D3.1.x Serendipity –Accidental Discoveries in Science

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| Version & Date: 11.5.2016 |  |  | Approved by: |  |

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**Introduction / Instructions**

***This part should be excluded from your FINAL Demonstrator***

1. **Summary of the CREATIONS approach**

As a result the CREATIONS approach is informed and grounded on three closely interrelated aspects: a) the CREATIONS features, b) the RRI principles and c) the IBSE principles.

|  |  |  |
| --- | --- | --- |
| **CREATIONS Pedagogical Framework**  | **IBSE** |  |
| **CREATIONS****features** | **RRI aspects** | **Essential features of IBSE** | **Effective learning environments** |
| * **Dialogue**
* **Interdisciplinarity**
* **Individual, collaborative and communal activities for change**
* **Balance and navigation**
* **Empowerment and agency**
* **Risk, immersion and play**
* **Possibilities**
* **Ethics and trusteeship**
 | * **Governance**
* **Public**
* **Science education engagement**
* **Gender equality**
* **Open access/open science**
* **Ethics**
* **Sustainability**
* **Social justice/inclusion**
 | * **QUESTION**
* **EVIDENCE**
* **ANALYSE**
* **EXPLAIN**
* **CONNECT**
* **COMMUNICATE**
* **REFLECT**
 | * **Communities of practice**
* **Simulations**
* **Arts-based**
* **Dialogic Space / argumentation**
* **Experimentation (Science laboratories and eScience applications)**
* **Visits to research centres (virtual/physical)**
* **Communication of scientific ideas to audience**
 |

Although the key aspects of the CREATIONS approach are presented in a tabular format, the process is in practice highly organic, enabling the dialogue among students, teachers, researchers, ICT media and creative representation, drawing on a range of personal and disciplinary knowledge to thread across and between these features

1. **The Demonstrators’ Generic Framework**

The design of **Demonstrators’ Generic Framework** is mainly based on IBSE Best Practice of Pathway (Summer school, 2013), Scenario of Metafora EU project (e.g. 3d juggler (Smyrnaiou et al., 2012a; 2012b)) and Implementation Scenario of CREAT-IT EU project (such as Science Theatre Implementation Scenario, M. Sotiriou, 2015).

There are different ways to approach inquiry. Reflective inquiry seeks to draw attention on the coupling of metacognition and inquiry in the context of solving open-ended, ill-structured investigations in science (Kyza & Edelson, 2003). The Shimoda et al (2002)’s generic inquiry cycle is made explicit to students and is presented as a sequence of goals to be pursued. The Bruce & Bishop (2002) circle aims for students to learn how to learn and metacognitive skills, and stresses the need to engage children as active learners to collaborate and to understand the perspectives of others. Schwartz et al (1999) circle is implemented as a technology template to guide learners through case-, problem-, project-based learning. Although many versions of the inquiry cycle have been presented by various authors (de jong et al., 2002; Pedaste et al., 2015), the IBSE Best Practice of Pathway cycle was chosen as the most suitable for Creations. Besides this core cycle, there is a place for Question, Evidence, Analyse, Explain, Connect, Communicate and Reflect (figure 1). This circle stresses the need to engage children as little scientists, creative learners and science communicators.

**Figure 1:** IBSE Best Practice of Pathway, Summer School, (Rosi, 2013)

**The Demonstrators’ Generic Framework** structures the description of the pedagogical intervention around what we called “Introduction” or “Demonstrator Identity” which includes information about the : author, subject domain, type of activity, duration, setting and effective learning environment. The second element of the structure is the “Rationale of the Activity/ Educational Approach” which focuses on: the teaching and learning problem (challenge) addressed by this demonstrator and the added value of using the Creation Project for implementing this demonstrator. Challenge-based learning builds on the successes of problem-based learning models where students engage in self-directed work scenarios (or “problems”) based in real life (Johnson, Laurence et al., 2009). By giving students the opportunity to focus on a challenge of global significance, challenge-based learning creates a space where students can direct their own research into real-world matters and think critically about how to apply what they learn (Smyrnaiou, et al., 2015; Johnson, Laurence et al., 2009). An example could be an art & science event (performance, paintings, etc.).

The third element of the structure involves the learning objectives which are divided to two categories which involve domain specific learning and general learning skills which is supported by the Creation Framework. The fourth element of the Demonstrators’ Generic Framework involves the “Demonstrator characteristics and Needs of Students” and aims at collecting information about the issues explored and the real needs of students. It is very important because the literature of Science Education offers important data concerning ****the students’ attitudes towards science and underlines the continuing decline of interest the young people show in pursuing scientific careers (S&M) in a way that threatens the future of Europe (ROSE, Osborne et al., 2003; Osborne & Dillon, 2008).

The fifth element provides information about the Sequence and description of the activities focusing on a detailed description of each activity and the effective learning environment (s) involved and the sixth additional information. Finally, some assessment suggestions are requested along with possible extensions and list of suggested sources/references. For example, inter-workgroup assessment: after performing a theatrical stage on / represents a scientific concept or cultural elements, the workgroups may exchange their ideas / performances/ representations and ask their peers to evaluate them. The criteria for the evaluation may be set collaboratively by the workgroups as they discuss in class /stage, etc.. Concerning the possible extensions, after having performed a theatrical stage on scientific concept or cultural elements putting into effect their own ideas, the students share their performance and ask the students of another team to perform on the same scientific concepts (or cultural elements). At this phase of the performance, the workgroups decide on the representation of scientific concept (or cultural elements) through embodiment (gestures, facial expressions, full body movements, sentiments), music, choreography, narration, or using digital tools or other objects.

# Introduction / Demonstrator Identity

## Subject Domain

Serendipity. Accidental Discoveries in Science !

Learning science by drama pedagogy.

The topic is mainly science, technology, engineering, and mathematics, which is taught by using also supporting method of art/skills education with drama pedagogy tools.

## Type of Activity

Bridging the gap between formal education and informal learning via teacher professional development (TPD).

## Duration

In the University of Helsinki; Department of Teacher Education; Autumn 2016 – Spring 2018

3 p. (StandardStudyCreditPoint) course containing 1) theory, 2) basic drama training; 3) lectures of public understanding of science; 4) integrative education (science; history; art; technology-handicrafts; media; mother language; 5) practicing at school; 6) Play (drama) presented; and 7) Introduction to scientific empirical thinking by the “Serendipity” phenomenon.

## Setting (formal / informal learning)

Out-of-school – Open learning environments – Drama – Books – Hands-on –science – web-based materials – History of science - Demonstrations

## Effective Learning Environment

Open learning environment both out-of-school and restructured classroom settings.

# Rational of the Activity / Educational Approach

## Challenge

*(Description of the problem)*

“Serendipity” is the term discovered by Sir Horace Whalpole in 1700s. The term has received a renessance in 2000s.

However, the scientific discoveries are not done by coincidence. “Only well prepared minds can make serendipitious discoveries”, said already Pasteur.

Scientific phenomena are mainly abstract and don’t have direct link to pupils everyday life.

On the other side, drama education is most often getting its topics from artistic topics, social matters, and psychology.

It is also essential to stay in the facts. Very often the drama or fiction is also giving scientifically wrongly expressed content. Here, the artistic approach may not lead into misconceptions.

## Added Value

*(Elaboration of the applied creative approaches and their purpose)*

The new Curriculum 2016 in Finland is underlining besides the subject based education also the phenomenon based education, learning and teaching.

The “phenomena”, however, are often very loosely described topics combining a variety of facts.

That’s why this Demonstrator will concentrate into very clear and reduced topic or phenomenon which can be clearly defined, and then to use drama education as a tool from STEM to STEAM.

“Serendipity” forms a link 1) between formal education and informal learning; 2) history and modern science; 3) theory and practice; 4) hard work and creativity; 5) skills and art.

# Learning Objectives

## Domain specific objectives

With the background materials like the classical book by Royston Roberts (*Serendipity. Accidental discoveries in science*) both in-service teachers and teacher students will receive deep background information and theories related to scientific process.

Thus, the teachers can select by themselves the explicit topic like Big bang, antibiotics, archelogy, vaccination, dynamite, nylon, etc. It can be found easily from this book and other available background material related to public understanding of science in web, newspapers and other sources.

This approach will also bring in the elements of RRI (Responsible Research and Innovation) to the teaching process.

## General skills objectives

The main idea is to teach the scientific process and empirical research. The classical, big historical discoveries in science from Aristoteles to Newton and Pasteur to Alexander Fleming, or x-rays to DNA, will give the inspiring starting point.

This is supported by the creative elements related to serendipity. The artistic element will have an input via drama pedagogy.

However, real hands-on experiments are included to the drama pedagogy approach. The background consists of evidence-based education repeating the empirical research model with the educational 5E-model.

# Demonstrator characteristics and Needs of Students

## Aim of the demonstrator

## Student needs addressed

# Learning Activities & Effective Learning Environments

|  |  |
| --- | --- |
| Science topic: (Relevance to national curriculum)Class informationYear Group: Age range: Sex: bothPupil Ability: eg (The scenario allows space for pupils of various abilities to participate) | Materials and Resources*What do you need? (eg.*printed questionnaires, teleconference, etc.)*Where will the learning take place? On site or off site? In several spaces? (e.g. science laboratory, drama space etc), or one?* *Health and Safety implications?* *Technology?* *Teacher support?*  |
| Prior pupil knowledge |
| Individual session project objectives *(What do you want pupils to know and understand by the end of the lesson?)*During this scenario, students will |
| Assessment | **Differentiation***How can the activities be adapted to the needs of individual pupils?* | **Key Concepts and Terminology****Science terminology:****Arts terminology:** |
| Session Objectives: During this scenario, students will |
| Learning activities in terms of CREATIONS Approach |
| **IBSE Activity** | **Interaction with CREATIONs Features** | **Student** | **Teacher** | **Potential arts activity** |
| **Phase 1:****QUESTION:** students investigate a scientifically oriented question | Students pose, select, or are given a scientifically oriented question to investigate. *Balance and navigation* through *dialogue* aids teachers and students in creatively navigating educational tensions, including between open and structured approaches to IBSE. Questions may arise through *dialogue* between students’ scientific knowledge and the scientific knowledge of professional scientists and science educators, or through *dialogue* with different ways of knowledge inspired by *interdisciplinarity* and personal, embodied learning. *Ethics and trusteeship* is an important consideration in experimental design and collaborative work, as well as in the initial choice of question.  | Eg. Engage with teacher’s questions. Watch videos and use the web to explore evolution. |  Eg. Will use challenging questions and the web (images, videos) to attract the students’ interest in …. |  |
| **Phase 2:** **EVIDENCE:** students give priority to evidence | Students determine or are guided to evidence/data, which may come from *individual, collaborative and communal activity* such as practical work, or from sources such as data from professional scientific activity or from other contexts. *Risk, immersion and play* is crucial in *empowering* pupils to generate, question and discuss evidence. |  |  |  |
| **Phase 3:** **ANALYSE:** students analyse evidence | Students analyse evidence, using *dialogue* with each other and the teacher to support their developing understanding. |   |  |  |
| **Phase 4:****EXPLAIN:** students formulate an explanation based on evidence | Students use evidence they have generated and analysed to consider *possibilities* for explanations that are original to them. They use argumentation and *dialogue* to decide on the relative merits of the explanations they formulate, *playing* with ideas.  | . |  |  |
| **Phase 5:****CONNECT:** students connect explanations to scientific knowledge | Students connect their explanations with scientific knowledge, using *different ways of thinking and knowing* (‘knowing that’, ‘knowing how’, and ‘knowing this’) to relate their ideas to both disciplinary knowledge and to *interdisciplinary* knowledge to understand the origin of their ideas and reflect on the strength of their evidence and explanations in relation to the original question. |  | .  |  |
| **Phase 6:****COMMUNICATE:** students communicate and justify explanation | Communication of *possibilities*, ideas and justifications through *dialogue* with other students, with science educators, and with professional scientists offer students the chance to test their new thinking and experience and be *immersed* in a key part of the scientific process. Such communication is crucial to an *ethical* approach to working scientifically. |  |  |  |
| **Phase 7:****REFLECT:** students reflect on the inquiry process and their learning  | *Individual, collaborative and community-based* reflective *activity for change* both consolidates learning and enables students and teachers to balance educational tensions such as that between open-ended inquiry learning and the curriculum and assessment requirements of education. |  |  |  |

# Additional Information

# Assessment

# Possible Extension

# References