Creativity, Arts and Science in Primary Education

CASE

Training Material

CASE Guidelines

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Guidelines

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1. INTRODUCTION

CASE will contribute to teachers' professional development and to the development and sustainability of creativity of young people and propose creative pedagogies. Embedded within this is the vitally important notion that young people are creating wisely and humanely, and that cyclical development occurs between their creativity and their identity. As they generate new ideas; this in turn generates change in them as 'makers'; they are also developing or 'becoming' themselves. Slowly, small changes accumulate to contribute to 'journeys of becoming'. These individual journeys accumulate together, embedded within an ethical awareness of the impact of creative actions on the group.

The **main targets of CASE project** are:

- design and develop training materials aimed at training of primary teachers. These will include user-friendly manuals, guidelines, learning scenarios, open educational resources and social-media tools available on the project's web platform.
- implement a wide-spread training approach for teachers, facilitating intake of creative Inquiry Based Science Education practices in primary schools. The project will realize numerous international mobility activities for primary teachers.
- validate and evaluate the project's approach.
- provide guidelines for continued communication and exploitation of results by the primary education community.

In CASE there will be implementation of 3 main categories of creative science education activities. These are:

Learning Science Through Theater: Students will perform theatrically a story related to scientific themes and will learn science in a creative way. This case promotes the comprehension of scientific concepts and phenomena, development of a spirit of cooperation and teamwork and the development of creative and critical thinking skills. The specific objectives of the activity have as a central axis the interdisciplinary connection of science with aspects of art, aiming at the enhancement of students' interest in science.

Learning Science Through Puppetry: In this case, inquiry-based science education will be combined with puppetry. In every activity, a puppetry story will be played by the teacher. In this story the puppets have a problem or a question. This will arouse children's curiosity, which instantly will stimulate them to discover. Children will help the puppets to find a solution or answer. All activities will be challenging tasks in the field of STEAM education and every process can have many different results. Children will research like scientists and design like artists.

Learning Science Through Digital Narratives & Storytelling: This CASE includes 2 sub cases.

Digital Narratives: This activity aims to transform science presented in curricula (usually strict, stiff and boring for young people) to open, friendly and interactive communication supported by the re-contextualization of science content in digital narratives created by learners. In order to do that a simple animation technique is used called slowmation: a slow and simple animation using only 2 photos per seconds. Slowmation movies are created in a creative learning environment where science concepts meet with art, music, literacy, society, history and philosophy of science. The developed digital narratives highlight and present the abstract science concepts and theories in a creative and original way. Furthermore, the presentation of the developed digital narratives on the web provides a meeting place for learning and cooperation between young people.

Digital Storytelling: The overall concept of the digital storytelling case is to provide the means and the tools along with the necessary collaborative and personalisation functionalities to introduce students in extended episodes of deeper learning in STEM combined with Art-related activities (visual and performing arts, music, movie making, 3D design). The specific case will introduce students in a progressive exploration of the different technologies that can be accommodated from the provided system, from simple text and video uploading to advanced augmentations of students' artifacts.

2. The CASE Framework

2.1 Introduction

This section describes the framework in which the CASE project is based on. It will present the concept and the approach that is used in order to introduce Creativity and Art in Science Education in the Primary Schools. It is based on already existing approaches that have been tested for many years (since 2014) mainly in secondary schools as well as in approaches that were used in Primary Schools settings. The combination of this approaches consists the CASE Framework.

2.2 Creative STEM Education

Figure 2 offers an overview on the CASE project approach. At the core of the approach are the **Cases** and the accompanying **pedagogic principles** (see Figure 1). The aim of the project is to be able to describe and inform these cases via the inquiry and creative learning approaches in order to generate innovative practice and creativity in STEM related activities in the primary education. Figure 2 therefore represents the CASE understanding of how the theories and ideas can be synthesised together conceptually, uniquely in order to achieve this.

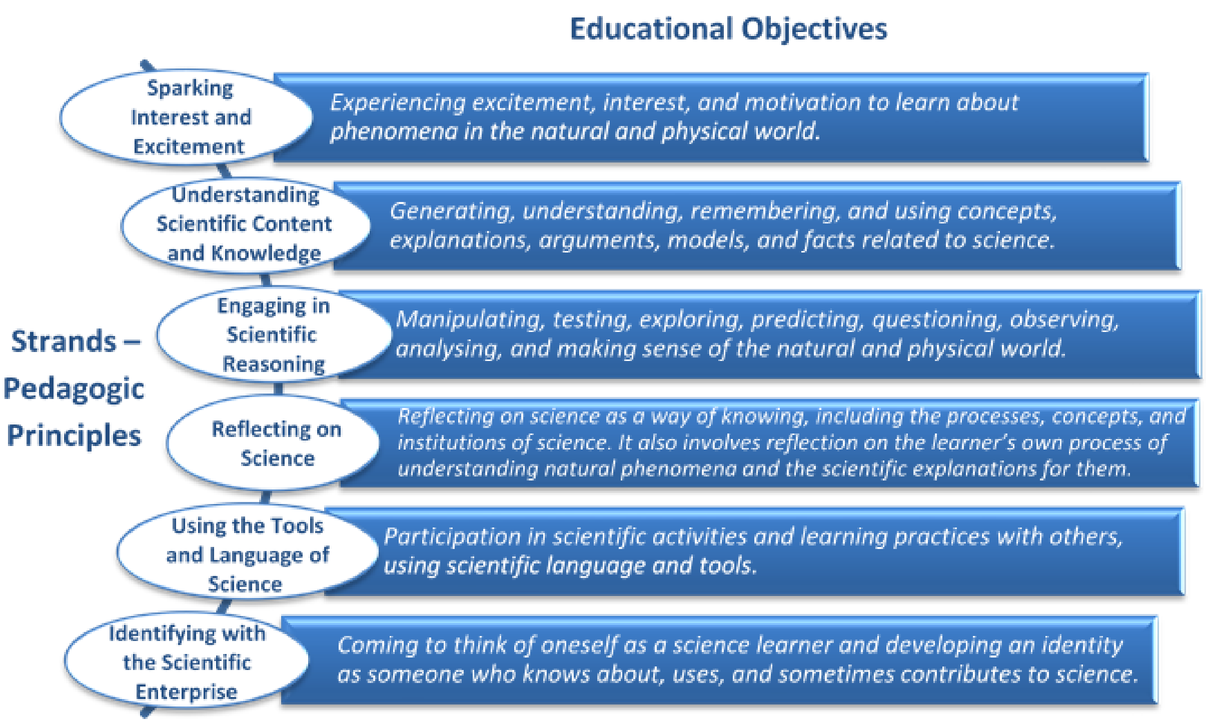


Figure 1: *The main Pedagogic Principles and the Educational Objectives for the design and implementation of the creative cases in the framework of CASE project.*

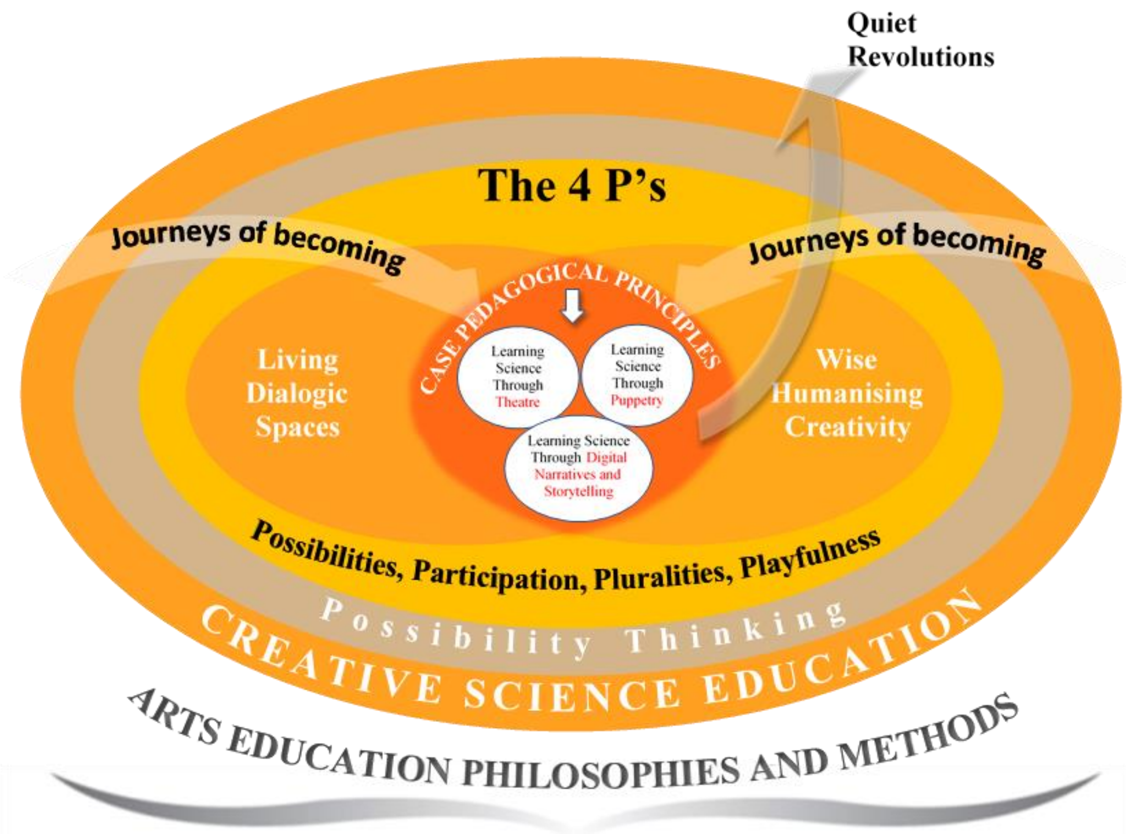


Figure 2: *The **CASE** approach that is based on the integration of arts into STEM activities, simulating the ways in which subjects naturally connect in the real world*[1]

Creative STEM education is the main context within which CASE project has been developed. At the bottom of the graph **arts education philosophy and methods** is positioned as a "holder" within which creative STEM education (as opposed to all STEM education) is being nurtured, grown or "encultured" via arts practice. As we move in towards the centre of the graph we can see that one of the main drivers for CASE creativity is **possibility thinking** for all involved. This means being able to ask "what if" and "as if" questions:

- what if I/we choose to explore this scientific question rather than that one…?;
- what if I/we use this arts approach to help me explore my question...?
- how can I/we imagine this as if I were…?;
- what happens if I as student collaborate with that artist as if I…?.

[1] This approach is based on the framework of CREAT-IT project (http://creatit-project.eu) and its update from the CREATIONS project (http://creations-project.eu/).

This will be strongly encouraged in the way the CASE pedagogic principles are ultimately employed in order to help learners and adult professionals imagine new ideas in STEM education; to shift from "what is" to new possibilities of "what might be". As we move in another layer towards the centre of the graph, we can see four key defining features of CASE classroom environments. These are the **4Ps** of engagement in creative STEM education (Craft, 2011):

- **pluralities:** opportunities for students and teachers to experiment with many different places, activities, personal identities, and people
- **possibilities:** opportunities for possibility thinking, transitioning from what is to what might be, in open possibility spaces
- **participation:** opportunities for students and teachers to take action, make themselves visible on their own terms, and act as agents of change
- **playfulness:** opportunities for students and teachers to learn, create and self-create in emotionally rich, learning environments.

We then come closer to the heart of the CASE graph and find **WHC (wise humanising creativity)** and **LDS (living dialogic space)**. The WHC that is being sought in CASE is not only an individual activity, but also happens in **collaboration** with fellow learners, teachers and other adult professionals (artists, researchers, science experts). These individual and collaborative creative activities form part of a wider web of ethically-guided communal interaction geared towards both helping children and young people become more creative and assisting teachers in becoming more creative in how they teach science. For this reason, WHC is positioned very close to the heart of the CASE graph as it is one of the core aims of the CASE pedagogic principles. Alongside and integrated with WHC, is LDS, always a partner to WHC in terms of conceptualising ideas and developing practice. Again, LDS is at the heart of the CASE graph because its methods (participation, emancipation, working bottom up, debate and difference, openness to action, partiality, and acknowledging embodied and verbal modes of knowing) are fundamental to allowing WHC to happen. Chappell et al, (2012) have evidenced the importance of dialogue at the heart of engaged, creative learning in the arts and it is this kind of dialogue that has been highlighted and applied within the CASE approach. Students' stories will promote the idea of dialogue between people, disciplines, creativity and identity, and ideas. This dialogue acknowledges and allows for conflict and irreconcilable difference. It might be argued that facilitating open discussion of the problems pupils are facing in understanding scientific concepts and in solving scientific problems is key to a pedagogy which acknowledges their values, needs and expectations as citizens of the European Society.

As detailed above all of these layers of conceptual ideas have been synthesised together not only to develop this CASE graph and accompanying narrative but also to generate CASE own set of unique working **pedagogical principles**. Hence the connector in the image between WHC and LDS, and the students' cases are these principles. The principles represent the unique way that the consortium ideas come together in order to underpin the CASE pedagogies.

So, via these processes the CASE project will contribute to developing creative young minds with deep knowledge in STEM and creative STEM teaching pedagogies. Embedded within this is the vitally important notion that students and teachers are creating wisely and humanely, and that cyclical developments occur between their creativity and their identity. As they generate new ideas; this in turn generates change in them as 'makers'; they are also developing or 'becoming' themselves. Slowly, small changes accumulate to contribute to "**journeys of becoming**" (shown developing across the layers in Figure 2). These individual journeys accumulate together, embedded within an ethical awareness of the impact of creative actions on the group. Through this process small-scale creative changes or "**quiet revolutions"** can take place for the group as a whole (shown as emerging from the heart of the project's cases).

The CASE approach is based on the fact that ideas generated through **individual, collaborative and communal activities** have a potent capacity to contribute to engagement and change. The layer of communal engagement is particularly important in terms of the societal level of the Responsible Research and Innovation, and the idea that innovators need to be mutually responsive within and beyond their communities. The idea of communal engagement (Chappell, 2008) acknowledges that when working creatively people exist in groups with shared identities which shape their ideas and thinking and which may be challenged by the thinking of other groups. This raises ethical questions which need consideration if these challenges are to be overcome (Craft, Claxton and Gardner, 2008) and people are to be genuinely engaged in scientific debates and questions via education.

Of vital importance to nurturing **empowerment and agency, dialogue, individual, collaborative and communal activities for change** and **ethics and trusteeship** are two more CASE principles which finally resonate with the way the scientific issues are research outcomes have to be communicated to the students. The first is the importance of rigorous **Discipline knowledge.** This means STEM disciplines knowledge but it is also embedded in the idea that there are different ways of knowing in the world, alongside those prioritised within the scientific realm which scientists must engage with in order to generate conversations between their ideas and those of the "public" in order that a shared dialogue can be ongoing rather than a one-way conversation. The second is the promotion of the idea of **professional wisdom.** At its heart, the CASE approach values the idea that teachers bring a wealth of often intuitive teaching and discipline knowledge and expertise; they cannot be viewed as "information deliverers". It is their professional wisdom that can make the STEM learning process creative and can engage children and young people in a meaningful way.

In the framework of the project we are aiming to initiate an informed debate regarding collaboration between Art and STEM at curricular level in schools.

Today, the subjects continue to be perceived as intrinsically different and separate, both pedagogically and culturally. In CASE we will **combine Science with Arts** and test it through the proposed approach, which **pushes the boundaries of subject interconnection in primary schools**, while simultaneously providing a vehicle for creative STEM education, the acquisition of skills and having fun while learning. In fact, there is an unparalleled level of connection between these two disciplines. As Wenham (1998, pg.61) states "there is and always has been significant common ground between art and science, encompassing not only issues of mutual concern but also modes of enquiry." If we accept that artists and scientists (amongst others) are searching for understanding and meaning, then this is our first common bond between the two disciplines, and our starting point. Deckert (2001, pg.125) says science is "usually seen as rational and analytical and art often considered subjective and emotional." With perceptions of art and science so diametrically opposed in our society, it is necessary to be clear about their commonalities and where opportunities for meaningful collaboration exist.

Prior to designing and developing such an experiment, we have identified five main categories of commonality between STEM and Art. This is essential to ensure authenticity in our approach and appropriate justification for implementing the project in schools. The five categories are: modes of inquiry; fields of study; experimentation; creativity and imagination; aesthetic experience and artistic attitude. The CASE approach is integrating all these characteristics in an integrated activity that is still seems a natural even to the young students.

3. The CASE Methodology

3.1 Creative Inquiry Based Science Education

The CASE project attempts to combine the Inquiry Based Science Education framework with creative learning approaches and arts in order to succeed fruitful and effective learning in primary education. There is a current demand for instructional material and teaching methods in order to support the development of cognitive, meta-cognitive, social and emotional skills both for the classroom and for teacher training. Therefore, the target skills developed in schools and teacher-training courses need to be reassessed, as also the ways in which students are expected to learn and teachers' to be trained (Seroglou 2006). When teaching science, learners' motivation is always a challenge: How to motivate students, and in-service teachers, to develop active interest in abstract and complex "theoretical" issues. Students and teachers find the various science concepts presented in curricula "too difficult" and, in their eyes, "not at all interesting" (especially when compared with, e.g. ethics or aesthetics courses). Especially in the case of in-service teachers, although they teach science, they often present low self-esteem concerning their skills in describing, discussing and elaborating science concepts, theories and phenomena in the classroom (Guskey 1988, Allinder 1994, Connor 2007).

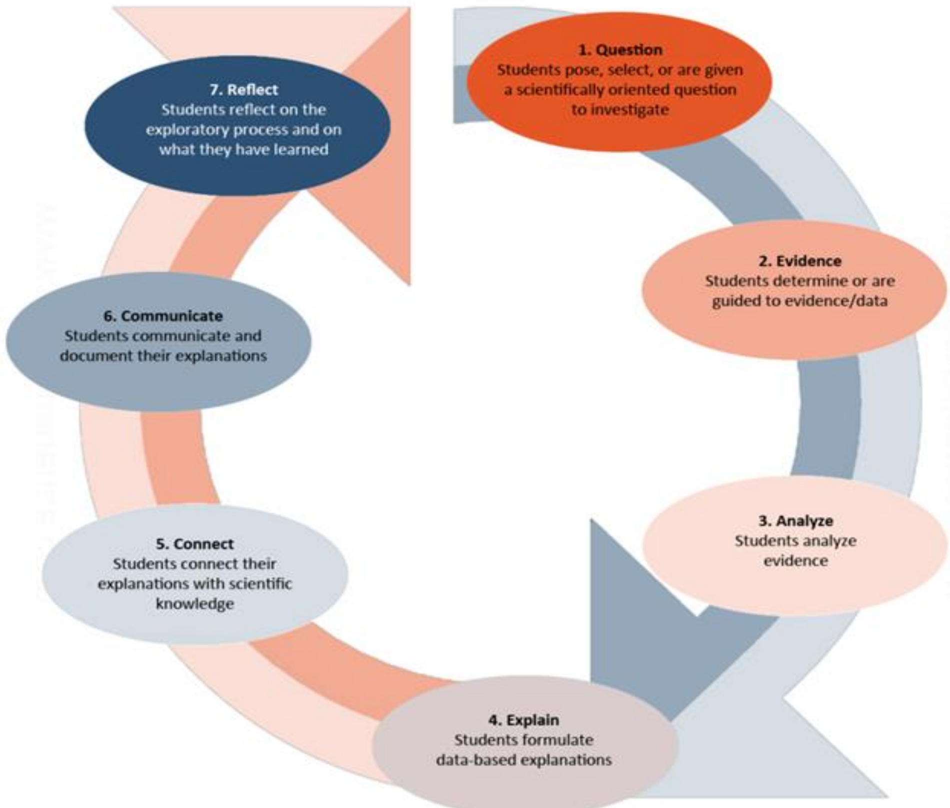


Figure 3: *Inquiry Based Science Education Circle in CASE project*

This is achieved through their active participation in activities that make sense to the students, chiefly due to the fact that they are largely initiated by those students themselves. Students understand in-depth the scientific concepts through their own perception of the world that surrounds them and through their own experiences and reflective processes.

3.2 The CASE Method

The CASE project elaborates a methodology that regards teachers as agents of change. It aims to empower their profession with skills and competencies that will enable them to widen their teaching capabilities by incorporating creativity and art in science education. For this, the consortium has a specific master plan that will be followed, containing a series of training events supported by the CASE materials. The scope of this training scheme will be to motivate teachers to become aware of specific weaknesses in their own practice and the need to make necessary improvements aligned to the guidelines of Europe for the future of science education. In general, this requires a deeper change in motivation that cannot be achieved through changing material incentives. Such changes come about when teachers have high expectations, a shared sense of purpose, and above all, a collective belief in their common ability to make a difference to the education of the children they serve. Individual teachers need to gain understanding of specific best practices. In general, this can only be achieved through training and demonstration of such practices in authentic settings.

The CASE project is going to be implemented following a structure with:

- 3 outputs to conduct the needed work of preparation and Development of support material (O2), Implementation Activities & Pilots (O3) and Evaluation, Validation and Quality of the projects activities (O4)
- 3 Training activities – summer schools (C1 – C3) where the participants will be trained on how they can implement the CASE Pilots and they will act as agents in their countries.

All categories of activities are presented in the following timeline (figure 4) so to illustrate the plan that the project has. The main aim is that each year CASE will train at least 16 persons (teachers, artists working with students, in service teachers) in order to be ready to implement the activities in the next school year. In total the project aims to train at least 48 persons so to initiate a network of CASE ambassadors that will work in their countries with other teachers and schools.

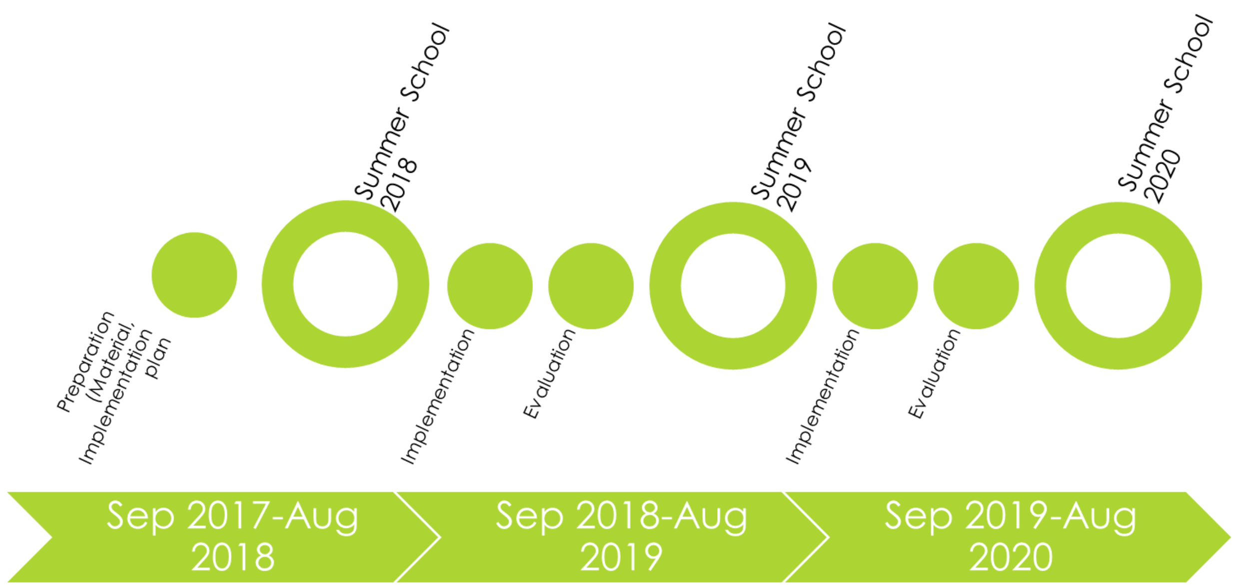


Figure 4: *The timeline of CASE project.*

3.3 Structuring the CASE Material

In CASE, science and art are intertwined, as shown in Table 1 below. The interaction between these fields within IBSE requires creative solutions on the part of both students and teachers and enables new ways of thinking about the science curriculum. In CASE, a core cycle of query, evidence collection, analysis, explanation, connection, communication and reflection is adopted and at the same time puppetry, theatre, slowmation and digital storytelling in science education create a multi modal learning environment. In CASE, science understanding is based on the use of models, representations and other forms of visualization, in order to explain, clarify and demonstrate complex or abstract phenomena (Seroglou, 2006). We are using the steps of the Inquiry Based Science Education Circle (figure 3).

Table 1: *CASE activities in the context of Inquiry Based Science Education*

IBSE Steps	Learning Science Through Theatre	Learning Science Through Puppetry	Learning Science Through Digital Narratives and Storytelling	
			Slowmation	Storytelling
Question	Students face a scientifically oriented question and are asked to think of a story and characters about it	Hand-puppets ask students scientifically oriented question	Students face a scientifically oriented question and are asked to develop a narrative about it	Students face a scientifically oriented question and are asked to develop a story about it. Students will create storyboards and flipbook-style animations with paper and pencils
Evidence	Students search for information and try to integrate them into a script	Students search for information in discussion with hand-puppets	Students search for information and include them in the narrative that they develop	Students search for information and include them in their story. They will work with relevant scientists and engineers to learn about the specific topic
Analyze	Students discuss, analyze science concepts while creating a theatrical script	Students play, discover and observe using their senses	Students discuss, analyze science concepts while creating a scenario for slowmation	Students discuss, analyze science concepts while creating their digital storytelling using a specific platform (the STORIES platform)
Explain	Students explain science concepts while developing their theatrical performance. They communicate with researchers as well as artists in order to integrate the explanations into the performance.	Students collaborate and discuss decisions with hand-puppets	Students explain science concepts while creating props (heroes and backgrounds)	Students will explore drawing, visual communication and image making to develop their ideas and concepts

IBSE Steps	Learning Science Through Theatre	Learning Science Through Puppetry	Learning Science Through Digital Narratives and Storytelling	
			Slowmation	Storytelling
Connect	Students explore the subject spherically and find interconnections during teamwork on music composition, scenography, lighting, costumes video production or editing etc.	Students discuss with hand-puppets in order to make connections of the new scientific knowledge	Students explore the subject spherically and find interconnections during teamwork on shooting and recording sounds and narration for slowmation	Student will follow their story. They will be able to compose music and prepare a video or a performance and film it. They will develop 3D printing models to use in their story and also a digital book, the digital storytelling, with all the components in it (music, theatre, visual objects).
Communicate	Students use their bodies and voices to communicate scientific concepts in their theatrical performance. They perform in front of audience within their school or in any local and national initiative. Also, they disseminate their event in their local community	Students communicate science concepts using forms of art (living statue, painting, puppets)	Students use images and sounds to animate and communicate science concepts as they edit their slowmation videos	Their project will be uploaded in the STORIES platform and they will share it and communicated to the rest of the school. Also, they will organize an event to perform and demonstrate their result, open to the audience.
Reflect	Students evaluate their work and receive feedback from artists and scientists	Students reflect on the learning process discussing with hand-puppets	Students show the developed video, discuss and reflect with artists and scientists	Students evaluate their work and receive feedback from artists and scientists

Students and teachers, in their way to become scientifically literate citizens, use puppets, theatre, slowmation and storytelling in order to learn science concepts and phenomena, representing them and their personal perspective about science in their activities. They develop a spirit of co-operation and teamwork, actively participating in the negotiation of scientific concepts and develop creative and critical thinking skills. Students and teachers handle knowledge from science in society, present attitudes and values that are expressed by science and affect their life in and out of the school (Seroglou, 2006, AAAS, 1993, Aduriz-Bravo, 2005).

Students and teachers recontextualize the facts and concepts of science creating new mediums of communication and interpretation of abstract science concepts (Hofstein & Rosenfeld 1996; Seroglou, 2006, Piliouras, et al., 2011; Seroglou & Aduriz- Bravo, 2007). Learning Science Through Theatre, Learning Science Through Puppetry and Learning Science Through Digital Narratives and Storytelling (Slowmation and Storytelling) contributes to further bridging school with society, allowing students to present their ideas, to improve their self-esteem, to take an active part, to use and develop educational material. A spread of information, collaboration, contribution, codependence and team spirit occurs, to achieve the knowledge and information transformation from single-dimensional and limited to multidimensional (Koulountzos & Seroglou 2007b).

The CASE science activities that use art and narratives (puppetry, theatre, slowmation, storytelling) seem to non-experts less complicated and friendlier than general descriptions of scientific theories and have the added bonus of being more “personal” and relatable. The CASE activities create the background to integrate knowledge, to set the scientific events in context and facilitate students and teachers to encounter science knowledge in a more holistic context as t is recommended in the EC’s recent report Science Education for responsible citizenship (2015).

During the CASE activities students learn in a pleasant, transformative and effective way using materials and situations they are familiar such as puppets, costumes, toys, photos, music, painting, 3D printing etc. to represent their constructions of science concepts, develop narratives to present their science knowledge, engage with science concepts in multiple and transformative ways (Kress et al., 2001; Hoban et al., 2007; Seroglou et al., 2008; Keast et al., 2010; Brown, 2011; Mezirow, 2000; Hoban & Nielsen, 2010).

4. Template for the Cases

In the Annex, the CASE project's template may be found. It is based on the structure of our training materials for Learning Science Through Theater, Learning Science Through Puppetry and Learning Science Through Digital Narrative and Storytelling.
The aim of the template is to support teachers' development, description and documentation of their own CASE-inspired teaching activities by providing a strong theoretical and pedagogical background. In this chapter, a brief description is provided as a guide to the teachers' working with the template. The description follows the template's structure.

Name of your activity

Choosing a name for the art-science activity is a fun and important part of your process. We recommend involving your students in this choice. This allows students to experience ownership towards the activity and its content.

There is no "correct" way to name your activity. Including an element of science and an element of arts in the activity's name is a good way to indicate to those involved what the nature of the activity is. Some suggestions may be "the Drama of Jupiter" or "Animation for the Seasons".

Some words about the activity

A general description of the activity should be included in this section. Some important issues to address are how you plan to bring together elements of science and art education; why you consider this to be a creative activity; an explanation of what you expect the students to learn; and added values for the students beyond the curriculum (e.g. how they may interact socially during the activity, potential to support critical thinking skills, etc.).

Implementation phases – General overview

Implementation of CASE activities follows an inquiry-based art and science approach in seven phases:

1) Question. 2) Evidence. 3) Analysis. 4) Explain. 5) Connect. 6) Communication. 7) Reflect.

For each of these phases, the CASE template accommodates detailing the key characteristics, the educators' actions, and the students' actions. When developing your own template, it is especially exciting to add new insights and ideas during the various phases, which you have not tried before.

Implementation phase – Question

Key Characteristics: Finding a scientifically oriented question for the students to investigate.

Educators' actions: Describe the chapter/module/theme from the classes' science curriculum which provides the focus for the CASE activity. Document the dialogue with the students, and the questions they ask.

Students' actions: Describe your expectations of the students during the "question" phase. What is required of them? Students may play an important role in choosing the overall question from a pool of options provided by the teacher and drawn from the curriculum.

Implementation phase – Evidence

Key Characteristics: Describing the details of how the students will gather evidence relating to their specific question.

Educators' actions: The teacher's role in this phase is to support the students' evidence gathering. Describe what you will need for this specific activity (e.g. specific books, laboratory equipment, internet access etc.).

Students' actions: Describe the details of how students will gather evidence in this activity. Mention specific challenges that may arise, and how they may be dealt with.

Implementation phase – Analysis

Key Characteristics: Describing the organization and analysis of data collected during the previous phase.

Educators' actions: Describe how to coordinate the discussions among students about the scientific data. Provide details about strategies which you may use to support the students' organization of their data. Then, provide details for how the students will be invited to begin their arts activity, inspired by their analysis. We encourage you to be creative here! There may not be a "one size fits all" way to make this transition from the scientific analysis to the artistic part of the activity.

Students' actions: students analyze and categorize the data. They make a first attempt to create a scenario on which their arts-education activity will be based. They may work in groups to generate ideas for how to achieve this.

Implementation phase – Explain

Key Characteristics: Here students engage in dialogue in order to contemplate possible explanations and answers for the question raised earlier.

Educators' actions: The teacher supports students' making connections between their question and the gathered data.

Students' actions: Students collaborate and discuss decisions about the basic explanations they will adopt to answer the scientific question(s). This discussion should provide content for the arts-education activity's process and product.

Implementation phase – Connect

Key Characteristics: Inter-disciplinarity: as students connect scientific concepts with areas of knowledge drawn from arts and art forms.

Educators' actions: Describe specific ways in which the teacher will guide the students' exploration of science connection to specific, concrete areas of knowledge in the arts. Note: there are many ways to do this, and we encourage you to discover your own new ones. It is important to remember that inter-disciplinary projects have the deepest meaning and added value when all disciplines are involved with equal levels and treated with equal value and importance. Specific, concrete measures may include finding materials from the science class (leaves, rocks, liquids, etc.) to be used in the arts education activities.

Students' actions: Describe the inquiry process you wish the students to undergo. What kind of understandings would you like them to gain at the intersection of science and art? What kind of questions do they need to ask in order to reach this? Note: be specific and use concrete, tangible examples from both science and art in your description of this phase.

Implementation phase – Communication

Key Characteristics: Describing the methods, tools, and activities the students will use to communicate their new knowledge and the process they have undergone.

Educators' actions: Describe the way in which the teacher(s) in your activity will guide students' reaching out to various target audience. These may be the general public, families, local community, professional artists, scientists, etc.

Students' actions: In this part of the template, describe the students' communication actions and ideas. Include links to websites (e.g. local radio station) which may inspire students to reach out to others. Also, include ideas which were raised by the classroom, but which were not realized due to limitations of time, resources, etc. These may come in handy for future implementations of your activity!

Implementation phase – Reflect

Key Characteristics: Describing the approach to student reflection and assessment of the activity.

Educators' actions: Describe how the teacher(s) intend to lead the students' reflection process. It is important to note that there many different elements and perspectives to reflect on in the CASE approach. Students may reflect on the scientific inquiry process, on the arts inquiry process, on the way in which the arts impacted their sensation and experience, on the challenges they met during the process, and more. Note: Typically, students will surprise you during reflections about the CASE activity! Make sure you are prepared for this by being open and accepting that the discussion may wander into "unchartered waters". This is acceptable and even recommended. Let it happen. See where it takes you.

Students' actions: Use this part of the template to plan for, and especially document, students' reflections upon their experience here. They may produce interesting reflections, and this is a crucial part of their inquiry process. For many of them, the CASE activity will have been a completely new experience. It will have challenged them in new ways which are surprising. Their physical class structure has probably been different than what they are used to. Their daily schedule may have changed. The goals of learning, as they perceive them, have been altered. They are in new territory. Many of your students will, during reflection, provide insight into their creative process. This helps the other pupils (and the educators) understand and put words to what they have experienced.

Note: CASE activities may be new, challenging, and exciting. But not all students find CASE to be easy. Some pupils depend very much on a rigid structure for the daily process in the classroom. For these students, CASE may be strange, and they may intuitively search for their familiar situation. Do encourage them to be open about this. You will most certainly gain new insights about how to adapt CASE to additional personalities of students in the future.

5. REFERENCES

Aduriz-Bravo, A. (2005). An introduction to the nature of science. Buenos Aires (in spanish): Fondo de Cultura Economica.

Alexopoulos, I., Sotiriou, S., Smyrnaiou, Z., Sotiriou, M., Bogner, F. (2016). CREATIONS: Developing an Engaging Science Classroom, HiSTEM

Allinder, R. M. (1994). The Relationship between Efficacy Consultants, Teacher Education and Special Education, 17, 86-95.

American Association for the Advancement of Science (AAAS) (1993). Benchmarks for Science Literacy: Draft, AAAS, Washington, DC.

Brown, J. (2011). The impact of student created slowmation on the teaching and learning of primary science. Post-graduate Thesis. School of Education Edith Cowan University, Perth, Western Australia.

Connor, R. (2007). The Effect on the Self-efficacy for Science Teaching and Knowledge in Practicing Elementary Teacher through Participation in a Professional Development Program Promoting Nature of Science Understanding. Paper presented at the Ninth International History, Philosophy & Science Teaching Conference, June 24-28, 2007, Calgary, Canada.

Chappell, K., Craft, A., Rolfe, L. &Jobbins, V. (2012). Humanising Creativity: valuing our journeys of becoming. International Journal of Education and the Arts.13:8, 1-35.http://www.ijea.org/v13n8/[Retrieved Jan 2013]

Chappell, K. (2008) Towards Humanising Creativity. UNESCO Observatory E-Journal Special Issue on Creativity, policy and practice discourses: productive tensions in the new millennium, 1:3, Available from http://www.abp.unimelb.edu.au/unesco/ejournal/vol-one-issue-three.html [Retrieved September 2014]

Craft A., O. Ben Horin, M. Sotiriou, P. Stergiopoulos, S. Sotiriou, S. Hennessy, K. Chappell, Ch. Slade, M. Greenwood, A. Black, E. Lale Dobrivoje, Đ. Timotijević, A. Drecun, A. Brajović, C. Belmontecinzia, G. Conforto, “CREAT-IT: Implementing Creative Strategies into Science Teaching”, New Developments in Science and Technology Education, Springer, Innovations in Science Education and Technology Vol. 23, 1, 2016, pp. 163-179, doi 10.1007/978-3-319-22933-

Craft, A., Gardner, H. & Claxton, G. (2008) Creativity, Trusteeship, and Wisdom. Thousand Oaks: Sage. Jennifer A. Strauss, Richard M. Allen; (2016) Benefits and Costs of Earthquake Early Warning. Seismological Research Letters ; 87 (3): 765–772. doi: https://doi.org/10.1785/0220150149

Craft, A. (2011). Creativity and Education Futures. Changing Childhood and Youth in a Digital Age.

Deckert, Diana (2001) Science and Art: Lessons from Leonardo da Vinci in Burnaford, G.

European Commission, Directorate-General for Research and Innovation Science with and for Society (2015), Report to the European Commision of the Expert Group on Science Education (SEEG*), Science Education for responsible citizenship*. Retrieved from: http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf

Guskey, T. R. (1988). Teacher Efficacy, Self-concept and Attitudes toward the Implementation of Instructional Innovation, Teaching and Teacher Education, 4, 63-69.

Hoban, G. & Nielsen, W. (2010). The 5 Rs: A new teaching approach to encourage slowmations (student generated animations) of science concepts, Teaching Science, 56 (3) (2010), pp. 33-38

Hoban, G., Ferry, B., Konza, D. & Vialle W. (2007). Slowmation: exploring a new teaching approach in primary school classrooms. Proceedings of the 2007 Australian Teacher Education Association Conference.

Hofstein, A. & Rosenfeld, S. (1996). Bridging the gap between formal and informal science learning. The Wizeman Institute of Science, Israel.

Keast S., Cooper R., Berry A., Loughran J. & Hoban G. (2010). Slowmation as a pedagogical scaffold for improving science teaching and learning. Brunei International Journal of Science & Mathematic Education, 2(1), 01-15

Koulountzos, V. & Seroglou, F. (2007a). 'Designing a Web-based Learning Environment: The Case of ATLAS'. Paper presented at IMICT 2007 Conference" Informatics, Mathematics and ICT: a golden triangle", 27-29, June 2007, Boston.

Koulountzos, V. & Seroglou, F. (2007b). 'Web-based Learning Environments and Teacher Training in Science Literacy'. Paper to be presented at ITET 2007 and ETLLL 2007 Joint Working Conference "Information Technology for Education and Training", 26-28 September 2007, Prague.

Kress, G., Jewitt, C., Ogborn , J. & T Satsarelis, c. (2001). Multimodal Teaching and Learning: Rhetoric s of the science classroom (London, Continuum).

Leci, A., Vourlias, K., & Seroglou, F., (2013). "Six activities to change pupils' science world": Science in the courtyard. Πρακτικά συνεδρίου ESERA, 2013.

Martina S. J. van Uum, Roald P. Verhoeff & Marieke Peeters (2016) Inquiry-based science education: towards a pedagogical framework for primary school teachers, International Journal of Science Education, 38:3, 450-469, DOI: 10.1080/09500693.2016.1147660

Gentzi, E. (2014). Teaching science through narratives in a science club. Thesis. School of Primary Education, Faculty of Education, Aristotle University of Thessaloniki (in Greek).

Pilliouras, P., Siakas, S., & Seroglou, F., (2011). Pupils Produce Their Own Narratives Inspired by the History of Science: Animation Movies Concerning the Geocentric-Heliocentric Debate. Science and Education, 20(7-8), 761-795.

Seroglou, F., & Aduriz-Bravo, A. (2007). Designing and evaluating nature-ofscience activities for teacher education. Paper presented at the 9th international history, philosophy and science teaching conference, June 24–28, 2007. Calgary, Canada.

Seroglou, F., Koulountzos, V., Papadopoulos, P. & Knavas, O. (2008). Restructuring science stories in films & role-playing: Teaching science concepts in their social and cultural context. Invited paper presented at the second international conference in science teaching, July 14–18, 2008. Munich, Germany: Deutsches Museum.

Seroglou, F. (2006). Science for citizenship. Epikentro publications. Thessaloniki. (in Greek)

Smyrnaiou, Z., Sotiriou, M., Sotiriou, S. & Georgakopoulou, E.. (2017). Multi- Semiotic systems in STEMS: Embodied Learning and Analogical Reasoning through a Grounded- Theory approach in theatrical performances, Journal of Research in STEM Education.

Smyrnaiou Z., Georgakopoulou E., Sotiriou M., Sotiriou S. (2017). The Learning Science Through Theatre initiative in the context of Responsible Research and Innovation, Proceedings of The 10th International Multi-Conference on Society, Cybernetics and Informatics: IMSCI 2017.

Suduc A-M., Bizoi, M., & Gorghiu, G. (2015). Inquiry Based Science Learning in Primary Education, Procedia - Social and Behavioral Sciences, 205, 474 – 479.

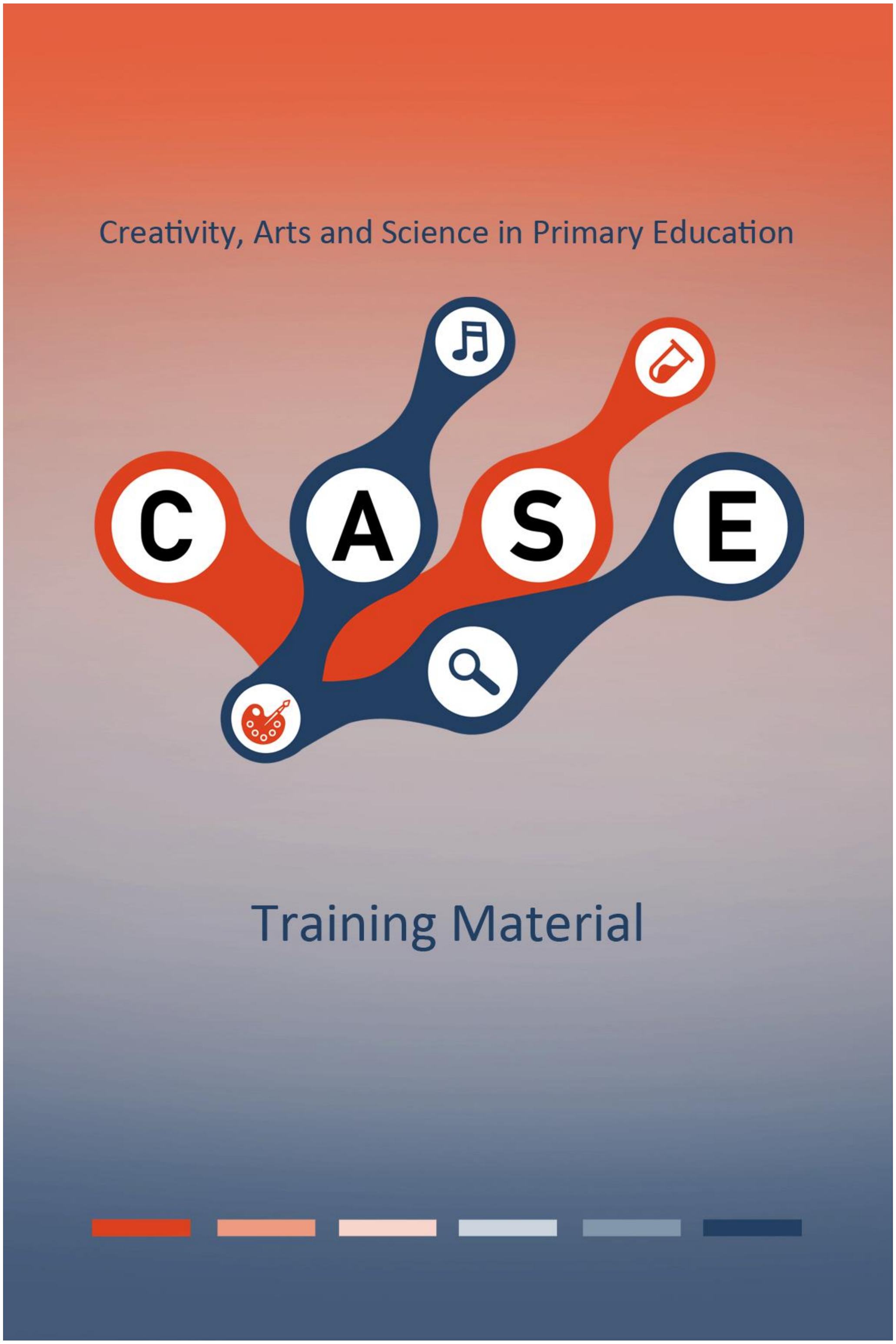
Wenham, Martin (1998) Art and Science in Education: The Common Ground. Journal of Art and Design Education Volume 17, Issue 1

6. ANNEX

Dear teacher,

This annex includes a template which you may use to structure, describe and document your own ideas for activities within the CASE project's framework.

Good luck!


Creativity, Arts and Science in Primary Education
CASE
Training Material

The CASE Project and Inquiry based science education

In CASE, primary teachers are agents of change.

Dear teacher,

This document is a template which the CASE project places at your disposal in order to encourage you to plan, document and communicate creative teaching sequences. In CASE, science and the arts are intertwined. Based on pre-existing creative CASE materials, we would like to invite you to take the exciting journey of developing your own ideas for how your classroom may *feel*.

CASE aims to empower teachers' profession with skills and competencies which will enable them to widen their teaching capabilities by strengthening creativity in the classroom. Our approach to creativity lies at the intersection of science and art in education.

Inquiry Based Science Education (IBSE) is a method of teaching and learning that focuses on use of questions, problems, and educational scenarios used to engage students in concepts of science and support their acquisition of scientific knowledge and skills. This is achieved through their **active participation** in activities that make sense to the students, chiefly due to the fact that they are largely initiated by those students. Students understand in-depth the scientific concepts through their own perception of the world that surrounds them and through their own experiences and reflective processes.

In CASE, science and the arts are intertwined. The interaction between these fields within IBSE requires creative solutions on the part of both students and teachers, and enables new ways of thinking about the science curriculum, as shown below.

Various approaches have been developed for IBSE implementation. In CASE, a core cycle of query, evidence collection, analysis, explanation, connection, communication and reflection (see Figure 1) is adopted, based on previous initiatives in the field (e.g. the CREATIONS project[2]).

[2] www.creations-project.eu / H2020-EU Project reference: 665917

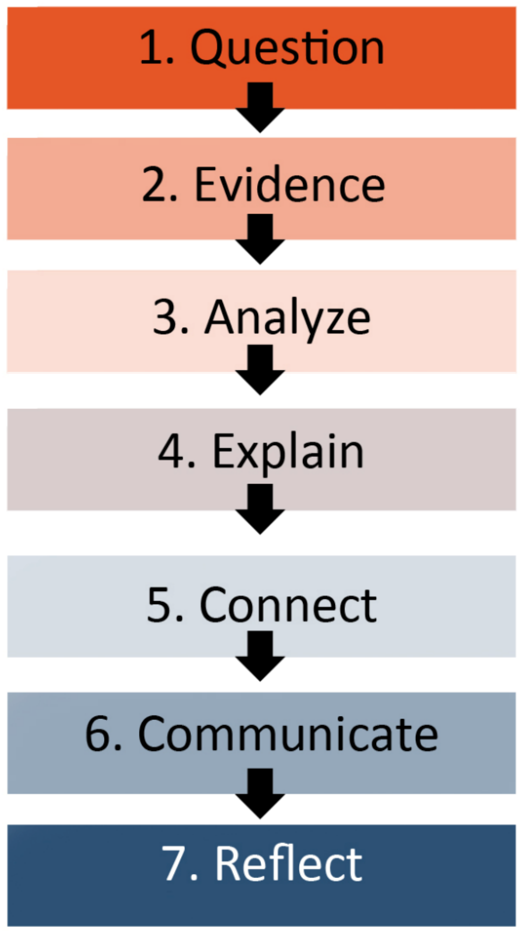


Figure 1: Phases of IBSE

This cycle emphasizes the need for students to engage in creative processes, through which they will act as young scientists and communicate science. In Figure 2, actions that students perform in each IBSE phase are briefly shown.

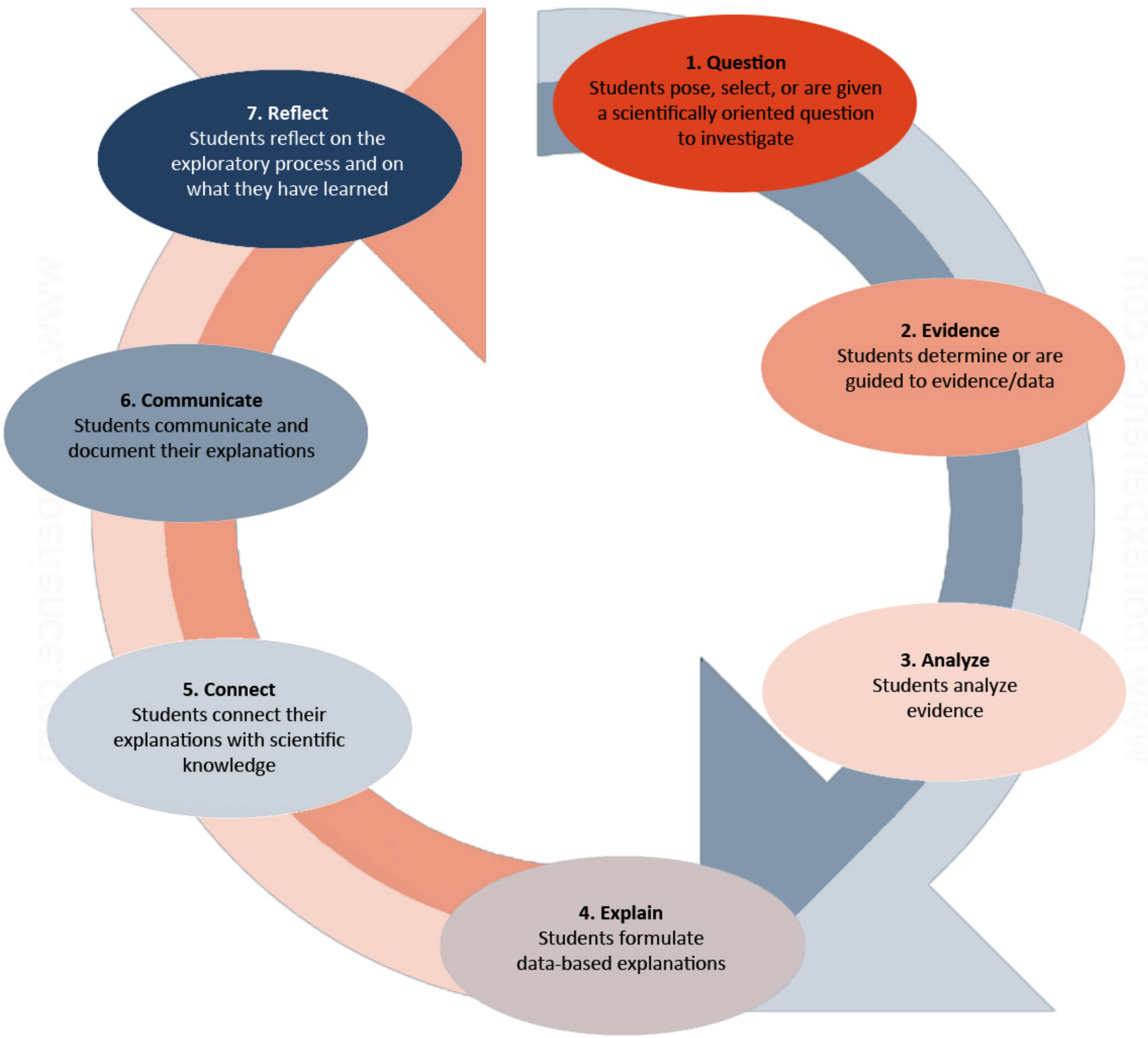


Figure 2: Student actions at each stage of IBSE

“Name of your activity”

Some words about the activity

Please provide a general description of your activity here.

Implementation phases

Below, provide a detailed description of the implementation phases of the activity.

PHASE 1. QUESTION

KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS' ACTIONS

Please describe the eduators' actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students' actions during this phase of the activity here.

LINKS

Please provide relevant links (e.g. websites, social media) here.

CASE has been funded within the framework of the European Union Erasmus+ programme

PHASE 2. EVIDENCE

KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS’ ACTIONS

Please describe the eduators’ actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students’ actions during this phase of the activity here.

LINKS

Please provide relevant links (e.g. websites, social media) here.

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PHASE 3. ANALYSIS

KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS' ACTIONS

Please describe the eduators' actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students' actions during this phase of the activity here.

LINKS

Please provide relevant links (e.g. websites, social media) here.

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PHASE 4. EXPLAIN

KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS’ ACTIONS

Please describe the eduators’ actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students’ actions during this phase of the activity here.

LINKS

Please provide relevant links (e.g. websites, social media) here.

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PHASE 5. CONNECT

KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS' ACTIONS

Please describe the eduators' actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students' actions during this phase of the activity here.

LINKS

Please provide relevant links (e.g. websites, social media) here.

PHASE 6. COMMUNICATION

KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS' ACTIONS

Please describe the eduators' actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students' actions during this phase of the activity here.

LINKS

Please provide relevant links (e.g. websites, social media) here.

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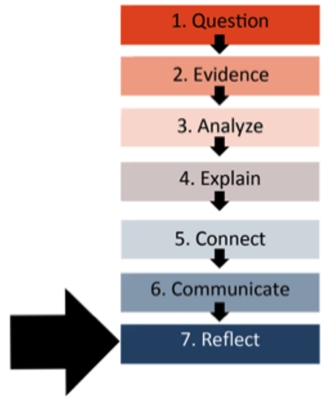
PHASE 7. REFLECT



KEY CHARACTERISTICS

Please provide the key characteristics of this phase of the activity here.

EDUCATORS' ACTIONS

Please describe the eduators' actions for this phase of the activity here.

STUDENTS ACTIONS

Please describe the students' actions during this phase of the activity here.

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