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Designing, developing & evaluating distance learning for S@TM: meeting the different needs of students and teachers

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1. Introduction

In distance learning the design and development of the instructional material has outmost importance since it is the main means for the educational process (Lionarakis, 2001) and constantly supports learners in every step they make. Figure 1 places instructional material within the educational process.
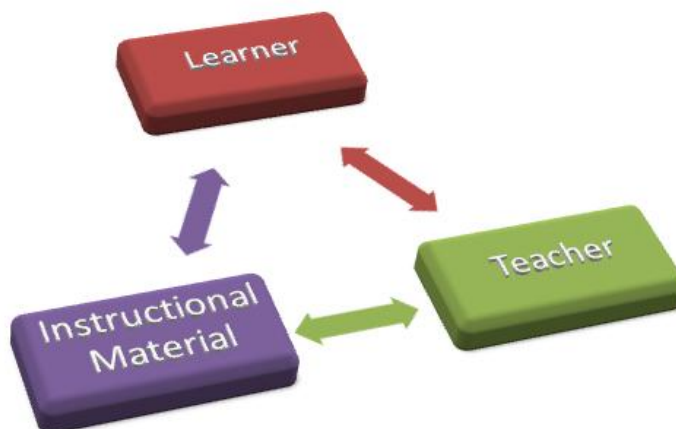
Figure 1: Instructional material within the educational process in distance learning.

The quality of the instructional material is affected by many factors like design methodology, instructional design, learning theories, means etc. Gros et al. (1997) suggest that

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the design of the instructional material aims to be a link between learning theories, data imaging techniques, deep learning and the construction of knowledge. Especially, the design of instructional material is a complex process which in addition to all other parameters has as its main angle the statement that *"it relates to anything that takes place in order to facilitate the learning process"* (Holmberg, 1995, Winn, 1997, Reigeluth, 1997, Lionarakis, 2001). (Manousou & Lionarakis, 2013, Makrakis 2000 Raptis, 2001, Lionarakis 2003).

It is noteworthy that the design and development of instructional material in distance learning is in most cases product of teamwork and the choice of members that form the team is of great importance (Chartofylaka, 2012). Staffing teams that design and develop instructional material depends on factors that affect the educational institution, the responsibles for the development of the instructional material, the final recipients, the content knowledge etc.

In every case decisive factors are:

The philosophy and the pedagogical approach of the educational institution. In this case, since there were many educational institutions that were partners to this European project, it was demanding to define a common pedagogical approach or a common philosophy. A mutual agreement was reached that social constructivism is the project's pedagogical approach as theoretical framework, nevertheless practicalities (e.g. lack of tutors or forum moderators) made difficult to fully apply it (Heering & Asmussen, 2014; Heering, 2000, 2007, 2012; P. Kokkotas, Rizaki, & Malamitsa, 2010; P. V. Kokkotas, 2003; Panagiotis V. Kokkotas, Malamitsa, & Rizaki, 2011; Malamitsa, Kasoutas, & Kokkotas, 2009, 2010; Rizaki & Kokkotas, 2013; Stinner, Heering, & Osewold, 2007).

*The available time.*Especially the deadline for delivering the instructional material as a final product is of outmost importance in relation to staffing a team as well as in relation to the instructional material's form, scope, range, depth and quality. Extremely short deadlines need small and flexible teams that give emphasis on taking advantage of the already existing material, since creating new educational material is time consuming (Lockwood, 1998, p. 81, Melton, 1997, p.91, Tight, 1985, p.67). If, however, there is enough available time then there is the possibility for strategic planning for the design and development of procedures as well as the entrustment of the project to an integrated team. This integrated team could handle the design and development of the educational material by itself taking into consideration, only criteria that are related to the educational process and are not affected by other extraneous factors (Chartofylaka, 2012).

*Resources, human and economic for the development of the educational material.*The project of designing and developing new educational material in every case demands significant resources, human & economic. The scientific efficiency of the human resources and its multifacet support during the project or even after its duration, is one more factor that defines the staffing of the team.

Economy of scale: target group numbers. It may demand a big initial cost for its creation, however in long-term it pays off for its cost since the channel of distribution is wide and ever increasing. This is especially the case when english is the language of choice for the educational material because it enables its use in many countries and cases. It must noted that the both e-courses were designed and developed initially in English and subsequently were translated to all other languages.

The scope and depth of the content knowledge included in the educational material as well as the perspective from which is presented are also important. Since the project was innovative and combined science, storytelling as well as elements of History of Science (HoS)

and Nature of Science (NoS), it was a very challenging task to create appropriate educational material.

In this paper the design, the development and the evaluation of a distance learning module for S@TM will be presented. Initially the design and the development of the teacher's e-course will be described, the presentation of the students' e-course will follow and finally the overall evaluation of the two e-courses using distance learning criteria will be presented.

2. Methodology

In an effort to meet the different needs of students and teachers, two distinct e-courses were developed, each of which adopted a different approach. However, the methodological approach used for the creation of both e-courses was the same.

The project Storytelling @ Teaching Model (S@TM): a Contribution to Science Teachers' Professional Development is funded under EU, Educational & Culture Directorate General, Lifelong Learning Programme, Comenius (Project 518094-LLP-1-2011-1-GR-COMENIUS-CMP) and it aims at the exploitation of storytelling in Science lessons in a way that enriches them with elements from the History of Science (HoS) and the Nature of Science (NoS)

Figure 2: Concept-map about the elements used at the creation of the digital stories.

The project contributes to the professional development of secondary education Science Teachers. Moreover it supports Science Counselors at Secondary Education, it enhances science teaching and encourages students to follow careers in Science.
The distance online learning component of the project was completed using a transformation model in 5 stages for both e-courses:

1. Staffing of the team that will design and develop the educational material. The final team consisted of 4 members with different fields of expertise that covered necessary areas in relation to the development of the material. The team defined the target group, its needs and the e-courses' specifications

2. The existing educational material was explored in depth. Necessary material that was missing was also specified.
3. Two sub-teams were created: The first team that would design and develop the e-course lessons and activities using on-line collaboration methods (web 2.0, online conferencing, document collaboration, email etc.) The second team that would support the first team by locatıng any lacking material, being a critical reader on what the first team produced and by completing the activities producing also the necessary feedback. The first team acted as a critical reader for the second team's feedback.
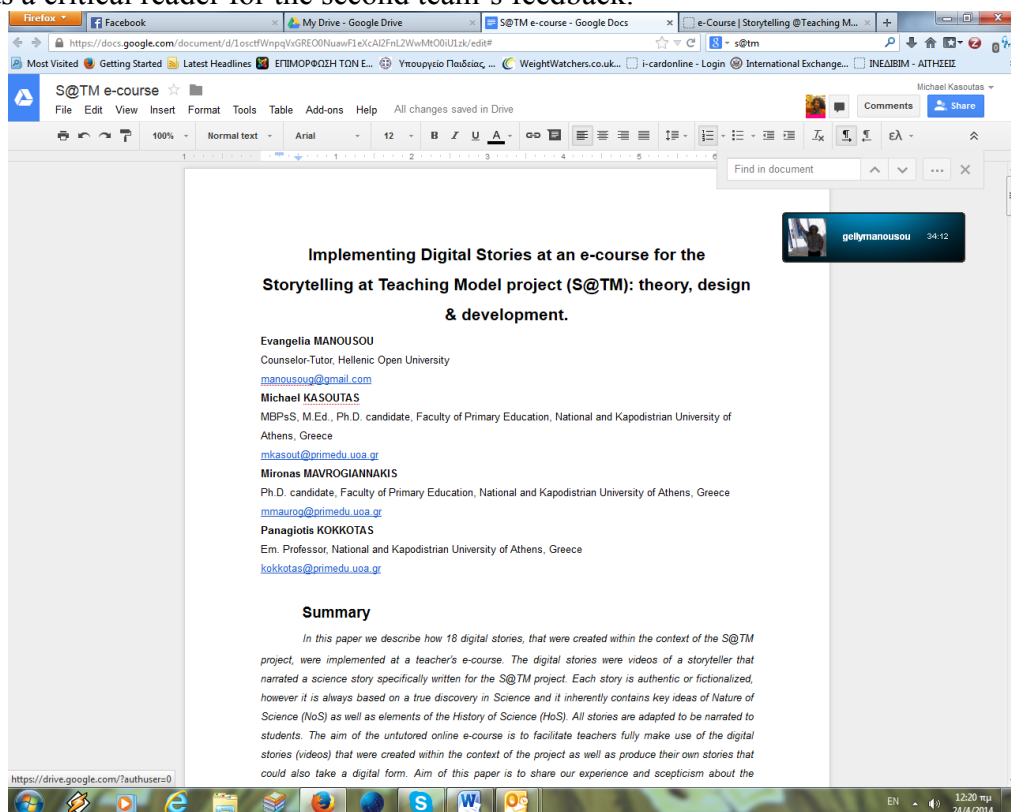

Figure3: Online collaboration with web 2.0 tools (google documents & skype)-stage 3

4. Each e-lesson for both e-courses was created and sent back to the project partners. Comments and necessary feedback from the partners was received and integrated in the reformulation of the e-lessons. The reformulated second version of the e-courses was the final product for the distance online learning component of the project.
5. After both e-courses were completed an independent evaluator, expert in distance learning education, as a third independent party was invited to assess the final distance learning component of the project.

3. The design and development of S@TM's educational material for distance learning

Within the framework of the project Storytelling @ Teaching Model (S@TM): a Contribution to Science Teachers' Professional Development, two distinct e-courses were created each of which had different target groups and, consequently, different aims, structure and activities.

In the context of the S@TM Project, eighteen stories were created (6 Physics, 6

Chemistry & 6 Biology stories), each of which is based on a different episode from History of Science that can be used in order to enhance teaching and students' learning. For each story a digital story in the form of a video with storytelling was created.

The teachers' e-course trains Science Teachers to make their teaching interesting and comprehensive by integrating storytelling using History of Science enriched with elements of the Nature of Science. The e-course for teachers aims at enabling teachers to get familiar with the art of storytelling, in case that they do not have the opportunity to participate in a face-to-face course. It also includes some lessons about how to develop your own story.

The e-course for students aims at enabling students to get familiar with each story and its main characters in case that they do not have the opportunity to experience it in a face-to-face course. It also includes selected activities about the Nature of Science and some of the Science that each story entails.

Multiple learning benefits are offered by the exploitation of storytelling in education. Starting point can be any kind of stimuli or a teacher's initiative. Storytelling benefits include: growth of team, support of collaborative culture in a classroom, cultivation of oral and written speech, development of skills related to investigation, analysis as well as to synthesizing, interpreting, decision making and experiencing consequences. Storytelling has a diachronic presence in human cultures and nowadays has been facilitated by the proliferation and use of digital cameras, tablets, video recorders, cell phones, and internet in our everyday life, thus providing alternative ways of presenting our stories in a digital era (Meimaris, 2013).

4. Teachers' e-course

The structure of the e-course allows teachers to create their own learning paths according to their specific needs and aims. The quality of the teachers' e-course was greatly enhanced by prior action research conducted within the context of the project at face to face workshops with teachers about integrating storytelling in a science lesson.

Moreover different ways of using this e-course were proposed to the teachers. One is using the e-course in a path that has escalating difficulty in an effort to provide a fading scaffolding effect in their training ranging from simply integrating something already made to their classroom up to creating their own stories. Alternatively, they could choose a skill they feel they need training for in order to integrate storytelling in their teaching and simply go to the corresponding lesson.

The contents of the teachers' e-course are:

Overview

- Introduction - Study Guide

A. Familiarizing

- E-lesson 1: Familiarizing with the story, the historical context (HoS elements)
- E-lesson 2: Familiarizing with the elements of Nature of Science (NoS) that are included in the story
- E-lesson 3: Find further information that may be required

B. Decision making on the function of the story

- E-lesson 4: Necessary Decisions: motivational introduction, main structure for a lesson or assessment?
- E-lesson 5: Necessary Decisions: how to bring the story in the classroom?
- E-lesson 6: Reflecting upon your choices, considering possible problems, organizing your

    lesson

C. Adapting the story

- E-lesson 7: Important elements in an engaging story
- E-lesson 8: Adapting the story
- E-lesson 9: Checking the adapted version of the story
- E-lesson 10: Developing worksheets/activities for your story

D. Developing your own story

- E-lesson 11: Learning about the Storytelling skills
- E-lesson 12: Create your own stories: Why?
- E-lesson 13: What makes a Good Science Story?
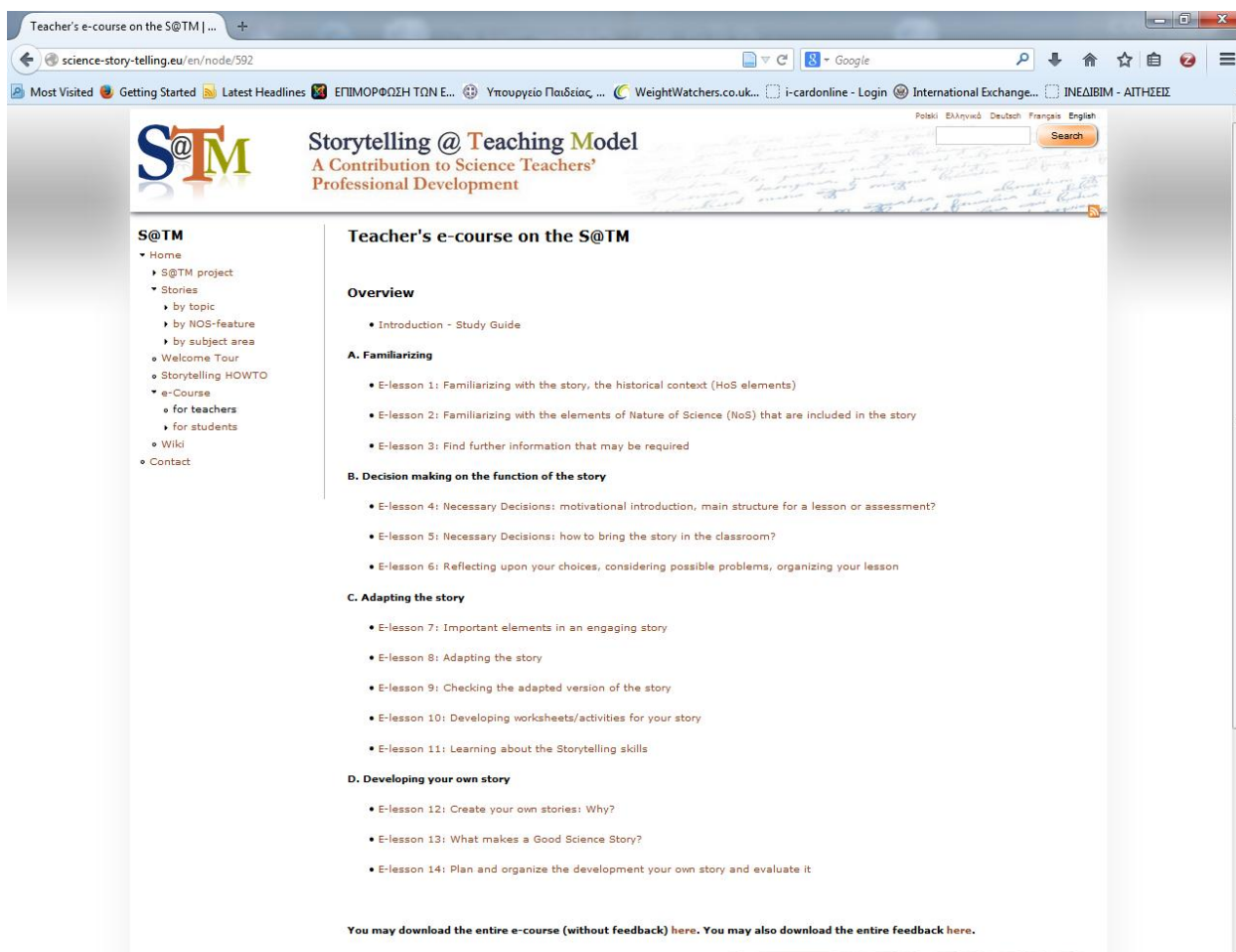- E-lesson 14: Plan and organize the development your own story and evaluate it

Figure 4: Snapshot from the on-line contents of the teachers' e-course.

Teacher's e-course on the S@TM: Adapting the story.

E-lesson 8: Adapting the story.

Aim of e-lesson 8 is to help you with the adaptation of a story or a video by making you aware of the things you need to consider.

Time required: 30´

In order to adapt a story for your students' needs you may need to:

    A. Add new interesting, important information (see also e-lesson 3 about how you may have decided to include more information).
    B. Remove `redundant' elements & information from the story. The redundancy of the elements (see also e-lessons 3 & 7).
    C. Add new elements & information to the story if necessary (see also e-lesson 3)
    D. Change the plot in order to include worksheets/activities for the classroom at specific points within the story. (see also e-lesson 10)

In your adapted version of the story you should include the following:

Elements of NoS (e-lesson 2), Elements of HoS (e-lesson 1), principal character feelings and, in general, the important elements of an engaging story (e-lesson 7).

You must also take into consideration how you are going to use the story (motivational introduction, main structure for a lesson or assessment? see also e-lesson 4) available time, your students' level and needs, local curricula, your students' interests and other aspects of teaching methodology.

**If you choose to integrate a video** in your lesson you might need to:

Find a free video editing tool (e.g. Windows Movie Maker, i-Movie, Photostory etc.). You can cut parts of the video according to your goals. **Alternatively** you can pause the video at specific points in order to allow your students to engage with the worksheets & the activities in so as to make sure that they reflect on the story. You may need to note down the time of the specific points that you are going to pause the video.

If you feel that this is too time-consuming, you may either reflect on whether the video may be used in its initial version, or whether you go back to e-lesson 5 and take this aspect into your decision making [PDF-Form].

Time	Reason/goal for pausing	Activity/Worksheet/Question
e.g. 00:04:18	focusing students on the conflict	Worksheet question 1

Figure 5: Snapshot from the on-line contents of the teachers' e-course: Adapting the story (e-lesson 8)
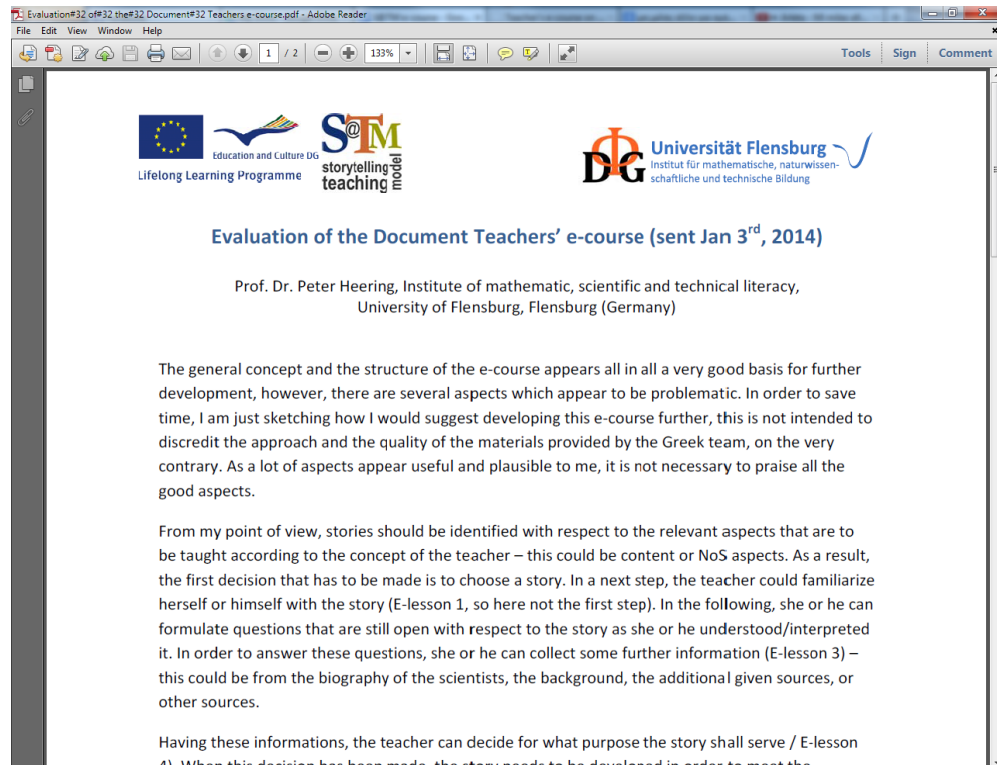
Figure 6: Example of partners' feedback on the teachers' e-course.

5. Students' e-course

The students' e-course uses educational resources that were produced by the partners of the S@TM Project. These educational resources are created with 15 year-old students in mind; however they could be also interesting to students of different ages.

The e-course is consisted of 6 e-lessons, each of which makes use of one the digital stories produced within the context of the project, it has its own aims and it cultivates specific skills. Since the project prioritized skills over content knowledge, the six lessons produced were considered more than enough because they covered the range of required skills. The aim of this e-course is to present 6 stories from the History of Science (HoS) emphasizing on elements of the Nature of Science (Nos). In order to do so each e-lesson's activities are structured in *a linear way* following the usual "steps" that a teacher would probably follow at a Science lesson. Even if this e-course's lessons have a linear structure students can follow their own path according to their needs.

In the long term the S@TM project aims also to encourage students to follow careers in Science.

The activities included in each lesson try to foster active learning. They foster active learning. For most of the activities there is indicative feedback. Additionally, the activities were designed in such a way that they could also be adapted so as to be used also with the rest of the projects' videos with storytelling. The feedback presented is not to be considered as the only correct answer to a lesson's activity, rather it is an indicative answer to give to students a feel of

what is expected from each activity.

The contents of the students' e-course are:

- Students' e-lesson: Irene and Frederic Joliot Curie and the artificial radioactivity
- Students' e-lesson: James Lind and the therapy of scurvy
- Students' e-lesson: Rutherford – Ernest's nuclear atom
- Students' e-lesson: Outstanding Marie and radioactivity
- Students' e-lesson: Sibylla Merian and the cocoons
- Students' e-lesson: Mouchot and the exploitation of solar energy

Figure 7: Example of activity related to the in-depth understanding the story.

Figure 8: Example of activity that requires students to summarize the story.

6. Evaluation of S@TM's distance learning component

The educational material in distance learning should substitute the teacher's or tutor's role in the classroom. It should not only teach but also create procedures that facilitate students learning and foster a learning environment. The educational material should be:

- clear and understandable,
- compatible to students' level
- give instructions in relation to the aim and the way of teaching
- break in small units
- integrate multimedia and ICT tools.

The procedures that the educational material proposes should:

- engage students to learn through activities.
- inform students in relation to the "how", "what" and "when" (aims, methodology, time) of the learning activities
- Includes feedback for each activity

- has different types (activation, in depth learning, self-evaluation etc.) and of increased difficulty (easy, difficult, simple, composite etc.) activities.
- connect activities with different instructional material (texts, pictures, etc)
- Integrate suggestions for further study

Furthermore, the educational material in distance learning should have the following morphological characteristics:

- It should be easy to read
- It should be user friendly to navigate within (especially if in electronic form it should be user-friendly)
- It should include suitable images and symbols that will make it easily understandable.

Taking into consideration the above mentioned criteria an evaluation report was produced by Dr. Yannis Giossos, tutor-counselor in the subject of Distance Learning at Hellenic Open University.

Teacher's ecourse		
Criteria	**Grade**	**Comments**
Clear and understandable	**9**	
Uses a variety of media (text, images, etc.)	**10**	
It is compatible to student's level	**10**	
Gives instructions in relation to the aim of each activity and the way of completing it.	**9**	
It is divided in small units	**10**	
It engages students through activities	**10**	
It informs student in relation to the aim, the way and the time required for each activity	**10**	
It provides feedback for every activity	**9**	
It includes activities of different kind (activation, in-depth learning, self-evaluation) and with diverse levels of difficulty.	**9**	
It connects the activities with diverse educational material (e.g. text, images etc.)	**10**	

It connects the activities with further study suggestions.	**9**	
It is easy to read	**10**	
It is user-friendly and easy to navigate	**10**	
It includes symbols and clip art that make it easy to understand	**8**	The design can be improved
Students' e-course		
Clear and understandable	**9**	
Uses a variety of media (text, images, etc.)	**10**	
It is compatible to student's level	**10**	
Gives instructions in relation to the aim of each activity and the way of completing it.	**9**	
It is divided in small units	**10**	
It engages students through activities	**8**	There are more activities than necessary
It informs student in relation to the aim, the way and the time required for each activity	**8**	It is not evident why it is necessary to do the activities
It provides feedback for every activity	**9**	
It includes activities of different kind (activation, in-depth learning, self-evaluation) and with diverse levels of difficulty.	**10**	
It connects the activities with diverse educational material (e.g. text, images etc.)	**10**	
It connects the activities with further study suggestions.	**9**	
It is easy to read	**10**	
It is user-friendly and easy to navigate	**10**	
It includes symbols and clip art that make it easy to understand	**8**	The design can be improved

Overall, both e-courses are considered efficient and suitable as distance learning material.

7. Conclusions

      The design and development of an e-course is a constantly evolving process as a result of

the interaction of all the partners. In a multilateral project that involves partners from different european countries as well as external partners from other continents the use of web 2.0 tools is a necessity. The quality of the learning material is dependent from the design and the available resources. In the specific case the distant learning material was based upon an educational material (digital stories, stories, storytelling teaching model) that was created within the context of the project. The fact that this endeavour combined digital storytelling along with Science created an extremely demanding task that had to be mediated through distance learning e-courses.

This had as a result specific choices in relation to the e-course design and development. The content and the structure of the e-course was innovative and original even if there were many constraints. One crucial point that had to be addressed was the lack of provision of a tutor or administrator for the e-course. This challenge made impossible the formation of teams or the collaboration of the learners as well as the implementation of a synchronous or asynchronous learning platform. Our team that was responsible for the students' and teachers' e-courses was formed just three months before the end of the project without any possible further extension. All these created a context within which we had to struggle in order to produce a quality result.

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