INSIDE

Social Inclusion of the Visually Impaired Students through STEM projects

O1_STEM Handbook

For Inclusion Classroom

[07/2021]

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Introduction

This Handbook aims at strengthening STEM skills for the Visually Impaired students (that is those who are totally blind or have low vision), as well as their Teachers, so as to motivate them create STEM based projects and improve technology and digital skills, while favoring opportunities for participation, social inclusion and interaction with their classmates. It also aims at diffusing best practices developed not only in countries with a long tradition in inclusion education, but even in those less developed in this educational area, via the creation of this handbook and an e-learning platform, about student STEM projects.

This STEM handbook was created in order to help and empower the educational process for all target groups involved, by a team of teachers' experts in the field of visual impairments alongside many years of experience. This is a handbook for inclusion classrooms, containing not only theoretical information about the visually impaired students and their educational needs concerning assistive technology, but additionally it includes examples/templates of five STEM lesson plans in an adapted version full of useful information and details for the Teachers working in an inclusion classroom.

The Teachers and Researchers who created this handbook have a scientific background of Mathematics, Physics, Engineering, Special Education and Social Policies. They worked together in an effort to provide an innovative manual simple and up to date.

The implementation of this handbook in European level will contribute to transferable outcomes and good practices between countries with different types of inclusion schools and different integration levels of STEM trends in education.

In a European level, the impact of the STEM handbook will contribute to Inclusion education Curriculum convergence between different European countries and promote the modern skills and knowledge (critical thinking, problem solving, design thinking etc.) required for Teachers and students, which are being developed through the implementation of the STEM approach in classroom. In the long term, this will affect the

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modernization, competitiveness and innovation of European education system.This project could be the spark for the design and implementation of similar projects for inclusion education concerning people with other types (than Visual impairment) of disability.

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Subtitle

O1_ First draft

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Erasmus+

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CHAPTER 1: Introduction in the Visual Impairment

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- **Disability and Visual Impairment**

A conceptual definition of Disability

The conceptual clarification and delimitation of "disability" is an extremely difficult task, a fact that is reflected in a large number of definitions in both Greek and foreign language literature review, but also in various theories and models that approach this multi-prism phenomenon (Soulis, 2013). Although this demarcation may be considered of major importance, it plays a key role in getting to know and understanding the attitudes taken by citizens, administrations and various institutions towards people with disabilities (Makri & Michael 2007).

The one that should be mentioned is that the various definitions which have been adopted during time, arise from the two main models of visas for disability, the medical and the social one, between which there is a long-standing controversy (Zoniou-Sideri, Vlachou, 2006).

Regarding the first model, it is of a medical nature and promotes stereotypical perceptions about disability (Thomas & Woods, 2008) which is approached only as the result of a pathology due to some sensory, mental, physical or psychological problem (Sideris-Zoniou, 2011). These individuals are not considered capable of meeting the demands of everyday life and face failures, difficulties and social constraints as a result of injury or disability (Zoniou-Sideris, 2011). They are called upon to adapt their lives so that they are often marginalized and excluded from important aspects of life, such as education, employment, mobility and generally a good quality of life. They need medical treatment, intervention and rehabilitation and society should invest mainly in health services which have a leading role in order to adapt a better way of everyday life for these (Oliver, 2009; Kaplan, 2000; Hersh & Johnson, 2010; Retrief & Letsosa, 2018; Goering, 2015).

For all these reasons, this model and the definitions derived from it are an anachronistic conception. Criticism, mainly from the disability movement, was sharp (Oliver, 2009) result-ing in the creation of an international classification system that does not focus

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exclusively on inadequacy and disorder but also on the social factor (WHO, 2002; Norwich, 2007).

In this modern approach, disability now focuses on the level of functionality of the individual in the environment (WHO, 2002). Functionality is related to all the functions of an individual's body that are directly related to the physical and social environment that can either make it easier or harder for it (WHO, 2002; Norwich, 2007; Oliver, 2009; Barner & Mercer, 2003; Swain, Griffiths & Heyman, 2003). This classification is therefore linked to the social model of disability, which has a human-centered orientation, more social implications and disability is a social construction, due to the fact that both the design of the environment and the way it is organized society are based on the model of the "normal" individual, re-sulting in the perpetuation of "disabled environments" (Karagianni, 2009; Oliver, 1990).

The relationship between disability and the environment is understandable if one considers that a person with a visual disability feels excluded and "disabled" in an environment based on visual information. However, if this is supplemented with audio / tactile information and e.g. a "blind guide" on the floor or a guide dog or innovative assistive technology, etc., the person functions completely differently, feeling safe and largely autonomous (Danforth, 2001). In essence, that is, a universally accessible environment ensures a common level of reference for all, removing any disadvantages created by a disabled social structure, allowing everyone to work on equal terms in areas such as education, everyday life, transport, culture, etc. Rightly, therefore, accessibility is considered the "key" to equal opportunities for all citizens, including citizens with disabilities (Mitra, 2006). This model is compatible with user-centered design approaches and their involvement in all dimensions of social life (Hadjiri, Afacan & Gadakari, 2016).

Based on this model, according to the WHO, a recent and quite comprehensive definition of disability defines it as: the result of organic and environmental causes, which result in a series of obstacles in many aspects of people's lives, such as daily living and self-service, education, employment, entertainment, autonomous movement and general social participation (Polychronopoulou, 2012; Makri & Michael 2007). People with disabilities include people with mental, intellectual, cognitive, motor and sensory problems

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who, in combination with institutional, environmental or social barriers, can create a barrier to their participation in society on an equal footing with others (Halfon et al.)

Visual Disability

One of the categories of disability that occurs due to eye disease and has a very significant effect on everyday life and the quality of life of people in general, is visual disability. The World Health Organization estimates that nearly 285 million people worldwide have vision problems, with an increasing incidence. 39 million of them are blind, while a large part of them have a moderate to severe visual impairment (Elsman, van Rens & van Nispen, 2019; WHO, 2017; Park, Ahn, Woo, & Park, 2015).

The deeper reasons that can cause vision loss vary depending on the country, socio-economic, environmental and genetic factors, but also the general availability and access of citizens to health services (Seland et al., 2011).

The prevalence and distribution of vision problems vary considerably from country to country, even in the same part of the world (Foster, Gilbert & Johnson, 2008). Research has shown that people with visual impairments are more likely to be women, people on very low incomes, and people living in developing countries where there are no organized health services.

For example, a study found that 85% of visually impaired people are from third world countries, with the rate of blindness in Africa being ten times higher than in Europe (WHO, 2011). It should be emphasized, of course, that visual impairment is a very important cause of disability in the western world. The chances of blindness, of course, are much lower than in an underdeveloped country, due to better socio-economic development and organization of health services, but also a healthier diet. According to the WHO (2012), the number of visually impaired people in Europe is estimated at more than thirty million, six of whom face blindness.

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Conceptual definition of Visual Disability

Due to the strong occurrence of the phenomenon of visual disability in the lives of individuals, many attempts have been made in order to define this concept. Many different definitions have been formulated over the years, but formulating a widely accepted definition has seemed to be a rather difficult task. Differentiation lies in the different ways of approaching it by the various disciplines dealing with it (Beverley, Bath, & Barber, 2011).

The definitions related to visual impairment come from the medical-scientific and educational approach (Kroustalakis, 2005).

In fact, according to the classification made by the WHO, there are four grades in terms of vision. These categories are related to normal vision, moderate visual impairment, severe visual impairment and blindness. The categories of moderate and severe visual impairment are often grouped through the term "low vision" (WHO, 2017). The combination of low vision and blindness represents the term "visual disability" (WHO, 2001).

It is estimated that reduced vision has a direct impact on the daily lives of 1% of people in the West-ern world. People with impaired vision can make use of their residual vision in order to facilitate professional, recreational, educational and social aspects of their lives (Scott, Smiddy, Sciffman, Feuer & Pappas, 1999). It should be emphasized that the majority of people with visual impairment in old age are faced with reduced vision and not blindness (Brennan, 2004).

With regard to total blindness, only a percentage of the order of 18% is faced with it. Most can distinguish between light and dark. For example, people with cataracts have the ability to distinguish light, but do not have the same ability to read print media. Similarly, a person with limited field of vision may have the ability to see a small portion of a form but not be able to locate the city bus heading in its direction (Holbrook, 2006).

It should be noted that visual disability is not only defined through its various legal but also through its educational definitions.

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Due to the fact that there are students who are characterized as legally blind, but are taught through the use of the Braille reading and writing system, the educational definitions for visual disability have been adopted by the educational community (Argyropoulos, 2014).

According to the educational definition of visual disability, blind are those people who are directly dependent on the sense of touch and hearing, the use of which helps to compensate for the loss of vision, interaction with the environment and the acquisition of knowledge (Christakis, 2006). These people use non-visual media so that they can meet the tasks and obligations of the school (Papadopoulos, 2007).

On the other hand, the student who uses his/her residual vision to adequately meet the requirements of the school curriculum is characterized as partially sighted. This presupposes the necessary modification and adaptation of the methods used, the educational material and the wider learning environment (Papadopoulos, 2007), such as the existence of appropriate lighting. Specifically, partially sighted students use in addition to texts that are written with quite large typographic elements and low vision aids such as magnifiers, screen magnifiers, CCTV systems, in order to the assistance of the learning process and the acquisition of knowledge (Polychronopoulou, 2003; Christakis, 2006).

According to Argyropoulos (2014), regarding the educational definitions, it is concluded that students with visual disabilities are divided into those who read through the embossed Braille system and those who read print (Print readers). This separation contributes to the design of educational pro-grams by teachers.

Definition

A visual impairment is any visual condition that impacts an individual’s ability to successfully complete the activities of everyday life. Students with visual impairments are infants, toddlers, children and youths who experience impairments of the visual system that impact their ability to learn.

There are three classification systems for individuals with visual impairment that are used by education professionals. To be declared legally blind, an individual must have visual acuity of 20/200 or less, or have a field of vision restricted to 20 degrees or less at the

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widest point. However, this federal classification system is used primarily to determine eligibility for adult agency services.

For educational purposes, a specially trained teacher must determine that the visual impairment impacts the child's ability to learn, and this professional determination, with the agreement of the IEP team ensures access to special education services. To implement appropriate classroom accommodations for students with visual impairment, these students are also classified according to their level of functional vision:

- Low vision – students use their vision as their primary sensory channel

- Functionally blind – students can use limited vision for functional tasks but need their tactile and auditory channels for learning

- Totally blind – students use tactile and auditory channels for learning and functional tasks

A third classification system exists is based on the advent of the visual impairment itself:

- Congenital – occurs during fetal development, at birth or immediately following birth; visual impairment is present before visual memory has been established

- Adventitious – occurs after having normal vision either through a hereditary condition or trauma; visual memory may remain.

Students with congenital visual impairment typically have more difficulty mastering visually strengthened concepts such as spatial orientation and many environmental concepts.

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- **How vision works**

By far the most important organs of sense are the eyes. Humans predominantly use visual sensory systems to interact with the environment. Eighty percent of sensory perception is gathered by the visual system. Vision is a multifaceted sensory function that requires the hierarchical interaction of receptors, transmission, and processing structures to transform captured visual information into meaningful senses. However, damage to photoreceptors, optic nerves and optic radiations, and visual cortex of the eye results in some degree of vision loss or blindness. The leading causes are genetic factors, situations during prenatal and postnatal periods, illnesses, and traumatic injury. Global estimation of the prevalence of visual impairment (VI) and blindness is 2.2 billion, and it is reported that growth and ageing will increase the risk that more people acquire VI. (Ferhat Esatbeyoglu & Ayse Kin-İsler, 2021).

When surveyed about the five senses — sight, hearing, taste, smell and touch — people consistently report that their eyesight is the mode of perception they value (and fear losing) most. Despite this, many people don't have a good understanding of the anatomy of the eye, how vision works, and health problems that can affect the eye.

Globally, more than 800 million people have distance impairment (i.e. myopia and hypermetropia) or near vision impairment (i.e. presbyopia) that could be addressed with an appropriate pair of spectacles. An estimated 100 million people have moderate-to-severe distance vision impairment or blindness that could be corrected through access to cataract surgery.

Interventions that address the needs associated with uncorrected refractive error and unoperated cataract are among the most cost-effective and feasible health interventions available. Key challenges in meeting the growing demand for these interventions include the ability to provide services for underserved populations and ensuring quality service delivery (World Health Assembly WHA74).

Vision can be best simplified into the following steps:

Light signals travel along this visual pathway to reach the brain.

1. Light from an outside source, such as the sun or an artificial light, either travels directly toward you or bounces off another object, and then travels toward you.
2. The light traveling toward your eye passes through the *cornea* (the clear, outer layer in the front of the eye) and enters through the *pupil* (the small, black opening in the middle of each eye).
3. Light then passes through the eye's natural *lens*, a clear, disk-shaped structure behind the pupil. Tiny muscles work together to focus light by automatically adjusting the lens. The curved lens "flips" the light upside down.
4. The light passes through the eye's *vitreous fluid* and lands on the *retina*, a thin layer of tissue in the back of the eye.
5. Along the retina, millions of light-sensitive cells called *rods* and *cones* react to the light. The rod cells activate mostly to low light and light in your peripheral (side) vision, while cones activate to color, bright light and small details.
6. Nerve impulses from the rods and cones "exit" each eye through the *optic nerve*, and some signals cross paths at the optic chiasm. Impulses relay through a gateway called the *lateral geniculate nucleus* and travel toward the back of the brain.
7. The impulses arrive at the *visual cortex*, where they're registered right side up. The brain sends this raw information to other parts of the brain, allowing you to interpret the batch of light as a meaningful image

Researchers at MIT recently discovered that the brain may be able to fully process images in as little as 13 milliseconds (about one-eightieth of a second). That's about 10 times faster than the amount of time it takes to blink. (Adam Debrowski, 2021).

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- ## Causes of Visual Impairment

Many of the diseases and syndromes that cause visual impairment are due to genetic causes and can be passed on to the child by one or both parents, who may not be aware that they are carriers. In some societies it is common for first cousins or other close blood relatives to marry each other, which increases the chances of eye diseases and other disabilities. It is therefore important to have genetic counseling for those at similar risk to plan their lives with knowledge.

Problems can arise during fetal development. Some of them have no obvious explanation, while others are the result of infections such as rubella. In the process of childbirth there is always the possibility of injury, while in premature births, where the newborn weighs less than 1,300 grams and needs a lot of oxygen to stay alive, often develops a condition called "premature retinopathy". Another condition called "cortical blindness" results from a number of neurological disorders, which can damage the visual pathways both before and after their complete formation.

Childhood illnesses, viral infections, brain tumors or injuries, such as those due to car accidents, are possible causes of vision problems in childhood.

Prolonged medications, such as those with certain types of steroids are also likely to have a temporary or permanent effect on the visual system.

In some hot climates, eye diseases such as trachoma (which is the most common cause of blindness in the world) are transmitted by insects. Unhealthy living conditions exacerbated by poor primary care and nutritional deficiencies are responsible for the world's most serious vision problems. In some developing countries, a relatively small proportion of blindness cases are due to genetic factors, premature retinopathy, or visual impairment.

Transmission of infections from animals is not observed only in tropical climates. Regularly information campaign about the dangers of diseases that cause blindness such as toxoplasmosis (which can be transmitted from mother to fetus from cats) and toxicara in which children can be infected by infected dog feces (Heather Mason & Stephen McCall, 1997).

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Globally, the leading causes of vision impairment are:

- uncorrected refractive errors
- cataract
- age-related macular degeneration
- glaucoma
- diabetic retinopathy
- corneal opacity
- trachoma

There is substantial variation in the causes between and within countries according to the availability of eye care services, their affordability, and the eye care literacy of the population. For example, the proportion of vision impairment attributable to cataract is higher in low- and middle-income countries than high-income countries. In high income countries, diseases such as glaucoma and age-related macular degeneration are more common.

Among children, the causes of vision impairment vary considerably across countries. For example, in low-income countries congenital cataract is a leading cause, whereas in middle-income countries it is more likely to be retinopathy of prematurity. As in adult populations, uncorrected refractive error remains a leading cause of vision impairment in all countries amongst children.

- ## Common eye diseases end their educational implications
  - **Short-sightedness (myopia):** Short-sightedness, or myopia, is a very common eye condition that causes distant objects to appear blurred, while close objects can be seen clearly. It's thought to affect up to 1 in 3 people in the UK and is becoming more common. Short-sightedness can range from mild, where treatment may not be required, to severe, where a person's vision is significantly affected. In children the condition can start from 6 to 13 years. During the teenage years when the body grows rapidly myopia may become worse. Myopia can also occur in adults. Some

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of the signs that a student may be short-sighted can include: needing to sit near the front of the class at school because they find it difficult to read the whiteboard, complaining of headaches or tired eyes, regularly rubbing their eyes.

- *Educational consequences:* corrective lenses – such as glasses or contact lenses can help the eyes focus on distant objects. It is important for the students with short-sightedness, all printed items including maps and charts to be clearly put in the appropriate size and in a proper color contrast.
- **Long-sightedness:** Long-sightedness affects the ability to see nearby objects. You may be able to see distant objects clearly, but closer objects are usually out of focus. It often affects adults over 40, but can affect people of all ages – including babies and children. The medical name for long-sightedness is **hyperopia or hypermetropia**. Long-sightedness can affect people in different ways. If a student find that nearby objects appear fuzzy and out of focus, but distant objects are clear, have to squint to see clearly, have tired or strained eyes after activities that involve focusing on nearby objects, such as reading, writing or computer work and experience headaches, they should be referred to an optician in order to get eye tested.
- *Educational consequences:* When objects are in front of a student, focusing is becoming even harder. Long periods of study should be avoided because symptoms of fatigue and headache often appear.
- **Alpinism or albinism or white passion:** It is an inherited disease associated with a lack of pigments or the body's ability to produce melanin (nhs.uk, 2020). Children with Albinism may have white hair and blond skin. However, there is also the case that they do not show any symptoms in their external appearance. When Albinism is presented in its worst form known as “oculocutaneous” Albibism, the spot is underdeveloped alongside with nystagmus (Palmer, 2007).
- *Educational consequences:* Sensitive to the sunlight, students with Albinism should wear special glasses with safety filters when exposed to the sun. Natural light in the classroom should be controlled and in general education should be done at lower levels of light. Also, students can be helped by the use of low aids

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vision. Fatigue and nystagmus, as well as irritation are symptoms to take into consideration.

- **Color Blindness:** Has a hereditary cause and affects men more than women. Conical underdevelopment in the spot causes complete color blindness and generally reduced visual acuity. Children and teenagers with color blindness present symptoms of photophobia and nystagmus.
- *Educational consequences:* similar to those of Albinism.
- **Aniridia:** Aniridia is an eye disorder where the iris (colored ring structure of the eye that forms the pupil) is malformed. In some cases, other structures of the eye are also poorly developed. The word aniridia implies that there is "no iris," but in fact there is a small ring of iris tissue present which is variable in size. Because the iris tissue is so small, the pupil is very large and may be irregularly shaped. Aniridia is a bilateral condition, meaning it is present in both eyes. However, the two eyes may be affected differently by the disease. In the general population, aniridia occurs in 1 per 50,000-100,000 people and the incidence varies in different regions.
- *Educational consequences:* similar to those of Albinism.
- **Cataract:** A cataract is any light scattering opacity of the lens. It is estimated that congenital cataracts are responsible for 5% to 20% of blindness in children worldwide. Incidence varies from country to country. One retrospective study of the prevalence of infantile cataracts in the U.S. showed a rate of 3-4 visually significant cataracts per 10,000 live births. This is a similar rate to a U.K. study which showed 3.18 per 10,000. These numbers underestimate the total number since they do not take into consideration visually insignificant cataracts. Cataracts may be unilateral or bilateral and can vary widely in size, morphology and degree of opacification from a small white dot on the anterior capsule to total opacification of the lens. Consequently, the effect on vision, course of treatment and prognosis may also be widely variable (Rahi JS, Dezateux C, 2001).
- *Educational consequences:* Cataracts cause a varying degree of blurry vision and dulling of color vibrancy. If a cataract is present in one eye and your student has good vision in the other, he will not technically have "low vision." However,

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diminished or absent vision in one eye can affect how your student functions in the classroom. Some children find it straining to read from a chalkboard or catch an oncoming ball, and many children struggle with depth perception. Students can benefit from assistive technology to more easily write, read, use the computer, and access information and from techniques and additional accommodations to perform activities with limited vision (Holmes JM, Leske DA, Burke JP and Hodge DO, 2003) .

- **Coloboma:** Coloboma is derived from the Greek koloboma, meaning mutilated, curtailed, or with defect. The term is used to describe ocular defects of the eyelids, iris, lens, ciliary body, zonules, choroid, retina or optic nerve. It is typically located in the inferonasal quadrant of the involved structure and is often associated with microphthalmia. It can affect one eye (unilateral) or both eyes (bilateral) (Warburg, M. , 1993). It is important to differentiate colobomas involving the globe from those of the eyelids. In either case, they can affect one eye (unilateral) or both eyes (bilateral). Ocular coloboma due to failed closure of the embryonic fissure occurs in 0.5 - 2.2 cases per 10,000 live births (Stoll, C., Alembik, Y., Dott, B. & Roth, M. P. , 1992) . It may be sporadic or inherited and is associated with systemic disorders in some cases. Eyelid coloboma is estimated to occur in 0.2 - 0.8 cases per 10,000 live births, and likewise may arise de novo or be hereditary. Eyelid colobomas may also occur as isolated defects or as part of a syndromic condition (Smith, H. B., Verity, D. H., & Collin, J.R. O., 2015).
- **Glaucoma**: Glaucoma is a common eye condition where the optic nerve, which connects the eye to the brain, becomes damaged. It's usually caused by fluid building up in the front part of the eye, which increases pressure inside the eye. Glaucoma can lead to loss of vision if it's not diagnosed and treated early. Both eyes are usually affected, although it may be worse in 1 eye. Very occasionally, glaucoma can develop suddenly and cause intense eye pain, nausea and vomiting, a red eye, a headache, tenderness around the eyes, seeing rings around lights, blurred vision. Glaucoma can be a hereditary condition and regular testing must be conducted.

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- *Educational consequences:* In Glaucoma there are many similarities with Aniridia. Dilation of pupil is observed resulting to photophobia. The look of the eye is appearing abnormal and as a consequence these students are being victims of bullying (Κωνσταντίνος Σ. Παπαδόπουλος, 2009).
- **Hemianopia:** Hemianopia is the absence of a visual field on the right or left half of each retina. As the cause of this condition is in the optic tract the ocher is usually intact and there may be some central direct vision. Students may adopt unusual head postures to make better use of their visual abilities (Jonathan Waddington & Timothy Hodgson, 2017).
- *Educational consequences:* Scanning and text-monitoring skills may be particularly limited in left-handedness, i.e. when the left half of each eye's field of vision is defective, this affects reading. Positioning in the classroom is a very important issue for the student to be able to capture the widest possible field of vision. Also the toddler may need a visual perception training program.

Annex I

Photos of eye diseases

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CHAPTER 2:

Educational policy system implemented by the Partner countries

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Introduction

During Intellectual Output O1, all Partner countries undertook the implementation of a focus group and answered an exploratory questionnaire. Both those tasks, provided information about their educational policy system concerning inclusion, but most importantly useful conclusions were retrieved about the educational gaps and the struggles both Teachers and Visually Impaired students face every day during the educational process. Bearing in mind that all Teachers and VI students from all partner countries, expressed the same worries and needs about STEM based lessons, strengthens even more the necessity of this project and encourages all the partner countries to share all the knowledge and good practices they have in the best possible way. Additionally, reports from the European Commission platforms about National policies will be mentioned in this chapter.

Portugal

The focus group was conducted according to the pre-defined protocol. The participants were eight Teachers (one with low vision) experts in the fields of Informatics, Mathematics, Physics-Chemistry, Arts, Portuguese and Special Education, but also a visually impaired student, who is studying Computer Systems Programming and Management Technician. The points highlighted during the conversation of the Focus group were the difficulty to present reality as it is for the VI students, in a world made on visual reality. Teaching is based their educational on vision, writing on the board, power point, reading, rather than oral procedure. Communicating the content to this group of students is challenging and needs a very well planned adapted approach. Detailed explanation and special attention given depending on the needs and capabilities of the VI students is the most common way to intergrade them in the classroom.

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According to the testimonial of the VI student participating, what leaves the student most out of class are the subjects that depend on a lot of graphics and images. She felt a lot of difficulty in the subjects of Geography, Biology, History, 3D models in these subjects would have been important to help her understand the subject. In Mathematics, the use of the multiplane helped a lot. In the drawing discipline, she used an eraser that left relief when drawing. The color coding is very important. Finally, the familiarity with the supportive technology is weak and makes inclusion education for the VI students difficult to acquire the knowledge and the skills provided.

Definition of the target group(s)

The legal framework for inclusive education (Decree-Law no. 54/2018, 6th July) establishes the principles and regulations that ensure inclusion, as a process which responds to the diversity of needs and capabilities of each and every student, through increased participation in the learning processes and educational community.

The abovementioned decree-law:

• does not use student categorisation systems, including the “special educational needs" category;

• is not a model of special legislation for special students;

• establishes a continuum of provision for all students;

• focusses on educational responses rather than student categories;

• foresees resource mobilisation (as a complement, whenever necessary and appropriate) in the areas of health, employment, vocational training and social security.

Support for children up to the age of six years old is governed by Decree-Law no. 281/2009, 6th October, which creates the national system of early childhood intervention (*Sistema Nacional de Intervenção Precoce na Infância* - SNIPI).

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This system consists of a set of organised centre-based and home-based settings to ensure conditions for the development of children with physical or functional disabilities that limit their personal and social participation in typical activities for their age, as well as children with serious risk of stunted development.

The SNIPI involves coordinated action by the Ministries of Labour, Solidarity and Social Security, Health and Education.

Admission requirements and choice of school

Decree-Law no. 54/2018, 6th July establishes that the following students have priority in terms of enrolment or renewal:

• students who need the organisational resources that exist in the benchmarked school clusters for bilingual education or benchmarked school clusters for visual impairment.

• students with an individual educational programme.

Age levels and grouping of pupils

Decree-Law no. 54/2018 does not presuppose the creation of a group of students according to their characteristics, except for groups or classes of students in bilingual education (Portuguese sign language and Portuguese as a second language) who attend the benchmarked school clusters for bilingual education.

The classes are made up of 20 students, whenever the technical-pedagogical report indicates the need to include the student in a smaller class, as a specific learning and inclusion measure. Smaller classes cannot include more than two students under these conditions.

Curriculum, subjects

In order to ensure that all students acquire the knowledge and develop the abilities and attitudes to achieve the competences defined in the exit profile for students leaving compulsory schooling, the curricula for basic and upper secondary education, as well as

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the guiding principles for its design, operationalization and evaluation of learning, are established in Decree-Law no. 55/2018, 6th July.

The curricular guidelines for pre-school education (*Orientações Curriculares para a Educação Pré-Escolar*) are used as a reference for pre-school education curriculum development, which is the legal document supporting pre-school teachers when constructing and managing the curriculum.

Decree-Law no. 54/2018, 6th July is based on each school's need to recognise the value of its students' diversity, finding ways to deal with this difference, adapting teaching processes to the individual characteristics and means of each student, mobilising the necessary resources to guarantee access to the curriculum and learning.

As part of specialised educational provision, benchmark schools for bilingual education and visual impairment, the same Decree-Law establishes that specific subjects or curricular subject areas may be introduced, such as Portuguese sign language (*Língua Gestual Portiguesa* - LGP) as a first language (L1), and written Portuguese as a second language (L2), Braille literacy and application of all specific spelling, guidance and mobility, everyday activities and social skills.

Teaching methods and materials

The methodology underlying Decree-Law no. 54/2018, 6th July, with amendments introduced by Law no. 116/2019, 13th September, are based on the universal design for learning and the multilevel approach to accessing the curriculum.

The multilevel approach is based on flexible curricular models for systematic monitoring of the effectiveness of successive interventions for each student to acquire a common set of key competences, focussed on their abilities and interests.

The different measures supporting learning and inclusion are divided into three areas: universal, selective and additional:

- Universal measures are those the school uses to promote participation and improved learning for all students, such as (i) pedagogical differentiation; (ii)

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curricular adaptation; (iii) curricular enrichment; (iv) pro-social behaviour; (v) academic or behavioural intervention in small groups.

- Selective measures meet the learning support needs not achieved by the application of universal measures, such as, (i) differentiated curriculum pathways; (ii) non-significant curricular adaptations; (iii) psycho-pedagogical support; (iv) forecast and consolidation of learning; (v) tutorial support.
- Additional measures focus on significant and persistent difficulties in communication, interaction, cognition or learning and which require specialised resources, namely, (i) grade attendance per subject; (ii) significant curricular adaptations; (iii) individual transition plan; (iv) structured teaching methodologies and strategies; (v) development of personal and social autonomy competences.

The Ministry of Education places special education teachers and other professionals with specific training, such as teachers and interpreters to teach specific curriculum areas, such as Portuguese sign language, Braille or the use of assistive technology.

The Ministry of Education's resource centre for the support of inclusive education adapts and produces school manuals in braille, large print and in Daisy format to all SEN pupils. It provides students with textbooks in PDF or E-book format in conjunction with textbook publishers.

For students who attend benchmark schools for the bilingual education, the Ministry of Education has drawn up Portuguese sign language and Portuguese as a foreign language programmes.

The National network of ICT Resource Centres includes 25 centres covering the national territory and based on school clusters. These resource centres are designed to assess students to identify and prescribe the support that meets their specific needs through the Support Products Allocation System (*Sistema de Atribuição de Produtos de Apoio* - SAPA), as well as provide information/training for teachers and other professionals, as well as families.

With SAPA, the aim is to implement a global, integrated and wide-ranging policy for people with disabilities to compensate and mitigate the limitations resulting from

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impairment or disability, via free and universal support (Decree no. 93/2009, 16th April; Ordinance no. 192/2014, 26th September; Dispatch no. 14278/2014, 26th November; Ordinance no. 78/2015, 17th March, Dispatch no. 5291/2015, 21st May; Dispatch no. 6478/2015, 11th June; Dispatch no. 7225/2015, 1st July).

Progression of pupils

According to Decree-Law no. 54/2018, 6th July, the progress of students covered by universal and selective learning and inclusion support measures occurs in accordance with the rules and procedures defined in the regulations. The progress of pupils covered by additional measures occurs under the terms defined in the technical-pedagogical report and individual educational programme.

Decree-Law no. 54/2018 establishes that schools must guarantee all students the right to participate in the evaluation process.

Adaptations to the assessment process include a variety of information collection tools, the use of examination questions in accessible formats and support material, as well as the assessment criteria in terms of types and means of communication, timing, duration and location.

The rules and procedures regarding assessment in the different education and training provision are regulated by an Order of the Government authority responsible for education.

Certification

When students finish compulsory schooling, they are entitled to a school-leaving certificate and diploma, and, where applicable, identification of the qualification level in accordance with the National Qualifications Framework and the corresponding level in the European Qualifications Framework.

For students whose school study has involved significant curricular adaptations, the certificate must include the cycle or level of education completed and relevant curricular information, as well as the areas and experiences throughout the implementation of the individual transition plan (*Plano Individual de Transição* - PIT).

The certificate model is regulated by ordinance of the government's authority responsible for the area of education and, whenever applicable, the area of vocational training.

Greece

Definition of the target group(s)

Special education constitutes a number of educational services for students with disabilities and special educational needs followed by a medical diagnosis and students with special educational needs.

The state ensures and continually improves the compulsory nature of special education emphasizing on the fact that it constitutes an integral part of compulsory and free of charge public education, provided to disabled individuals of all ages and of all grades and levels of education.

Pursuant to law 3699/2008, students with disabilities and special educational needs include those manifesting significant learning difficulties during an entire or limited period of their school life due to sensory, mental, cognitive, developmental, psychological and neuropsychological disorders, affecting school adaptation and school learning process, based on and interdisciplinary evaluation.

This category of students includes individuals presenting mental disabilities, sensory impairments in vision and hearing, mobility disabilities, chronic incurable diseases, speech disorders, special learning difficulties (e.g. dyslexia, dyscalculia), attention deficit disorder with or without hyperactivity, diffuse developmental disorders (autism spectrum) and multiple disabilities.

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Students with special educational needs also include students with complex cognitive, emotional and social difficulties, delinquent behavior due to abuse, parental neglect and abandonment or due to domestic violence. The category of students with special educational needs may also include students with one or more special mental skills and talents.
Students with low school performance associated with external factors, such as linguistic or cultural particularities do not fall under the category of students with special educational needs.

Specific support measures

The educational policy on special education supports the inclusion of students with disabilities and special educational needs within mainstream schools by providing suitable supporting structures and services.

The special educational needs of students with disabilities and special needs are ascertained and diagnosed by the Educational and Counselling Centres (KESYs), the Interdisciplinary Educational, Evaluation and Support Committees (EDEAYs) and the validated by the Ministry of Education, Community Centers for the Mental Health of Children and Adolescents of other Ministries.

KESYs recommend students' registration, placement and attendance in the appropriate learning environment, or whenever judged necessary the changing of learning environments and the proper psycho-pedagogical and educational support, as well as the appropriate equipment and educational material which will facilitate the process of teaching and communication with the student. The evaluation report is foreseen to be accompanied by a Personalized Education Programme, which includes key axes and general guidelines. The formation of the basic axes of the personalized education programme is completed in collaboration with the parent or guardian of the student with disabilities or special educational needs or the students themselves, where this becomes possible. The final evaluation report and the main points of the personalized education programme are communicated to the parents or guardians. As regards the time of re-evaluation, this is determined by KESYs according to the type and degree of the student's identified educational needs and learning difficulties. If the re-evaluation time is not specified, the reports of the committee are permanently valid.

Based on the individual evaluation and the recommendation of KESYs, the education of individuals with disabilities and special educational needs may take place in a mainstream school, where the following schooling options are available.

Specifically, students may attend:

- An **ordinary mainstream school classroom**, in case of students with mild learning difficulties, supported by the classroom teacher, who cooperates on a case by case basis with the KESYs and with the Coordinators of the Educational Work of general and special / inclusive education
- A **mainstream school classroom**, with concurrent support-inclusive education by special education teachers, when this is imperative by the type and degree of the special educational needs
- Specially organised and suitably staffed **integration classes**, operating in the general and vocational education schools, offering two types of programmes:

1. Combined mainstream and specialised programme (up to 15 teaching hours weekly), as determined by the competent KESY for students with milder special educational needs.
2. Specialised group or individualised programme of extended hours, as determined by the competent KESY for students with more severe special educational needs, not accounted for by separate special education schools corresponding to the kind and degree of needs. The specialised programme may be independent from the common one, in accordance with students' needs.

Integration classes aim at creating a fully inclusive school environment for students with special educational needs. Teachers of integration classes shall support students inside their school environment whilst working closely with classroom teachers to differentiate activities and teaching practices and introduce adjustments into the learning content and teaching environment (law 4368/2016). This is achieved through the implementation of

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special education programmes, teaching and learning content adjustments and the use of special equipment, including e-equipment, software, logistics and other solutions provided for by the Educational and Counselling Centres (KESYs).

For students attending primary and secondary schools of general and vocational education, with a disability and/ or special educational needs diagnosed by a competent public body (KESYs, Medical Education Centers), second foreign language progress is not assessed in the general mark of school grade promotion or school exit, upon the relevant request of those exercising parental care and guidance.

In primary education integration classes, students are supported by teachers with the specialisation PE61 or PE60 trained in special education for nipiagogeia (pre-primary schools) and by teachers with the specialisation PE71 or PE70 trained in special education for dimotika scholeia (primary schools). In secondary education integration classes, students are supported by teachers with the specialisations PE02, PE03 and PE04 trained in special education. Teachers of other specialisations may also be placed in integration classes for students with visual or hearing impairments.

Parallel support is provided to primary education by teachers with the specialisation PE60 and PE70 trained in special education, PE61 and PE71. In secondary education, parallel support is provided by teachers with the specialisation PE02, PE03 and PE04 trained in special education. If these teachers are not sufficient, other teachers with the specialisation PE60, PE70, PE02, PE03 and PE04 may also take part in these programmes. These teachers are obliged as a priority to participate in training and specialisation programmes implemented by the competent authorities for teacher training.

Not self-served students attending general education schools or integration classes are supported by specialised auxiliary personnel depending on their disability and their special educational needs or by a school nurse following a medical diagnosis by a state hospital.

In cases of co-housed or neighboring schools, integration classes are conjoined with a maximum of twelve pupils per integration class.

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Blind students and students with impaired vision without mental retardation or other special educational needs can attend, based on the expert opinion of the competent KESY, the classes of general education schools supported by the class teacher and in each single case with the support of members of the special educational staff (EEP) with the specialisation PE31 or members of the special assistance staff (EBP). By virtue of law 4547/2018, the primary aim of the Educational and Counselling Centres is to support school units and the Special Vocational Education and Training Workshops of the areas falling under their competency in order to ensure equal access to education to all students independently and to defend their psychosocial development and progress (Institute of educational policies)

KESYs, as bodies with an educational direction are competent on the following levels:

- The level of exploring and evaluating educational and psychosocial needs
- That of focused educational and psychosocial interventions and actions of vocational guidance
- That of supporting school work in total
- Of informing and training
- Raising the level of social awareness.

KESYs conduct individual evaluations and issue assessment reports – diagnoses on the following situations:

1. When relevant needs are made obvious after actions undertaken to explore educational and psychosocial needs. In these cases, students for whom there is evidence for special educational needs or students facing other kinds of psychosocial difficulties undergo further evaluation from KESYs. Especially if it is found necessary after the completion of a short supporting programme.
2. After a recommendation of Interdisciplinary Educational, Evaluation and Support Committees, when it is found that students need further evaluating and diagnosing, despite the short supporting programme they had at school.

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3. At the recommendation of the students' educational support team, in school units where there are no Interdisciplinary Educational, Evaluation and Support Committees (EDEAYs), proposed after an applied short support programme.
4. At the request of a parent to the competent KESY.

KESYs, besides individual evaluation and support, also examine requests made by school Teachers' boards, when it is part of their duty.

KESYs support school units for the preparation and implementation of short-term intervention programs, the specialization of the main axes of students' Personalized Educational Programmes as well as the support and monitoring of the educational and psychosocial progress of students.

Operation of the Interdisciplinary Educational, Evaluation and Support Committee (EDEAY):

Educational evaluation and support of students and the school community, within the school's premises is undertaken by the Interdisciplinary Educational, Evaluation and Support Committee which operates in every school unit belonging to the School Network of Educational Support (SDEYs).

SDEYs are founded upon decision of the Regional Educational Director and they are constituted by school units and training workshops of primary and secondary general, special and vocational education with the purpose to promote co-operation, as well as to coordinate the work of school units, so as to ensure equal access to education of all students and to promote their psychosocial health in total.

A Special Education School Unit (SMEAE) is the support centre of every School Network of Educational Support (SDEY).

The Interdisciplinary Educational, Evaluation and Support Committee consists of the following members:

1. A school head acting as coordinator

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2. A primary or secondary education teacher, specialized in special education and placed in the school unit or the Support Centre of the Network (SDEY)
3. A psychologist placed in the Support Centre of the Network (SDEY)
4. A social worker placed in the Support Centre of the School Network
5. The teachers responsible for the students in need of support.

The Interdisciplinary Educational, Evaluation and Support Committees also:

- Conduct evaluations of the difficulties and possible educational and psycho-social or other relevant impediments in student learning.
- Support the teachers in issues like pedagogical response to the diversity of the student population.
- Support the school community in issues of equal access to education and in tackling phenomena like early school leaving and school violence.

In school units where there are no Interdisciplinary Educational, Evaluation and Support Committees (EDEAYs), a student educational support group, which is assisted by Educational and Counselling Centres (KESYs), is set up to carry out the committee's task. It consists of the school head or deputy school head, the teacher in charge of communicating with the competent KESY and the teacher in charge of the respective class. During the meetings of the educational support groups both the students' parents as well as the students themselves, if possible, are invited to express their views on the design of the individualised education programmes. They are also invited in any other case that is deemed appropriate.

Supportive measures are also the following regulations:

- Braille is officially recognized as the writing method for blind students.
- The Greek Sign Language is recognized as the first language of the deaf and hard of hearing students and Modern Greek is recognized as their second language, which is received and pronounced in written form, while its oral perception and expression constitutes an additional social choice of deaf students. Greek Sign

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Language and Modern Greek are recognized as equal to each other, and therefore the appropriate language pedagogical approach is bilingual education.

- For autistic students with or without reason, Modern Greek is recognized as the official language, which is received and pronounced in its oral form, in its written form and/or in the form of symbols-images. A desirable condition for the placement of teachers and special educational staff (EEP) in the special school units for autism, in addition to the other qualifications, is the specialization and training of teachers in modified-assisted forms of communication.

Pursuant to law 3699/2008, the Ministry of Education establishes an advisory committee

- to monitor the physical accessibility of people with disabilities to the educational and administrative structures of the Ministry of Education and Religious Affairs
- and to monitor the digital accessibility of educational materials and websites (Ministry of Education & Religious Affairs, n.d.).

Cyprus

Definition of the target group(s)

Laws 113(I)/1999 - 69(I)/2001 specify that the following categories are recognized as pupils or students in need of special support:

● Any child who has serious learning or special learning difficulties, or who has difficulty in adapting or functioning, due to his/her physical or mental condition;

● Any child whose learning, adaptation or functioning skills are impaired compared to other children of his/her age;

● Any child who suffers from an incapacity which prevents him/her from using educational facilities of the kind that are generally available at school for pupils of his/her age.

Specific support measures

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Special educational support within mainstream education can be provided at any public school, pre-primary, primary or secondary. Public schools are obligated to adapt their facilities to suit children with special educational needs. For the vast majority of pupils with special needs support is provided within a class at the child's local school, which receives all of the necessary modifications and resources.

In cases where full-time attendance in a mainstream class is not appropriate for the child's needs, special tuition in a resource room for specified periods per week may be recommended, or alternatively, attendance at a special unit within a mainstream school. Such special units offer the opportunity to provide more intensive special educational support to a small number of pupils (usually a maximum of six), whilst maintaining contact and a certain level of integration with a mainstream class.

Staff members in the special units include the special unit teacher and pupil assistants who work in close cooperation with the teacher. Speech therapists are often placed in schools offering support to special unit pupils as well as mainstream pupils with language problems. Special educational support staff who are either fully assigned to mainstream schools, run special units or are peripatetic, are considered to belong to the teaching staff of the school. When a member of the special education support staff is in class with a pupil, he/she must cooperate and interact with the child's classroom teacher in the development and delivery of the Individual Educational Programme (IEP) of the child.

In addition to the special education support staff, there are coordinators of special education, whose role is to offer guidance in mainstream schools, special units and separate schools of special education. They offer advice and support to special education teachers, mainstream teachers, and administrators and they report to the Inspector for Special Education (Inspectorate of Primary Education). One of their main responsibilities is the development of the child's IEP in cooperation with a multi-disciplinary group and the parents of the child.

Children with special educational needs attending mainstream schools follow the normal curriculum, which may be adjusted to suit their particular needs. During the development of the child's IEP, the staff will make every effort to ensure that the child is fully involved in all class and school activities. If a child requires individual assistance outside the

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classroom, this is provided so as not to restrict access to any subject of the curriculum. However, it is possible to remove some subjects from the curriculum, which may be deemed as unsuitable for the child.

In the secondary school special support setting, children are graded in the same way as their peers, unless they have special permission from the District Committee for Special Education and Training for their evaluation to be carried out in a different way. The Committee can also give instructions for evaluation material and procedures to be modified in order to facilitate the specific needs of the child, according to the philosophy that special educational needs should not impede the expression of individual abilities.

At the gymnasium level, the progression from one grade to the next depends on the results of examinations. Children graduating at the gymnasium level sit examinations with provisions designed to accommodate their disability without altering the validity of the examination. They graduate with the same school leaving certificate (apolytirio) as their peers. Students with special educational needs who are not able to sit the examinations can be classed as 'attendees' and be promoted without examinations, issued with an informal leaving certificate.

Children who attend special units within schools follow the same timetable as the mainstream school and, depending on their individual needs, may join their designated class for as many subjects as possible (depending on their IEP). The amount of time spent in the special unit depends on the severity of the learning difficulty which the child presents. This will also determine the amount of differentiation that the child's IEP will have from the curriculum followed by his/her peer group. (Education, European Agency Statistics on Inclusive, 2021)

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Estonia

Definition of the Target Groups

Where it becomes evident that a student needs support, a parent is notified thereof and the school arranges a pedagogical-psychological evaluation of the student. Where necessary, cooperation with the specialists of other fields is pursued and additional surveys are recommended. The school provides a student who has difficulties in performing the duty to attend school or lags behind in achieving the study outcomes with general support, which involves individual additional instruction by a teacher, the availability of the services of the support specialists and, where necessary, the organisation of study assistance lessons individually or in a group.

Where it becomes evident that a student is **gifted**, an individual curriculum is drawn up for the student at school and, where necessary, additional instruction and learning opportunities in education programmes or other educational institutions are provided by subject teachers or other specialists.

Where the general support provided by the school does not produce the desired results for the development of the student, enhanced support or special support may be applied upon recommendation of an external advisory team. In such an event the student is considered a student with special educational needs.

Specific Support Measures

A regular school organises study of students with special educational needs, like that of all other students, according to the Basic Schools and Upper Secondary Schools Act and the Education Act. Every child has the right to study at a school of residence and according to a suitable curriculum and receive support arising from the special educational need. In general, children with special educational needs study in ordinary classes of ordinary schools. In case teaching of students with special needs requires, due to their disability or disorder, a very specific organisation of studies and implementation

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of resource intensive support measures, an ordinary school may open a class for students with special needs.

A need for enhanced support and special support is assessed by an **external advisory team**. As a result of the assessment, the advisory team provides recommendations for the support of the development of the child and organisation of studies and education.

According to the recommendation of the external advisory team and with the written parental consent, the school provides the student with enhanced support or special support, studies at home for health reasons, non-stationary studies with regard to the student who is under the obligation to attend school, reduces and replaces the learning outcomes provided for in the national curriculum in one or more subjects, recommends the application of studies for students with mild learning difficulties, students with moderate learning difficulties and students with severe and profound learning difficulties, or releases the student from having to study a mandatory subject.

Enhanced support is applied to a student who, due to their permanent learning difficulty or psychical or behavioural disorder or another health condition or disability, needs a constant support specialist service and an individual curriculum in one, more or all subjects, or part-time studies individually or in a group, or individual support during studies in the class, or studies in a special class.

Special support is applied to a student who, due to their severe and permanent mental disorder, intellectual or mental disability or multiple disabilities needs disability-specific organisation of studies, study environment, study methodology, study aids and a constant support specialist service combined with social or health services or both in order to be able to participate in studies; part-time studies individually or in a group or constant individual support in a class or studies in a special class.

In vocational educational institutions the school, along with the manager of the school, ensures a student with special needs with an access to support services, remedial instruction, special education teacher, social educator and psychologist services; and the school can apply the following support measures in support of the student:

- drawing up and implementing an individual curriculum;

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- studies in small groups;
- a moderate or deep pedagogical intervention;
- use of a sign-language interpreter.

A school appoints an employee or a support group that is responsible for the identification of the special needs of the student, assessment of the competencies and needs of the student, specifying and application of the required support measures, monitoring the effectiveness of such measures, and coordination of these activities.

Support specialists, incl. Speech specialists, special education teachers, psychologists or social educators, support the development of a student and the pursuit of studies that correspond to the student's abilities and social skills.

A support specialist:

- cooperates with other support specialists for identifying the student's needs for aid and support, and assesses, based on the competencies of the specialty, the student's development and coping in study environment;
- advises and supports the teacher in planning and conducting the student's study and development activities, finding a study methodology and study form suitable for the student, selecting and adjusting suitable learning materials and aids, and drawing up an individual plan for organization of studies or curriculum;
- supports and guides a student in solving problems that have emerged, plans and conducts interventions arising from the special educational needs of the student and activities supporting the student's development, coping and social capability individually or in a group, and assesses the effectiveness of the applied measures;
- in cooperation with other support specialists, advises school management, teachers and staff in organising the study of students with special educational needs, designing a development and study environment based on the needs of the student, and selecting the measures suitable for supporting the student;

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- advises, within his or her professional competencies, the parents and family in issues related to supporting a child's development and coping;
- Cooperates, where required, with medical, rehabilitation, social care, etc. specialists for providing the child with the required support. (Eurydice, 2021)

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CHAPTER 3: Pedagogical inclusive strategies for the VI students

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According to the European Agency for Special Needs and Inclusive Education, the operational definition of an inclusive setting refers to education where the child/learner with SEN follows education in mainstream classes alongside their mainstream peers for the largest part – 80% or more – of the school week (European Agency Statistics on Inclusive Education, 2018). Taking this fact into consideration, this chapter is going to explore the pedagogic and didactic design, as well as the study of the educational standards for inclusion, support and progress of students with special educational needs or/and disability, especially for those students facing visual impairment.

- **Educational Considerations**

Children with visual impairments need to learn the same subjects and academic skills as their sighted peers, although they will probably do so in adapted ways. They must also learn an expanded set of skills that are distinctly vision-related, including learning how to:

- Move about safely and independently, which is known as orientation and mobility;
- Use assistive technologies designed for children with visual impairments;
- Use what residual vision they have effectively and efficiently; and
- Read and write in Braille, if determined appropriate by the IEP team of the child after a thorough evaluation.

These are just some of the skills that need to be discussed by the student's IEP team and included in the IEP, if the team decides that's appropriate. Each of the above skill areas—and more—can be addressed under the umbrella of special education and related services for a child with a visual impairment. (Parent Information & Resources, 2017)

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- **Impact on Learning**

One characteristic that is shared by all students with visual impairment is that these students have a limited ability to learn incidentally from their environment. It is through sight that much of what we learn is received and processed. It is believed that up to 80% of what children without visual impairments learn is through visual cues. The other senses do not fully compensate for the loss of sight. Touch and hearing can be ineffective substitutes for many individuals.

Children with visual impairments must be taught compensatory skills and adaptive techniques in order to be able to acquire knowledge from methods other than sight. The presence of a visual impairment can potentially impact the normal sequence of learning in social, motor, language and cognitive developmental areas.

Reduced vision often results in a low motivation to explore the environment, initiate social interaction, and manipulate objects. The limited ability to explore the environment may affect early motor development. These students cannot share common visual experiences with their sighted peers, and therefore vision loss may negatively impact the development of appropriate social skills. As a result, these students may experience low self-esteem that limits their sense of mastery over their own lives.

It is not enough to just provide instruction in the general core curriculum. Students with visual impairments also need specialized instruction in a number of other essential skill areas. These areas, called the expanded core curriculum, include communication skills, social interaction skills, orientation and mobility, independent living skills, recreation and leisure skills, use of assistive technology, visual efficiency, and career education skills, and self-determination. Mastery of these skills is essential for students' long-range educational and life outcomes.

Students with visual impairments can learn at roughly the same rate as other children but require direct interventions to develop understanding of the relationships between people and objects in their environment.

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- **Understanding How Children with Visual Impairments Learn**

Each student is a person with special needs. However, in visually impaired students, this principle is particularly important, as only the visually impaired person is able to say what the student can or cannot see. As a result, good practices for one student may not be effective or even harmful for another.

Usually children with visual impairments develop their own strategies and techniques to deal with the conditions of their daily lives. It is therefore important that each student actively participates in the selection of teaching strategies that suit his / her case.

Visually impaired children can certainly learn. And in fact they can learn well. However, they do not have easy access to the visual learning that sighted children have. The volume of learning that takes place through vision in such cases must be achieved using other senses or methods.

Hands and the sense of touch is a key information gathering tool for visually impaired children. The same goes for the senses of smell, taste and hearing. Until the child holds an object in his/her hands, he/she must learn and explore its dimensions - say, a stuffed animal, one cannot understand its details. This is why sensory learning is so powerful for visually impaired children and why they need to have as many opportunities as possible to experience objects directly and sensorially.

Seeing allows us to record the "whole" of an object immediately. This does not apply to visually impaired children. They cannot see the "whole", they have to work from the details until they build an understanding of the whole.

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- **Inclusive strategies for the VI students**

Inclusive education has been internationally recognized as a philosophy for attaining equality, justice and quality education for all children, especially those who have been traditionally excluded from mainstream education for reasons of disability and other characteristics. Inclusion education came as a rescue mission in the actualization of educational and psycho-social services for person with visual impairment.

Most children and young people with visual impairment (VI) attend inclusive schools and receive numerous adjustments to facilitate the educational procedure.

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One very important fact that needs our attention, according to the study of Ben Whitburn is that students considered class teachers' practices indispensable to their inclusion. However, there appeared to be a fine line between pedagogical practices that effectively included the students with VI and those that excluded them. Moreover, this line could be easily crossed in two distinct directions, which led to social marginalization. Many teachers failed to provide instructions in classes in a way that included students with VI (Higgins & Ballard, 2000). Often this is the case because teachers do not adapt classroom instructions, or neglect to provide them with accessible resources. In contrast, students with VI reported that they received too much support from teachers at times, which made them feel disempowered and contributed to their being socially outcast.One of the most effective techniques to facilitate the inclusion procedure is Teachers' impact on students' access and autonomy. Being able to function autonomously and having seamless access to the academic and social dimensions of the school comprised the two elements fundamental to the participants' inclusion. These two categories are set at the center of the emergent theory because the students usually refer to matters of access and autonomy. They also refer repeatedly to having autonomy – accessing these elements of their schooling without overwhelming paraprofessional support, which often arose when class teachers neglected to provide appropriate access. Therefore, when class teachers appropriately adapted pedagogy to the students' needs, they were able to study autonomously, with seamless access to learning material, to lesson instructions, and subsequently to parity with classmates (Whitburn, 2014).

- **Inclusive Education in STEM**

In a special education setting there is typically one special education teacher and several paraprofessionals. Within the classroom there are, and again this varies by state and school district, between one and three grade levels.

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Typically the students with special needs in the classroom require specific lesson plans either by grade level or by individual. Usually, the special education teachers are so overwhelmed just trying to keep up with accommodations and grade level standards, that they have little time to incorporate anything else.

These teachers do a remarkable job with their strenuous jobs and limited resources, but could their students benefit from hand-on activities that are engaging, on grade level, involve problem solving skills, social interaction, and technology?

- **How does this relate to STEM?**

STEM education takes place in any classroom, but generally in a general education classroom. For STEM the students are placed into groups, this allows the students with special needs to work on social skills with their peers (most of the time, their peers unaware that they are an "inclusive" student). Then while in groups, each student is assigned a job; likewise, this enables the inclusion student to learn responsibility and collaboration. In some cases the inclusion student is a low level learner, by those students in groups, teachers greatly reduce stress and anxiety for two reasons: 1) the student is not always responsible for the answer, the group is; and 2) if unsure of an answer a higher level learner can peer mentor the inclusion student. In addition, the student is receiving content related material that is on grade level, as well as, problem solving skills.

Once the design and construction of the lesson objective start, learning levels no longer matter. The only thing that matters is your ability to problem solve!

In the special education setting, there is too much emphasis on the individualization of the subject matter to be able to complete a STEM lesson. Do not get me wrong, the special education teachers are phenomenal at their jobs, but there are just too many differences to be able to plan one lesson to fit all of the students at once.

Inclusive settings, where students with special needs are able to participate to the best of their abilities in the STEM activities, where the work is on grade level, there is problem solving, and social development is in the best interest of the inclusion student.

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- **Collaborative Teaching Method**

Collaborative teaching refers to the restructuring of teaching in a way that two or more teachers with different knowledge and skills collaborate and coordinate their work so that they are able to teach heterogeneous groups of students in the general classroom. In some cases collaborative teaching is a form of educational approach, while in other cases it is an alternative form of support services and is often identified with school integration. Although collaborative teaching directly contributes to the promotion of school integration practices, it should not be considered synonymous with school integration. School integration according to the needs of students can be implemented in a variety of different ways just as collaborative teaching can be used to achieve a variety of different purposes. Collaborative teaching is commonly used to broaden teaching choices for all students, increase the intensity and coherence of the program, reduce the status of students with disabilities, and improve the provision of immediate support to teachers.

According to research, three main ways of practice have been recorded: a) teachers, one of whom is a special education teacher, are in the same class b) The two teachers are co-responsible for the design and teaching of heterogeneous classes involving students with and without special needs and c) both teachers teach a significant part of the curriculum at the same time.

In this dynamic relationship the general education teacher knows the goals of the operation, the coherence and the content of the curriculum, knows specific cognitive objects and has significant knowledge and experience in organizing and managing large groups of students. On the other hand, the special education teacher can, when necessary, individualize the learning, possess skills of assessment of individual needs and the increase of possibilities, has specialized knowledge for specific disabilities, possess specific practical modifications of the curriculum as well as applied behavioral analysis practices. The combination of these skills and knowledge is a dynamic framework that provides opportunities for immediate improvement of the learning process and teaching methodology (Βλάχου & Σιδέρη, 2009).

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Universal Design for Learning (UDL) is often associated with students with disabilities, because of accessibility considerations. Although, it is worth noticing that universal design is not a synonym or a euphemism for accessibility standards. Universal design can be distinguished from meeting accessibility standards in the way that the accessible features have been integrated into the overall design. This integration is important because it results in better design and avoids the stigmatizing quality of accessible features that have been added on late in the design process or after it is complete, as a modification.

Universal design also differs from accessibility requirements in that accessibility requirements are usually prescriptive whereas universal design is performance based. Universal design does not have standards or requirements but addresses usability issues. The Principles of Universal Design, published in 1997 by the Center for Excellence in Universal Design, articulate the breadth of the concept and provide guidelines for designers. (CAST)

- Principle 1: Equitable Use: The design is useful and marketable to people with diverse abilities.
- Principle 2: Flexibility in Use: The design accommodates a wide range of individual preferences and abilities.
- Principle 3: Simple and Intuitive Use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- Principle 4: Perceptible Information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- Principle 5: Tolerance for Error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.

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- Principle 6: Low Physical Effort: The design can be used efficiently and comfortably and with a minimum of fatigue.

- **Differentiated learning**

Inclusive teaching strategies have a didactic dimension including the teachers' knowledge about the subject, teaching competencies and knowledge about the students' different learning capabilities. Here, the teachers' ability, time and willingness to adjust and differentiate the instructions, together with clear learning objectives, and both continuing and systematic assessment are crucial to ensuring all students participate. When focusing on the differentiated learning the teachers must work with core categories such as learning objectives, feedback and continuously develop their teaching practice through critical reflection and the construction of didactical theory in order to ensure all students receive the opportunity to learn. In this context, teaching is to be seen as a content-based intentional, interventional, interactional and institutional activity that is framed by planning, evaluation and development on different levels, which stresses the many didactical elements the Teachers must take into account. (Molbaek, 2017)

Adjustments concerning the teaching procedure

- The use of the Braille code
- The use of a recorded book or e-book
- Give simple descriptive instructions
- Encourage the use of supporting materials/aids
- Create the best environmental circumstances in the classroom, depending on the student case
- Try to be close to the VI student offering your support
- Use the supportive technology
- Tactile material

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- Sound signs
- Use large print
- Color contrast
- Prepare as much information as possible in electronic format - this makes it much easier to provide materials in accessible formats and allows users with disabilities to adapt the information to a format which is suitable for them.
- Make required book lists and course materials available early so there is sufficient time for them to be reproduced in audio or Braille, if required.
- Indicate compulsory texts in your reading list, noting important chapters if possible. Specifying the order of reading within a text is helpful, as it can take many weeks to have a book reproduced into audio or Braille.
- For students with vision impairment your teaching style will need to be 'verbal'. Think about how to communicate information to students who cannot see what you are doing.
- Verbalize what is written on the blackboard and on PowerPoints. Talk through any calculations as they are made or procedures as they are carried out. Read any printed information and describe any charts or graphs being used.
- Academic activities which take place off-campus (such as industry visits, interviews or field work) may pose problems and on-campus alternatives may need to be considered.
- Provide an individual orientation to laboratory equipment or computers in order to minimize the anxiety likely in an unfamiliar environment.
- Consider supplementing laboratory practical, experiments or field trips, for example by audio taping commentaries.

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- Inform the student if you plan to use videos, slides or PowerPoints, and discuss alternative ways of presenting the necessary information.

- Because students with vision impairment are generally slower than other students in completing reading tasks (reading is slower; considerable time is involved in getting material taped or Brailled), provide reading lists well before the start of a course so that reading can begin early. Consider tailoring reading lists and provide guidance to key texts.

- Providing the student with a vision impairment with prior notice that you plan to use a film or video in class allows him/her the option to request to see it beforehand. This will enable him/her to sit very close to the screen or have someone explain the film or video. It would be helpful to 'pause' on important points when the student is viewing the resource in class with others.

- A student may have difficulty finding his/her essay or assignment in a pigeonhole or amongst a pile of other students' work.

- Students may not be able to read your hand-written comments. It would be helpful if you could negotiate alternative feedback mechanisms with the student.

- Students are usually able to access online learning materials with the use of assistive technologies if websites follow accessible web design guidelines.

- The vision of some students may be affected by the glare from fluorescent lights or sunlight so you may need to attend to some aspects of your teaching environment. This should be done unobtrusively.

- Use tactile graphics where necessary (Australian Disability Clearinghouse on Education and Training, 2021)

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CHAPTER 4:

ICT (Information and Communication Technologies) Accessibility as a driving tool for inclusion

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In the following paragraphs we will try to lead some light on three aspects of the new technology in education such as the participation of blind students in regular computer education, the new technology as a personal aid for the blind in education and new technology as an aid to support the teaching of visually impaired students. Nonetheless there is so much more into the use of ICT into education. As Lidstrom and Hemmingsson indicate, *the rationale for the use of information and communication technology (ICT), technologies for the manipulation and communication of information through voice and sound or images, such as computers, computer-based assistive technology, special software, and communication aids, in schools by students with physical disabilities is to prepare all students for participation in the information society*. But apart from being part of the information society, ICT has to play an important role in education as well, into teaching and learning and into education in general. Education is a right to every child and that is made clear through legislation such as the United Nation (Salamanca), Unicef and the European Union. According to the Universal Declaration of Human Rights , "education is a right like the right to have proper food or a roof over your head". It can be said therefore that the right to education is necessary and obligatory for everyone regardless of religion, ethnicity, gender or economic status (UNICEF, 2014). The United Nations expands this idea and declares that education is not only a right but also a passport to human development, as it opens doors and expands opportunities and freedoms (United Nations, 2014). It continues that there should be a continuum of support and services to match the needs of every student and asserts that human differences are normal and that learning must be adapted to the needs of the child, rather than the child fitted to the process (Centre for Studies on Inclusive Education, 2014, United Nations Educational, Scientific and Cultural Organization, Salamanca Statement and Framework for Action). And The Charter of Fundamental Rights of the European Union [2000] states that: "Any discrimination based on any ground such as sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexualorientation shall be prohibited" (Bocconi et al, p.491). Concluding from all the above that it is important that all students should have equal opportunity and appropriate support to acquire

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competence with the technology, irrespective of whether or not they have a physical disability. However, for students with disabilities, the literature appears to support the use of ICT as an assistive technology device (ATD), specifically designed to assist and enable an individual's participation in education and other areas (Lidstrom and Hemmingsson, 2014).

In order to improve the functional abilities of persons with disabilities, assistive devices are used. To improve the quality of life of people with visual impairment, technology can provide a big support and to improve education of people with visual impairment assistive devices can be used. Assistive devices can be little things of everyday life, such as rubber bands or little things that can be accommodated with an easy way, such as tactile rulers, or pictures that their surface is tactile. The teaching and learning can have a big support with the use of technology or assistive devices in general. And all this can lead to much better results, to so many better outcomes. Assistive devices can be of many kinds. These include telescopes, magnifiers, and talking book readers. Assistive devices are useful for the inclusion of people with disabilities within the education system and society in general (Raskind, 2013).

For those with acquired vision loss, such devices facilitate the ability to resume daily activities such as reading, cooking, and traveling. As a consequence, they can enhance a users' subjective quality of life and self-esteem (Scherer & Glueckauf, 2005).

From traditional assistive devices to ICT

To develop inclusive teaching environments a number of things should take place. The most important is the conversion to tactile forms of textbooks, drawings, graphs, diagrams and the use of other pedagogical tools. Adaptive material in any form: simulations, enlargements, hands-on models and activities can attract the attention of sighted students

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as well and simultaneously contribute to a better understanding of the cognitive content on their part, thus increasing effectiveness of curricular delivery (Pedagogical Institute, 2003). Gobert, O'Dwyer, Horwitz, Buckley, Tal Levy, and Wilensky claim that model-based pedagogical approaches have the potential to impact scientific literacy more than traditional curricula do (Gobert *et al.,* 2011). In order for all students to have equitable opportunities to engage in science there is a need for classroom practices which remedy injustices or provide access to material resources and instructional support (Villanueva, Taylor, Therrien and Hand, 2012).

However, nowadays, the percentage of abandonment of traditional assistive devices is quite high (Furer, 2001). The main reasons for that is the social stigma attached to their use (Sugawara, Ramos, Alfieri, & Battistella, 2018). For instance, the abandonment of the white cane by blind and partially sighted people's can be summarised in five reasons: (i) stigma, psychological and other barriers to cane use; (ii) safety concerns; (iii) acceptance and adaptation to cane use (iv) cane use as a symbol of blindness; and (v) formal and informal training (Hersh, 2015). The decline of the Braille is also a fact with the spread of audio books and voice technology being one of the factors that affect it. All these assistive devices were used for many years for teaching and learning, they have helped many students around the world. As argued before, nowadays, visually impaired students can take advantage of a large number of effective assistive technologies.

However, the use of mainstream devices, such as smartphones and tablets, among persons with visual impairments seems to replace traditional visual aids for certain tasks of daily life, including learning and education in general. And this is something that happens mainly in countries that are already developed, where technology and its benefits are easy to get. Specifically, Lidlstrom and Henningsson say that conditions in the environment were crucial in terms of whether or not the outcome of ICT use was successful. Examples of beneficial conditions were access to computers and software (portable computers were preferable) and teachers' knowledge of the use of word-prediction programs. Other benefits reported, based on teacher and therapists'

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observation, were children's increased motivation for writing and the fact that writing became less tiring when a computer was used (Lidlstrom and Henningsson, 2014).

Adaptive Math Tools for the Blind and Visually Impaired

Printed materials and visuals need to be provided in alternative formats. These alternative formats could include conversion to audio-books, probably enlargement through projection, books written in Braille and tactile materials (Sahin & Yorek, 2009, as cited in Rule et al., 2011). One of the most economical ways to produce tactile drawings in a timely manner is to use a tracing wheel and a sheet of Braille paper (which is heavier and stiffer than typical note or photocopy paper). The image is intentionally drawn in an inverted manner so that when the tracing wheel step is applied, the image will be raised on the opposite side of the Braille page (Supalo, 2005). All these, and many other approaches, are extremely useful when teaching sciences. ICT can be used to speech-generating hardware together with special software applications, making graphical elements in maths accessible, access solution system (single-switch text-entry system) to enable a student with visual impairment to use the computer for writing. The special maths software, the Talking Tactile Tablet, and an advanced text-entry solution were newly available devices.

Talking Tactile Tablet

A talking tactile tablet or T3 is a graphic tablet with a touch surface that can be used as an input device that uses swell paper to create 3D overlays and connects audio files to parts of the overlays. The device is connected to a computer and run with a programme CD, and has a tactile surface which produces touchable icons that provide audio feedback when they are pressed. It can be used to help visually impaired users to interpret diagrams, charts and maps by producing a tactile, touchable image, and audio feedback.

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The T3 was developed at the United Kingdom's Royal National College for the Blind in Hereford in conjunction with a software company based in the United States. The device was originally developed for educational purposes but is adaptable for other uses. In 2005, Hereford Museum and Art Gallery became the first in the United Kingdom to invest in the technology. The T3 was later sold on the international marketplace with the help of the UK Trade & Investment's passport initiative – a scheme which gives new exporters the training, planning and support they need to succeed in overseas markets.

Technology tools for the visually impaired

Technology for the visually impaired can be separated into two wide groups. The group of assistive tools that help people with low or no vision in everyday life and the group of assistive tools that are technological and can support the learning of visually impaired persons. As far as the first group of tools is concerned, there are some examples of them that can be used, or they are already used by visually impaired people. Some of them are shown below and they are tools or objects, while others are applications or softwares that can be installed in a smartphone, computer or tablet to facilitate the visually impaired. Some of the devices that can be used are: smartphones, magnifiers, screen readers and more.

As assistive tools screen readers can be used. There are many screen readers that can help the visually impaired to read. A screen reader is an essential piece of software for a blind or visually impaired person. Simply put, a screen reader transmits whatever text is displayed on the computer screen into a form that a visually impaired user can process (usually tactile, auditory or a combination of both). While the most basic screen readers will not help blind users navigate a computer, those with additional features can give people with visual impairment much more independence. Whilst most screen readers work by having a synthetic voice that reads text aloud, others can also communicate data via a refreshable braille display.

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Another tool that has a big impact on communication and even on education of visually impaired persons is the smartphone technology. It seems quite obvious nowadays but it is something new. Although it has conquered our everyday life, the technology of a smartphone is something that is in use only in the last twenty years. Smartphones have been widely used for the last twenty years. They have made our lives easier and they have a huge range of applications that help, educate, navigate, support and so many other forms of help or fun. An application that is made for the visually impaired is called Sullivan and it helps visually impaired users to enhance their accessibility. It gives information perceived via the smartphone camera. It can even recognize a person photographed with the camera and tell the person's age and gender.

Smartphones can have many other uses as well depending on the applications that someone uses. For example a magnifier application: Lumin is an electronic magnifying glass for your iPhone or iPad. Not only does it magnify items, it can also keep a running history of images and can save or share these images with your friends via email, Facebook, Twitter, and Instagram. Locked images can be magnified 10 times, or even more with ideal lighting, and can also be automatically mirrored to your Dropbox account.

As far as softwares is concerned, there are a lot available and they usually are free of charge. Some of them are described below.

a) NVDA (Windows) has been designed by a blind software engineering graduate, James Teh, for use with Windows computers. This free and open source screen reader has a synthetic voice that reads whatever the cursor hovers over, and can be used directly from a USB stick, making it ideal for students.

b) Serotek System Access (Windows)

This downloadable and complete screen reader can be used even outside your browser, thus making it one of the quickest ways of getting a screen reader up and running on your system. Serotek offers extended versions for a fee, although it is much cheaper than other screen readers.

c) Apple VoiceOver (OS X)

Apple VoiceOver includes options to magnify, keyboard control and verbal descriptions in English to describe what is happening on screen. It also reads aloud file content as well as web pages, E-mail messages and word processing files whilst providing a relatively accurate narrative of the user’s workspace.

d) ORCA (Linux)

ORCA is a Linux based screen reader which has also been evolving for the past number of years. Although it is not the sole Linux-based screen reader, ORCA is definitely the most popular. Recently it has been included with the Ubuntu installation CD, and with a couple of initial key presses it allows blind people to have audible interaction during the installation process.

e) BRLTTY (Linux)

BRLTTY is a background process (daemon) which provides access to the Linux/Unix console (when in text mode) for a blind person using a refreshable braille display. It drives the braille display, and provides complete screen review functionality. Some speech capability has also been incorporated. All these softwares above are only some from a wide range that is available (https://usabilitygeek.com)

Another interesting tool is the Wave plugin: WAVE is a web accessibility evaluation tool developed by WebAIM.org. It provides visual feedback about the accessibility of your web content by injecting icons and indicators into your page. No automated tool can tell you if your page is accessible, but WAVE facilitates human evaluation and educates about accessibility issues. All analysis is done entirely within the Chrome browser allowing secure valuation of intranet, local, password protected, and other sensitive web pages.

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All these tools and applications help visually impaired people in so many different ways and so many different areas. Some help reading, some others provide information, others help mobility, while others contribute to accessibility on internet. All of them have become part of our lives due to the progression of technology. All of them can be used into the education of the visually impaired, which means into teaching and learning.

As Bocconi et al, illustrate, ""e-learning" as a learning process that "takes places via any electronic medium". In a global perspective, such a term refers, then, to any educational process making use of technological/electronic media and applications such as: "web-based teaching materials, hypermedia in general, multimedia CDROMs, web sites, discussion boards, collaborative software, e-mail, blogs, wikis, computer aided assessment, educational animation, simulations, games, learning management software, etc…"

• "Online learning": those educational resources made available through interconnected computer networks, comprising also synchronous and asynchronous communication tools, when used in an educational perspective.

• "Computer-based learning": those learning materials locally available on the user's PC and used when the computer is not connected to a network.

• "M-learning": those educational tools made available through "mobile devices" such as palmtops (or handhelds), Personal Digital Assistants (PDAs), tablet PCs, mobile or smart phones; such tools, may also take advantage of the connection to the net via "wireless transmission" [Hoppe et al, 2003]. The concept of "e-learning tool" is, then, linked both to the media (hardware devices) employed and to the programs (software applications) used to support the educational process. Such software applications can be roughly divided into:

• E-learning platforms: those internet-based environments expressly addressed to the delivery of integrated electronic educational contents and to the management of a variety of educational activities aimed at fulfilling specific educational objectives 1 Section 508 of the Rehabilitation ACT Subpart C - Functional Performance Criteria § 1194.31). 494 S.

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Bocconi et al. [Lin and Kuo, 2005]. All the digital contents made available by and through such platforms, are generally called "learning objects".

• Web based applications: those applications (both designed for educational purposes and used to fulfil educational objectives) which are directly accessible using any available browser and which don't need to be installed on the user PC.

• Standalone applications: those products (both "educational" and "used for education") which cannot be used directly via browser but that need to be installed locally, on the user machine; this category includes also products "downloadable" from the Web, but that still need to be installed on the computer" (Bocconi et al, 2007, p.493).

ICT accessibility as a driving tool for inclusion

Education is an instrument for social inclusion, a tool for developing identity, perceptions and understanding. Furthermore, access to information and knowledge is the key to reach employment, to reach opportunities in the labor market and career. Education can be the vehicle through which we can promote principles of social cohesion, equality and understanding and 'avoid' prejudice, stereotypes and discrimination.

As Booth and Ainscow assert, inclusion in education involves: valuing students and stuff, increasing the participation of students and reducing their exclusion from the cultures, curricula and communities of local schools. It is about reducing barriers to learning and participation of all students "*viewing the difference between students as resources to support learning, rather than problems to be overcome (…)Recognising that inclusion in education is one aspect of inclusion in society"* (Booth and Ainscow, 2009, p. 3). The same states Barton as well when he argues "*inclusive education is not an end in itself but a means to an end. It is about contributing to the realisation of an inclusive society with the demand for a rights approach as a central component of policy-making"* (Barton, 2003, p.13). Thinking that technology is an important part of getting accessibility to a number of things, such as communication and education, we can comfortably declare that technology can bring together information and communication in order both of them to

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serve the teaching and learning of people with disabilities. Especially for people with visual impairment ICT can be extremely useful and help overcome many barriers. ICT can help a lot in inclusive education for the visually impaired. In Bocconi et al there are many examples of technology providing accessibility to visually impaired persons. "Educational software products are a very large category showing a wide number of different technical solutions; in the last years, GUI (graphic user interfaces) have been widely used and also the mouse has been often used as the only input system; recently international and national initiatives have produced significant changes in the direction of producing more accessible products even in this field" (Boccoli et al., 2007, p. 495).

Conclusions

In order to guarantee equal opportunities to all students, the accessibility of ICT educational tools is worldwide considered a major issue. Because it is difficult for visually impaired or partially sighted students to be included in regular classrooms (Sahin and Yorek, 2009). STEM education needs a variety of things in order to be accessible. Science education must include guided inquiry, hands-on science, and students working in heterogeneous laboratory groups then the teaching can be appropriate and effective for students with special needs (McGinnis, 2013) and for students with visual impairment. However, the variety of obstacles they may find on their way is quite large mainly because the term "visually impaired" encompasses a wide range of deficits, ranging from blindness to a number of other multifaceted, although less severe, visual impairments. But nowadays, visually impaired students can take advantage of a large number of effective assistive technologies that can help in everyday life, while ICT can provide high quality and inclusive education.

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CHAPTER 5:

STEM Education: What it is and how it can help VI students

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- ## STEM definition

Science, technology, engineering, and mathematics (STEM) is a broad term used to group together these academic disciplines. STEM has its origins in the 1990s at the USA's National Science Foundation (NSF) and has been used as a generic label for any event, policy, program, or practice that involves one or several of the STEM scientific branches (Bybee R.W., 2010). This term is typically used to address an education policy or curriculum choices in schools. The acronym (STEM) was first adopted by Rita Colwell in the ceremony for 2001 Awardees (NSF Director's Award for Distinguished Teaching Scholars. November 8, 2001). As the president of NSF said: “The Director's Award is the highest honor bestowed by NSF for excellence in teaching and research. This particular award embodies the high priority that NSF places on promoting the efforts of outstanding scientists, mathematicians, and engineers who are dedicated to advancing the frontiers of science, technology, engineering, and mathematics (STEM) education”.

- ## What is STEM Education?

STEM is a curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications (Hom E.J., 2014).

What separates STEM from the traditional science and math education is the blended learning environment and showing students how the scientific method can be applied to everyday life. STEM teaches students computational thinking and focuses on the real world applications of problem solving. At the U.S.A.'s educational system STEM begins while students are very young.

- Elementary school: STEM education focuses on the introductory level STEM courses, as well as awareness of the STEM fields and occupations.

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- Middle school: At this stage, the courses become more rigorous and challenging. Student awareness of STEM fields and occupations is still pursued, as well as the academic requirements of such fields.
- High school: The program of study focuses on the application of the subjects in a challenging and rigorous manner. Courses and pathways are now available in STEM fields and occupations (Hom , 2014).

- **STEM in our days**

U.S.A.

According to the U.S. Department of Education : “All young people should be prepared to think deeply and to think well so that they have the chance to become the innovators, educators, researchers, and leaders who can solve the most pressing challenges facing our nation and our world, both today and tomorrow. But, right now, not enough of our youth have access to quality STEM learning opportunities and few students see these disciplines as springboards for their careers.”

Introducing curricula and educational programming focusing on science, technology, engineering and mathematics is intended to help prepare students in these areas of learning and create practical applications how these lessons apply to the real world. STEM education is designed to encourage students to pursue these subjects as well as innovation and research in their education and career paths. This focus will help prepare future generations to best handle our world’s biggest problems (National Inventors Hall of Fame Blog).

Thusfore, in an ever-changing, increasingly complex world, it's more important than ever that our nations’ youth are prepared to bring knowledge and skills to solve problems, understand and use all given information, and know how to gather and evaluate evidence in order to make decisions. These are the kinds of skills that students develop in science, technology, engineering, and math, including computer science—disciplines collectively

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known as STEM/CS. “If we want a nation where our future leaders, neighbors, and workers can understand and solve some of the complex challenges of today and tomorrow, and to meet the demands of the dynamic and evolving workforce, building students' skills, content knowledge, and literacy in STEM fields is essential”. We must also make sure that, no matter where children live, they have access to quality learning environments. A child's zip code should not determine their STEM literacy and educational options (U.s. department of education: Science, Technology, Engineering, and Math, including Computer Science).

Europe

Most of the European countries follow the “new” trend in studies supporting STEM education. So, we can find almost everywhere foundations or non-profit organizations focusing on STEM.

Such as :

- The International Centre for STEM Education (ICSE) located at the University of Education in Freiburg, Germany.
- London International Youth Science Forum (LIYSF).
- The Science, Technology, Engineering and Mathematics Network (STEMNET), United Kingdom.
- Hellenic Education Society of STEM (E3STEM), Greece.
- Union of Professors of Industrial Sciences and Techniques (UPSTI), France.
- Mathematics, Imperial Science, Science and Technology (LUMA), Finland.

Skills in Science, Technology, Engineering and Mathematics (STEM) are becoming an increasingly important part of basic literacy in today's knowledge economy. According to European Commission’s evidence for research and innovation: “To keep Europe growing, we will need one million additional researchers by 2020”. Yet science education can no longer be viewed as elite training for future scientists or engineers; only science-aware

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citizens can make informed decisions and engage in dialogue on science-driven societal issues (European Schoolnet).

European Schoolnet is the network of 33 European Ministries of Education, based in Brussels. As a non-profit international organisation, aims to bring innovation in teaching and learning to the key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners.

European Schoolnet is at the forefront of the debate on how to attract more people to science and technology to address the future skills gap that Europe is facing. STEM is one of European Schoolnet's major thematic domains. It's been involved in more than 30 STEM education initiatives, financed through European Schoolnet's Ministry of Education members, industry partners, or by the European Union's funding programmes.

Through all these, the Scientix project, leaded by Schoolnet, promotes teaching materials from STEM research projects and supports Europe-wide collaboration among science and math teachers, researchers, policymakers and other professionals in STEM education. Originally, an initiative of the European Commission's Directorate-General for Research and Innovation, the project receives financial support from the seventh Framework Programme of the European Union (Research and Innovation. Seventh Framework Programme: Building the Europe of Knowledge).

Despite all these, according the article: "STEM Education in Europe & the PISA Test" "the 2018 Pisa (Programme for International Student Assessment) test results, which were announced in December 3, 2019 (Sleicher, 2019), showed no progress in the EU students" performance in Mathematics and Science (European Commission, 2019). From 2000 to 2015, the advancement of STEM (Science, Technology, Engineering and Mathematics) Education has not been very encouraging. In the 2018 Pisa test, the situation remained static despite the EUN's (European Schoolnet's) ongoing activity during the last few years in Europe" (Roungos et al, 2020, p.177).

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- **Mentorship in STEM**

Mentorship has been well-established in the literature as fostering scientific identity and career pathways for underrepresented minority students in STEM fields. Mentorship is prioritized by programs that aim to increase diversity and support future leadership in STEM fields. The analysis highlights how different mentoring experiences can contribute to development of future STEM leadership (Atkins et al, 2020).

- **Students with disabilities in STEM courses**

Students with disabilities are underrepresented in STEM majors. Self-advocacy is a skill some students with disabilities have that involves taking action to ensure equal access to learning opportunities in their courses. Although self-advocacy is important for academic success in college, knowledge of self-advocacy in STEM disciplines is still developing, states Mariel Pfeifer in her article titled : "What is self-advocacy and why is it important for students with disabilities in STEM?". And she continues: "I wondered about the experiences of students with disabilities in STEM courses: what was it like to access and manage accommodations in that type of environment?".

The original model of self-advocacy includes knowledge of self and knowledge of rights. Knowledge of self is knowing your own strengths and weaknesses as a student with a disability, and knowledge of rights is awareness of federal laws that guide the accommodation process in college. Besides knowledge of self and knowledge of rights, self-advocacy in STEM courses involves knowledge of STEM learning contexts. For example, students using accommodations need to know that they can always request accommodations in any part of their STEM course whether that is the lecture, lab, or discussion section. Promoting self-advocacy in undergraduate STEM courses will support more students with disabilities in earning STEM degrees (Pfeifer, 2020).

In the article "Equity Oriented Conceptual Framework for K-12 STEM literacy", the authors are introducing a conceptual framework of K-12 STEM literacy that rightfully and intentionally positions each and every student, particularly minoritized groups, as

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belonging in STEM, conceptualizing the equity-based framework of STEM literacy. The Equity-Oriented STEM Literacy Framework illuminates the complexities of disrupting the status quo and rightfully transforming integrated STEM education in ways that provide equitable opportunities and access to all learners. The Equity-Oriented STEM Literacy Framework is a research-based, equity and access-focused framework that will guide research, inform practice, and provide a lens for the field that will ensure each and every student, especially minoritized students (Jackson, C., Mohr-Schroeder, M.J., et al, 2021).

- **STEM and Spatial thinking**

Spatial thinking is related to the knowledge and understanding of spatial concepts and relationships, as well as the various ways in which these concepts and relationships are represented, and even how to argue and draw conclusions about spatial information (NRC, 2006). Spatial thinking is defined as the ability to visualize and interpret position, distance, direction, relationships, changes, and movements related to space. Spatial thinking uses the properties of space as a means of problem solving, finding answers and formulating solutions (NRC, 2006). Spatial thinking has been recognized as an important skill for both science and everyday life. The report of the US National Research Council (NRC, 2006) "Learning to Think Spatially: GIS as a Support System in the K-12 Curriculum" stressed that without explicit attention to spatial education, education can't meet its responsibilities for equipping the next generation of students with regard to their personal and working skills in the 21st century.

Spatial thinking is considered a key competence for the STEM disciplines. The results of the research emphasize the rewarding effects of the development of geospatial skills to increase participation in STEM branches, whereas the lack of them lead to a brake on students' performance and even to drop out of school (Uttal & Cohen, 2012). In addition, spatial thinking is a talent vital to achieving innovation in relation to the STEM innovation sectors, however, due to its neglect by educational systems it has been largely lost by students (Wai et al., 2009).

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Just the last decade, spatial thinking has been recognized as particularly useful in the social sciences and humanities (Goodchild & Janelle, 2010), as critical to the various tasks required in daily life issues, such as providing and instructing, navigating known and unknown places, and the interpretation of images, graphs, and diagrams. In addition, the understanding of basic visual-spatial notions, such as scale and generalization, also meets cognitive analogy with the way people learn, communicate, and deal with (not necessarily spatial) everyday issues.

Therefore mentioned in NRC report marked a major shift in education towards enhancing scientific thinking: strengthening spatial literacy can only be achieved through systematic educational reform (NRC, 2006). In addition, the US Department of Labor has recognized geotechnology as one of the three most important emerging and developing fields (Gewin, 2004). The geospatial sector presents an excellent opportunity to achieve a meaningful connection between theoretical concepts, higher level (eg, geographical phenomena and processes) and representation tools (eg, maps and soil models) and their application in everyday life, such as finding a place or getting guidance in an unknown place via mobile phones or internet applications. It remains a fact that spatial thinking has long been overtaken in education by other forms of thinking (verbal, metaphorical, hypothetical and mathematical). This distinct form of thinking is defined as a constructive synthesis of three elements: (a) spatial concepts, (b) representational tools, and (c) reasoning processes. For example, in order to identify areas vulnerable to flooding due to rising sea levels, students will need to understand concepts of space, such as "location", "distance", "proximity" and "elevation", to understand and use representation tools such as maps and terrain models, and be able to perform reasoning procedures, such as combining maps and evaluating multiple criteria (eg location of settlements) and drawing conclusions about environmental impact. These three elements are also useful for understanding many other geospatial phenomena.

- **Distinction of Spatial and Geospatial Thinking**

The terms spatial and geospatial thinking are often used indiscriminately, however the distinction between them is real. The term "geospatial" refers to the environmental and

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geographical space according to Montello's categorization and has been used in the literature to represent and analyze geographical phenomena (Golledge et al., 2008). Some examples of Spatial Activities VS Geospatial Activities are: Arranging clothes in a VS suitcase, the planning of residential development of a suburb, laying the dining table VS learning the route in the workplace.

- **Can Visual Impaired students think spatially?**

Regarding the effect of visual impairment on the treatment of the space, three theories have been developed in order to categorize the results of the individual researches.

Deficiency theory argues that congenitally blind people are not able to gain a general view of space because they have never experienced the perceptual processes. This process is believed to be necessary in order to understand two-dimensional and three-dimensional arrangements, scale changes, and more complex abstract spatial concepts such as hierarchy, model and sequence. As a result, these individuals cannot engage in complex mental-spatial problem-solving processes involving rotations and transformations. In contrast, individuals who lost their sight at an older age show signs of spatial proficiency precisely because they had experience with perceptual processes (Kitchin, Blades & Golledge, 1997; Ungar et al., 1996).

Inefficiency theory accepts that visually impaired people can understand spatial concepts and mentally manipulate them. However, the fact that information comes from auditory and tactile cues, understanding and knowledge of space are inferior to those derived from visual perception (Kitchin, Blades & Golledge., 1997; Ungar et al., 1996).

Finally, the Difference theory argues that people with visual impairment are just as proficient as people with normal vision in processing and understanding spatial concepts, and that any differences - qualitative or quantitative - are due to the interference of other factors: such as access to information, experience, and stress (Golledge et al, 1993; Ungar et al., 1996).

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One of the fundamental questions, which was the beginning of several studies on the spatial behavior of visually impaired people, is whether there is the possibility for mental representation of space. The performance of blind individuals in various spatial coding and representation tests has shown that the process of mental imagery is feasible and its characteristics are spatial rather than visual-iconographic (Kerr & Neisser, 1983; Neisser & Kerr, 1973). After all, according to Carpenter and Eisenberg, spatial representation differs from the visual. Spatial representation includes information about the relationship that governs the positions of various elements or attributes, according to some reference coordinates. Visual representation includes this information in conjunction with some highly visual object-stimulus elements, such as colour and glare (Carpenter & Eisenberg, 1978). Spencer, Blades, and Morsley asked visually impaired children (born with total blindness and partial vision) to draw familiar and unfamiliar shapes and then comment on the unknown and associate them with a familiar object. It is of particular interest that all children made correspondences with the same objects. This shows not only that all children are capable of mental imagery that allows them to match shapes with familiar objects, but also that these images are common to all children, regardless of visual ability (Spencer et al., 1989).

- ## STEM and adaptive materials

It is well known that people with disabilities face various discriminations inside societies. Access to education, health, work and even buildings can be limited. Our main interest here is the access to education and especially in the field of science, technology, engineering and mathematics to people with visual impairment. It is too easy to understand this lack of accessibility to the STEM field if we read the numbers of the statistics. Up to now, there seems to be an issue of lack of interest and concern for visually impaired students getting involved with the STEM field. There is a percentage of 34.31% of the Greek universities that exclude blind students, while 78.3 % of public vocational colleges exclude blind students as well (National Federation of the Blind, 2010). Until 2014, it was impossible for blind or visually impaired students to become students of the Physics department all over Greece, while until now it is forbidden for visually impaired students to study Chemistry at University.

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Therefore, students with visual impairments rarely develop an interest in science, technology or engineering, and often, when they exhibit interest or ability in these areas, they are discouraged from pursuing these fields (Rule *et al*., 2011). It is well known that fields such as biology, chemistry, physics, and mathematics use so many drawings, charts, graphs, and other illustrations to present content and relationships, making them particularly challenging for students with visual impairment (Sahin and Yorek, 2009). Hence, very few visually impaired students try to get in higher education in this field (Rule *et al*., 2011). Thus, we have to work hard if we want to challenge discrimination towards visually impaired people, and the beginning has to be made in the school classroom. In order to do that, many adaptive materials are needed apart from the Braille typewriter and all kind of enlargements. Adaptive materials of all kinds, such as embossing diagrams on special paper, a lot of audio material, 3D printers and every kind of simulation that can be made in order to make students understand through touching or hearing (Pedagogical Institute, 2009).

3D printers are one the best ways of adaptive material that can be used in order to accommodate visually impaired students into better understanding of the STEM field. As Nam, Li, Yamaguchi, and Smith-Jackson (2012) point out, although students with severe visual impairments receive full access to the general education curriculum until the end of secondary education, they are not adequately provided for in terms of science instruction (Nam *et al*., 2012). To enhance students' learning we have to bring into use not only new technologies but firstly especially haptic material because, "it has been postulated that haptic perception such as force, vibrotactile, and thermal changes, combined with hearing, can improve blind students' ability to understand scientific concepts" (e.g., McLinden, 2004; Yu & Brewster, 2003, cited in Nam *et al*., 2012). Sahin and Yorek (2009) believe as well that visually impaired students need mostly tactual and more hands-on experiences to learn science (Sahin and Yorek, 2009).

For visual impaired students it is highly important to have many opportunities in hands-on learning. Many studies have shown that tactile materials make a high impact in learning to visual impaired and non-visual impaired students. Especially for visually impaired students haptic material such as 3D printings, or 3D diagrams or other adaptive

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material that can be touched, are very important for their learning due to the amount of information that visually impaired people get from their hands and their fingers, while touching. 3D objects or printings can be very useful to all STEM subjects (physics, chemistry, biology, engineer, technology and mathematics). Vigotsky has pointed out that knowledge has to become embodied in order to be truly conquered.

As Mathematics is concerned and especially as Geometry is concerned, the use of adaptive material, such as 3D objects (or other haptic material) is very important for the understanding of the geometrical shapes. Potari, Diakogiorgi, Gioni & Zanni (2002) conclude that the interaction between students and haptic objects is the one that defines the choice of the object and the outcome after all. According to (Klatzky et al., 1985) for students with visual impairment the tactile exploration of shapes is a substitute for vision (Klatzky et al., 1985). Furthermore, according to Williams (1983) and Millar (1981), visually impaired students explore objects to a degree that gives them an overall view of them and are led to an accurate mental representation of the shape they touch.

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CHAPTER 6: Social Skills through participation in STEM Projects

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The acronym STEM is commonly used to reference a set of educational and occupational fields or domains related to science, but there is inconsistency in the definition of this set and debate about whether the four fields deserve special attention as a collective entity (Gonzalez & Kuenzi 2012). In particular, what is considered STEM education varies enormously by educational level (Breiner et al. 2012)

In other words, "STEM" is an approach to Education that is designed so that in the teaching of Mathematics and Natural Sciences, which become necessary for the understanding of basic phenomena for life, the sciences of Technologies and Engineering are introduced, as they are for man the means of interaction with the universe. STEM thus focuses on solving authentic-real problems, through an interdisciplinary approach. This is achieved by choosing concepts, methodologies and tools from various sciences, in order to solve a problem, to create a construction, to understand a concept, etc. Interdisciplinary means the multifaceted study of topics and the connection of scientific fields (interdisciplinarity), so that beyond from the specialized knowledge, the student to perceive the "conversation" of the sciences and their contribution to all aspects of everyday life (Matsagouras, 2012).

Across Europe, countries wanting to grow their domestic industry are trying to integrate STEM into education at all levels of education, and into the pedagogical departments of higher education.(Fioriello, 2015)

Research from the National Science Foundation shows that, through good practices in STEM education, students of all types of schools can engage in high quality learning in science, technology, engineering and math. One of the issues that arise during this process is the search and securing of the conditions that will allow the involvement - cognitive, emotional, and behavioral - of more students in STEM activities. (Κατσαβού, 2017)

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Significance of STEM education

In recent years there has been a lot of talk about the skills that the student must be equipped to meet the challenges required in modern times.

Skills, based on skill development, are not innate in all individuals, but acquired. That is, they are acquired and developed through learning through all education and practice. Skills are the key to practicing and succeeding in a profession. An employee, in order to succeed in today's working conditions, must have a set of key skills. From the researches carried out in European bodies and in educational-research institutes, the basic skills were classified in the following categories:

- Basic skills
- Process handling skills
- Social skills
- Complex problem solving skills
- Technical skills
- Systemic skills
- Resource management skills

Utilizing digital environments and different subjects, such as STEM, strengthens Social and Emotional Learning (SEL).

SEL is a process that helps children and even adults to develop basic life skills. SEL teaches the skills we all need to manage ourselves, our relationships with others, and our work effectively and ethically. These skills include recognizing and managing our emotions, developing interest and care for others, building "healthy" relationships, making decisions, and effectively solving problematic situations. More specifically, the five basic elements of SEL are:

- Self-awareness,
- Self-management,
- Social awareness,
- Relationship-skills and
- Decision-making.

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It can also be linked to emotional intelligence, emotional literacy, positive development and well-being. All of these skills and elements are essential to all students. (Σμυρναίου, 2020)

SOCIAL DETERMINANTS OF STEM EDUCATION

STEM challenges are already an integrated approach with real-world applications. Is there any better way to teach the skills needed for success in the real world than collaborative environments like STEM projects? The key here is that during STEM challenges, educators should implement naming, addressing, and providing strategies to overcome obstacles in students' self-management, in order to conquer all the skills that can be acquired. (Xie, 2017)

Self-awareness

Self-awareness is the ability to recognize your emotions and aspects of your personality and to understand how they affect your behavior (Identifying emotions).

In particular, social-emotional self-awareness means having the ability to understand your thoughts, address emotions when they happen and figure out values, as well as knowing how those factors influence your behavior. Added to this understanding is the capacity to open-mindedly and realistically assess your strengths and weaknesses while maintaining your confidence, drive, and desire to grow. STEM challenges are usually conducted in a team environment, and this allows for many opportunities to address both positive and negative emotions. (Σμυρναίου, 2020)

The World Health Organization (2003) recognizes self-awareness as one of the life skills that promote well-being across all cultures. The other skills include:

- <u>Empathy</u>: Empathy is the ability to feel the other person's feelings as our own and through this ability, we can understand someone's behavior. We learn to share our feelings and so we "bond" with the other people, we make healthy emotional bonds. With empathy we recognize the positive emotions such as joy, satisfaction but also the unpleasant ones such as anger, shame, and jealousy.

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Regarding children, they learn to name the emotions, they are trained to recognize, understand and manage them. They thus take the first step towards understanding themselves and others, gaining an identity, learning to build more solid and healthy relationships.

- Critical thinking: Critical thinking is the mental and emotional function in which the individual evaluates the reliability of information and decides what to think or what to do through reasoning made based on all the possible facts at his disposal.

  Initially the person learns to be critical when he knows what to ask how and when and then how to think logically when and what methods and strategies to use to deal with a situation.

  Critical thinking skills are important for children's cognitive development. The introduction of these skills can begin as early as preschool age, while engaging in stem projects catalyzes this. It is important that analysis, comparison and synthesis skills be developed at an early age so that students can apply them to appropriate situations, whether in their academic or personal lives.

  Critical thinking involves a complex combination of skills. Among the main characteristics are the following: logic, self-knowledge, honesty, open-mindedness, discipline and determination.
- Creative thinking: Creative thinking means thinking outside the box. Often, creativity involves lateral thinking, which is the ability to perceive patterns that are not obvious. It might also mean devising new ways to carry out tasks, solve problems, and meet challenges. It means bringing a fresh, and sometimes unorthodox, perspective to ones work. Moreover, the most important is that creativity thinking isn't limited to artistic types. Creative thinking is a skill that anyone can nurture and develop, even if the children though their STEM projects.
- Effective communication: Effective communication is a process of exchanging ideas, thoughts, knowledge and information such that the purpose or intention is fulfilled in the best possible manner. In simple words, it is nothing but the presentation of views by the sender in a way best understood by the receiver. Conveying a message effectively is an art as well as a skill developed after continuous practice and experience. The predetermined set of skills required for

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an influential communication process are a patchwork of the aforementioned skills, including observance, clarity and brevity, respectfulness, etc.

Self-management

Self-management defines the ability to manage your emotions in a variety of situations. Effectively control stress and impulses (Impulse control). In this way you acquire organizational skills. Working well in teams is challenging for most students. Students should be guided in developing rules that they must agree to at the beginning of every class. These rules can address how they should manage their own emotions and sets the tone for beginning each challenge, regardless of the result.

In fact, according to Child Mind Institute, parents tend to see their mission as helping their kids succeed. But there’s a growing realization among teachers and other professionals who work with children that kids increasingly need help learning how to fail. (Arky, n.d.) The various STEM programs are also based on this idea

When a child experiences a failure, its community should help them evaluate what went wrong and how they can prevent it from occurring again. Children can learn about problem-solving through failure. Reframing failure as an opportunity to assess and plan for better outcomes can ease the sting of defeat and build resiliency while also prepping them to do better next time. Through trying and failing, then trying again and succeeding, kids learn about patience, perseverance, and the feeling of pride in their accomplishments. Encouragement and praise are powerful tools we can use to shape the positive response we want to see.

Social awareness

Social awareness is the ability to show respect to others especially if they come from a different background (appreciating diversity). The ability to also meet your obligations when you belong to a community whether it is called a family, or a group, or a school or a community.

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Leadership instills confidence, and helps children solve problems creatively, work in a team, and work collaboratively with others strengthening in this way their social awareness.

Leadership skills allow children to have control of their lives and the ability to make things happen. Leadership instills confidence, and helps children solve problems creatively, work in a team, and work collaboratively with others. Leadership gives children many opportunities to develop responsibility.

While you may not find the word leadership in the early learning standards, many states have statements related to leadership in their standards in the social-emotional section. Key phrases that relate to leadership are "self-confidence", "problem solving", "pro-social," and "makes independent decisions and choices."

Relationship development

Relationship development is the ability to create healthy relationships with different people. That is, the ability to help others when they need it and not react as an individual within the team (relationship building, team work). Kids maintain curiosity and interest when they have a voice in selecting the real-world projects they wrestle with solving.

Undoubtedly, curiosity also plays an important role in this. If students do stay curious, they will continue to imagine, explore, discover, and learn. Kids and students who are less curious tend to make fewer new friends, join fewer social groups and read fewer books. No wonder a student without curiosity is harder to teach, inspire, and motivate.

Curiosity is a state of mind that supercharges learning. Children enter the world filled with curiosity and constantly asking questions. They keenly observe the world around them and connect ideas. They build things, take things apart, constantly explore, and try new things. In a nutshell, children are great natural learners — just the kind of learners we need for successful STEM work.

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Decision-making

Decision-making is the ability to solve problem situations, respect and listen to the opinion of others and negotiate to reach a final (negotiation). Making good decisions is a complex process and takes years to learn well.

Children need guidance and education, so that they can acquire the basics that will allow them to make the right decisions in their lives as much as possible. One of the best gifts parents can give their children is to help them learn to properly analyze the data in front of them before making and implementing decisions.

Of course it is inevitable that mistakes will be made. Yet, the consequences of mistakes can be lessons for better decisions in the future. Decision making is a skill that must be acquired by children. It is important that children feel responsible for their decisions, because that way they will have the responsibility for the results that must be attributed to them. In this way they will improve their own decision-making ability.

Based on this principle, the conditions are created for the success and happiness of children, when they will be active citizens in their adult life. The social, professional and family implications of the decision-making skills of a child who grows up and becomes an adult are extremely important.

Team collaboration

Often times in the real world and in the workplace, teams are required to solve and complete multifaceted problems. In light of this, STEM education prioritizes collaboration and teamwork in its syllabus to teach to kids the importance of communication and leadership towards achieving common goals.

Communication skills

Communication skills are perhaps the most important of all life skills. Having the ability to discuss and convey complex concepts to others while also learning from one another will be the key to achieving success in a child's life as they grow up. Group activities in STEM promote sociable skills like active listening, open-mindedness, and open them up to giving and receiving constructive feedback.

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With STEM there are instructions and final reports to be written about the activity. Visually impaired students can work with their group members. The inclusion student that needs to work on social skills will be working on them in the group. STEM is about working as a group to complete and finish an activity. Its purpose is to teach you that you cannot do it alone, that you need the help of everyone in the group to complete the project. From construction, to paperwork. (Σμυρναίου, 2020)

To sum up

STEM education is a process through which children acquire and effectively apply the knowledge, behaviors and skills that are necessary to understand and control their emotions, to set and achieve goals, to feel its emotion, empathize, build healthy relationships and make responsible decisions.

STEM-based education teaches children more than science and mathematics concepts. The focus on hands-on learning with real-world applications helps develop a variety of skill sets, including creativity and 21st century skills. (Smyrnaiou et al., 2020)

21st century skills include media and technology literacy, productivity, social skills, communication, flexibility and initiative. Other skills attained through STEM education include problem solving, critical thinking, creativity, curiosity, decision making, leadership, entrepreneurship, acceptance of failure and more, as analyzed during this chapter. Regardless of the future career path considered by these children, these skill sets go a long way to preparing them to be innovative.

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CHAPTER 7: The role of Assistive Technology

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Braille

The most popular resource for writing and reading for visually challenged persons is Braille. Braille was invented and named by the French man Louis Braille (1809-1852). He accidentally blinded himself in one eye with a stitching awl taken from his father's leather workshop at the age of three. His other eye went blind because of sympathetic ophthalmia, an inflammation of both eyes following trauma to one. When he was 15, he invented a universal system for reading and writing to be used by people who are blind or visually impaired that now bears his name.

Braille is read by passing one's fingertips over characters made up of an arrangement of one to six embossed points. The relative positions of these points represent different alphanumeric characters. Braille can be written with a Braillewriter (similar to a typewriter) or by using a pointed stylus to punch dots through paper using an instrument called a Braille slate, which has rows of small cells in it as a guide. Braille has since been adapted to almost every known language and is an essential tool for blind people everywhere (Roth , Fee, 2011).

Since Louis Braille and his great invention to our days, a large number of various aids for the visually impaired have been manufactured. A large number of the most popular of these devices use a Braille writing and reading system. Such as,

- The classic Perkins Braillewriter, first of all. It is a manually operated, six-key machine that, as its name indicates, is used to produce Braille letters. Electronic and computerized Braillers, also available, are portable and lighter.
- Low/Medium Tech Devices for Tactile Learners like Braille Compass, Braille Labelers or Braille Watches. There are a variety of low and medium technology devices that allow persons who are blind to access and produce Braille, complete math activities and activities of daily living.
- High tech Braille devices like a Braille Display, Braille Printer Embosser or Electronic Braille Note Takers. High tech Braille devices are available for students who are blind or visually impaired to access and produce Braille (Willings, 2020).

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OrCam

OrCam, a novel artificial vision device using a mini-camera mounted on eyeglasses, allowed legally blind patients with end-stage glaucoma to read independently, subsequently improving their quality of life. This device may offer visually impaired patients additional resources to help function independently (Waisbourd, Ahmed et al.,2015).

In August 2018, Jamie Pauls, author, blind himself since birth, mentions: “In the March 2016 issue of *Access World*, I had the privilege of writing about several new products introduced at ATIA (Assistive Technology Industry Association). One product that particularly caught my interest was OrCamMyEye, a device that coupled a camera and standard eyeglasses to allow a blind person to recognize faces and read text, among other things. I was impressed by the potential afforded by this piece of technology, and dreamed of being able to recognize faces of people around me simply by looking in their direction. In that article, I mused about how well this product would really work. When I had the opportunity to conduct a more extensive evaluation of the newest iteration of OrCam in April of this year, I was ecstatic”.

Other devices

There are many other assistive devices for visually impaired people. According Carmen Willings on her website teachingvisuallyimpaired.com (updated April 12, 2020) a sorting list of them:

- Non optical low vision devices for students who are blind or visually impaired such as: Acetate or Color Filters, Bold Line Paper, Book Stands and Slant Boards, Felt Tip Pens, Graphite Pencils, Large Print Keyboards, Low Vision Watches, Reading Guides with highlighters, task Lighting and Typoscopes. There are a variety of low-tech and mid-tech non-optical devices which will help persons with low vision to access, print and complete activities visually. Non-optical devices range from low tech to high tech.

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- Low/Medium Tech Devices for Tactile Learners. Students who are blind or visually impaired and use their tactual skills as a primary or secondary mode of learning will need tactual adaptations to materials in order for them to be accessible, such as: Bump Dots, Cranmer Abacus, Script Letter Board, Full Page Writing Guide, Raised Line Paper, Signature Guide, Slate and Stylus, Work Play Trays.
- Optical Devices for Near Viewing (Type of Lenses or Type of Magnifiers) and Optical Devices for Distances Viewing (Hand Held Monocular, Binoculars, Spectacle Mounted Telescopes, BiOptic Telescopes).
- Video Magnifiers, such as: Stand Video Magnifiers, Video Magnifiers with Distance Capabilities, Portable Video Magnifiers, and Optical Character Recognition. Video magnifiers (formerly called closed-circuit televisions or CCTVs) use a stand-mounted or handheld video camera to project an image onto a screen (ex. video monitor, television, computer monitor, iPad, etc.). With this device, people with low vision can read books, magazines, newspapers, manage a checkbook, read prescription bottles, or view photos comfortably. Most models allow for the user to adjust the magnification, contrast and illumination to suit the individual student's needs.
- Tactile Graphics Technology. In order to create tactile graphics, at an upper level, it is important to gather material and choose the tools needed to create, in addition to knowing the guidelines in creating them.
    - Low Tech Tactile Graphics Materials: Brailleable Labels and Sheets, Feel 'n Peel Sheets /Carousel of Textures, Graphic Art Tape, Textured Paper.
    - Medium Tech Tactile Graphic Materials : Crafty Graphics II Kit, Swail Dot Inverter, Draftsman Tactile Drawing Board, Crafty Graphics, Stencil Embossing Kit, inTACT Eraser, inTACT Sketchpad, Tactile Graphics Kit.
- Auditory access devices such as: Recording Devices, Auditory Books, Electronic Dictionary, Audible Gym Equipment, Talking or Large Print Calculators, Talking Watches. Auditory devices are another means for a student who is blind or visually impaired to access print and information. These devices can help a student access

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information easily. Auditory devices should be used in tandem with print or Braille as it is essential for a student to be as literate as their cognitive skills allow.

In Greece

In the long list of technical aids that exist in the exhibition of the Panhellenic Association of the Blind and among others already mentioned, there are some particular small and simple devices which make the everyday life of visually impaired people easier. Their use has a positive impact in various aspects of everyday life. Some of them are described or mentioned following. Speaking scales, diabetes' meters and sphygmomanometers help in the health area. On the other hand, PenFriend is a voice labeling system. A low-cost, audio labeler for blind and visually impaired users that lets them label everything with discrete audio labels using their own voice. Another article that is used as a little helper is the Taxi card. The Taxi card has the word TAXI printed on it on both sides. Helps visually impaired people to find taxis on their own. Or, plastic aid to get the thread through the needle. There are also board games and a voice color announcement and light sensor (Colorino). Finally, a speaking tape measure (Vox tape) and a liquid level index.

In another list, which belongs to another organization that is called Faros, there are more assistive devices for making everyday life easier. "Faros (Lighthouse) for the Blind in Greece" has existed since 1946 and it is a nonprofit charity association. In the list of Faros there are two more small devices. The one that is called "Find my things" is a small technical aid for locating objects and the one that is called "Smart guide" is a portable electronic navigation device for the visually impaired that can be connected with an external temperature measuring sensor.

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Assistive Technology for Orientation and Mobility

Assistive Technologies (AT) support a great number of people with disabilities in Europe and worldwide. Visually impaired people primarily rely on sighted guidance and traditional travel and navigation aids: long (white) canes and guide dogs for overcoming the mobility challenges. Unfortunately, the use of guide dogs is not universal and is limited mainly to developed countries. Long canes are the most popular and commonly used assistive device around the world. It increases the detection range to nearly a meter and provides rich information about the ground-level obstacles and the surfaces. The absence of visual cues and limited perception bandwidth of alternate senses pose serious challenges that severely affect independent travel and safety which in turn affects their quality of life.

Even though, AT devices are continuously increasing and extending their capabilities improving the quality of life of the VI, still the potential of each individual user is very specific and their situation may change radically since the day of purchase. To date several devices are available, providing a wide spectrum of assistive applications, enabling the VI people participate in modern society equally (Roland Ossmanna*, David Thallera, Gerhard Nussbauma, Franz Pühretmaira,Christoph Veiglb, Christoph Weißb, Blanca Moralesc, Unai Diazc, 2012).

For the VI people travel can be defined as a combination of mobility and environmental access. Mobility involves avoidance of obstacles, orientation in the environment, and navigation. Environmental access involves minimization of hazards and access to signs and related information. The mobility for a VI person involves perception of obstacles, landmarks, and orientation (William R. Wiener , Richard L. Welsh , Bruce B. Blasch , 2010).

A folding long cane (white cane) is the most widely used travel aid across the world for both indoor and outdoor environments. A person with good orientation and mobility skills can effectively detect obstacles on ground, surface changes, etc. and can manage travel especially in structured known environments by gathering surrounding information

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through sense of hearing, touch, and smell. It also helps in locating the landmarks but does not help much in gathering directional information for navigation at decision points.

Technology-centered approach with limited focus on the user needs is one of the major concerns in the design of most of the systems. State-of-the-art sensor technology and processing techniques are being used to capture details of the surrounding environment.

Holistic solutions need to be developed with the close involvement of users from the initial to the final validation stages

According to Wiener et al., **the limitations of traditional assistive solutions led to the development of electronic assistive travel aids**, for the purpose of detection of objects as well as guiding the user by providing the required orientation and navigation information.

- Detection of obstacles in the travel path from ground level to head height for the full body width
- Travel surface information including textures and discontinuities
- Detection of objects bordering the travel path for shore-lining and projection
- Distant object and cardinal direction information for projection of a straight line
- Landmark location and identification information
- Information enabling self-familiarization and mental mapping of an environment (Richard G. Long and Nicholas A. Giudice, 2010)

Obstacle detection systems make use of laser, infrared, ultrasonic sensors, cameras, etc. for detection of objects in their field and convey this information to the user through the haptics, audio or tactile interfaces. Sonic guide, Path sounder, Mowat sensor, Sonic Pathfinder, etc. Very few devices have continuously evolved and are commercially available. Miniguide RAY and PalmSonar are handheld ultrasonic sensor-based commercial obstacle detection systems. They convey the distance

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information about the nearest detected obstacle through vibration and/or audio beeps by varying its frequency with the change in distance of the nearest detected obstacle.

Tom Pouce 1 and 2 are cane-mountable obstacle detection systems that use multiple IR transmitters with 2 and 50 horizontal and vertical angular resolution, respectively. The resolutions are such that the width of the shoulders in horizontal direction and knee to head height in the vertical direction is covered for detection of objects that cannot be detected with the white cane.

It is important to take into consideration the fact that the standard cane allows detection of obstacles up to knee and if the sensor technology allows detection of objects from knee to head height and across the body width, then the system qualifies as primary mobility aid. The UltraCane comes as a single cane assembly that uses a pair of ultrasonic transceivers. Lower sensor detects the objects on the ground or in front and the upper sensor detects the head-level objects. Distance information about the detected obstacles is conveyed through two vibrating buttons. The implication is that the device must be gripped in a manner such that fingers are exactly positioned on the buttons throughout the journey.

Also navigation systems play an important role in assistive technology concerning O& M by providing directional information on a predetermined route. Navigation systems provide information of passing landmarks and points of interest (POI) that may help in better orientation on the correct route or exploring the surrounding environment. This section explores the systems that support navigation in outdoor and indoor environments (Piyush Chanana, Rohan Paul, M Balakrishnan and PVM Rao, 2017).

Research conducted in the United Kingdom has found that the proportion of braille readers among people with visual impairments is remarkably low. They proposed that this low incidence of braille readers may be a result of the increase in the use of computers and assistive technology by students with visual impairments over the past decade (Konstantinos Papadopoulos and Athanasios Koutsoklenis, December 2009).

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When a person with visual impairment is travelling, the relevant information must be provided in the right amount, in the right format, and in real time to ensure successful navigation to the destination. The type, amount, and format may vary according to the needs and preferences of the user. However, they solve only a part of the travel problem. Many are technology centered designs rather than user centric designs The real need is to develop a user centric solution that would be capable of assisting visually impaired pedestrians in different environments and situations. To ensure usability, devices should be designed with user centric design approach with special focus on the individual's travel needs. In a user, evaluation study of two electronic mobility aids it was found that ''individual users' characteristics and preferences appear to be critical for their appraisal of the devices.'' The focus should be on the ergonomics, robustness, and simplicity of the user interface, comfort of the user, and adoption time. Invasive design, bulkiness, and heavy weight often contributes to rejection of assistive devices by the users.

According to a recent study, audio-tactile maps—combining the significant advantages of tactile maps (configurational presentation of spatial components and salient points of reference leading to an allocentic encoding) with the solutions brought with the inclusion of auditory information (simultaneous perception of auditory and tactile information, spatial relations inference provided auditory, soundscape cues)—enable an individual with blindness to navigate more efficiently when he/she arrives in the physical environment. Verbal description appears to be a weaker tool for wayfinding and points of interest detection in the physical environment (Konstantinos Papadopoulos, PhD, Eleni Koustriava, PhD, and Panagiotis Koukourikos, MAb, 2017).

In conclusion, there is a variety of supportive technology concerning O&M to choose from, but according to the users experience technology often can fail or need constant update. This fact shows the necessity of the traditional way of travelling and the importance of the O&M techniques in their everyday life.

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IT supportive Technology

Users with disabilities are a specialized, but large user population. It is estimated that in Member States of the WHO European Region, 6 to 10 out of every 100 people live with a disability. In total, an estimated 135 million people in the Region live with a disability. With population ageing and the rising prevalence of no communicable conditions, including injuries, this number is set to increase in the future (WHO_Europe, 2020). Throughout the world, it is estimated that at least 6 million people have some form of visual impairment that hinders the use of traditional computer displays. Although there is no exact count of the number of blind computer users, a majority of blind individuals that are employed do use computers in their work (Jonathan Lazar et al., 2007).

Many of these users with impairments utilize various assistive technology devices. Some of the assistive technology devices include alternative keyboards and pointing devices, speech recognition, eye tracking, Braille displays, and screen readers (Paciello, M., 2000).

In the modern days, it is a common assumption that Visually Impaired people face many challenges related to communication and access to information that sighted people take for granted. However, technology is helping them to reduce many of these barriers and the possibility of being information excluded. Through the use of computer technology for tasks such as reading, writing, communicating, navigating, and searching for information, trained individuals with blindness are capable of performing a wide range of activities independently. As technology has evolved from computers to tablets and smartphones, manufacturers have recognized the need for applications or "apps" that make activities of daily living easier not only for the general population.

However, the difficulty to access visualizations such as images and objects can be challenging to interpret. Many tool and technologies seek to help blind people solve these problems by enabling them to query for information such as color or text shown on object. Blind use Braille technique to read. Also there are many applications like screen reader which help them to read. But there is a need of special training to use these techniques

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and also they are not so much portable (Kharmale Arati, Jori Sayali, Dangare Sushanta & Ahire Harshata, 2015).

A radical change has occurred since the development of touch screen based mobile devices, such as the iPhone, iPad or Android devices, while in the same time gesture based interaction has become a standard on the majority of mobile devices.

A research from Carleton University (Matthew Ernst, Travis Swan, Victor Cheung and Audrey Girouard, 2017) revealed that 91 percent of the survey's visually impaired respondents owned an iPhone. Yet such touch-centric smartphones present strong challenges for blind users: with no tactile reference to anything other than edges or corners, blind users cannot interact with the visual interface or process its feedback. This creates accessibility challenges and reduces access to the wealth of information available through today's mobile technology. Currently, to interact with a touch smartphone, a large proportion of blind users depend on audio cues from screen readers to understand the system status and perform generalized swipe and tap gestures to navigate and select content. However, because the touch gestures must be highly accurate and often require multifinger use, learning and executing the gestures can be difficult.

The concept of Universal Design who refers to the idea of designing products to be aesthetic and usable by everyone, regardless of their age, ability or status of life is closely related to accessibility or usability terms in a way that all features are simple, intuitive, equitable, flexible, perceptible or tolerant for error.

Due to the rapid growth of the new technologies, computers in their majority include new and innovative solutions for people with disabilities.

Many researchers, studied assistive technologies for web browsing describing more thoroughly speech recognition, screen magnification or screen reader software.

B. Accessibility in mobile Apps

What do we mean with the term accessibility in mobile apps is described by the degree to which a product, device, service, or environment is available to as many people as possible. Specifically, iPhone and iPad include a set of features designed to provide

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accessibility to users with special needs, including Visually Impaired people. Some of these features are: VoiceOver, Voice Control, White on Black, Zoom, Speak auto-text, tactile buttons, giant fonts, hands-free speakerphone, audible, visible and vibrating alerts or assignable ringtones (Javier Sánchez Sierra & Joaquín Selva Roca de Togores).

Accessible mobile apps

Be My Eyes- helping the blind to see

This is a free mobile app that connects visually impaired people with visually impaired assistants who can help with a variety of tasks, such as describing photos, paintings or other artwork, matching or explaining colors, reading labels on household products, and more. This service is offered around the world via live video calling. A user logs into the app and the main screen displays a button that allows the user to call a volunteer and make a video connection using the phone's camera and microphone. The assistant will explain the things a user shows to the camera. Volunteers are called at random and are based on language and time zone. Most calls are answered within 60 seconds.

Claro MagX

This is an application designed to turn an iPhone, iPod Touch, iPad or Android device into a powerful high-definition optical magnifier, making objects on the screen larger. Converts readable text to books and newspapers. Offers a wide range of zoom, high contrast and color projection options to make text easier on the eyes.

KNFB reader

An application that converts text to speech or braille to a renewable screen on iOS, Android, and Windows 10 devices. At the touch of a button, it can read almost any type of text, including mail, receipts, notes, and many other documents, and can recognize and read printed material in various languages. Additional features include read modes for single and multi-column formats, line-by-line text navigation, sentence, word and

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character, automatic text detection to activate hands-free or touch-free operation (American Foundation for the Blind, n.d.).

TapTapSee - Sullivan +

Camera application designed to help blind and visually impaired people locate objects they encounter in their daily lives. With a simple double tap on the screen, the phone will take a picture of anything, at any angle and the application will speak / identify the object. (Note: Voice recognition requires VoiceOver to be enabled).

Screen Readers

On the other hand, **screen readers** are the most popular assistive technology utilized by the visually impaired users. Because Braille literacy rates are low, speech output is the most common assistive technology for this population. In addition, other assistive technology tools for the blind, such as tactile displays, are prohibitively expensive. Screen readers are software packages that, in combination with computer speakers, read what is displayed on the computer screen out loud, in computer-synthesized speech. Two of the most popular screen readers are JAWS (Freedom Scientific, St. Petersburg, FL) and Window-Eyes (GW-Micro, Ft. Wayne, IN). There are also simple versions of screen readers built into some operating systems.

Screen readers are software programs that allow visually impaired people to read the text displayed on a computer screen either by listening to it synthetically or by reading it on a braille display. The user sends commands by pressing different key combinations on the computer keyboard or on the braille screen to guide the speech composer what to say and will speak automatically when changes occur on the computer screen. A set of keys can command speech composition to read or spell a word, read a line or an entire text screen, find a series of text on the screen, and more. In addition, it allows users to perform more specialized functions, such as detecting text displayed in a specific color, reading

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predefined parts of the screen, reading highlighted text, and specifying the active focus - focus on what I clicked or what I selected in a menu. Users can also use the spell checker in a word processor or read the cells of a spreadsheet with a screen reader (Screen reading software, 2021).

Examples include BRLTTY, Jaws (CakeTalking for music notation), Dolphin Guide, Eye - Pal Ace, NVDA, VoiceOver, ZoomText for PC and TalkBack or Accessibility Suite for mobile depending on the brand of the mobile and its date.

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CHAPTER 6: LESSON PLANS FOR INCLUSION CLASSROOM

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Introduction

All lesson plans included in this handbook were created in an effort to demonstrate teaching of STEM subjects to VI students in an optimal way. The selection of the teaching subjects that were made in order to fit the curricula of all countries of the European Union. Our lesson plans include some adaptive material, which are made by the 3D printer technology and are easy to make. In addition, they are adjustable to the different types of visual impairment. Additionally, the adaptive materials were chosen to be flexible for other subjects as well as useful for making STEM teaching easier, more fun, attractive and learning effective.

Our research team consists of two mathematicians, a physicist and two Special Education researchers, all holding a master's degree in Special and Inclusion Education.

One of our goals was to fill the educational gap of teaching STEM subjects effectively, bearing in mind the specific educational needs of the VI students. Bibliography has shown gaps in that research field. Additionally, we made an effort to demonstrate those assistive tools that can be made by a 3D printer easily and cheaply, but most importantly in a way that they can be used in a number of other subjects covering a variety of items that should be/are necessary to be taught in the STEM education. Some of them have a lot of potential and have multiple uses in different scientific areas. It has been important to focus on exploratory learning through experiment and tactile results. The lesson plan subjects were chosen because of the different teaching approach through 3D objects that can be made with a 3D printer easily and quickly, applying the principles of STEM education and its advantages. Overall, STEM needs imagination and an unseized appetite for learning and exploring the world we live in and more.

We would like to remark that the teaching template was created by the Uminho University of Portugal in order to expose the assistive material that we have constructed as the INSIDE Project. All necessary 3D objects were made by the NGO e-Nable with which we had close cooperation on a weekly basis.

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Lesson Plan: Universal Design for Learning (UDL) and Science Technology Engineering and Mathematic (STEM)

Grade level: High school Subject(s): Mathematics and construction Program content(s): Cartesian coordinates system	**Student**: **Identify barriers for learning**: Visual impairment

	Strategies to mitigate identified barriers		
	Representation Present ideas and information in multiple ways	**Expression** Provide students with multiple ways to express their comprehension and mastery of a topic	**Engagement** Tap into students' interests, challenge them appropriately, and motivate them to learn
Objectives	Describe objectives in ways that are clear and specific	Describe objectives in ways that are measurable and achievable	Establish objectives that motivate students to learn
	The construction, in some scale, of a bus stop in the same distance from 3 villages A,B,C. On a Cartesian coordinates system, using perpendicular bisectors.		
Instructional Materials	Provide options in the way information is presented	Provide options for students to express what they know	Provide options in the ways students can interact with instructional materials
	• Creation of a proper theoretical basis. Teaching or reference to corresponding geometrical notions. • Locate a point on the Cartesian system of coordinates. Join two of them A, B to form a line segment. • Calculate the coordinates of the median M of a line the segment . Construct the perpendicular bisector (l) of a line segment AB. • Select random points on the line (l) and calculate their distances from the edges of the line segment AB. • Discussion, a brainstorming again, about the problem, as it was initially introduced. • All information is given in digital or in braille support. • Checkpoints of working development and clarification of doubts.		
Methods	Provide options for building knowledge	Provide options for building skills	Provide options for building motivation and engagement
	• Discussion and Research • Connection of Mathematics to construction and real life: "*Geometry brings justice !*" • Frequent checkpoint of the conclusions • Team working • 3D printing • Diagnosis test in the end of the lesson		
Assessment	Use assessments that accurately measure knowledge development	Use assessments that measure skill development	Use assessments that accurately measure emotional (attitudinal) development

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	• Assessment of the whole plan according to the needs of the particular students' group. • Assessment of the 3D printing model according to criteria focusing on visually impairment. • Assessment of presentation or webinar, supporting answers for all possible questions related to the issue. • Assessment of the flexibility of the plan in order to be used again in another somehow different group.
Notes/ Reflections/ Adjustments for next time the lesson is taught	

Theorical Basis of Lesson Plan

Instructional Materials

A. *Creation of a proper theoretical basis*. Teaching or reference to corresponding geometrical notions. Teaching from scratch or through a brainstorm for identifying the existing knowledge and skills of students, related to the topic.

1. Mark two points $A(x_A,y_A)$, $B(x_B,y_B)$ on the Cartesian system of coordinates and join them to form the line segment AB.
2. Calculate the coordinates of the median $M(x_M,y_M)$ of the segment AB, given that (x_M,y_M) = (A+B2 , yA+yB2). Hence we find the point M.

   **. The teacher takes care so that the coordinates of A and B are whole numbers, such that, their medians, as shown in the previous formula, will be also whole numbers. **

3. Construct the perpendicular bisector (l) of the segment AB
4. Select random points on the line (l) and calculate their distances from the edges of the line segment AB. After a series of measurements, we conclude that: "all points of the perpendicular bisector are equidistant, that means have the same distance, from the edges of the straight line segment".
5. At this point the proof of the theorem is completed and we can proceed to the geometrical construction as a follow-up of this theorem

B. *Making the construction.* We discuss, a brainstorming again, about the problem, as it was initially introduced. We decide that we must construct 3 line segments AB, AC, BC, find their

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corresponding midpoints and then draw the perpendicular bisectors of the segments at those 3 points.

C. *Checking the results*. As soon as we do so, we mark their point of intersection, name it P. We focus on P , because this is the solution of the problem. It is exactly where the bus stop must be constructed, so that all 3 villages are in equal distances. In other words, if the bus stop was to be constructed at any point other than P, then, to their grief, some villagers would have to walk longer distances and that would not be fair at all.

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Lesson Plan: Universal Design for Learning (UDL) and Science Technology Engineering and Mathematic (STEM)

Grade level: 1st grade of high school Subject(s): Geometry Program content(s): Types of angles	**Student**: **Identify barriers for learning**: Visual impairment

	Strategies to mitigate identified barriers		
	Representation Present ideas and information in multiple ways	**Expression** Provide students with multiple ways to express their comprehension and mastery of a topic	**Engagement** Tap into students' interests, challenge them appropriately, and motivate them to learn
Objectives	Describe objectives in ways that are clear and specific	Describe objectives in ways that are measurable and achievable	Establish objectives that motivate students to learn
	• To get to meet and understand different types of angles, acute angles, right angles, obtuse angles, straight angles, reflex angles and complete angles.		
Instructional Materials	Provide options in the way information is presented	Provide options for students to express what they know	Provide options in the ways students can interact with instructional materials
	• Brainstorming for identifying the existing knowledge, related to the topic. • Definition of an angle. Discussion of existing angles around us. To identify different types of angles, to become able to draw/construct different types of angles and to measure different types of angles. • All learning supports are given in advance before the lesson including references, videos and website in audio clips. • All information is given orally and in braille support. • Assistive material for hand-on learning, constructed by 3D-printer, will be available for all students.		
Methods	Provide options for building knowledge	Provide options for building skills	Provide options for building motivation and engagement
	• Discussion • Learning through discovery • 3D printer		
Assessment	Use assessments that accurately measure knowledge development	Use assessments that measure skill development	Use assessments that accurately measure emotional (attitudinal) development
	• Assessment of the learning outcome. • Assessment of the 3D printing model according to criteria focusing on visually impairment. • Assessment of the form of the graded scale that demonstrates many different types of angles.		

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	• A general reflection about the project
Notes/ Reflections/ Adjustments for next time the lesson is taught	

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Lesson Plan: Universal Design for Learning (UDL) and Science Technology Engineering and Mathematic (STEM)

Grade level: High school Subject(s): Mathematics and construction Program content(s): Pythagoras Theorem	**Student**: **Identify barriers for learning**: Visual impairment

	Strategies to mitigate identified barriers		
	Representation Present ideas and information in multiple ways	**Expression** Provide students with multiple ways to express their comprehension and mastery of a topic	**Engagement** Tap into students' interests, challenge them appropriately, and motivate them to learn
Objectives	Describe objectives in ways that are clear and specific	Describe objectives in ways that are measurable and achievable	Establish objectives that motivate students to learn
	Consider whether a shelf mounted on a vertical wall with a metal bracket is horizontal, given the length of the shelf and the length of the metal bracket.		
Instructional Materials	Provide options in the way information is presented	Provide options for students to express what they know	Provide options in the ways students can interact with instructional materials

	• Creation of a proper theoretical basis. Teaching or reference to corresponding geometrical notions.
	  ◦ All kinds of angles. The right angle. The definition of a pair of lines perpendicular to each other.
	  ◦ All kinds of triangles. The right triangle. The two vertical sides and the hypotenuse.
	  ◦ The square and its area.
	  ◦ Pythagoras theorem: The proof.
	  ◦ The inverse of the Pythagoras theorem.
	• Discussion, a brainstorming again, about the problem, as it was initially introduced.
	• All information is given in digital or in braille support.
	• Checkpoints of working development and clarification of doubts.		

	Provide options for building knowledge	Provide options for building skills	Provide options for building motivation and engagement
	• Discussion and Research • Connection of Mathematics to construction and real life: *Geometry easies daily life !* • Frequent checkpoint of the conclusions • Team working • 3D printing • Diagnosis test in the end of the lesson		
Assessment	Use assessments that accurately measure knowledge development	Use assessments that measure skill development	Use assessments that accurately measure emotional (attitudinal) development

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	• Assessment of the whole plan according to the needs of the particular students' group. • Assessment of the 3D printing model according to criteria focusing on visually impairment. • Assessment of presentation or webinar, supporting answers for all possible questions related to the issue. • Assessment of the flexibility of the plan in order to be used again in another somehow different group.
Notes/ Reflections/ Adjustments for next time the lesson is taught	

Objectives

Consider whether a shelf mounted on a vertical wall with a metal bracket is horizontal, given the length of the shelf and the length of the metal bracket.

the shelf (must be horizontal)

the wall

the metal bracket

Instructional Materials

A. Creation of a proper theoretical basis. Teaching or reference to corresponding geometrical notions. From scratch or through a brainstorm for identifying the existing knowledge and skills of students, related to the topic.

1. All kinds of angles. The right angle. The definition of a pair of lines perpendicular to each other.
2. All kinds of triangles. The right triangle. The two vertical sides and the hypotenuse.
3. The square and its area.
4. Pythagoras theorem: The proof.
   A right angled triangle ABC is given (A= 900).
   The lengths of its three sides are also given as AB = c cm, AC= b cm (the two sides are perpendicular to each other) and BC= α cm (the hypotenuse). We construct three squares, two of them on the sides AB, AC and the third on the hypotenuse BC. Then, the area of

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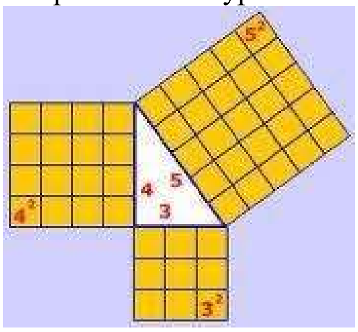
each square will be $AB^2 = c^2$ cm^2, $AC^2 = b^2$ cm^2 και $BC^2 = a^2$ cm^2 respectively. It may easily be shown from the diagram, that the sum of the areas of the two squares on the perpendicular sides is equal to the area of the square on the hypotenuse .

Therefore $BC^2 = AC^2 + AB^2$ ή $a^2 = b^2 + c^2$.



Arithmetical example of the proof above

5. The inverse of the Pythagoras theorem. How can we recognize the existence of a right angle in any given triangle ?

B. We discuss about the problem, as it was initially introduced. We decide that in order for the shelf to be horizontal, it suffices that the triangle which is formed by the shelf, the wall and the metal bracket be a right angled triangle. All we have to do is measure its three sides and check if the Pythagoras theorem applies!

Geometry easies daily life !

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Lesson Plan: Universal Design for Learning (UDL) and Science Technology Engineering and Mathematic (STEM)

Grade level: High school Subject(s): Geometry Program content(s): Measurement of the circumference of a circle.	**Student**: **Identify barriers for learning**: Visual impairment

	Strategies to mitigate identified barriers		
	Representation Present ideas and information in multiple ways	**Expression** Provide students with multiple ways to express their comprehension and mastery of a topic	**Engagement** Tap into students' interests, challenge them appropriately, and motivate them to learn
Objectives	Describe objectives in ways that are clear and specific	Describe objectives in ways that are measurable and achievable	Establish objectives that motivate students to learn
	• To understand that the contanst number π is involved.		
Instructional Materials	Provide options in the way information is presented	Provide options for students to express what they know	Provide options in the ways students can interact with instructional materials
	• Brainstorming for identifying the existing knowledge, related to the topic. • Definition of a circle. Discussion of existing circles in everyday life. • All information is given orally and in braille support. • Assistive material for hands-on learning, constructed by 3D-printer, will be available for all students. • Disks of various radii (plural of radius), bending tactile rulers. Rubber bands can be used instead or in addition.		
Methods	Provide options for building knowledge	Provide options for building skills	Provide options for building motivation and engagement
	• Discussion • Learning through discovery • 3D printer		
Assessment	Use assessments that accurately measure knowledge development	Use assessments that measure skill development	Use assessments that accurately measure emotional (attitudinal) development
	• Assessment of the learning outcome. • Assessment of the understanding of the formula: $L=\pi*\delta$ or $L=2\pi r$. • A general reflection about the project and the teaching method.		

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Notes/ Reflections/ Adjustments for next time the lesson is taught	

Lesson Plan: Universal Design for Learning (UDL) and Science Technology Engineering and Mathematic (STEM)

Grade level: 1st High Scholl grade Subject(s): Physics, Mechanics Program content(s): Static and Sliding Friction	**Student**: Maria, Saidi, John, **Identify barriers for learning**: Total vision loss

<table>
<tr><td></td><td colspan="3">Strategies to mitigate identified barriers</td></tr>
<tr><td></td><td>Representation
Present ideas and information in multiple ways</td><td>Expression
Provide students with multiple ways to express their comprehension and mastery of a topic</td><td>Engagement
Tap into students’ interests, challenge them appropriately, and motivate them to learn</td></tr>
<tr><td rowspan="2">Objectives</td><td>Describe objectives in ways that are clear and specific</td><td>Describe objectives in ways that are measurable and achievable</td><td>Establish objectives that motivate students to learn</td></tr>
<tr><td colspan="3">• Build an inclined plane with variable angle. Add different floor textures, smooth, rough etc use different natural materials and textures.
• Understand the role of the angle and floor texture to the calculation of friction force.
• Understand the difference between static and sliding friction.</td></tr>
<tr><td rowspan="2">Instructional Materials</td><td>Provide options in the way information is presented</td><td>Provide options for students to express what they know</td><td>Provide options in the ways students can interact with instructional materials</td></tr>
<tr><td colspan="3">• Brainstorm for identifying the existing knowledge of students, related to Newton 1st and 2nd lows.
• Identify the difference between different floor textures and how they affect the measure of friction.
• Define friction coefficient.
• Measure the angle and calculate the resistance from the ground.
• Build static and sliding friction’s mathematical formulas. $F_{\kappa}=\mu *N$, $F_{f}\leq \mu_{K}*F_{N}$
• All written information is given in Braille code.</td></tr>
<tr><td rowspan="2">Methods</td><td>Provide options for building knowledge</td><td>Provide options for building skills</td><td>Provide options for building motivation and engagement</td></tr>
<tr><td colspan="3">• Project Base Learning
• Problem solving «How the box will roll without exerting force on it?». Place the box on inclined plane with different coefficients of friction and a fixed angle. Draw conclusions.
• Problem solving «What angle should we have in order to exert less force to move the box upwards?» Calculate the force of friction through the formula as changing the angle. Draw conclusions.
• Combine conclusions, find the formula.</td></tr>
</table>

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<table>
<tr><td></td><td colspan="3">3D printing</td></tr>
<tr><td rowspan="2">Assessment</td><td>Use assessments that accurately measure knowledge development</td><td>Use assessments that measure skill development</td><td>Use assessments that accurately measure emotional (attitudinal) development</td></tr>
<tr><td colspan="3">Check grids for the assessment of checkpoints.
Assessment of the 3D printing model, can it change angles in an easy way, has the floor
Assessment of presentation or webinar and respective defence (questions), according to predefined criteria. The former includes clarity in the presentation and knowledge of the elements contained in the model.
A general reflection about the project</td></tr>
<tr><td>Notes/ Reflections/ Adjustments for next time the lesson is taught</td><td colspan="3"></td></tr>
</table>

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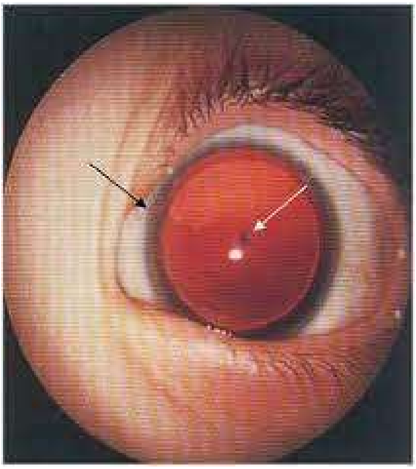
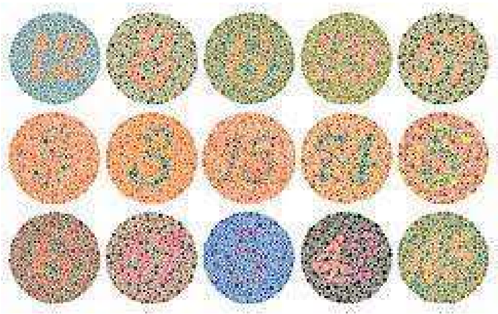
ANNEX I


Albinism

Aniridia



Colorblind

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Coloboma

Cataract

Hemianopsia

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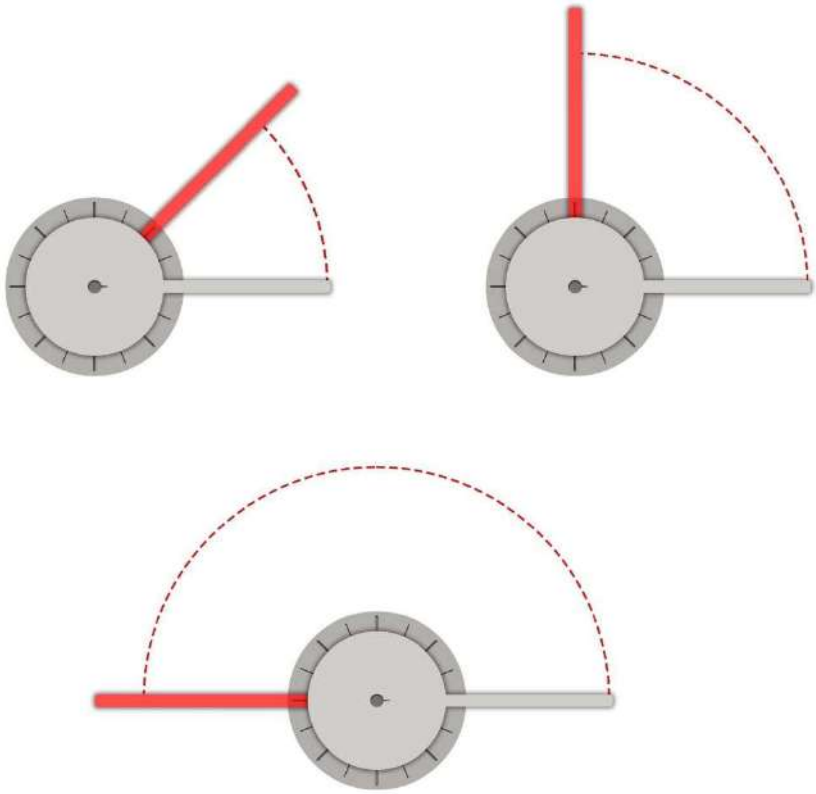
ANNEX II



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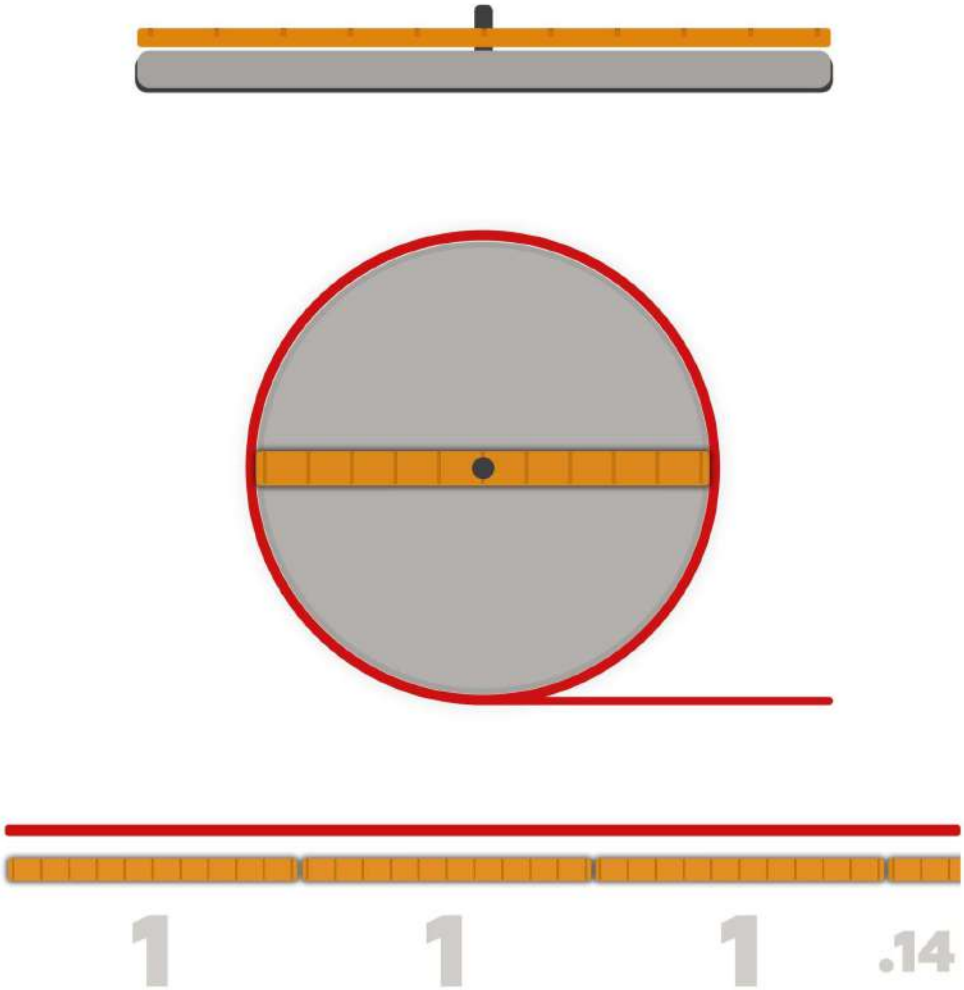

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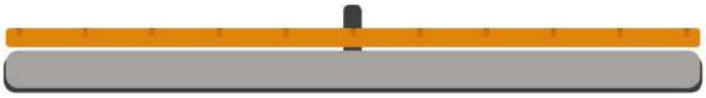

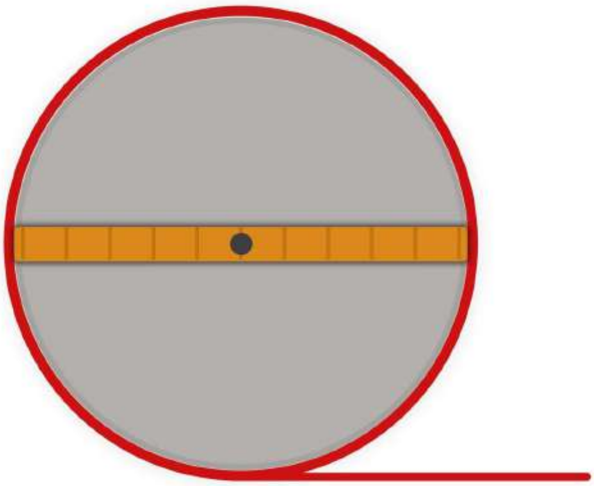

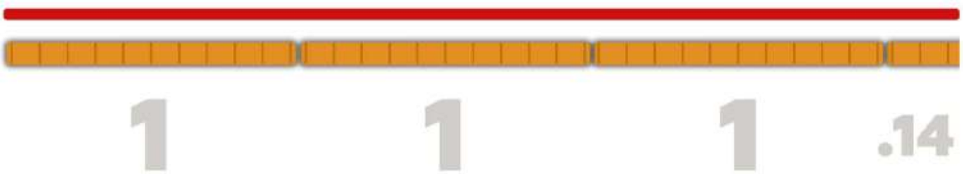

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