in Greece, the Netherlands, Bulgaria & Spain in reaction to the state-of-affairs reports

> "*Measures and support structures (ideally available at local levels) should be in place to facilitate the **lifelong career development** of teachers. Initial teacher education and continuous professional development with a focus on drop-out prevention should help teachers practice differentiation and active learning. It should prepare them to effectively use **competence oriented teaching and formative assessment**, and to apply more project-based and cooperative teaching and learning. It should **reinforce** relational and **communication expertise** (including techniques/methods **to engage with parents** and external partners), and provide teachers with classroom management strategies, diversity management strategies, relationship building, conflict resolution and bullying prevention techniques."*
>
> (EC 2016, A Whole School Approach to tackling early school leaving Policy Messages p. 14)

Setting the scene

Official EU policy has recognised the importance of engaging parents and learners in all aspects of education since the early 2010's. A need to assess and improve teachers' collaboration and negotiation skills has also been identified as an important development field to transform European education systems to meet the needs of 21st century learners, and thus also help to achieve the EU2020 headline target of reducing early school leaving. The aim of the document to complement the analysis of four national contexts from the perspective of parents, to provide ground for discussion and reflection among STEM education stakeholders on how to improve teacher training and competence development – both pre- and in-service.

Recognition of parents as primary educators

Legally[5] and de facto parents are the primary – first, but also most impacting at all ages - educators of their children. In teacher trainings, this is not used as a starting point, parents are often shown and thus seen as a burden, an extra task. Innovative approaches must include this as a starting point, empower teachers in innovative training for parental engagement and cooperation. Necessary methodology is to be offered to teachers to empower parents.

[5] according to the UN Convention on the Rights of the Child

Parental engagement & teacher training: prominent issues for consideration

- teacher training does not aim at understanding that parental engagement is an obligation for both the school and the parent, and does not offer methodology to make parents also understand this – parents staying away and not 'interfering' are still considered a positive role model, while they it is a legal obligation of the parent to be involved in designing elements of the right educational pathway for their children
- teachers in Europe confront difficulties in making parents understand the need for innovation – although parents want the best for their children, the vast majority of them has no other reference point than their own schooling and experiences, but they bring real life and realistic future needs to the school that could be used as a basis
- teacher training does not consider co-designing curricula building on personal experiences and professional knowledge of parents
- teacher training does not offer methodology to support STEM-at-home

The role of parents in teacher training

It is still seen as unusual, happens very rarely that parents or parents' associations are invited to offer part of training for teachers, and co-training of teachers and parents is also nearly unheard of. This should be considered as a necessary element, to include the parents' associations' experiences and expectations on cooperation.

Make transitions smooth - cooperate with ECEC[6] and primary

In most European countries, the transition between different levels of education is not smooth enough, with STEM becoming more and more theoretical with age. At the same time cooperation of secondary school teachers and parents should also aim at ensuring a solid STEM basis, totally linked to the everyday experiences of children. Thus, innovative teacher training of secondary teachers should include the element of reaching out to ECEC and primary, with the assistance of parents.

Make transitions smooth – have knowledge about and cooperate with tertiary education

The content of STEM curricula is a very delicate one. When designing local and individualised curricula, teachers should be able to make the right choices to include knowledge for everyday life, but also to prepare students for their respective career pathways, not teaching tertiary curricular content in secondary.

Gender

Early childhood links are crucial also for balancing the gender bias happening early. Secondary teachers' training should include elements that help parents in avoiding gender bias with their younger children and also to help other parents in it.

Need to change general public opinion

For strengthening a balanced approach to STEM there is a need to change general public opinion and bias towards arts subjects (that considers it 'normal' that somebody is bad at maths, not interested in chemistry, etc.). Innovative teaching methodologies and media (including social) presence have led to changes of general attitudes. Innovative methodologies for this should include real life connections, a holistic approach to STEM, to decrease subject segregation (and to stop it in primary) and to put emphasis on soft skills necessary for lifelong learning and future life-success (as an employee, a citizen and in private life)

[6] ECEC = early childhood education and care

Use of digital technology

When using digital technologies in training and also in STEM teaching, the digital divide should be considered. Internet penetration and the use of smartphones, tablets, etc. is different in different countries. Digital technology is a great asset in STEM, so teachers should be prepared for exploring individual access of students, and also to encourage the use of public offer (libraries, internet centres, school access). Digital technology use at home and at school can help make the real-life connection as well as increase attractiveness. Teachers awareness levels are to be raised of resources, teacher communities on the internet, but they should also be able to use digital technologies for parental engagement in a way comfortable for everyone – taking into consideration parents' schedules, but without too much intrusion into their private lives.

Ensuring the children's voice

In most cases, it falls on parents to ensure that they are given a real voice and decision-making power with regards to their own personal learning pathways as well as the STEM offer of the school. Child rights, the best interest of the child and their impact on school life is often missing from training.

A key to ensuring education reform for a 21st century education we need to put the learner in focus and offer learning pathways individualised enough to be relevant and attractive for each and all. This is crucial in education in general, but even more so in STEM education, an area still not held at high enough esteem by many, but an absolute necessity in present and future labour markets. This needs a collaboration of all stakeholders, but especially students, parents and teachers, and must be based on new approaches to training, empowerment and teaching. In this document, reflecting on the state of play in four very different European countries and feedback from parents, the aim was so draft an ideal scenario and highlight areas to tackle in training of STEM teachers, most of them not traditional, subject-specific areas, and to offer a starting point for training development.