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

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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).

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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 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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