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To cite this article: A Valente *et al* 2019 *J. Phys.: Conf. Ser.* **1286** 012056

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Seeking co-production of knowledge in alternating training: insights from DESCi first round of world cafés

A Valente¹, C Pennacchiotti¹, Z Smyrniou², K Kotsari², L Petropoulou², V Tudisca¹, F L Ricci¹ and The DESCi Consortium³

¹ Institute of Researches on Population and Social Policies - The National Research Council of Italy *adriana.valente*

² National and Kapodistrian University of Athens

³ The members of the DESCi Consortium. Coordinator: Institute for Research on Population and Social Policies of the National Research Council of Italy (IRPPS CNR): Adriana Valente, Valentina Tudisca, Claudia Pennacchiotti, Silvia Caravita, Fabrizio Ricci. Partners: Polibienestar – University of Valencia: Irene M. Payá, J. Garcés, B. Branchini, E. Durá, F. Ródenas, P. Sabater; National and Kapodistrian University of Athens (NKUA): Zacharoula Smyrniou, Konstantina Kotsari, Eleni Spinou; Ass. FormaScienza: Cinzia Belmonte, Angelo Cei; Ass. Assoknowledge: A. Sciolari, S. Rotondi; Ass. Science View: M. Sotiriou, Valia Grigoriou, Theoni Charalabidou; ITS E. Fermi school of Rome: R. Innocenti, A. Attorre, R. Santelia, F. Cirino, E. Purchi; 1st Experimental School of Athens: K. Kontogiannis, M. Boumpouka; Centro de Formacion Somorrostro: E. Urresola, S. Sanmartin, M. Marin

adriana.valente@irpps.cnr.it

Abstract In the last years the debate on competences and their role in the development of a more inclusive societies and in promoting innovation processes has become increasingly crucial at European level. The European Commission identified 8 key competences (basic and transversal competences and soft skills) that have to be attained by all citizens during their learning process. Also employers require from their employees more and more these kind of skills, and this is true also in the scientific education and research context. Indeed “Communication, working with others, problem solving and other similar abilities are considered very important requisites for a recently graduated student by a large section of the research laboratories responsible.” Nevertheless, European school curricula bestow little attention to transversal competences and soft skills. In this framework DESCi¹ project, funded by Erasmus + Program, aims to develop a methodological pattern for alternating training in secondary school systems, adopting participatory design methodologies based on a Living Lab environment, to improve the connection between school, research, enterprise and territory and to promote the development of soft and transversal skills in students, needed to allow them to foster the innovation process, to increase their employability, express themselves, acting consciously in the system and driving the innovation and social inclusion in their communities. The DESCi approach undergoes to a continuous and participated evaluation process, under

¹ DESCi project has been funded with support from the European Commission (Erasmus +, KA 2 – Ref.: 2015-1-IT02-KA201-015417). This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein



RRI principles, meant in order to explore, in a process of co-creation of knowledge, the ongoing results of the project. The evaluation outputs emerged at this stage of the project confirm that, in the learning AT process, the DESCi approach promote the increase of transversal competences and soft skills in the students, mainly referring to those included in the 8 key competences identified by the EU Commission.

1. Key competences and soft skills: accomplishing European challenge

In the last years the debate on competences² and their role in the development of a more inclusive societies and in promoting innovation processes has become increasingly crucial at European level. However, in Europe, more than 70 million people lack reading and writing skills; the situation referred to numeracy and digital skills is even more serious: all those people are at risk of social exclusion [1]. Indeed, in the current economic context, the capability of people and societies in updating their competences has a considerable influence in performances, competitiveness and innovation. “With the right skills, people are equipped for good-quality jobs and can fulfill their potential as confident, active citizens” [2]. Moreover, the ability of people in applying, integrating and using their knowledge is one of the most crucial educational issues we are facing. Also employers require from their employees more and more transversal skills, like, eg., team working, problem solving, critical thinking, learning to learn, entrepreneurship and creativity. The early acquisition of these skills represents the basis for the development of higher and more complex skills, needed to stimulate creativity and innovation. Nevertheless, as pointed out by *Valente and Mayer* [3], European school curricula bestow little attention to transversal competences and soft skills; moreover they are rarely the subject of a formal evaluation. One of the issues we face is to build a common classification of competences and a common glossary at European and transnational level. The complexity of this task becomes evident by the progressive and continuous evolution of the definitions within the EU documents, from the Recommendation 2006/962/EC on key competences for lifelong learning, revised in 2018 (Proposal for a Council Recommendation on Key Competences for Lifelong Learning 17/01/ 2018) to the most recent pronouncements of the European Council and European Parliament (2016- 2017).

In this framework, the European Commission identified 8 key competences [4] that have to be attained by all citizens during their learning process: communication in the mother tongue; communication in foreign languages; mathematical competence and basic competences in science and technology; digital competence; learning to learn; social and civic competences; sense of initiative and entrepreneurship; cultural awareness and expression. Teachers should take care to developing these key competences in their students. By this way, the improvement in the process of acquiring skills becomes a crucial issue in changing people from “users of innovative products” into “knowledgeable citizens” (according to Jasanoff 2012 [5]), able to make informed choices concerning individual and social sphere [3]. Dealing with such challenges requires reforms in the educational and training system at national and European level, first of all, improving the training on the job activities and the connections between school

² In recent European Documents, a strict difference is not made between skills and competences. While “skills means the ability to apply knowledge and use know-how to complete tasks and solve problems”, “competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development” 2017/C 189/03.

system and the world of work. PISA and PIAAC [6] reports underline better levels of student skills in those countries where students are involved in working activities already during the period of study. The Commission supports EU countries, regions and education and training institutions with programs such as Erasmus+, COSME, and the European Social Fund. In this framework, DESCi - Developing and Evaluating Skills for Creativity and Innovation (www.desci.eu), funded by Erasmus + Program, aims at developing a methodological pattern for alternating training (AT) in secondary school systems, adopting participatory design methodologies to improve the connection between school, research, enterprise and territory. The main project challenge is enabling the school to become a co-working space, an innovation laboratory for the local community, by which students, also guided by researchers and company tutors, can develop innovative ideas and products that will be socially, ecologically and economically sustainable. In the AT process, attention is given to soft skills, mainly, referring to the 8 key competences identified by the EU Commission: learning to learn, sense of initiative and entrepreneurship, social skills and problem solving. These objectives are pursued following a participatory approach, based on a Living Lab environment³, applied in two different phase of work:

- the process of co-creation of targeted educational toolkits, built after the analysis of European and national documents on AT and a comparison of alternating training systems in Europe. The toolkits implement guidelines in order to support teachers in applying the DESCi approach;
- the evaluation process meant in order to explore, in a process of co-creation of knowledge, the ongoing results of the project and to promote an active participation in the development of the DESCi approach. The participatory approach actualizes in two main phases of the evaluation process:
 - throughout the testing phase, partner schools, teachers, students and hosting organizations are asked to use, in real context, the tentative educational toolkits managing the AT under a DESCi approach, giving feedback on the general structure of the system, the usability and effectiveness of the tentative toolkits and suggesting changes useful to solve critical issues emerged;
 - throughout the Open Campus, a wider group of stakeholders (teachers, students, researchers, communities, enterprises, third sector organisations, policy makers) is actively involved in the evaluation process, being asked to elicit the strengths and weaknesses, the opportunities and threats of the toolkits and the possible application scenarios of the DESCi approach.

2. Methodology - Toolkits development, improvement and testing

The DESCi project is aimed at creating guidelines for fostering, developing, evaluating students' creativity and innovation skills, eliciting and representing the knowledge and visions of all the actors involved, first of all students, teachers, external tutors.

The guidelines are being developed in order to be finally embedded in educational toolkits, that make reference to three main frames:

- the consideration of both technical-scientific and soft-transversal skills, in order to integrate and balance the variety of relevant knowledge, attitudes, talents relevant for creativity and innovation, in accordance to the European documents and in particular to

³ Living Labs are intended as “an open innovation environment in real-life settings in which user-driven innovation is fully integrated with the co-creation process for new services, products and societal infrastructures” (European Network of Living Labs)

the key competences (cit doc), and aligning to the RRI (Responsible Research and Innovation) approach ;

- the AT processes, for their being in the threshold between school and work environments, able to assume peculiar shapes in the different European Countries and to involve a variety of stakeholders as external tutors (among which research centers, enterprises, cultural organizations, NGOs); therefore, guidelines developed for AT processes in various school types and in different European Countries can face a variety of situations and be a pattern for other contexts of school/work engagement, adapting to them.
- the involvement, among the social actors, of communities of the territory and of possible end-users of the students releases, that may be products, services, ICTs, intellectual outputs. Societal needs and points of view should be included in students' handiwork.

The DESCi project provide 3 different toolkits: 1 targeted to Teachers and Tutors, 1 to Students and an Evaluation toolkit. Each toolkit provides the basic elements and tools for planning AT at school, using the living lab approach implemented by DESCi. They pursue a modular approach showing sets of activities and methodologies that teachers, tutors and students can adapt to the specific school environment.

Moreover, toolkits include methodological references, a template to design AT paths, tools and resources that help teachers, tutors and students in implementing the scenarios designed, samples of "Implemented Scenarios", which are specific trainings that have been already realized in relation to specific curricula/delivery/skills, evaluation template and tools.

In order to finalize the guidelines and the relative toolkits, two testing phases of one year each have been planned in Italy, Spain and Greece. The leading schools in each Country are Institute Fermi in Frascati (Technical Institute), Italy, 1° Protipo Peiramatiko Gymnasio (Gymnasium) in Athens, Greece and Centro de Formación Somorrostro (Professional School) in Spain.

Each year, at least 60 students per school are involved, for a total of 200 students; actually several school were involved in the testing phase in the 3 European countries, but the DESCi monitoring and valuation activity was limited to the 3 schools partners.

In Greece (age of students 12/13) during the first testing year (2016- 2017) were implemented 4 linked scenarios: "Gastronomy Business Club", aimed at putting the students in contact with the professional field and the production - business process; "Math Club", in which students created products related to mathematics, educational games and logical games, ready to be commercialized; "ICT Club", aimed at developing applications for Android for the school Clubs; "Virtual enterprises", that enhanced business plans to put products developed by the school Clubs on the market. In Italy (age of students 16- 17) 2 different scenarios were implemented: "Tech-Care", for designing a home automation system related to elderly citizens' needs; "Environmental monitoring", for designing a system to detect and evaluate environmental parameters. Finally, in Spain (age of students between 18 and 30) was implemented 1 single scenario, in which students developed technical solutions for "Electricity grid failure simulator trainer".

During the first testing year 2016-2017, corresponding to the second year of the DESCi project, the tentative guidelines and toolkits have been tested following a RRI process. This means that testing activities have embedded the following RRI principles:

- anticipating and assessing potential implications and societal expectations of research and innovation, fostering the design of inclusive and sustainable, besides innovative, students' handiworks;

- fostering societal actors (students and teachers with researchers, communities, enterprises, third sector organisations, etc.) to give their inputs during students' AT process, in order to align students' handiworks with the values, needs and expectations of society;
- promoting institutional change, to foster the uptake of the RRI approach by all institutions - including schools - and all the social actors involved.

In order to implement the above mentioned issues, the testing of the tentative educational toolkits has been designed as a complex process encompassing:

- the involvement of schools with societal actors in participative tables in which innovative aspects as well as limits of the tentative toolkits have been debated by means of a SWOT analysis -a technique for understanding Strengths and Weaknesses, and for identifying both the Opportunities open and the Threats faced by the Toolkits-, performed during the first sessions of the DESCi Open Campuses, held in November-December 2016 in Athens, Rome and Valencia;
- the experimentation of the tentative Toolkits in the AT scenarios of different types of schools in Athens, Rome and Valencia, involving a total of 200 students, together with a process of monitoring and evaluation aimed at validating the general structure of the DESCi approach and the tools that have worked and suggest the changes useful to resolve criticalities;
- the constitution of DESCi National Advisory Boards in which various social actors from the world of school, business, policy making contributed with comments on the toolkits and the testing process.

A particular in depth analysis has been performed on the toolkit specifically devoted to teachers, that is the crucial one, being teachers the main accountable stakeholders for the AT process. The next chapter presents the main results of the first year of the testing process with specific reference to the issues related to skills and competences described in and developed through the toolkit for teachers.

3. Results

3.1. *Comments on soft skills from the three DESCi open campuses*

Open Campuses with participatory tables have been organised in each of the three Partners' Country, Greece, Italy and Spain, in the towns of Athens, Rome and Valencia in November and December 2016, with the aim of debating and providing insights on the three tentative educational toolkits, involving schools and societal actors (teachers in physics and cross-sector, researchers and academics, enterprises, NGOs and policy makers) in a process of co-creation of knowledge. The stakeholders involved in the participative tables have been 150 in total, including teachers, researchers, enterprises and NGOs, policy makers and representatives of students.

In all 3 Countries, the aim of the participative tables was eliciting negative and positive factors by means of a SWOT analysis, to find out the strengths and weaknesses, and the opportunities and threats of the guidelines expressed within the toolkits. The process provided an open forum for discussion in order to understand and learn knowledge, experience and points of view from multiple actors. Participants had conversations in response to questions emerged from crucial issues inside the educational toolkit, expanding the collective knowledge of the group.

Being the teachers the pivot actors, that always refer to students and to stakeholders in the process of AT, particular relevance has been attributed to the participative tables having the objective of developing the SWOT analysis on the toolkit specifically devoted to teachers. This toolkit includes: the description of the methodological approach; practical guidelines - lessons plans and tools, that define the role of the teacher in the AT, how to organize and drive the learning processes of students -; how to explore the local research/production and business system, as well as local context and communities;

how to implement a Living Lab in the School; how to design and implement Scenarios and personalized training for the students; definition of the skills and link to the School Education Plan.

All these sections were analysed during the SWOT Analysis. Among the relevant results, some make specific reference to skills and competences.

In the view of skill promotion and development, most participants in the three countries have considered as “strengths” the attitude of the Teacher Toolkit to:

- include skills planning
- foster use of scientific method
- foster production of innovative ideas
- follow an interdisciplinary approach
- promote communication skills
- promote skills and competences to be applied in authentic work/research situations
- reinforce learning to learn

On the side of Opportunities, the above mentioned issues have been considered as premises for the enlargement of occupational opportunities, particularly in research environments.

Coming to the negative results – the weaknesses– crucial issues have been considered: the difficulties in involving well motivated internal tutors (teachers) and external tutors (research/business) and the lack of teacher training devoted to these achievements. On the side of students, it has been stressed the possible fall of interest of students involved in a rather long term programme (one or two years, according to the different systems of AT) and that not all students can be mature enough to handle with the provisions of a participative AT model, very requiring in terms of motivation and personal commitment. Main threats, besides economical resources, included the different aims and expectations between school and external organizations, as well as the difficulties of alignments of timing and evaluating methods.

3.2. Beyond DESCi open campuses: focus on soft skills during the testing phase

The ability of people in applying and using the knowledge they have acquired, in integrating their knowledge within subjects, is one of the most crucial educational issues we are facing. Under this point of view, it is crucial that learners fully understand the real meaning and significance of things they learn and become able to use the knowledge acquired in different contexts. For this reason, the implementation of curricula based on soft - key competences “is not in contradiction with the development of an in-depth thematic or disciplinary knowledge and target the acquisition of specific skills.” [7].

The key competences identified by the European Commission in 2006 [4] are all considered equally important, because each of them contributes to a successful life in a knowledge society. Without them, the scope for personal fulfilment and social cohesion would be reduced. They have to be attained by all citizens by the end of their initial education and training, and also teachers, irrespective their subject specialization, must be aware of them. Teachers should take care of developing these key competences in their students. This is true also in the scientific education and research context. Indeed “*Communication, working with others, problem solving and other similar abilities are considered very important requisites for a recently graduated student by a large section of the research laboratories responsible. Faced with such an evident interest towards the development of such abilities, amongst which a “new” important skill emerges, defined as the skill of “being able to learn how to learn”* [8].

These considerations have been at the basis of the testing phase devoted to the experimentation of the tentative toolkits in three school environments during the school year 2016-2017 and a specific attention has been paid to the detection of competences acquired by the students during the testing process, with reference to the 8 Key Competences identified by the EU Commission. This aspect might be considered as one of the effectiveness indicators of the DESCi approach to the AT. Indeed, specific tools were provided in the DESCi toolkits devoted to detect the competences acquired by the students

(both technical/ professional skills and transversal/soft skills) and the level of achievement of each one of these:

- Rubrics: used to evaluate competences through a matrix that allows to identify, for each competence to be assessed, the link existing between the elements that compose it (the knowledge, the relevant skills activated and relevant indicators). The rubric consists of a scale of predetermined scores and a list of criteria that describe the characteristics of each score of the scale.
- Questionnaires targeted to the 3 different subjects directly involved in the AT process (students, teachers and external tutors) providing a specific section devoted to detect the level of increase of competences in the students during and after the AT process, categorized in line with the European Recommendations [4].

The experimentation in schools also included the issues emerged during the Open Campuses, with particular reference to competences to be acquired by students. Would the skills emerged as “strength” be improved in students? Would the limits and threats, particularly those related to the students maturity and capability to afford the AT participative process be totally or partially overcome? The soft competences target of DESCi AT process that emerged during the first testing phase throughout the tools described above are well included in the 8 key competences identified by EC.

- Learning to learn: ability to effectively manage one’s own learning, either individually or in groups.
- Social and civic competences: ability to participate effectively and constructively in one’s social and working life and engage in active and democratic participation, especially in increasingly diverse societies.
- Sense of initiative and entrepreneurship: ability to turn ideas into action through creativity, innovation and risk taking as well as ability to plan and manage projects.

A synthesis of the skills enhanced in students participating to the experimentation phase, as observed by the teachers, are presented in Table 1

Table 1. Main EU key competences emerged in DESCi experimentation phase

Learning to learn skills	<ul style="list-style-type: none"> • responsibility for their own learning • reflect critically on the purposes and aims of learning • ability to get questions by examining data • learn to understand • autonomous learning • research skills
Sense of initiative and entrepreneurship	<ul style="list-style-type: none"> • initiative • leadership • self management
Social skills	<ul style="list-style-type: none"> • team working • conflict resolution • communication
Creativity and innovation	<ul style="list-style-type: none"> • divergent thinking
Problem Solving	adapt own behaviour to circumstances in solving problems

The first experimental phase gave good tentative results with reference to the competences promoted in students. In particular, the soft skills target emerged by the first testing phase is fully coherent with the EU indications and guidelines and support the need of “applying and using the knowledge acquired, integrating knowledge within subjects”.

4. Debate

Multiple actors were actively involved in the improvement, testing and validation of the educational tools developed within DESCI and devoted to foster students skills and competences.

In addition, DESCI approach promotes soft skills and transversal competences, needed to allow students to foster the innovation process, to increase their employability, express themselves, acting consciously in the system and driving the innovation and social inclusion in their communities. Most of the inputs from the testing process have been implemented in the second release of the toolkits and in the evaluation frame.

The DESCI partners and the schools involved are now working on matching the curricular activities and participatory methodologies with the soft skills improved in students. The results will be used in the second experimentation phase (school year 2017-2018) in order to go into further details in competences recognition.

Aim of the second experimentation phase is also to go on deserving attention on the further success elements and limits emerged as a result of the SWOT analysis performed during the Open Campuses. Being the first experimentation phase performed within the schools already involved in the DESCI, some issues emerged by the Open campuses, like the motivation of teachers, could not be investigated and are part of the second experimentation phase.

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