

# SpicE



Special EduCation **STEAM Academy**

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## WP2 Development of SpicE Strategy for STEAM in Special Education

### DEV2.3 Education Framework for STEAM in Special Education

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## Executive Summary (EN)

Important parameters of appropriate pre- and in- service teacher training for implementing effective inclusive STEAM Education for primary students with Mild Disabilities (MD) are delineated in the present Educational Framework. It is stressed that the multiple and high demands of successful participation of students with MD in general classroom STEAM activities presuppose that teachers should be able to deal with: (a) the instructional demands of each STEAM field, (b) the specifics of the learning needs of each MD group, and (c) the evidence-based applications of Instructional Methodology for the inclusion of students with MD in general classroom activities. Effective teacher training in these knowledge and skill areas require the use of: (a) procedures and tools for assessing teacher attitudes, knowledge and skills before and after the implementation of a program, (b) methods and techniques for enhancing teacher ability to deal with the demands of inclusive STEAM Education, and (c) specification of contextual factors facilitating the success of pre- and in-service teacher training. The combination of results (a) obtained in the context of D2.1 and D2.2 of SPICE project, and (b) reached at after careful literature review conducted by the SPICE partners, shows that: (i) in reference to assessment of teacher knowledge and skills, surveys using questionnaires may provide valuable information before the beginning and after the completion of the training program, whereas Portfolios, Lesson Plans, and Performance Tasks may serve assessment procedures during and after training, (ii) with regard to teacher training in putting inclusive STEAM Education to practice, modeling and performance feedback in the context of problem-based approaches may provide viable solutions, which acquire more power when they are combined with collaborative teacher activities in the context of Experiential Learning initiatives, and (iii) as far as the organizational dimension of teacher training is concerned, training in school classrooms combined with specialized online courses and the use of OERs may be very effective. The aforementioned means and procedures of potentially effective teacher training in inclusive STEAM Education constitute main elements of a meta-methodology proposed by the SPICE consortium. If implemented with fidelity, this meta-methodology is expected to produce positive results for the benefit of all stakeholders of the present Educational Framework, and especially for the students with Mild Disabilities.

## Executive Summary (GR)

Στο παρόν Εκπαιδευτικό Πλαίσιο (Educational framework) περιγράφονται σημαντικές παράμετροι της κατάλληλης εκπαίδευσης των εν- ενεργεία και μελλοντικών εκπαιδευτικών για την υλοποίηση αποτελεσματικής Συμπεριληπτικής Εκπαίδευσης STEAM σε μαθητές πρωτοβάθμιας εκπαίδευσης με Ήπιες Αναπηρίες. Τονίζεται ότι οι πολλαπλές και υψηλές απαιτήσεις της επιτυχούς συμμετοχής των μαθητών με Ήπιες Αναπηρίες σε δραστηριότητες STEAM της γενικής τάξης, προϋποθέτουν ότι οι εκπαιδευτικοί θα πρέπει να είναι ικανοί να αντιμετωπίσουν (α) τις διδακτικές απαιτήσεις του κάθε πεδίου του STEAM, (β) τις ιδιαιτερότητες των μαθησιακών αναγκών της κάθε ομάδας Ήπιων Αναπηριών και (γ) τις τεκμηριωμένες εφαρμογές της Διδακτικής Μεθοδολογίας για τη συμπερίληψη των μαθητών με Ήπιες Αναπηρίες στις δραστηριότητες της γενικής τάξης. Η αποτελεσματική κατάρτιση των εκπαιδευτικών σε αυτούς τους τομείς γνώσης και δεξιοτήτων απαιτεί τη χρήση: (α) διαδικασιών και εργαλείων για την αξιολόγηση των στάσεων, της γνώσης και των δεξιοτήτων των εκπαιδευτικών πριν και μετά την υλοποίηση του προγράμματος κατάρτισης, (β) μεθόδων και τεχνικών για τη βελτίωση της ικανότητας των εκπαιδευτικών να αντιμετωπίσουν τις απαιτήσεις της Συμπεριληπτικής Εκπαίδευσης STEAM και (γ) της εξειδίκευσης των παραγόντων που διευκολύνουν την επιτυχία της κατάρτισης των εν ενεργεία και μελλοντικών εκπαιδευτικών. Ο συνδυασμός των αποτελεσμάτων (α) που παρήχθησαν στο πλαίσιο των παραδοτέων D2.1 και D2.2 του SpicE και (β) μετά από προσεκτική βιβλιογραφική ανασκόπηση που διεξήχθη από τους συνεργάτες του SpicE, δείχνει ότι: (i) σε σχέση με την αξιολόγηση της γνώσης και των ικανοτήτων των εκπαιδευτικών, έρευνες που χρησιμοποιούν ερωτηματολόγια μπορούν να παράσχουν πολύτιμες πληροφορίες πριν από την έναρξη και μετά την ολοκλήρωση του προγράμματος κατάρτισης, ενώ οι Ατομικοί Φάκελοι (Portfolios), τα Σχέδια Μαθήματος (Lesson Plans) και οι Ασκήσεις Επίδοσης (Performance Tasks) μπορούν να αποτελούν αξιολογητικές διαδικασίες κατά τη διάρκεια της κατάρτισης αλλά και μετά την κατάρτιση, (ii) όσον αφορά την κατάρτιση των εκπαιδευτικών στην πρακτική εφαρμογή της Συμπεριληπτικής Εκπαίδευσης STEAM, η μοντελοποίηση και η ανατροφοδότηση επίδοσης στο πλαίσιο των βασισμένων σε προβλήματα προσεγγίσεων (problem-based approaches) μπορούν να παράσχουν βιώσιμες λύσεις, οι οποίες αποκτούν μεγαλύτερη δύναμη όταν συνδυάζονται με συνεργατικές δραστηριότητες εκπαιδευτικών στο πλαίσιο πρωτοβουλιών Βιωματικής Μάθησης (Experiential Learning) και (iii) όσον αφορά την οργανωτική διάσταση της κατάρτισης

των εκπαιδευτικών, η εκπαίδευση σε σχολικές τάξεις σε συνδυασμό με τα εξειδικευμένα διαδικτυακά μαθήματα και τη χρήση Ανοικτών Εκπαιδευτικών Πόρων (OER- Open Educational Resources) μπορεί να είναι πολύ αποτελεσματική. Τα προαναφερθέντα μέσα και διαδικασίες για τη δυνητικά αποτελεσματική κατάρτιση των εκπαιδευτικών στη Συμπεριληπτική Εκπαίδευση STEAM αποτελούν τα βασικά στοιχεία μιας μετα- μεθοδολογίας που προτείνεται από την κοινοπραξία του SpicE. Εάν εφαρμοστεί πιστά, αυτή η μετα-μεθοδολογία αναμένεται να παράγει θετικά αποτελέσματα προς όφελος όλων των εμπλεκόμενων φορέων του παρόντος Εκπαιδευτικού Πλαισίου και ιδιαίτερα των μαθητών με Ήπιες Αναπηρίες.

## Executive Summary (BG)

В настоящата Образователна рамка са очертани важни параметри на подходящо предварително и по-нататъшно обучение на учители за прилагане на ефективно приобщаващо STEAM образование за начални ученици с леки увреждания. Подчертава се, че многобройните и високи изисквания за успешно участие на ученици с леки увреждания в общи STEAM дейности в класната стая предполагат, че учителите трябва да могат да се справят с: (а) изискванията за обучение на всяка STEAM област, (б) спецификата на обучителните потребности на всяка група с леки увреждания и (с) базираните на доказателства приложения на методологията за обучение за включване на ученици с леки увреждания в общи дейности в класната стая. Ефективното обучение на учители в тези области на знания и умения изисква използването на: (а) процедури и инструменти за оценка на нагласите, знанията и уменията на учителите преди и след прилагането на програма, (б) методи и техники за подобряване на способността на учителя да се справя с изискванията на приобщаващото STEAM образование и (в) спецификация на контекстуални фактори, улесняващи успеха на обучението на учители преди и по време на работа. Комбинацията от резултати (а), получени в контекста на D2.1 и D2.2 на SPICE, и (б), достигнати след внимателен преглед на литературни източници, извършен от партньорите на SPICE, показва, че: (i) по отношение на оценката на знанията и уменията на учителя, анкетите, използващи въпросници, могат да осигурят ценна информация преди началото и след завършването на програмата за обучение, докато портфолиата, плановете за уроци и задачите за изпълнение могат да послужат като процедури за оценка по време и след обучението, (ii) по отношение на обучението на учители в прилагането на приобщаващото STEAM образование на практика, моделирането и обратната връзка за изпълнението в контекста на подходи, базирани на проблеми, могат да осигурят жизнеспособни решения, които придобиват повече сила, когато се комбинират със съвместни учителски дейности в контекста на инициативи за учене чрез преживяване, и (iii) доколкото се отнася до организационното измерение на обучението на учителите, обучението в училищните класни стаи, съчетано със специализирани онлайн курсове и използването на отворени образователни ресурси, може да бъде много ефективно. Гореспоменатите средства и процедури за потенциално ефективно обучение на учители в

приобщаващото STEAM образование съставляват основните елементи на метаметодологията, предложена от консорциума SPICE. Ако се прилага вярно, тази мета-методология се очаква да доведе до положителни резултати в полза на всички заинтересовани страни от настоящата Образователна рамка и особено за учениците с леки увреждания.





## Executive Summary (SP)

En el presente Marco Educativo se delinear los parámetros importantes de una formación del profesorado en activo y en formación para implementar una Educación STEAM inclusiva eficaz para el alumnado de Primaria con Diversidad Funcional Leve (DFL). Se subraya que las múltiples y elevadas exigencias de una participación satisfactoria del alumnado con DFL en las actividades STEAM generales del aula presuponen que el profesorado debe ser capaz de abordar (a) las demandas instruccionales de cada campo STEAM, (b) las especificidades de las necesidades de aprendizaje de cada grupo con DFL, y (c) las aplicaciones basadas en la evidencia de la Metodología Instruccional para la inclusión de estudiantes con DFL en actividades generales de aula. Una formación eficaz del profesorado en estas áreas de conocimiento y habilidades requiere el uso de: (a) procedimientos y herramientas para evaluar las actitudes, conocimientos y habilidades del profesorado antes y después de la implementación de un programa, (b) métodos y técnicas para mejorar la capacidad del profesorado para hacer frente a las demandas de la Educación STEAM inclusiva, y (c) la especificación de los factores contextuales que facilitan el éxito de la preparación del profesorado en activo y en formación. La combinación de los resultados (a) obtenidos en el contexto de D2.1 y D2.2 de SPICE, y (b) alcanzados tras una cuidadosa revisión bibliográfica llevada a cabo por los socios de SPICE, muestra que: (i) en referencia a la evaluación de los conocimientos y habilidades del profesorado, las encuestas mediante cuestionarios pueden proporcionar información valiosa antes del inicio y después de la finalización del programa de formación, mientras que los Portfolios, Lessons Plans y Performance Tasks pueden servir como procedimientos de evaluación durante y después de la formación, (ii) con respecto a la formación del profesorado en la puesta en práctica de la Educación STEAM inclusiva, el modelado y la retroalimentación del rendimiento en el contexto de los enfoques basados en problemas pueden proporcionar soluciones viables, que adquieren más fuerza cuando se combinan con actividades colaborativas del profesorado en el contexto de iniciativas de Aprendizaje Experiencial, y (iii) en lo que respecta a la dimensión organizativa de la formación del profesorado, la formación en las aulas escolares combinada con cursos especializados en línea y el uso de REA puede ser muy eficaz. Los medios y procedimientos mencionados de formación del profesorado potencialmente eficaz en la Educación STEAM inclusiva constituyen elementos principales de una meta-metodología propuesta por el consorcio SPICE. Si



se aplica con fidelidad, se espera que esta meta-metodología produzca resultados positivos en beneficio de todas las partes interesadas del presente Marco Educativo, y especialmente para el alumnado con Diversidad Funcional Leve.

## 1. Introduction

The present Educational Framework (EF) incorporates policies, principles, guidelines, procedures, methods, and tools that may (a) inform the teacher training program which will take place in subsequent phases of the SPICE project, and (b) contribute to the formation of effective teacher training schemata in all contexts referring to inclusive STEAM Education. Findings obtained and conclusions formulated in D2.1 (Gap Analysis) and D2.2 (Inclusive STEAM Educators' Competence Framework) of the SPICE project are combined in the EF with information from literature review on assessment procedures and tools, instructional methods and techniques, and implementation strategies and good practices. The resulted combination, which was reviewed and ratified by the SPICE partners, may offer valid solutions for (a) the investigation of pre- and in-service teacher knowledge on Inclusive STEAM Education, and (b) the training of pre- and in-service teachers in implementing Inclusive STEAM Education for students with Mild Disabilities.

Specific foci of the EF are: (a) the contemporary policies on teacher training in implementing inclusive STEAM Education for students with Mild Disabilities, (b) the Stakeholders who may take advantage of the EF, (c) the potential effect of the EF on the instructional management of STEAM fields, (d) the way in which the EF may promote the teacher roles identified in D2.2, (e) the selection and the use of instructional design principles and educational resources for teacher training (including Open Educational Resources, namely OERs), and (f) the structure and the main features of a meta-methodology for pre- and in-service teacher training on inclusive STEAM Education for students with Mild Disabilities. In what follows each of the aforementioned foci is explained.

## 2. Body of knowledge

### 2.1 Policy trends

Modern societies lay special emphasis on preparing their members for adapting in a rapidly changing world. In their search for means that may facilitate the achievement of this goal, many educational authorities have recognized the advantages of STEAM (and its predecessor STEM) Education, i.e. they have acknowledged the positive impact on students' critical thinking, creativity, and innovation that may result from participation in learning activities related to Science, Technology, Engineering, Arts, and Mathematics. Hence, international organizations and national governments try to develop policies that encourage and promote the implementation of STEAM Education. For example, in the UNESCO position paper "Exploring STEM Competences for the 21<sup>st</sup> Century" it is mentioned that STEM Education may provide innovative solutions to global issues connected to the 2030 Sustainable Development Goals; thus, governments are urged to commit themselves to supporting the implementation of STEM Education, especially by training teachers to cope with the cognitive, epistemological, and pedagogical demands of this new educational approach (Ng, 2019). In the document III.8 of a series of position papers on "Human Resources for Innovation" the Organization for Economic Cooperation and Development (OECD) mentions the advantages of STEM Education and stresses the importance of appropriate policies for its promotion, including policies on teacher training (OECD, 2019).

Following such exhortations, governments in many developed and developing countries, such as India, Indonesia, Singapore, Australia, Zimbabwe, and the USA, have developed national educational policies for incorporating STEAM/STEM Education in their school curricula (e.g., Mpofu, 2020; Sheffielda et al., 2018). EU countries strive also to shape and implement policies favoring the promotion of STEAM/STEM Education (Costello et al., 2020), and EU -funded programs like STEAMonEdu and STE(A)M-IT attest to the interest of European Countries in this educational approach.

In trying to secure the equitable application of STEAM Education in daily school practice and to widen the circle of students participating in respective instructional activities, policies on STEAM / STEM Education tend to stress the need for making necessary adjustments for the inclusion of underrepresented groups in STEAM lessons. One such group is the group of students with Mild Disabilities (Learning Disabilities, Mild Intellectual Disability, Attention Deficit/Hyperactivity Disorder, and Mild Behavioral Problems). Evidence reported in detail in D2.1 (Gap Analysis) of SPICE shows that, although students with MD belong to the population of the general school, policies on their inclusion in STEAM Education activities are at their infancy both at the international level and also with regard to the national educational systems of the countries participating in SPICE. Furthermore, the policies on the training of pre- and in-service teachers who would promote the implementation of inclusive STEAM Education for students with MD are at a rudimentary phase. The importance of training teachers so that they can cope successfully with the challenges of STEAM Education has been recognized in EU (e.g., AISR, 2021), but the transformation of this recognition into concrete practical steps with immediate and wide applicability seems to require many more efforts. The present EF may contribute to the formation of the needed policies.

## 2.2 Stakeholders

Stakeholders who may take advantage of the present EF may be: (a) students with Mild Disabilities (MD) and their peers without special educational needs (SEN) or disabilities, (b) teachers and school managers, (c) Continuing Professional Development (CPD) providers, Teacher Associations, and committees / authorities responsible for the Programs of Studies for pre-service teachers, (d) individual parents and parent associations, (e) policy makers. In specific:

(a) Students with MD may benefit from the present EF in the sense that it refers to the implementation of inclusive STEAM Education, which may increase their participation in activities promoting the understanding of today's complex world. Along with their peers without SEN or disabilities, students with MD may learn to deal with

life demands in creative and innovative ways, which may enrich their skills and boost their learning motives. On the other hand, students without SEN may learn to better understand human nature, to respect individual differences, and to cooperate in environments characterized by different needs, abilities, and perspectives; thus, they may improve their communication skills, their social knowledge, and their empathy.

(b) Teachers and School Managers may use the present EF in order to specify and promote accordingly the development of qualities that need to be possessed by professionals implementing inclusive STEAM Education activities, which take into account the specific learning profiles of students with MD. In the context of D2.1 of SPICE it was found that pre- and in-service teachers have a rather basic understanding of what exactly is presupposed in terms of knowledge and skills so that they succeed in realizing inclusive STEAM Education for students with MD. In this respect and according to D2.2, educators involved in inclusive STEAM Education have to fulfill the roles of:

- Inclusive STEAM teacher- trainer-tutor/ implementing the Inclusive STEAM educational procedure
- Inclusive STEAM Education designer and creator/ designing and creating Inclusive STEAM opportunities
- Inclusive STEAM orchestrator / coordinating Inclusive STEAM procedures, resources, and classroom's members
- Community member/ interacting with the environment
- Growing Inclusive STEAM professional/ developing and applying competences

Taking into account the above roles, educators may make appropriate choices in terms of continuing professional development; they may also regulate productively their instructional activities in the daily school practice.

School managers, on the other hand, may find in the EF clear descriptions of domains on which they should concentrate their efforts for creating and sustaining school units, structures, organizations, and schemata of pedagogical services that may

function effectively in terms of achieving concrete and measurable educational goals with regard to inclusive STEAM Education.

(c) Continuing Professional Development (formal or informal) providers, Teacher Associations, and committees / authorities responsible for the Programs of Studies for pre-service teachers may benefit from studying the present EF as it contains training guidelines based on the findings of D2.1 of SPICE and on contemporary bibliography. In the D2.1 document the knowledge and skills possessed by pre- and in-service teachers with regard to inclusive STEAM Education were analyzed. The results of the analysis verified the need for wide improvements in terms of teacher training, because in order to change how students engage with STEAM we have to alter how we educate teachers initially and how we support them during their careers.

(d) Individual parents and Parent Associations may find useful the present EF in the sense that it includes valuable insight into the specifics of pre- and in-service teacher knowledge on and training in inclusive STEAM Education. Having at their disposal such information, individual parents and parent organizations may increase the effectiveness of their social and political influence with regard to decision- making by ministries and other authorities in reference to the content of teacher training programs; in this way parents may contribute substantially to the creation of better instructional conditions for their children.

(e) Policy makers (regional, national or international) certainly belong to the stakeholders of the present EF as they may find in it reliable information regarding the most important parameters of pre- and in-service teacher training in reference to inclusive STEAM Education. As explained in the section “policy trends” policies on teacher training regarding inclusive STEAM Education for students with MD are just beginning to be part of the wider discussion pertaining policies on STEAM Education; hence, the present EF may play a constructive role in the respective procedure.



## 2.3 The SPICE Educational Framework and the instructional management of STEAM fields in inclusive settings

Teachers aiming to the creation of successful inclusive STEAM activities for students with MD should possess knowledge and skills in reference to (a) the instructional demands of each STEAM field (important concepts, type and structure of information, and effective methods), (b) the specifics of cognitive characteristics and general learning needs of each MD group, and (c) the fundamental principles and means of Instructional Methodology for the inclusion of students with MD in general school activities.

In reference to the demands of teaching each one of the STEAM fields it should be noted that, although all fields may contribute to the promotion of critical and innovative thinking, and certainly their combination in interdisciplinary or transdisciplinary schemata yields a dynamic instructional tool, they also have considerable differences in terms of content knowledge and learning prerequisites. For example, the field of Mathematics is characterized by (a) the expression of ideas through a highly abstract code, (b) the hierarchical structure of knowledge, and (c) the need for using multiple modes of representation in order for learners to be able to construct knowledge. These characteristics influence instruction in ways that are not necessarily part of teaching Arts or Science. Furthermore, in the context of Mathematics, the different sub-fields (e.g. Arithmetic, Geometry, Algebra) do not have the same cognitive demands and prerequisites; for example, the visual-spatial ability is central in Geometry, but negligible in Algebra. Moreover, the relationships among the STEAM fields have special features that need to be taken into consideration when organizing inclusive lessons. For example, in Science students need to use appropriately Math knowledge and skills in order to make the most of Physics, Chemistry, Astronomy or Biology, but the opposite does not apply (Agaliotis, 2023). In other words, in order for positive outcomes to result from efforts to include students with MD in STEAM lessons, teachers need to have deep knowledge of the subject matter, especially in terms of knowledge interrelationships, skill structures, and learning prerequisites.

With regard to the cognitive and learning characteristics of the four MD sub-groups, it should be noted that, despite the existence of some common features, each disability group presents certain idiosyncratic characteristics that influence learning efforts in diverse ways. For example, students with *Learning Disabilities* face considerable difficulty when they have to build new knowledge by processing symbolic codes (like the code of Language or Mathematics). On the other hand, students with *Mild Intellectual Disability* face significant restrictions with regard to concept formation, and tend to fail when teachers urge them to proceed with knowledge acquisition without having previously secured the sound understanding of critical ideas. Students with *Attention Deficit Hyperactivity Disorder* present difficulties in devoting the necessary time and energy for processing appropriately the details of the learning goals, as they tend to pay attention to many environmental stimuli at the same time. Finally, students with *Mild Behavior Problems* are usually strongly unwilling to participate in learning activities, and tend to exhibit socially unacceptable forms of interaction in their effort to avoid their involvement in the instructional process (Agaliotis, 2023).

The above-mentioned general characteristics of the four MD groups appear in many different combinations with various strengths and weaknesses usually found among the MD population. Hence, the effective inclusion of these students in STEAM activities presupposes their careful personalized assessment and the subsequent production of instructional programs tailored to their needs. However, in practice, learning individualization does not mean that each student with MD should have a completely personalized instructional program. It rather means that educators should know in detail which parts of the STEAM curriculum will be learned by students with MD through common activities and by the same means that are considered effective also in the case of students without disabilities, and which parts require the implementation of special measures for individual students with MD. Evidently, the making of such decisions presupposes the deep understanding of the nature, the learning characteristics, and the instructional needs of students with MD by every teacher involved in the implementation of inclusive STEAM Education.

In reference to the fundamental principles and means of Instructional Methodology for the inclusion of students with MD in general school activities, it should be stressed that inclusion should be understood as the creation of contexts which give students with MD the opportunity to present continuous, observable, and measurable learning progress. The mere co-existence of students with and without disabilities in the same classroom cannot be deemed as inclusion. According to EADSNE (2017), main pillars of qualitative inclusive education are: (a) positive teacher attitudes, (b) possession of necessary instructional skills by teachers implementing inclusion, (c) teacher direct response to learners' voices (consideration of their needs), (d) special measures for the active participation of students with disabilities in the instructional activities, (e) visionary school leadership, (f) coherent interdisciplinary services (effective collaboration of various special and general education professionals). Specifically, in reference to the necessary instructional skills the aforementioned Report stresses the importance of (a) systematic implementation of student assessment through a range of approaches, (b) provision of multiple learning opportunities with choice for all learners, under the light of the multi-dimensionality of intelligence, (c) realization of flexible teaching that rejects dogmatism and adapts to student learning preferences, (d) planning of a relevant curriculum that facilitates the utilization of multiple learning experiences, (e) use of feedback to identify and overcome barriers to learning, and (f) cooperative teaching. Several of the above-mentioned dimensions of high-quality teaching have been included in the questionnaire through which the knowledge of pre- and in-service teachers on inclusion of students with disabilities was investigated in the context of D2.1. of SPICE. The results were encouraging though not satisfactory and rather showed that extensive training is required for rendering teachers capable of dealing with the demands of inclusive education. Furthermore, some of the above-mentioned teacher qualities have been included in D2.2 (Competence Framework) of SPICE, as discussed in the next section.

## 2.4 The SPICE Educational Framework and the various teacher roles in inclusive STEAM Education

As already mentioned in a previous section of this EF, in D2.2 of SPICE five wide roles of educators implementing inclusive STEAM Education have been defined. Each role includes several components, which contribute to the formation of a rich professional profile. In total, sixteen components have been proposed which cover a wide range of knowledge and skills including theoretical foundations of inclusive STEAM Education, student assessment and instruction, design of lessons and selection of means for their realization, coordination of human resources and utilization of new technologies, community awareness raising, and lifelong learning skills. The development of each component requires systematic teacher training based on the discrete needs of pre- and in-service teachers. The present EF presents and proposes procedures, tools, methods, techniques, practices and Open Educational Resources that can be used in teacher training contexts, in order to increase teacher effectiveness in reference to inclusive STEAM Education and ultimately benefit students with Mild Disabilities.

It should be stressed that being a highly demanding educational task, inclusive STEAM Education creates almost unprecedented challenges in terms of teacher training, in the sense that it needs to take into account not only the current state of teacher knowledge, but also the potential for its growth in the context of schools that face constantly new social, financial and educational demands (Milner-Bolotin, 2018).

## **2.5 Procedures, resources, and tools for teacher training in inclusive STEAM Education for students with Mild Disabilities**

Effective pre- and in-service teacher training on inclusive STEAM Education for students with MD necessitates the exploitation of an array of evidence-based procedures, resources, and tools. As happens in most teacher training programs, important parameters of programs pertaining to inclusive STEAM Education are: (a) the procedures and tools for assessing teacher attitudes, knowledge and skills before and after the implementation of a program, (b) the methods and the techniques used in the framework of a program for enhancing teacher ability to deal with the demands of inclusive STEAM Education, and (c) the contextual factors (organizational practices) that facilitate the success of pre- and in-service teacher training. In reference to each

one of these three wide parameters, review of contemporary literature shows the following:

### **2.5.1 Procedures, resources, and tools for the assessment of pre- and in-service teacher attitudes toward and knowledge on Inclusive STEAM Education for students with Mild Disabilities**

It is well known that teacher attitudes and knowledge referring to various educational issues are usually studied through one of the following types of initial or final assessment procedures:

- Surveys (asking teachers to answer questions that are presented mainly through questionnaires or interviews)
- Classroom Observations (observing teacher instructional behaviors in daily school context)
- Portfolios and Lesson Plans (requesting teachers to submit portfolios or lesson plans demonstrating their understanding and appropriate application of various important instructional principles put to practice for an extended time period)
- Performance Tasks (asking teachers to execute assignments requiring the selection of specific measures for dealing with well- defined instructional situations)
- Self-Reflection and Self-Assessments (encouraging teachers to engage in self-reflection and self-assessment with regard to specific duties).

Undoubtedly, from all the above-mentioned types of assessment procedures most commonly used are the surveys, especially those utilizing questionnaires as means for gathering information. In this respect and in reference to the domains making up the complex educational schema of Inclusive STEAM Education for students with MD it should be noted that there are tools investigating separately teacher knowledge on or attitudes toward: Inclusive Education, instruction of students from different disability groups, and STEAM/STEM Education (e.g., Forlin, 2011; González-Gil et al., 2019; Karlsson & Nilsson, 2023; Nilsson & Karlsson, 2018; Schuster et al., 2007; Yang et al., 2023). However, there are no individual tools available that examine all the aforementioned domains in combination, because inclusive STEAM Education for

students with Mild Disabilities is a very new and still under-researched area. The SPICE group has constructed such a tool in the context of D2.1 of the project by carefully analyzing many significant parameters of pre- and in-service teacher attitudes, knowledge, and skills regarding Inclusive STEAM Education for students with MD. Although it is not a standardized instrument, this questionnaire has undergone rigorous examination by the SPICE experts and has served well the purposes of the initial assessment of pre- and in-service teachers in the four participating countries. The information obtained through the use of this questionnaire is considered as valuable with regard to the structuring of a fruitful teacher training program on inclusive STEAM Education for MD students.

### **2.5.2 Instructional methods and techniques for enhancing pre- and in-service teacher knowledge and skills regarding Inclusive STEAM Education for students with Mild Disabilities**

It is widely admitted that successful participation of students with MD in STEAM activities taking place in the general classroom depends heavily on teacher ability to deal with the challenges of this complex instructional aim. Effective management of these challenges presupposes that teachers are properly prepared in terms of professional knowledge and skills (Florian & Camedda, 2019). Examples of issues that teachers trying to implement inclusive STEAM Education for students with MD have to deal with include: program pacing, specialized student support for understanding content and process, planning interdisciplinary or transdisciplinary activities that may be tackled by all students, dealing with school district policies, integrating technology in school practice, and managing issues related to assessment (Evmenova, 2018; Herro et al., 2019).

Since teacher training focusing specifically on Inclusive STEAM Education for students with MD is practically non-existent, respective training programs should take advantage of the available experience resulting from effective teacher training on each one of the constituent parts of this complex domain. In other words, methods and techniques that have proven their value in the context of training teachers to put to



practice instruction for students with MD, Inclusion of students with SEN in the general classroom, and STEAM Education, should be combined so that a coherent training schema emerges that can be used in Inclusive STEAM Education for students with MD. Exploration of meta-analyses examining teacher training programs in each of the above-mentioned areas have revealed the following noteworthy information:

*In the area of implementing interventions for students with disabilities or SEN* it seems that as evidence – based teacher training approach of high value may be regarded the combination of two specific training strategies, i.e., modeling and performance feedback (Brock & Carter, 2017). This combination was associated with improved implementation fidelity and high rate of success. In specific, it was found that modeling of instructional steps prior to implementation likely reduces the errors that need to be addressed with performance feedback. Furthermore, re-modeling steps during performance feedback likely improves the informational power of the feedback. Video recording of instructional interventions that are critically discussed with colleagues and/or experts of Instructional Methodology have also been found as effective, especially in the context of problem-based approaches to teacher training. In contrast, increasing the length of training alone, without making informed decisions on training strategies or format, seems not to affect substantially implementation fidelity.

*In reference to teacher training on inclusive education for students with disabilities or SEN* it is stressed that an important dimension is the changing of teacher perspectives and their philosophy regarding inclusion per se. Such a change may be achieved through asking pre- and in-service teachers to (i) develop lesson plans for hypothetical students presented in the form of case studies, and (ii) discuss critically the rational, the implementation details, and the social aspects of these lesson plans with peers under the guidance of expert teacher educators (Engleman & Schmidt, 2007). In this context, concepts related to instructional objectives, learner variability, Universal Design for Learning, and technology affordances that meet the needs of all students certainly play a decisive role (Evmenova, 2018). Furthermore, it is important to consider that inclusive education of students with disabilities in daily school practice often requires the close collaboration of general and special education teachers. However, it is not easy for professionals who have been trained separately and have

learned to work on an individual basis to start collaborating in school contexts in order to put to practice demanding inclusionary programs. Hence, it is recommended that pre- and in-service teacher training programs include collaborative activities in which general and special education teachers try together to find solutions for including students with disabilities in general classroom activities. The issue of collaboration is a central one also with regard to the relationship between school and the families. With regard to this issue too, the use of teacher training approaches that favor collaborative problem-based learning, critical thinking, and the enhancement of instructional decision-making is regarded as sound choices for the preparation of effective teachers (Allday et al., 2013).

*In reference to teacher training for dealing with the demands of STEAM/STEM Education* a four-step approach [Model-Reflect-Research-Practice] based on the theoretical premises of Experiential Learning seems to be very promising (McCarthy, 2018; Milner-Bolotin, 2018). Each of the aforementioned steps has the following content: (a) **Model**: Teachers experience research-based pedagogy (e.g., instruction of Mathematics and Science according to STEAM principles) through appropriate means of presentation (e.g. through virtual reality equipments); (b) **Reflect**: Teachers reflect on their experiences as learners and the potential effect of these experiences on their role as instructors; (c) **Research**: Teachers discuss the research foundation of the experienced pedagogy; (d) **Practice**: Teachers practice incorporating this pedagogy in their own teaching. On the basis of this training schema mini-lessons may be produced by pre- or in-service teachers, which may be recorded and uploaded onto an online collaborative platform, in order for peer feedback and further reflection to follow.

### 2.5.3 Contextual factors (organizational practices) facilitating the success of pre-and in-service teacher training on Inclusive STEAM Education for students with Mild Disabilities

The exact way in which teacher training is put to practice, i.e., the organizational parameters of this complex enterprise, may play an important role as to the result that

may be produced. For example, in addressing what teachers need to know about students with disabilities, inclusion, and STEAM Education, two main approaches have been promoted: One has been to add content knowledge to existing programs through additional courses, whereas the second has been to incorporate specialist knowledge into existing courses. However, the view has been taken that these approaches are insufficient to improve teacher knowledge and skills because the content is out of the context of the broader pedagogical and curriculum knowledge that pre- and in-service teachers have to manage and apply in the classroom (Florian & Rouse, 2010). Only the combination of the above-mentioned approaches with well-defined and rigorously implemented applications in school frameworks may be expected to produce desirable results.

Similarly, it is stressed that the place in which teacher training is realized may affect the produced outcomes. In this regard and especially in reference to the instruction of students with disabilities or SEN in the general classroom, it is emphasized that the practice of delivering teacher training in contexts that have no connection to the general school perpetuates segregation and obstructs the establishment of inclusive education systems. Initial teacher training and teacher professional development schemata that focus on special educational needs instruction and not on effective education for all students in the general school may lead to inaccurate perceptions regarding the essence of inclusion (Woodcock & Hardy, 2017). Likewise, teacher training on each of the individual fields of STEAM may constitute an ill-service to the development of knowledge and skills for realizing interdisciplinary or transdisciplinary lesson plans.

A solution to the aforementioned problems could come from the implementation of teacher training courses in schools which offer inclusive programs and programs of STEAM Education. However, this practice has also inherent organizational difficulties, although it has produced some positive results (Van Laarhoven et al., 2007). In an effort to tackle problems of the organizational dimension of teacher training and, also, to promote active teacher learning and inquiry-driven activities, educational researchers and teacher educators make nowadays extensive use of New Technologies. STEAM Education in particular has benefited considerably from the

exploitation of the advantages of distance learning and online courses, although the actual gains from such training programs in terms of improved teaching results in daily school practice continue to be studied by experts as there are several inconclusive results (Milner-Bolotin, 2018). In this context, educational platforms offering Open Educational Resources (OERs), and the chance for exchanging experiences regarding their use, may be an effective means for supporting teachers in their efforts to put to practice Inclusive STEAM Education for students with Mild Disabilities. In the Appendix of the present Report a list of OERs that can provide valuable insights and functional solutions for teacher training on various dimensions of inclusive STEAM Education is presented.

### **3. Toward a meta-methodology for training teachers in inclusive STEAM Education for students with Mild Disabilities**

A main aim of the SPICE project is the development of a meta-methodology for pre- and in-service teacher training on inclusive STEAM Education for students with Mild Disabilities. According to an older but still valid proposal for meta-methodology development (Thomann, 1973), the respective process contains the following steps:

1. State the purpose
2. Test the purpose by criteria
  - a. Is it desirable?
  - b. Is it operationalizable?
  - c. Is it practicable?
  - d. Are existing methodologies insufficient?
3. If the answers are affirmative, then analyze the implications of the purpose
4. Operationalize the purpose
5. Design procedures
6. Test the procedures
7. Revise the purpose and/or procedures, if necessary

The content of each step in the context of the SPICE project may be formulated in the following way:

**-State the Purpose:** The purpose is to render primary pre- and in-service teachers capable of implementing Inclusive STEAM Education for students with Mild Disabilities.

**-Test the purpose by criteria** - a. Is it desirable? - b. Is it operationalizable? - c. Is it practicable? - d. Are existing methodologies insufficient?: The answers are all affirmative.

**-If the answers are affirmative, then analyze the implications of the purpose:** Teachers capable of implementing Inclusive STEAM Education may support students with Mild Disabilities in their effort to achieve measurable cognitive, learning, and social progress in the framework of general classroom.

**-Operationalize the purpose:** In order to prove that they have achieved the goal of the project pre- and in- service teachers may be asked to construct at least one Inclusive STEAM Education lesson plan for students with Mild Disabilities.

**-Design procedures:** The procedures should include a documented synthesis of assessment, training, and organizational methods, techniques and approaches that have proven their value in the context of respective research, as mentioned in the sections 2.5.1, 2.5.2, and 2.5.3 of the present Report. In specific: (a) In reference to Assessment, surveys using questionnaires (especially the questionnaire developed by the SPICE consortium) may provide valuable information before the beginning and after the completion of the training program, while Portfolios- Lesson Plans and Performance Tasks may serve assessment procedures during and after the implementation of the training. (b) With regard to actual teacher Training, modeling and performance feedback in the context of problem-based approaches constitute very promising choices. The critical discussion of lesson plans for individual students with disabilities in the framework of collaborative teacher activities, coupled with Experiential Activities following the “Model-Reflect-Research-Practice” schema may also offer significant teacher training opportunities. (c) As far as the organizational dimension of teacher training is concerned, training in school classrooms in

combination with specialized online courses and the use of OERs may provide fruitful solutions.

**-Test the procedures:** Procedures will be tested during and after the implementation of the training program.

**-Revise the purpose and/or procedures, if necessary:** Depending on the results of the final program evaluation revisions may be proposed regarding the methods, the techniques, the approaches, and the procedures used for training pre- and in- service teachers in Inclusive STEAM Education for primary students with Mild Disabilities.

## 4. General conclusions and proposals

The present Educational Framework has sought to create a coherent set of principles, guidelines, methods, approaches and procedures that can inform the effective training of teachers in implementing inclusive STEAM activities in the general classroom. It is evident that the creation of such a framework is very demanding because there is no evidence available as to what constitutes training choices of high validity and reliability and which are the main obstacles or the most important aspects of this task. By necessity then, the production of the educational framework is based on hypotheses and includes several proposals that may appear plausible, but can only be justified, retained or rejected, through the results of the next phase of the SPICE project. In order for these results to be as illuminative as possible and to allow the drawing of valid conclusions regarding the specifics of future teacher training programs, the above-described EF should be implemented with fidelity and evaluated with the highest consideration. In this way evidence will be produced that will increase the safety of methodological choices for the future training of teachers in inclusive STEAM Education for primary students with Mild Disabilities.

## 5. References

Academy for International Science and Research (AISR). (2021). *Improving STEM*



*Education across European Schools.*

<https://improving-stem-education.eu/wp-content/uploads/2021/08/SoAR-Stem-Survey-Analysis-Final.pdf>

- Agaliotis, I. (2023). *Effective Mathematics Instruction for Students with Learning and Behavior Difficulties: Assessment and Intervention in the General School and in Special Education Units* (in Greek). Athens, GR: Grigoris Publications.
- Allday, R. A., Neilsen-Gatti, S. & Hudson, T. (2013). Preparation for inclusion in teacher education pre-service curricula. *Teacher Education and Special Education*, 36(4): 298-311. doi: 10.1177/0888406413497485
- Brock, M.E., & Carter, E.W. (2017). A Meta-Analysis of Educator Training to Improve Implementation of Interventions for Students With Disabilities. *Remedial and Special Education*, 38(3), 131– 144.
- Costello, E., Girme, P., McKnight, M., Brown, M., McLoughlin, E., & Kaya, S. (2020). Government Responses to the Challenge of STEM Education: Case Studies from Europe. ATS STEM Report #2. Dublin: Dublin City University.  
<http://dx.doi.org/10.5281/zenodo.3673600>
- European Agency for Development in Special Needs Education (EADSNE). (2017). *Keyprinciples for promoting quality in inclusive education*.  
<https://www.european-agency.org/sites/default/files/Key-Principles-2011-EN.pdf>
- Florian, L. & Camedda, D. (2019). Enhancing teacher education for inclusion. *European Journal of Teacher Education*, 43(1), 4-8.  
<https://doi.org/10.1080/02619768.2020.1707579>
- Forlin, C., Earle, C., Loreman, T., Sharma, U.(2011).The Sentiments, Attitudes and Concerns about Inclusive Education Revised (SACIE-R) scale for measuring teachers' perceptions about inclusion. *Exceptionality Education International*, 21(3), 50-65. <https://doi:10.5206/eei.v21i3.7682>
- González-Gil, F.; Martín-Pastor, E.; Orgaz Baz, B.; Poy Castro, R. (2019). Development and Validation of a Questionnaire to Evaluate Teacher Training for Inclusion: The CEFI-R. *Aula Abierta*, 48(2), 229-238.
- Herro, D., Quigley, C., & Cian, H. (2019). The Challenges of STEAM Instruction: Lessons from the Field. *Action in Teacher Education*, 41(2), 172-190.

DOI:10.1080/01626620.2018.1551159

- Engleman, M., & Schmidt, M. (2007). Teaching an experimental universally designed learning unit in a graduate level online teacher education course. *MERLOT Journal of Online Learning and Teaching*, 3, 112-132.
- Evmenova, A. (2018). Preparing Teachers to Use Universal Design for Learning to Support Diverse Learners. *Journal of Online Learning Research*, 4(2), 147-171
- Karlsson, G.& Nilsson, P. (2023) Capturing student teachers' TPACK by using T-CoRe and video-annotation as self-reflective tools for flexible learning in teacher education. *Technology, Pedagogy and Education*, 32(2), 223-237.
- McCarthy, D.L. (2018). A STEM Experiential Learning Experience: A Five-Year Synthesis of Lessons Learned, *Experiential Learning & Teaching in Higher Education*: 2(1), Article 10. <https://nsuworks.nova.edu/elthe/vol2/iss1/10>
- Milner-Bolotin, M. (2018). Evidence-Based Research in STEM Teacher Education: From Theory to Practice. *Frontiers in Education*.  
<https://www.frontiersin.org/articles/10.3389/feduc.2018.00092>
- Mpofu, V. (2020). A theoretical framework for implementing STEM Education. In K.G. Fomunyan (ed.), *Theorizing STEM Education in the 21<sup>st</sup> Century*. Intech Open. <https://www.intechopen.com/chapters/68740>
- Ng, S. B. (2019). *Exploring STEM Competences for the 21<sup>st</sup> Century*. UNESCO, International Bureau of Education [12304]  
<https://unesdoc.unesco.org/ark:/48223/pf0000368485>
- Nilsson, P.& Karlsson, G. (2018). Capturing student teachers' pedagogical content knowledge (PCK) using CoRes and digital technology. *International Journal of Science Education*, 41(4), 419-447.
- Organization for Economic Cooperation and Development (OECD). (2019). Strengthening Education for Innovation. III.8. STI Policy Profiles: Human Resources for Innovation.  
<https://www.oecd.org/media/oecdorg/satellitesites/stie-outlook/files/policyprofile/STI%20Outlook%2012%20PP%20HREducation.pdf>
- Schuster, D., Cobern, W. W., Applegate, B., Schwartz, R., Vellom, P., Undreiu, A., & Adams, B. (2007). Assessing pedagogical content knowledge of inquiry science teaching - Developing an assessment instrument to support the

- undergraduate preparation of elementary teachers to teach science as inquiry. October 19-21, 2007, *Proceedings of the National STEM Conference on Assessment of Student Achievement*, hosted by the National Science Foundation and Drury University, Washington D.C.
- Sheffielda, R., Koula, R., Blackleya, S., Fitriani, E., Rahmawati, Y., & Resek, D. (2018). Transnational Examination of STEM Education. *International Journal of Innovation in Science and Mathematics Education*, 26(8), 67–80.  
<https://core.ac.uk/download/pdf/229407828.pdf>
- Thomann, J. (1973). *Meta-Methodology: An Overview of What It Is and How It Was Developed*. Paper presented at the 58th Annual Meeting of the American Educational Research Association <https://eric.ed.gov/?id=ED078505>
- Van Laarhoven T. R., Munk, D. D., Lynch, K., Bosma, J., & Rouse, J. (2007). A model for preparing special and general education preservice teachers for inclusive education. *Journal of Teacher Education*, 58, 400-455.  
doi:10.1177/0022487107306803
- Woodcock, S., & Hardy, I. (2017) Beyond the binary: rethinking teachers' understandings of and engagement with inclusion. *International Journal of Inclusive Education*, 21(6), 667-686, DOI: [10.1080/13603116.2016.1251501](https://doi.org/10.1080/13603116.2016.1251501)
- Yang, W., Wu, R. & Li, J. (2023). Development and validation of the STEM Teaching Self- Efficacy Scale (STSS) for early childhood teachers. *Current Psychology*, 42, 7275-7283. <https://doi.org/10.1007/s12144-021-02074-y>

## 6. APPENDIX

### OERs for Inclusive STEAM Education for students with mild disabilities

#### Introduction

OER stands for Open Educational Resources, which usually refers to free access (open), learning oriented content (educational) in digital format (resources). This common definition is linked to concepts such as accessibility, reusability and interoperability which ensure universal access to the online content.<sup>1</sup>

UNESCO adopted a Recommendation on OER in 2019 to promote the openly licensed sharing of teaching and learning material. UNESCO defines OER as “learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others”.<sup>2</sup>

In the next section we will present a few examples of OER targeting teachers and educators in STEAM and inclusive education. While harvesting data on the web we observed that there are plenty of online resources to be found either in STEAM or in inclusive education. However, it seems that the area of inclusive STEAM education, specifically, with a focus on mild disabilities, has received little attention.

The OER examples follow the below categorization:

- OER name
- 

<sup>1</sup>Rodriguez, Germana & Cueva Carrión, Samanta & Tovar, Edmundo. (2011). Reusable and interoperative specifications for OERs based on Standards. 763 - 770. 10.1109/EDUCON.2011.5773225.

<sup>2</sup>UNESCO <https://www.unesco.org/en/open-educational-resources>

- Description
- Language
- Area/topic
- Key terms
- Target group
- Educational/training framework
- Media format
- License
- Author/s
- Link to OER

## OER examples

<b>OER name</b>	STEM Career Days Webinar: Accessible and Inclusive STEM Education
<b>Description</b>	A webinar about how technology and STEM can improve the education of students with disabilities. During the event, guest speakers talked about their solutions to give autonomy and possibilities to people with disabilities. Besides, attendees got some recommendations, general rules, and useful tips, for designing accessible online courses. Duration: 1 hour and 25 minutes.
<b>Language</b>	English
<b>Area/topic</b>	Web content accessibility
<b>Key terms</b>	Accessibility
<b>Target group</b>	Special education teachers
<b>Educational/training framework</b>	Primary and secondary education
<b>Media format</b>	Video
<b>License</b>	Creative Commons
<b>Author/s</b>	<ul style="list-style-type: none"> <li>• STE(A)M IT</li> <li>• STEM Alliance</li> </ul>

	<ul style="list-style-type: none"> <li>• Scientix</li> </ul>
<b>Link to OER</b>	<a href="https://www.youtube.com/watch?v=xxeGYGtzoE&amp;embeds_euri=http%3A%2F%2Fwww.stemalliance.eu%2F&amp;source_ve_path=MjM4NTE&amp;feature=emb_title">https://www.youtube.com/watch?v=xxeGYGtzoE&amp;embeds_euri=http%3A%2F%2Fwww.stemalliance.eu%2F&amp;source_ve_path=MjM4NTE&amp;feature=emb_title</a>

<b>OER name</b>	Inclusive STEM learning environments: challenges and solutions
<b>Description</b>	This observation paper outlines the key discussion points raised during the Science Topics Networking seminar. The main points to consider in achieving an inclusive STEM learning environment are: (1) creating a personalized strategy for each student; (2) organizing teacher training programs on how to promote inclusivity in STEM teaching; (3) eliminating barriers, such as gender inequality or socio-economic barriers; (4) implementing policies to support inclusivity; and (5) involving parents and local communities
<b>Language</b>	English
<b>Area/topic</b>	Inclusive STEM leaning environment
<b>Key terms</b>	Accessibility, assessment, professional development, equity & inclusion, STEM education, gender equality, assistive technology
<b>Target group</b>	Educators, General public
<b>Educational/training framework</b>	Primary and secondary education
<b>Media format</b>	Pdf document
<b>License</b>	<i>Not found</i>
<b>Author/s</b>	Milanovic, I., Molina Ascanio, M., Bilgin, A. S., Kirsch, M., Beernaert, Y., Kameas, A., Saygın, S., Dancheva, T., Sayed, Y., Xhomaqi, B., Covernton, E., Sangiuliano,



	M., Agaliotis, I.1, Colli, A.1, Abrantes, S., Damjanoska, K., Quarta, B., Roig-Vila, R., Niewint Gori, J., Van der Niepen, P., Gras-Velázquez, A.
<b>Link to OER</b>	<a href="https://www.scientix.eu/documents/10137/121801/Scientix-STNS_Inclusive-STEM-Learning-Enviroments-Ready-for-publication.pdf/9f8ebd46-a84f-feac-8bb3-748e3a7f582f?t=1676035712496">https://www.scientix.eu/documents/10137/121801/Scientix-STNS_Inclusive-STEM-Learning-Enviroments-Ready-for-publication.pdf/9f8ebd46-a84f-feac-8bb3-748e3a7f582f?t=1676035712496</a>

<b>OER name</b>	The Use of Velcro in Special Needs Science Lessons
<b>Description</b>	Students with moderate or severe learning difficulties can find it difficult to take in information from a static display, and so teachers at Forest School use Velcro to make versatile displays. Other uses described include using pictures to help sequence lessons and the use of large number lines to help students analyze data. Three short videos (<5 min) and one accompanying pdf document.
<b>Language</b>	English
<b>Area/topic</b>	Special needs science learning
<b>Key terms</b>	special needs, science education, science learning
<b>Target group</b>	Teachers
<b>Educational/training framework</b>	Special needs education
<b>Media format</b>	Video, pdf document
<b>License</b>	<i>Not found</i>
<b>Author/s</b>	Patrick Organ and Barbara Watson (The Forest School), Centre for Science at Sheffield Hallam University
<b>Link to OER</b>	<a href="https://www.stem.org.uk/elibrary/resource/30019">https://www.stem.org.uk/elibrary/resource/30019</a>

	<a href="https://scienceforall.shu.ac.uk/resources/SFA03-Use_of_velcro.pdf">https://scienceforall.shu.ac.uk/resources/SFA03-Use_of_velcro.pdf</a>
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<b>OER name</b>	Gamified Lesson Plans
<b>Description</b>	<p>The Gamified Lesson Plans (GLP) constitute the main day-to-day interaction with the BEAKONING platform for students and teachers. The deliverable presents the overall architecture for the definition, construction, deployment and experiencing of the GLP. The aim is:</p> <ul style="list-style-type: none"> <li>• To detail the design, role and the collocation of the Gamified Lesson Plans within the overall BEACONING ecosystem architecture.</li> <li>• To provide an overview and a demonstration of all the components that support the deployment and utilization of Gamified Lesson Plans (Game Plots, Authoring Tool, Mini games, Location Based Activities).</li> <li>• To describe how teachers and students will experience Lesson Plans both from a user experience point of view and in their pedagogical content.</li> <li>• To provide examples of Lesson Plans currently being developed.</li> <li>• To outline links with the feedback dynamics of Beaconing, as supported by Learning Analytics</li> </ul>
<b>Language</b>	English
<b>Area/topic</b>	Information technology, Technology, Education
<b>Key terms</b>	Lesson plan, mini games, gamification, problem-Based Learning
<b>Target group</b>	Teachers

<b>Educational/training framework</b>	Secondary education
<b>Media format</b>	Pdf document
<b>License</b>	<i>Not found</i>
<b>Author/s</b>	Luca Morini, Sylvester Arnab, Michael Loizou
<b>Link to OER</b>	<a href="https://beaconing.eu/wp-content/uploads/deliverables/D4.8.pdf">https://beaconing.eu/wp-content/uploads/deliverables/D4.8.pdf</a> <a href="https://core.beaconing.eu/auth/login">https://core.beaconing.eu/auth/login</a> (teacher dashboard)

<b>OER name</b>	STEAM and robots in education
<b>Description</b>	<p>Presentation of a STEAM game to primary and secondary teachers. The game combines subject knowledge:</p> <ul style="list-style-type: none"> <li>- The Human and Nature</li> <li>- Bulgarian language</li> <li>- Mathematics</li> <li>- The Human and Society</li> <li>- Social Emotional Learning</li> <li>- Engineering</li> <li>- Programming</li> </ul> <p>The game is copyrighted and is suitable for STEAM learning and can be combined with learning for children with disabilities. After the event, the National Forum - STEAM School under steam, where the game was presented. It has been tested with students and teachers.</p>
<b>Language</b>	Bulgarian
<b>Area/topic</b>	STEAM
<b>Key terms</b>	robots, STEAM learning, educational game

<b>Target group</b>	Teachers
<b>Educational/training framework</b>	Primary and Secondary education
<b>Media format</b>	Video
<b>License</b>	DIITT, Trakia University
<b>Author/s</b>	Chief Assistant Professor Mihail Kozhuharov, Assist. Prof. Mariya Zhelyazkova
<b>Link to OER</b>	<a href="https://www.youtube.com/watch?v=VcY8SCvU7Sc&amp;t=132s&amp;ab_c_hannel=%D0%91%D1%8A%D0%BB%D0%B3%D0%B0%D1%80%D1%81%D0%BA%D0%BE%D1%88%D0%BA%D0%BE%D0%BB%D0%BE">https://www.youtube.com/watch?v=VcY8SCvU7Sc&amp;t=132s&amp;ab_c_hannel=%D0%91%D1%8A%D0%BB%D0%B3%D0%B0%D1%80%D1%81%D0%BA%D0%BE%D1%88%D0%BA%D0%BE%D0%BB%D0%BE</a>

<b>OER name</b>	EFYES: Eyes For Your EyeS (Μάτια για τα μάτια σας)
<b>Description</b>	This project concerns the educational process followed in the framework of a Robotics group during the school year, in order for the target students to approach educational robotics and STEAM activities. At the same time, sensitization was attempted on the issues of people with disabilities and human rights. By studying and constructing a vision replacement device, students developed skills such as collaboration, creative thinking, innovation, communication, critical thinking, and problem solving while raising awareness on issues of inclusion of people with disabilities and abilities.
<b>Language</b>	Greek
<b>Area/topic</b>	Educational Robotics – STEAM training
<b>Key terms</b>	Arduino, Scratch, Tinkercad, STEAM, visual impairment
<b>Target group</b>	Pupils and teachers of Primary and Secondary Education
<b>Educational/training framework</b>	Primary and Secondary Education

<b>Media format</b>	pdf files, mp4, doc, pptx
<b>License</b>	Creative Commons
<b>Author/s</b>	Angeliki Alexandropoulou, Gerasimos Kalogeratos
<b>Link to OER</b>	<a href="https://openedtech.ellak.gr/robotics2023/efyes-eyes-for-your-eyes-matia-gia-ta-matia-sas/">https://openedtech.ellak.gr/robotics2023/efyes-eyes-for-your-eyes-matia-gia-ta-matia-sas/</a>

<b>OER name</b>	A school for all - Pedro's experience (Una escuela para tod@s - La experiencia de Pedro)
<b>Description</b>	In this video we can see a report about Pedro, a boy with Down's syndrome, and his experience with educational inclusion in a regular school. In the video we can see testimonies from their relatives and other people close to them. The aim of this video is to raise awareness about inclusion in society.
<b>Language</b>	Spanish
<b>Area/topic</b>	<ul style="list-style-type: none"> <li>• Why inclusion – the benefits of inclusive education</li> <li>• The social context of disability and identifying the barriers to inclusion.</li> <li>• The role of the family supporting inclusive schooling.</li> <li>• Community support for inclusive schooling.</li> </ul>
<b>Key terms</b>	Inclusive education, barriers to inclusions, inclusive education experiences
<b>Target group</b>	Teachers, families, students, other professionals and parents interested to learn about experiences in inclusive education
<b>Educational/training framework</b>	Inclusive education
<b>Media format</b>	Video
<b>License</b>	<i>Not found</i>
<b>Author/s</b>	Down Galicia. The Down Galicia Federation is a non-profit organization that brings together the seven

	<p>specific organizations for Down's syndrome in the Autonomous Community of Galicia. The Federation was created at the beginning of 1998 to channel the demands of the group of people with Down's syndrome before the Administration and to provide solutions to help normalize their situation in society. Its functions also include coordinating, collaborating and proposing programs of activities to public and private institutions for their implementation through its member organizations.</p> <p>Other stories: <a href="https://www.youtube.com/@DownGalicia">https://www.youtube.com/@DownGalicia</a></p>
<b>Link to OER</b>	<a href="https://www.youtube.com/watch?v=6FkiYdzU1zI">https://www.youtube.com/watch?v=6FkiYdzU1zI</a>

<b>OER name</b>	Profile of Inclusive Teachers
<b>Description</b>	<p>The Profile is one of the main outputs of the Teacher Education for Inclusion (TE4I) project and it presents information on what essential values and areas of competence should be developed within all ITE programs. However, it does not attempt to describe how these areas of competence should be used within different country programs for ITE. Although some key issues relating to implementation are considered within a later section of this document, the Profile has been drafted as a tool to be examined and developed in ways that specifically fit within the different context of each individual country's ITE system.</p> <p>The objectives for the Profile are to:</p> <ol style="list-style-type: none"> <li>1. Identify a framework of core values and areas of competence that are applicable to any initial teacher education program;</li> </ol>



	<ol style="list-style-type: none"> <li>2. Highlight the essential core values and areas of competence necessary for preparing all teachers to work in inclusive education considering all forms of diversity;</li> <li>3. Highlight key factors supporting the implementation of the proposed core values and areas of competence for inclusive education within all ITE programs;</li> <li>4. Reinforce the argument made within the TE4I project that inclusive education is the responsibility of all teachers and that preparing all teachers for work in inclusive settings is the responsibility of all teacher educators working across ITE programs</li> </ol>
<b>Language</b>	Available in 22 languages
<b>Area/topic</b>	Inclusive teacher values and competences
<b>Key terms</b>	Inclusive education, values, competence, continuous professional development
<b>Target group</b>	Teacher educators and decision makers – managers and policy makers for Initial Teacher Education (ITE)
<b>Educational/training framework</b>	Inclusive education
<b>Media format</b>	Pdf document
<b>License</b>	<i>Not found</i>
<b>Author/s</b>	European Agency for Development in Special Needs Education
<b>Link to OER</b>	<a href="https://www.european-agency.org/resources/publications/teacher-education-inclusion-profile-inclusive-teachers">https://www.european-agency.org/resources/publications/teacher-education-inclusion-profile-inclusive-teachers</a>
<b>OER name</b>	Education for All: Disability, Diversity and Inclusion

<b>Description</b>	Learning about inclusive education, understanding what barriers there are to learning and how to challenge them; Discovering practical ways to create a more inclusive learning environment. Duration: six weeks.
<b>Language</b>	English
<b>Area/topic</b>	<ul style="list-style-type: none"> <li>• Why inclusion – the benefits of inclusive education</li> <li>• The social context of disability and identifying the barriers to inclusion</li> <li>• The role of the family supporting inclusive schooling</li> <li>• The importance of a home-school partnership</li> <li>• How to build an inclusive school environment?</li> <li>• Community support for inclusive schooling – key stakeholders, community assets and changing mindsets</li> <li>• Changing classroom practices to maximize inclusion</li> <li>• Curriculum differentiation and practical tips for teaching</li> <li>• Professional support networks to sustain teachers and develop inclusive practice</li> </ul>
<b>Key terms</b>	Inclusive education, barriers to inclusions, inclusive education practices, inclusive school environment
<b>Target group</b>	Teachers, other professionals and parents interested in developing inclusive education
<b>Educational/training framework</b>	Inclusive education
<b>Media format</b>	Video and Text
<b>License</b>	CC-BY
<b>Author/s</b>	University of Cape Town
<b>Link to OER</b>	<a href="https://www.futurelearn.com/courses/education-for-all">https://www.futurelearn.com/courses/education-for-all</a>

<b>OER name</b>	Inclusive schools Education pack
<b>Description</b>	<p>A range of materials to help teachers work with everyone involved in the school so that it becomes more inclusive. Tips, methodology and activities to lead in the classroom or within the school community. The toolkit is designed to guide teachers through five phases during an academic year:</p> <ul style="list-style-type: none"> <li>• Phase 1: Getting started</li> <li>• Phase2: Where are we now? An in-depth look at priorities</li> <li>• Phase 3: Where are we going first? How will we get there?</li> <li>• Phase 4: Making it happen</li> <li>• Phase 5: Where have we got to? Where next?</li> </ul>
<b>Language</b>	English
<b>Area/topic</b>	Inclusive education
<b>Key terms</b>	Inclusive school, Inclusion week, Planning, Activity set, Assessment
<b>Target group</b>	Teachers
<b>Educational/training framework</b>	Primary and Secondary education
<b>Media format</b>	PDF document
<b>License</b>	<i>Not found</i>
<b>Author/s</b>	Sian Williams (British Council)
<b>Link to OER</b>	<a href="https://www.inclusiveschools2.net/dl/100/951258/EN_Inclusive_Schools_Education_Pack.pdf">https://www.inclusiveschools2.net/dl/100/951258/EN_Inclusive_Schools_Education_Pack.pdf</a>

<b>OER name</b>	Designing for Personalization and Inclusion with Technologies MOOC
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<b>Description</b>	A self-paced course that tries to analyze the problems that the teachers find in designing in complexity and how digital technologies can support the design. The course starts from the design model mediated by the Conversational framework proposed by Diana Laurillard, which presents an interactionist approach to teaching through an application, DEPIT, which supports explicit and visible design to students. In addition, it presents experiences and reflections of many schoolteachers who have used DEPIT in Italy and Spain and have highlighted their strengths and suggestions for an effective work.
<b>Language</b>	English
<b>Area/topic</b>	Pedagogical instruction
<b>Key terms</b>	Annual planning, class action, learning path, pedagogical model
<b>Target group</b>	Teachers
<b>Educational/training framework</b>	Primary and secondary education
<b>Media format</b>	Video
<b>License</b>	Creative Commons
<b>Author/s</b>	DEPIT project consortium
<b>Link to OER</b>	<a href="https://www.europeanschoolnetacademy.eu/courses/course-v1:DEPIT+design_personalisation_technologies+2020/about">https://www.europeanschoolnetacademy.eu/courses/course-v1:DEPIT+design_personalisation_technologies+2020/about</a>