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EDMUSE PLATFORM ARCHITECTURE:

Digital cultural resources for teaching

Report V.0.1.

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I. EXECUTIVE SUMMARY

This report presents the design and implementation of a system which supports personalized eLearning and cultural education. The system is designed for the Edmuse Erasmus Project. The services and teaching units are especially designed so as to be accessible through networks and varying devices. The teaching units are aiming mainly in Learning environment applied e-learning or blended learning way through cultural education and dissemination of cultural heritage in education.

The basic principles on which the platform is designed are the following:

1. **Design a cultural data repository of museum objects based on the Linked Open Data standard. The key feature is sharing open education resources created or indicated by teachers of the project's area.**
2. **Design annotation tools which allow teachers to annotate the cultural objects with useful information directly associated with the learning process.**
3. **Design tools and services which allow teachers to manage and download multimedia cultural content related to the museum objects.**
4. **Design tools and services which the allow teachers to create and manage multimedia didactic units based on the Linked Open Data standard.**

Towards the implementation of the system this report collects and presents all the key elements which lead to the design and development of a successful e-Learning platform for cultural education. Specifically the next key issues are being analyzed:

1. **Cultural education as a challenge and long term objective in innovative method learning.**
2. **State of the art in personalized and adaptive elearning systems and mobile platforms specifically focusing on cultural education.**
3. **The MUSED platform analysis. The key advantages and future challenges towards the new EdMuse platform.**

Based on this analysis it is concluded that MUSED platform could serve as an excellent basis for further developing and providing services for cultural education for the EdMuse project.

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In addition the architecture of the platform has been created and presented based on the MUSED platform and several key improvements are being proposed so as the MUSED platform to be optimize and provide more coherent cultural education services.

All the aforementioned issues are being presented in the next sections.

Keywords—cultural education, personalized eLearning, web services, linked open data.

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II. STEM EDUCATION AND CULTURAL HERITAGE

In this section we set out our definition of culture and of the roles of STEM (Science, Technology, Engineering and Mathematics) Education with cultural heritage. We argue that creative education and cultural education are closely related and that there are important implications for the balance of the school curriculum and for teaching and learning. Recent studies are showing how the student need art to work across disciplines for improving to learn science topics and to become creative people to form productive collaborations with scientists, educators, and technologists to make a positive impact on the world.

Defining Culture

Like creativity, culture is a term that is used in many ways in different contexts. It is a term with a complicated history and with a range of different, sometimes conflicting meanings. Like creativity, culture is strongly associated with the arts and letters. While accepting the importance of this particular sense of culture, we want to adopt a more general definition which includes, but goes beyond, it. The exclusive association of culture with the arts overlook many other aspects of human culture, including, not least, science and technology.

Since the late eighteenth century, culture in one sense, has meant a general process of intellectual or social refinement. This is the sense in which a person might be described as cultured. This process has been linked particularly with an appreciation of the arts. By extension, culture has also come to mean the general field of artistic and intellectual activity through which this process of refinement was promoted. It is this meaning of culture that is implied in describing the arts and related fields as the cultural industries. Ministries of culture throughout the world, and national cultural policies often focus specifically on the development of the arts, including music, cinema, literature, dance, visual art and also ancient, traditional and folk culture, especially traditional music and dance.

On this basis, an assumption is made that cultural education should consist principally, if not wholly, of teaching young people to understand and appreciate high art, particularly works in the classical European tradition. We think that all cultural education should certainly include this, but in relation to particular roles which we set out later.

There is, then, in the sense set out above, a strong association between the arts and culture. Practising and understanding the arts in all their forms are essential elements of creative and cultural education. But the definition of culture must, in our view, go beyond an

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exclusive association with the arts in general and high art in particular. The importance of these can only be fully recognised in educational terms within a more general social definition of culture: a definition which embraces the importance of other significant fields of creative activity.

In this sense, culture is where we live our shared mental lives. We need a way of understanding this habitat, of treating it with the respect and care it deserves. Also in this framework cultural diversity and identity is created.

Culture as we have said has a long association with the arts. But in this century particularly, the term culture has also been used in a more general sense to mean a community's overall way of life. This definition of culture has been developed particularly in anthropology and sociology. It recognises that different social groupings are held together by shared values, beliefs and ways of relating which are characteristic of them, and which distinguish them from others. Most people now belong to many different cultural groups national, local, ethnic, religious, ideological and professional. Each has its own values and ways of doing things, its own distinctive culture. The culture of a group includes its sense of identity its sense of what makes it a group; and the various ways in which its identity is expressed and maintained its patterns of behaviour and organisation.

At the heart of the social definition of culture is the concept of values: those things, the ideas, beliefs, attitudes which the group considers worthy and important, and which it holds in common as a group. These values are shaped by many factors: by human nature itself, which may be taken more or less as a constant; by the physical environment, including climate and geography; by relations with, or isolation from, other communities; by religious beliefs or lack of them; by science and technology, by economics and by events. These values underpin and shape social institutions such as the law, education and the family, and personal behaviour. In turn they are influenced by changes in knowledge, understanding and experience.

Cultural identity is expressed and maintained in many ways. Traditionally, one defining factor of cultural groups has been a shared language and, at more specific levels, shared dialects, accents and vocabularies. This continues to be so for cultural groupings of all sorts, even within the increasingly pervasive use of English as an international language. Customised vocabularies, styles and rhythms of speech are among the most common ways that cultural groups and sub-groups define themselves in relationship to others. In the fastchanging world of youth culture, new slang, styles and rhythms of speech are among the most important ways in which cultural identities are created and recreated. Cultural identity is also expressed in many other ways, from styles of dress, to patterns and structures of social relationships.

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Our concern in this report is with ways of enabling young people, through education, to understand and make their way in the increasingly challenging social and personal circumstances of the contemporary world. For these reasons, and because of its inherent importance for education, we will also use the term culture here in this broader social sense. Accordingly, we define culture as:

The shared values and patterns of behaviour that characterise different social groups and communities.

Most national communities are a complex mix of ethnic, generational, religious, ideological and political cultural groupings which overlap with and affect each other. Many young people live in, and move among many different cultural communities, each of which might contribute more or less to their individual sense of cultural identity, or lack of it.

The Dynamics of Culture

Creative practical engagement provides opportunities to share different cultural influences, challenge received thinking, develop means for expression, critical thought and problem-solving skills.

Social cultures can be described and analysed in terms of their different systems and elements: legal systems, religious beliefs, technologies, economic activities and patterns of social relations. But they can only be fully understood in terms of how all of these various elements affect each other. Three important examples of this interaction are particularly relevant to our arguments. First, the cultural impact of science and technology; second, the dynamic relations between the arts, technology and design; third, the interaction between different cultural forms and traditions.

The Impact of Science

Science and technology interact with the social culture in many ways and at many levels. From time immemorial, technology - the design and use of tools - has changed the conditions and possibilities of human culture. In the last three hundred years particularly, and with increasing speed in our own time, science and technology have transformed human perceptions of how the world works and of our roles within it. Galileo, Darwin, Newton, Einstein and the rest are towering historical figures and not only in science. Their ideas, and the shifts of perception they provoked are woven into the fabric of global culture and have profoundly influenced the nature and course of it.

Science is the dominant culture of the 20th Century and is set to become even more dominant in the 21st. However, as we become even more dependent on scientific and engineering advances, society appears to become less and less aware of it and how they

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have freed the human race from the slavery of existing merely to survive. As the next century approaches, the need thus becomes even more urgent that everyone should have some deeper understanding of the way

Through technology, science has also directly changed the practical circumstances of human life and culture. From harnessing electricity to the new frontiers of bio-genetics; from the steam engine and motor cars to nuclear fission; from antibiotics to birth control; from railways to the Internet, science and technology have changed how we think, what we think about, what we do and what we are able to do. For example, developments in contraceptive techniques, notably the Pill, have revolutionised patterns of sexual morality and behaviour and deeply affected roles and relationships between men and women. The current revolutions in information technology are transforming the world of work for men and women and the economic relationships between them. Science and technology offer profound evidence of the variety of human creativity and they are implicated at every level in the formation and expression of the social culture of the late twentieth century. Any definition of cultural education must take account of this.

The Arts and Technology

There is a powerful relationship between science, technology and the arts. Artists make things: new tools and materials generate new forms of creative practice. In 1980, the House of Commons Select Committee defined the arts in this way:

The term the arts includes, but is not limited to music, dance, drama, folk arts, creative writing, architecture and allied fields, paintings, sculpture, photography, graphic and craft arts, industrial design, costume and fashion design, motion pictures, television, radio, tape and sound recording, the arts related to the presentation, performance, execution and exhibition of such major art forms and the study and application of the arts to the human environment.

Scientific principles underpin their daily life. In fact, the intrinsic cultural nature of these principles, as well as the way they have been applied for the benefit of society, need to be revealed. Judicious use of these advances in the future is necessary and this will only occur if some key scientific principles are understood at every level of society.

Many of the art forms listed here in the early 1980s were inconceivable in the 1780s. Film, photography and television are among the dominant art forms of the twentieth century: they did not exist in the eighteenth. It was not only impossible to make films then, it was probably inconceivable. The technology of the moving image not only made film possible, it made the idea of film possible. Shakespeare did not read nor write novels. There were none in the sixteenth century. The evolution of the novel, now one of the most popular art forms of our time, was only possible in the cultural circumstances that followed the invention of the printing press.

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The relationship between the arts and technology has always been dynamic. Technology makes new forms of expression possible: artists drive technology to new levels of sophistication. This is happening now with digital technologies. At one level, the new technologies are making existing processes of creativity easier. There is software for musical composition, for choreography, theatre design and architecture, and this facilitates many existing forms of work. But new technologies are also generating new forms of creative practice in computer animation, sound synthesis and digital graphics. Some of the most adventurous developments in the arts are taking place at the boundaries of the new technologies: in multimedia and cybertechnology. The new technologies are providing for new languages and methods and modes of creativity in the arts, now as they have always done. A further example is the interaction of design and technology and their interactions in industry and economics. Throughout industry designers and technologists work together; they create new product systems and services.

High Art and Popular Culture

In the future, creativity in industry, founded on the interaction between design and technology, will be the driver of national and international growth. Therefore, very early in education pupils should see these two fields, Arts and Science, not as two cultures to be separated, but facets to be conjoined for the good of mankind.

Young people tend to view listening to or playing classical music as activities which create a poor impression among their peers. These beliefs do not necessarily stem from something that is inherent in the music itself, but rather from the cultural positioning of classical music relative to other forms of music which young people have come to associate with their own sub-cultures.

The conventional view of high art is that there are some works in music, painting, literature, dance and so on that are qualitatively superior to others in their depth of understanding of the human condition, and in the power and eloquence of their expression. In contrast, elements of popular culture are thought of as ephemeral and shallow. Both of these statements are true. There are examples of artistic expression, in all cultures, of transcendent beauty and power and which are in the highest reaches of human achievement. Much of commercial or popular culture makes no such claims. But this division is too neat. There is, and has always been, a traffic between different areas of cultural expression. The fact that something is popular does not disqualify it as high art. Some of the greatest classic writers are amongst the most widely-read. In recent years, opera has become hugely popular through television, CDs, the Three Tenors, football, fashion shows and film. The fact that large audiences now enjoy opera does not detract from its expressive power or its high aesthetic claims.

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Equally, art forms that have their deepest roots in popular culture contemporary dance, cinema, jazz, rap and rock music have produced work of intense power and eloquence. Artists of every sort live within, not outside the social culture and they draw deeply from it in their ideas, themes, and forms of expression. A great deal of classical music is rooted in popular and folk music. Jazz draws from the themes of classical music as much as from the rhythms of popular song. Developments in contemporary dance, through Rudolf Laban and Martha Graham, were deeply influenced by the patterns and rhythms of ordinary human movement at work and play. These processes of influence and inspiration, borrowing and conversion are at the heart of creativity in the arts in all cultures and also across them. For example, some of the key figures of Modern Art, including Picasso were inspired and influenced in their work by African art and imagery. Increasingly in contemporary cultures, the use of new technologies and the free access to many different cultural forms they provide, is generating dynamic fusions of forms within and across different cultural genres and traditions - between Asian, European, African and American cultures - and at all levels, from the concert hall to the street.

We have defined creativity as a process with outcomes that are both original and of value. But just as values differ between cultures, they also change within cultures over time. There are many examples in the arts as in the sciences of innovations that were not valued or understood at the time they were made: of discoveries whose significance was unrecognised, even condemned or ridiculed by contemporary audiences. The music of Stravinsky, the paintings of Van Gogh, and Picasso, jazz, blues, rock and rap music were all rejected before being absorbed into the mainstream. As social and aesthetic values change, avantgarde works of high culture can become icons of popular taste, just as work produced for mass audiences can be assimilated into the canons of high culture. This process of re-evaluation is also true in science. The real significance of scientific discoveries has sometimes become apparent only when social values have changed or when attitudes of other scientists have caught up or when the acceptance of new paradigms change scientific perceptions.

The Evolution of Culture

Culture in the biological sense implies growth and transformation. This is true of the social culture. One of the consequences of the dynamics and diversity of social cultures is an irresistible process of change. Some years ago a national newspaper campaigned with the slogan, Times change, values don't. For all the reasons we have suggested, the opposite is true. Many of the values and patterns of behaviour in the closing moments of twentieth century are wholly different from those of the late nineteenth century: as they were from the previous century. Contemporary ways of life are not only different from those of the Victorians, they were largely unpredicted by them and were essentially unpredictable. Cultural change is rarely linear and uniform. It results from a vortex of influences and events

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which is hard enough to understand with hindsight and impossible to plan in advance. Nonetheless, education has to prepare young people in the best ways possible to engage with these processes of change. What should this involve?

Absolute and Relative Values

We have associated the social definition of culture with the idea of values: those things - the ideas, beliefs and attitudes that groups or communities consider of worth and importance. We have also described contemporary cultures as dynamic and diverse. As a matter of urgency, education must help young people to understand these processes and to engage with and respect cultural perspectives which may differ from their own. In part, this is what we mean by cultural education. We will return to this idea shortly. But first, we want to comment on a view that is commonly taken when discussing cultural change and diversity: this is that there are no longer any core values to be taught in schools and that, instead, young people need to be taught that all values are relative and that there is no basis for choosing between them except personal preference. We do not think that this is the case in our national context. There clearly are some values which are at the core of our national way of life - our national culture. Two in particular underpin many others.

The first is a commitment to the unique value and central importance of the individual. On this commitment is built a series of connected attitudes and beliefs. They include a belief in the right of all individuals to fulfilment and self-realisation; to freedom of personal expression and action, providing the freedoms of others are not infringed; and respect for different value systems and ways of life. On these commitments is built a network of legal and political principles including a wide range of democratic rights and responsibilities. These principles permeate our social, legal and educational processes which in turn are meant to express and sustain them. For all its diversity, our national culture is rooted in the core value we attach to the life and rights of the individual. In some national systems this is not so.

A second touchstone of our national culture is the idea of contingency: the view that things might be different from how they seem or are currently believed to be. This assumption is the basis of our interests in empirical enquiries and observations in science and of our modes of analysis in the humanities - in history, criticism, politics and philosophy. It is this that encourages us to question current perceptions, knowledge and practices and to believe in the virtues of openness in public and political life rather than closure and censure.

These two core values, and the practices and attitudes they give rise to lie at the heart of our national culture. They are not negotiable if individual fulfilment and open enquiry are to continue to characterise our way of life. It is because these are core values that our national culture is so diverse and creative. Benefiting from this diversity and promoting our creative

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resources is precisely what is at issue on our arguing for a more systematic and sustained approach to creative and cultural education. What does cultural education entail?

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.

The importance of STEM education

The importance of STEM Education for young people is very high because STEM education offers blended learning.

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. It teaches students computational thinking and focuses on the real world applications of problem solving. As mentioned before, STEM education 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. This initial step provides standards-based structured inquiry-based and real world problem-based learning, connecting all four of the STEM subjects. The goal is to pique students' interest into them wanting to pursue the courses, not because they have to. There is also an emphasis placed on bridging in-school and out-of-school STEM learning opportunities.
- 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. Student exploration of STEM related careers begins at this level, particularly for underrepresented populations.
- 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, as well as preparation for post-secondary education and employment. More emphasis is placed on bridging in-school and out-of-school STEM opportunities.

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Much of the STEM curriculum is aimed toward attracting underrepresented populations. Female students, for example, are significantly less likely to pursue a college major or career. Though this is nothing new, the gap is increasing at a significant rate. Male students are also more likely to pursue engineering and technology fields, while female students prefer science fields, like biology, chemistry, and marine biology. Overall, male students are three times more likely to be interested in pursuing a STEM career.

The importance of STEM education has been recognized both by the EU and US. The manufacturing sector faces an alarmingly large shortage of employees with the necessary skills — nearly 600,000. The field of cloud computing alone will create 1.7 million jobs between 2015 and 2017, according to the report. For example, the U.S. Bureau of Labor Statistics projects that by 2018, the bulk of STEM careers will be:

- Computing – 71 percent
- Traditional Engineering – 16 percent
- Physical sciences – 7 percent
- Life sciences – 4 percent
- Mathematics – 2 percent

This is not a problem unique to the EU. In the United Kingdom, the Royal Academy of Engineering reports that the Brits will have to graduate 100,000 STEM majors every year until 2020 just to meet demand. According to the report, Germany has a shortage of 210,000 workers in the mathematics, computer science, natural science and technology disciplines.

Also STEM education is also highly interrelated with cultural heritage. This connection is presented in the next section.

STEM Education Culture and Cultural Heritage

Against this background, we see four central connections of STEM education with cultural heritage. STEM education can be exploited:

- To enable young people to recognise, explore and understand their own cultural assumptions and values.
- To enable young people to embrace and understand cultural diversity by bringing them into contact with the attitudes, values and traditions of other cultures.

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- To encourage an historical perspective by relating contemporary and scientific values to the processes and events that have shaped them.
- To enable young people to understand the evolutionary nature of culture and the processes and potential for change.

Taken together these suggest key principles for the balance of STEM teaching and learning in schools and for the balance of the school curriculum.

To enable young people to recognise, explore and understand their own cultural assumptions and values.

Most young people belong simultaneously to a range of different cultural groups and communities. They do not develop their ideas and values in isolation. They do so in relation to the groups and communities to which they belong and they express them in the clothes they wear, the stories they tell, the jokes they like, and the music they make. All young people, particularly during adolescence, are faced with a complex task of constructing a sense of personal identity from what is now an accelerating traffic of images, ideas, pressures and expectations that surround them, from home, friends, street culture, the media and from commercial interests of every sort.STEM education offers an excellent basis for young people to understand their uniqueness and cultural identity.

Recorded music and images, broadcast and printed material, consumer items mainly made mechanically, live entertainment, digital information, games and recreations, educational aids, food and drink, travel and holidays, drugs and cosmetics: these are the languages of commercial culture as spoken to young people An adult view sees them as an everincreasing mountain of goods and waste which require great effort to manage. For young people, they are important as a means of communication of the identities they are busy creating. Seen in this way and the money used to buy them as a means of independence, the products of commercial culture should be much less frightening to us. Anything can be sold, but how it is used is another matter. Young people select and discard a huge range of available material, ideas, words and images with impressive speed. The past and other contemporary cultures provide them with the material to create an individual style. Strangeness and difference, aspects of the other, are particularly valuable to them in establishing the unique character which will guarantee their presence in the world. Young people require flexibility of the things they take over. Their great skill is in transformation and STEM education can support a smooth transition to the future knowledge. They can make ordinary and mundane objects special with new uses and combinations. They adapt and they invent. Their language is precise, original and distinctive. They experiment with sensuality, the feel of substances, the pleasure of properties and material goods.

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To enable young people to embrace and understand cultural diversity by bringing them into contact with the attitudes, values and traditions of other cultures.

Cultural education is a complex field with many dimensions and difficulties. It involves teaching for a diverse society: an education that enables young people to live in a multi-ethnic and multicultural Europe. The need for STEM multicultural education has long been recognised in schools, particularly at the level of policy. It is essential now to go beyond statements of policy to forms of practice and provision which encourage cultural understanding and promote a positive sense of cultural inclusion.

There is an important difference between STEM multicultural and anti-racist education. The general aim of multicultural education is to promote understanding of, and respect for, other cultures by deepening young people knowledge and experience of them. Anti-racist education builds on multicultural education but it includes specific strategies to challenge racist attitudes and behaviour. Both are needed in schools. Increasingly since the 1960s, multicultural education has been a high priority for schools in culturally diverse communities. For them the need to address issues of diversity was immediate and urgent. Schools in more homogeneous or even mono-ethnic areas might have felt less pressure to take up this agenda. But the need for multicultural education in such schools is just as pressing. If young people do not have direct day-to-day experience of other cultures of having friends from other ethnic traditions and races they will be less prepared than others for the culturally diverse societies they will eventually encounter.

To encourage an historical perspective by relating contemporary values to the processes and events that have shaped them.

We noted earlier that values and patterns of behaviour are shaped by many factors and that they tend to change over time. Helping young people to understand the processes that have influenced their own and other cultures is an essential role of education. Collectively as well as individually, our sense of our own identity is bound up with memory and knowledge of the past. Discussing the importance of the humanities in education, Sir Alan Bullock emphasises the necessity of historical understanding to a sense of cultural identity. He notes that any society that turns its back on the past and falls into a cultural and historical amnesia, weakens its sense of identity.

Multicultural education, as we described it earlier, has to go beyond a familiarity with how other cultures look and sound now, to a deeper understanding of how they evolved and were shaped. Many cultural attitudes and practices can seem strange, even irrational without some understanding of the contexts in which they emerged and the meanings they

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have acquired. An historical understanding of cultural development should also enable young people to grasp the many ways in which different cultures have long intersected and shaped each other. Young people need to recognise the distinctiveness of different cultural histories and experience and their roles in shaping global cultures.

To enable young people to understand the evolutionary nature of culture and the processes and potential for change.

A knowledge of the past is essential to understanding the present. But any culture that is oriented only to the past and refuses to identify with the new elements of experience in the future will stagnate. STEM education is unique in this field as engages young people in the possibilities of change: not only to teach them why things are as they are, but to understand what they might become and how. STEM education is ideal in this role as it can combine all the timeline of past to the future within its didactic units. The task is to avoid the extremes of cultural rigidity - of promoting absolute values with no room for debate; and laissez-faire - the relativity of anything goes. When there is too much rigidity, social institutions, including education, become closed systems in which individuality is discouraged and even penalised. When anything goes and nothing is certain, all that has been learnt and built in the past is lost or abandoned. It is in the balance between closure and openness, between tradition and innovation, that creativity thrives or dies: and with it the diversity and vitality of human culture itself.

Creative STEM Education and Cultural Education

In our view, creative STEM education and cultural education are intimately related. First, creative processes in STEM education draw directly from the cultural contexts in which they take place. Artists draw from the work and inspiration of other artists, styles and traditions just as scientists build on the insights and achievements of the wider scientific community. Sometimes the relationship between innovation, science and received knowledge is positive: refining and adding to what is already known or done. Sometimes it is a reaction against them: developing radically new ways of seeing. This is true in all fields of human action.

Second, human culture is as rich, complex and diverse as it is because of the richness, complexity and diversity of human creativity. Culture is shaped by, and is the product of, human creativity: it is generated by our different responses to the problems of meaning and practicality with which we are confronted. How we see events is deeply affected by the ideas and values we bring to them. History is marked by the often profound changes in consciousness, in ways of seeing the world which came about through the constant

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interaction of ideas and events: between science, religion, morality, politics and the arts, and between tradition and innovation. Education must recognise these intimate relations and promote them throughout the school curriculum. To do so we need to promote three principles of balance in schools.

We need to demand from our STEM education system and the curriculum that underpins it, pupils that do not pursue facts for their own sake, but make use of facts for the purposes of understanding.

First, there must be a balance in the curriculum between different fields of STEM and cultural education: particularly the sciences, arts, humanities, physical education and technological education. The school curriculum has tended to emphasise the importance of some of these disciplines over others, largely because some have been thought of as more useful or relevant to employment. This assumed hierarchy is reflected in the division in the EU curricula between core and foundation subjects; and in the patterns of options in many secondary schools. In our view, and for the reasons we give throughout this report, each of these is essential to the balanced development of the individual, and to the individuals balanced understanding of the social culture: its dynamics, diversity and development.

Second, there must be a balance within the teaching of all disciplines between tradition, innovation and science. People are not creative in a vacuum, they are creative at something in a context. Being creative involves a growing understanding of the possibilities, range and methods of a discipline. Consequently, there must be a balance between young people making their own work and the coming to understand the fields in which they are working. Education has a duty to transmit knowledge and culture from one generation to the next: to pass on an understanding of why things are as they are. Education also has to encourage imaginative and critical thinking, the ability to hypothesise, and to question the way things have always been done.

Third, there must be a balance between the teaching of different cultural values and traditions. The world young people live in and will inherit is multicultural. It is essential that schools reflect and respond to cultural diversity. This means promoting respect for different cultural traditions and practices, and an understanding of different cultural values and perspectives. Schools must take account of this diversity in the forms of cultural practice they include in the curriculum and in the values that are promoted in teaching and learning. We develop these arguments in Part Two.

Conclusion

In this section we have outlined our understanding of STEM education and cultural heritage and its relations to creative education. STEM, cultural education and cultural heritage are

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essential in helping to meet the challenges that education and young people face. In the next chapter we proceed in analysing the state of the art in systems for cultural education.

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III. STATE OF THE ART: ELEARNING & CULTURAL EDUCATION

As proved in the previous section cultural education is strongly associated to technology and new advances in networks, web and relevant applications.

Nowadays, e-learning environments have become increasingly popular in educational establishments and are widely used in cultural education. The rapid growth of e-learning has changed traditional learning behavior and presented a new situation to both educators and learners. Cultural education is also supported and affected by these e-learning environments.
The majority of current e-learning systems are based on Learning Management Systems (LMS). Learning Management systems allow students attending courses free from space and time limitations, since they can attend the class anytime they are available and regardless of the place. LMS are web-based educational systems that offer students an active role in their own education through a variety of learning activities and different kinds of learning content, that the teacher has produced. Although this fact, most Learning Management Systems lack of personalization and adaptivity features.

The modern trend in education nowadays, is the production and organization of Massive Open Online Courses (MOOCs) by large and internationally recognized Universities and educational organizations, such as MIT and Harvard. Most times Universities collaborate with other Universities or educational organizations, in order to offer for free a great variety of online courses which belong to different categories and sciences. Two very popular consortiums are Coursera and edX. The educational process in MOOCs is based on an e-learning platform, in which professors upload the educational content. The educational content most times is restricted only at text resources, links and video lecturing. Students must sign in the e-learning platform in order to have access to learning objects. These courses are cost-free, any student can attend the class, submit assignments and complete the course successfully. If a student prefers to take a certificate for the successful attendance of the course, he must pay the required cost. So, Universities focus on gathering too many people in these courses (MOOCs). A key feature which is not efficiently supported is education based on the user profile, that is personalized e-learning based on the weak and strong points of each learner.

There is a great research interest in distance learning and especially in e-learning systems. Researchers have proposed some solutions that extend e-learning platforms in order to solve the problem of e.g. personalization and adaptivity. These suggestions and solutions many times are based on students' learning styles, learning paths, system log files and activity-based learner models, agent-based systems and ontologies. The result of the

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research and all these proposals, is the need of personalization and adaptivity services in each modern e-learning system. At this "direction" student modelling is very useful.

Several methods have been proposed for modelling students and offering them personalized learning activities. A frequently proposed personalization technique is Course Sequencing, in which learning activities that make up a course, are sequenced based on key information about the student. The learner's most observed and modelled characteristic is his knowledge about the learning domain, as assessed through quizzes, questionnaires or usage-based information. Some e-learning systems are based on modelling student's knowledge, but also on their learning styles as modelled through specific tests, and if necessary, updated on the basis of their progress.

In order the system to be adaptable to each individual student, an Intelligent Tutoring System (ITS) has to keep track of student's actions, and subsequently analyze them in order to deduce how the student's characteristics evolve over time. The representation of the student's characteristics in a point of time is called student model. A student model contains all the information that the system knows about the student such as his learning style, background knowledge, job situation, colors or media preferences, and the like. Based on this abstraction of the student's state the system is able to decide how to perform the adaptation.

Especially in case of distance learning, that teacher and students have no face-to-face communication, learner's personalization is essential in order the teacher to be aware of each learner's characteristics. In e-learning systems, personalization could be achieved with an integrated user profile (student profile), which would include except from the classic information (name, surname, email) more specific and useful information. If the teacher had more information about each student, he could be able to guide him more effectively and evaluate him more correctly. In addition to that, if teacher was aware of each learner's profile, meaning his learning style, interests, preferences and his previous knowledge of the course topics, he would be able to adapt the learning content to his needs. That would increase student's satisfaction, motivation and consequently his participation in the course. The aim of adaptive e-learning is to provide the students the appropriate content at the right time, meaning that the system is able to determine the knowledge level, keep track of usage and arrange content automatically for each student for the best learning result. The learner's most observed characteristics are his knowledge about the learning domain of the course and his learning style.

One of the most popular and commonly used LMSs, is Moodle (Modular Object-oriented Dynamic Learning Environment). It is used from a great number of Universities globally, as well as from Italian and Greek Universities. According to the study and evaluation conducted by Graf S., Moodle achieved the best value five times, among nine open source platforms for e-learning, that were analyzed and evaluated especially on adaptation and

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personalization features, but generally as well. In the evaluation took part Moodle, ATutor, Dokeos, dotLRN, ILIAS, LON-CAPA, OpenUSS, Sakai and Spaghettilearning. The general point of view is that adaptation receives little coverage in e-learning platforms, but Moodle obtained the best results in general as well as in the specific adaptation evaluation. So an extension of the selected platform in a way that the courses adapt to the unique strengths, learning objectives, knowledge levels, and learning styles of each individual learner, is feasible.

Based on the above facts a modern eLearning system is being proposed and designed for the EdMuse project which supports efficient cultural education. The services and teaching units are especially designed so as to accessible through land and mobile networks and devices. The teaching units are aiming mainly at cultural education and Life Long Learning. The platform has been designed based on MUSED platform which is an already installed and evaluated platform for cultural education. The next section analyses the MUSED platform and proposed improvements so as to build an improved version for the EdMuse project.

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IV. THE MUSED PLATFORM

MUSED is a platform for sharing and reuse of museum objects in learning environments. In recent years many projects have developed online catalogues and repositories to manage and promote cultural heritage. After the massive digitalization of cultural heritage, open data modality suggests that we rethink access to digital resources of museums and their use and reuse in different environments such as learning and tourism. Museums are rethinking who they are and what they can do to partner with schools and others to encourage interest and curiosity from citizens, teachers and students.

Indeed the online accessibility of cultural materials and their sharing through technology can provide the use and reuse in particular of museum information for developing learning, educational content and tourism applications, with full respect for copyright and related rights, with the aim of deploying museum community content as a means to enhance visit experience. While the information system for managing digital collections facilitates administration and accessibility by internal staff or researchers, this modality may not be useful for teachers and pupils or the public. Furthermore, not all information concerning museum objects can be shared. For these reasons the need arose for technology that increases content related to cultural or scientific objects useful to the general public in order to improve knowledge dissemination related to cultural institutions and their heritage.

Linked open data (LOD) technology has suggested an opportunity to organize and promote heterogeneous content within different catalogues. This way of managing data provides the dissemination of cultural content in different contexts. In fact, LOD has taken on more specific roles and functions in relation to territory and visitors. In this context in 2010 The museums of Sapienza University launched a project to develop a linked data repository to enhance teaching and learning activities. The new platform aims to promote cooperation between museum staff and teachers to integrate cultural heritage information and educational materials to promote and disseminate cultural heritage. These museums are part of the European Digital Library project. In 2012 the “Museum information for science teaching towards a Learning Management System” project, supported by the Italian Ministry of Education, began. The project’s aim was to solve critical issues around the language used to share museum object content within an education environment.

The MUSED platform was developed and annotation tool integrated in it to allow museum staff to develop cultural heritage content, and teachers and students to capture open metadata for planning lessons and improve their learning. The open data access, sharing museum resources and annotation tools were provided to encourage teachers and students

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to access and to know their cultural heritage. After being given access to a reserved area of the MUSED website, teachers and students could find the information material online within the virtual paths offered by the Museums and track down useful objects to use the content in a customized e-lesson, a container of explanatory panels and virtual museum objects relating to the subject matter. With the aid of specific software, each teacher is able to create a hypertext with the support of images and information from the museums' catalogues. After the lesson, the teachers bring students to the museums so they will see objects that have already got to know, placed within the hypertext. In this way the students can implement the associative and experiential activities for the improvement of their cognitive abilities and their curiosity. The museum object becomes a tool for teaching and educational environments will be created to improve engagement and student learning. At the same time, through annotation tools teachers and students are able to integrate information of museum objects with content related to school subject so different information can increase digital museum resources.

Use and re-use of museum objects in teaching

How to use and make accessible cultural heritage is an essential part of the Digital Agenda for Europe. Several activities are already stimulating the re-use of cultural heritage in order to demonstrate the social and economic value of cultural content. The online accessibility of cultural material will make it possible for citizens throughout Europe to access and use it for leisure, studies or work. Moreover, the digitised material can be reused – for both commercial and non-commercial purposes – for uses such as developing learning and educational content, documentaries, tourism applications, games, animations and design tools, provided that this is done with full respect for copyright and rights.

Many projects have developed open data applications and tools in this context so museums' object metadata is available for reuse in different fields such as teaching, tourism and the creative industries. An international debate on use and reuse of digital resources is ongoing in order to provide specific reference to the cultural heritage field. Many curators are asking how they can rethink their relationship with the school and how to use technology to stimulate the interest of teachers and students to scientific and cultural heritage. New paths and laboratories have been built by curators within museums and teaching spaces have been earmarked on museums' websites. Virtual educational areas provide games, customization paths and learning objects (LO) and educational services. Meanwhile, technologies that are used by museums to promote and disseminate cultural heritage to schools allow:

- For planning new training
- To provide online engaging content to students

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- To develop cross-disciplinary lessons

Teachers create lessons using different contents, tools and Interactive Whiteboard to explain multimedia products in the classroom. In recent years, many institutions have also provided open data for cultural heritage for making lessons.

In 2010 the same research group designed an application to allow teachers to build a personalized path through web access to the PMS catalogue (the repository of Sapienza University museums) and to download images and information on museum objects to be used in the production of multimedia lessons. Different modes and content have been provided in a reserved area for teachers to make online lessons integrating museum objects, such as the Canadian Museum experience, lessons related to the course of study, interactive games, personalized virtual tours, developing a network of cultural heritage object repositories for educational purposes. A recent application is Rijskstudio, an innovative digital application that makes a large part of the museum's collection available to all, absolutely free of charge or the open data content of The J. Paul Getty Trust.

The Project

The project aims to test a new approach to bring cultural and scientific heritage in the classroom. This experience can help teachers to make curriculum related to e-books using non-traditional content, integrating digital cultural heritage resources. The project partners are the museums of Sapienza University (Herbarium, Museum of Mineralogy, Chemistry Museum and Museum of History of Medicine), "Via Val Maggia" and another four primary and secondary schools of Rome, and the Digilab Research Centre of Sapienza University.

The results of previous projects have pointed out critical issues around the language and terminology adopted by museum staff and in the limited information related to school courses that is shared by online catalogues. To solve this problem, the research group has applied technologies that can provide opportunities to rethink the increase and presentation of content. An annotation tool to increase digital object descriptions by museum staff, teachers and students was developed.

In this way the website will be useful to promote a virtual learning environment based on collaborative work to share content and LO among many schools. The aim of the project was to develope a framework that allows a user-centered approach for developing different means of access to digital resources and (re)use of them, including:

- access to linked a open data repository
- annotation of cultural objects

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- creation of personalized paths related to interesting topics chosen by users
- exporting procedure for metadata as xml files and images of objects for reuse in educational environments
- hypermedia lesson plans using the CMS Scuola tool in order to provide opportunities to integrate content previously downloaded from the MUSED Platform with formal educational content
- uploading lessons onto platform by users for sharing with all.

The MUSED Platform collects the metadata of cultural heritage objects extracted from museum catalogues involved in the project and from the Europeana Digital Library extracted through the Sparqlutililty. The metadata, by encoding, is imported like the XML files in MUSED through a mapping process. The MUSED database allows the maintenance of essential data such as object name, description, museum membership and image. Each inserted object provides two links: one to the original card, another to the museum that made it available. The annotation tool allows to staff to add the name of the object in Italian and a description of it related to interesting topics for teaching. This additional information can improve the search and accessibility of cultural heritage content by users. For example: the object “Laurusnobilis L.” card guaranteed by the “Herbarium“, has joined the common Italian name “Alloro” and a notation which extends the information of the description: family and genus of the plant, form, uses and properties. Cards and catalogues are available on the MUSED usable to any visitor who can look up and see what interests them; teachers and students logged in the project have an opportunity to create their own catalogues structuring specific paths in which they’re going to insert the objects of their interest; they have also the option to add other descriptions visible to all using the annotation tool.

A personalized access tool to the Repository has been designed to allow teachers to build a reserved area to store the content and images related to the museum objects chosen. This digital content may be used to describe teaching topics through multimedia lessons.

The personalized catalogue is stored in xml format based on the RDF model. Teachers will be able to download this file onto their computer and also capture images of chosen objects. The xml file includes metadata based on Linked Open Data technology to allow access to object information, museum websites, and images by Hypermedia lesson. For re-using downloaded metadata and images, the tool ASD (Accessible Site Developer) Scuola, developed by Sapienza University, automatically builds a hypertext from content and is accessible via the web.

In this way, teachers will be able to explain the lesson with museum object images and information re-contextualized. For example, a teacher can reuse an ancient pot from the

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Museum of the Near East in a lesson on ancient cooking, so the teacher will be able to adopt a methodology to connect ancient time with everyday life (next figure).

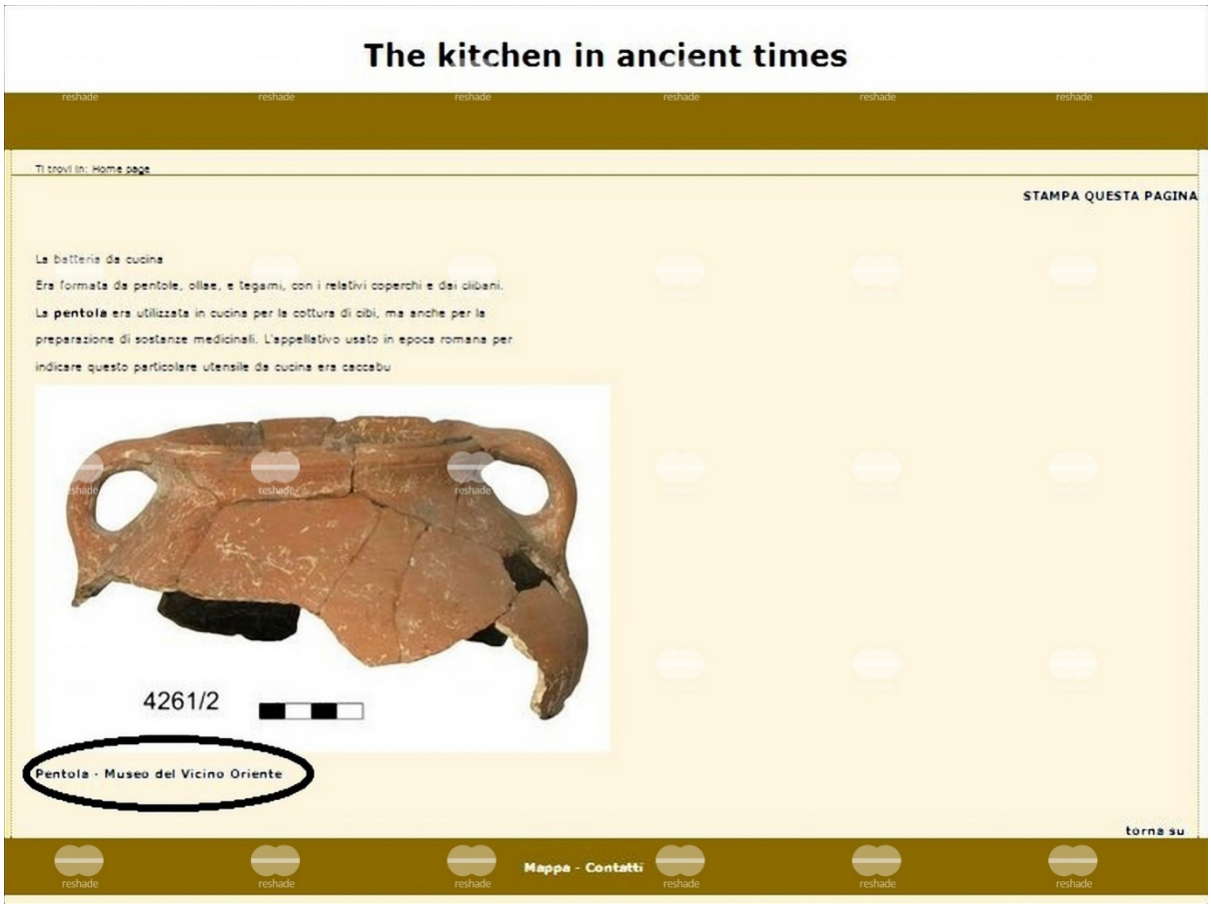

Figure 1 webpage of a lesson

Results and evaluation

Part of the project was an evaluation of the methodology and tools used to assess the impact on learning levels of students. A questionnaire was designed and administered to students. The results of the questionnaires of students who have used the technology approach have showed increased learning compared to students of control groups. Museum staff have observed that students in classes using the technology showed greater involvement and asked questions that deepened their understanding rather than out of mere curiosity during the visit. Access to the platform allows users to experience the annotation tool and to look at the lessons made by the teachers related to the museum

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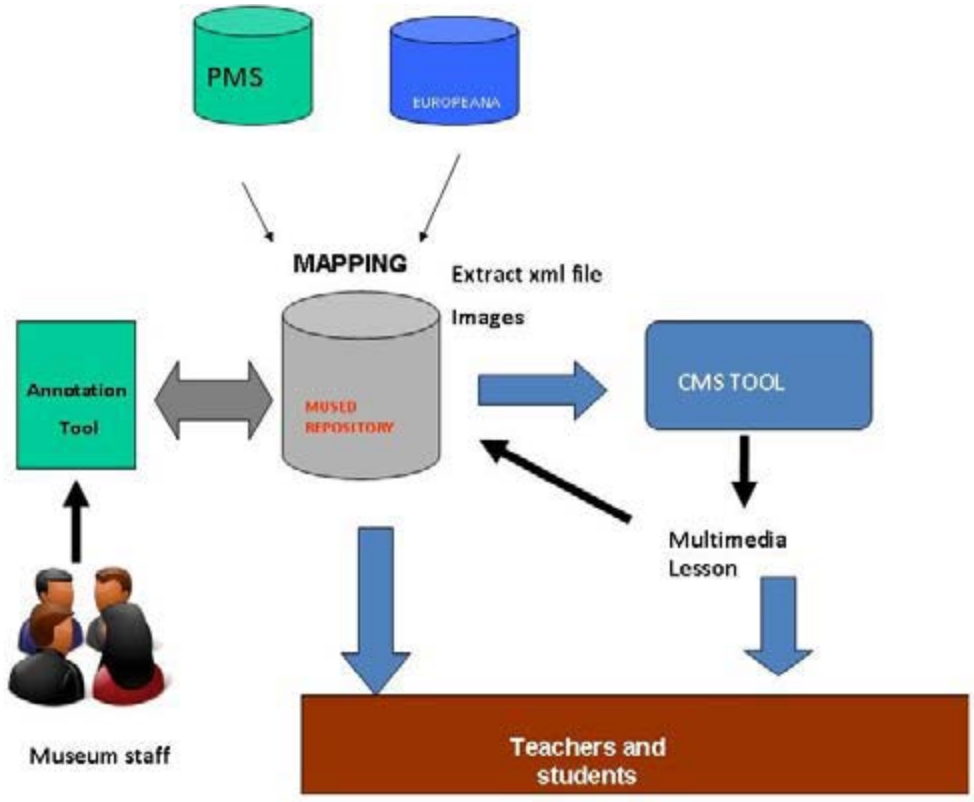
objects used. Results and hypertext of the project made by teachers are available via the web on the MUSED platform.

A new communication strategy applied to the theory for learning and technologies can help to develop a better relationship between the environment and the educational museum. The project results have shown how digital resources and technology tools can be used as teaching materials to build a new learning environment. The impact assessment in relationship to learning can be a useful element to think or rethink future developments and implementations of the platform. The proposed teaching framework can also be considered a useful platform for the re-use of digital resources in the context of permanent training and cultural tourism. The next steps are planning to implement the annotation tool to allow users to add other content such as videos, 3D models and so on. This idea will allow encourage museum visits and improve the relationship between museum and learning environment.

The MUSED platform is an excellent basis to provide added value cultural education services. The Database is structured based on international metadata standards for cultural heritage content exchange.



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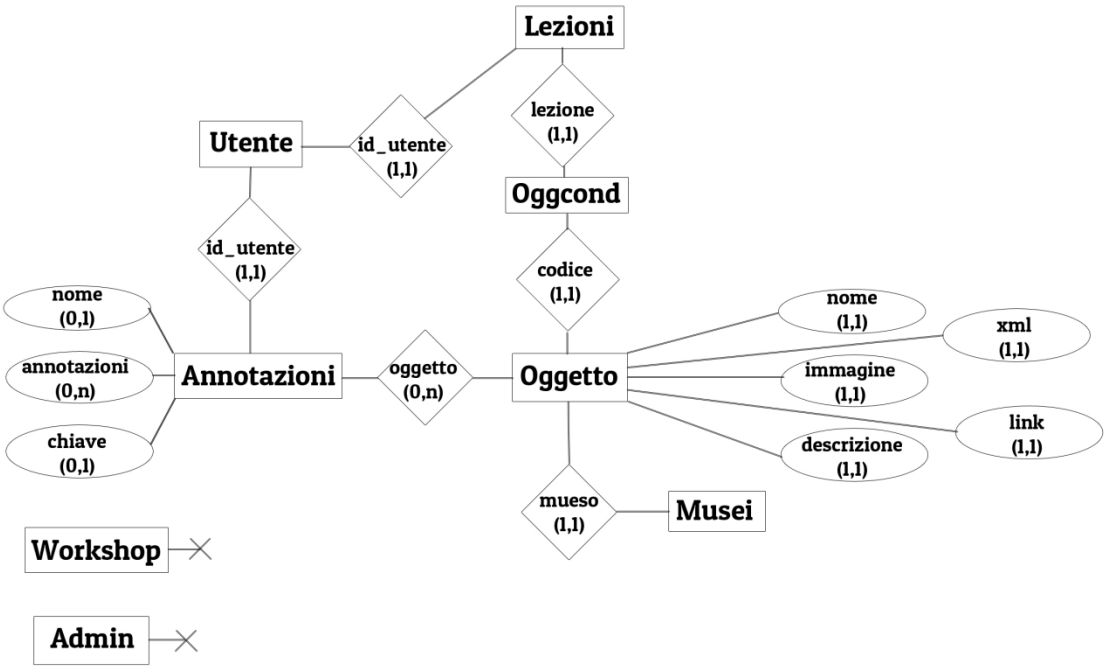

The platform could serve as an excellent basis for providing cultural education services and should be improved based on the following actions – implementations:

1. The platform should be translated to the EdMuse partners' languages (English, Portuguese and Greek).
2. The user interfaces and graphic presentation should be improved and modernized. In addition access to the platform through mobile devices should be under consideration.
3. The exporting procedure for the museum objects content should be enhanced so as teachers to be able to export metadata as xml files or other type file accompanied with images so as the content to be used and reused in several curriculum activities and in different multimedia formats (e.g. .ppt, doc, etc.).

Based on these facts the EdMuse platform is proposed to be based on an improved version of MUSED platform. The key architectural concept and proposed improvements are presented in the next section.

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This new optimized platform could be based on new open source software (such as Moodle) so as to be harmonized and interoperable with similar platforms.

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V. EDMUSE SYSTEM'S DESIGN KEY PRINCIPLES

Based on the MUSED platform and towards an improved version the basic principles on which the EdMuse platform for cultural education is designed are the following:

1. Design a cultural data repository of museum objects based on the API access. The key feature is sharing open education resources created or indicated by teachers of the project's area.
2. Design annotation tools which allow teachers to annotate the cultural objects with useful information directly associated with the learning process.
3. Design tools and services which allow teachers to manage and download multimedia cultural content related to the museum objects making personalized catalogues.
4. Design tools and services which the allow teachers to create and manage multimedia didactic units based on the Linked Open Data standard.

In Cultural Education traditional and commonly used e-learning platforms offer to their users the same educational content, the same learning activities and possibilities, and generally exactly the same content, with no further support. Most LMS provide limited or zero personalization and adaptability throughout the learning process, although it's a very important requirement in life-long learning. Some existing open source e-Learning systems may support, under certain circumstances adaptation and personalization features, but need extension and elaboration to acquire sufficiently these characteristics.

In this section the EdMuse platform's architecture is being presented and new features are being proposed in order to enrich student's learning experience and educator's capabilities. The teacher will have the ability to organize suitable learning objects and learning paths for each student, depending on particular fields, learning styles and student's preferences.

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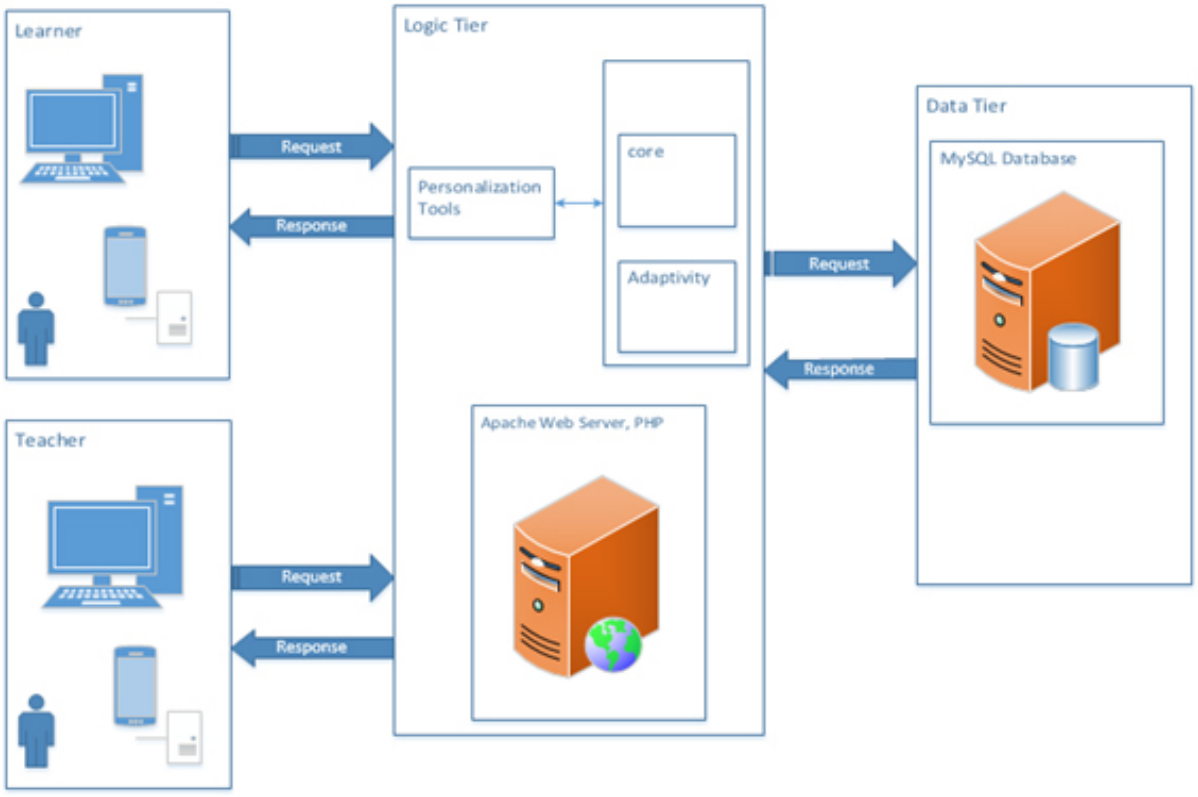
VI. System Architecture and Implementation Technologies

At this section the system's architecture and technologies that will be used for the implementation of the EdMuse e-learning system are introduced.

For the development and implementation of the system the next key elements are required: a web server, the PHP programming language and a database system. More specifically, we use Apache web server 2.4.9., PHP 5.5.12, MySQL 5.6.17 and PHPmyAdmin 4.1.14 for database management through web. The installation is structured at three points, which are: folder for e-learning system files, folder for data and database.

The architecture of the EdMuse e-learning system is a 3-tier architecture, which consists of the three levels: Presentation tier, Logic tier and Data tier. It appears below:



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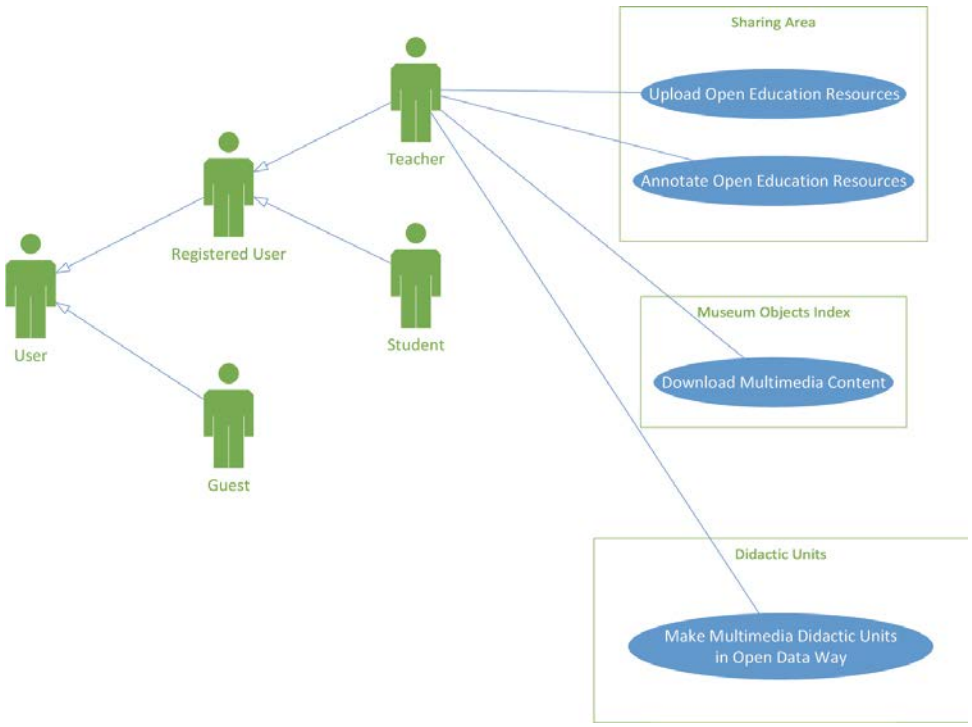
The development of the proposed personalized e-learning system, is based on the MUSED system. The software and source code is available and will specific code will be added so as the new features to be implemented. Also open source software such as MOODLE could be used to produce new tools and interoperability. The new features will focus on multilingualism, better system's aesthetical design and new content extraction processes. In addition a personalization features is proposed to be added but this implementation is still under inspection. The personalization feature is considered important in order to enrich student's profile and adjust learning content to learner's needs and preferences, depending on his profile fields, learning style and learning progress. Moodle has certain features for personalization and interoperability.

The next UML diagram presents the basic user categories, the data flow and main system's ontologies and entities.



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VII. The ELearning System – UIs and Provided Services

For the planning and the development of the EdMuse e-learning system we took into consideration the current situation of e-learning, we carried out a study on existing e-learning systems and their services and especially the MUSED platform. The conclusion is that, MUSED is an excellent basis for developing the EdMuse platform with certain modernization.

Firstly, web technologies are used in order to develop the e-learning environment with a variety of course activities and possibilities. Courses about Cultural Education can be structured and uploaded into topics. These didactic units consists of several educational resources, either text, or multimedia content. The teacher has the ability to upload and annotate the didactic units, the student the ability to download and extract the units in various formats and in accordance with her / his preferences.

The implementation of the activities mentioned above will be based on MUSED core, and there have been added new features in order to enrich student's learning experience, depending on his profile and learning progress.

The teacher has the ability to adjust and annotate educational content and course learning activities, to students' needs. Meaning that, he is able to produce and organize learning material in a better and more suitable way.

The architecture includes also a module for Mobile e-Learning. This is considered crucial so as the objectives of ubiquitous e-Learning to be fulfilled. A specialized user interface which includes e-Learning services for mobile phones and especially for smart phones has been designed and is under implementation. Creating learning courses for mobile devices and i-phones raise specific technical and functional requirements, which are summarized in the next important points:

- Limit Graphical Content. With the tight mobile device screen being roughly a twelfth (or smaller) of a desktop screen, large-screen graphics not only increase load times, but also take up valuable space that is needed to display text, hyperlinks, and other important information.
- Text Considerations Text should be limited – briefer is better. Layout should be structured to avoid the need for scrolling. Thus, this involves breaking up text into smaller pieces/sections and linking to those smaller pieces, instead of putting a lot of text on one screen. Smaller fonts are also recommended. For example, Microsoft

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Windows Mobile standard is Tahoma with a point size of eight, which is an appropriate size for text viewed in the Apple iPhone's Safari Web Browser.

- Limit Use of Data Entry Since the keyboard is a limited size, input fields should be kept to a minimum to reduce the amount of typing. Where possible, provide possible text or phrases to avoid needing the user having to type. These text items should have a hyper-link associated with them to serve as an easy way for users to select them, rather than their having to type them on the keyboard.
- Utilize Empty Space Another design guideline is to utilize screen space. Avoid excessive horizontal and vertical spacing between screen elements. Unlike designing a print ad or brochure, you don't need a lot of "white space" on mobile device's screen.
- Place Non-Essential Links at the Bottom of the Screen Hypertext links that are not relevant to the information being displayed should be placed at the bottom of the page to preserve space. This places critical information in the user's view upon entry to the screen or page. For example, a navigation menu that would normally be on the left or top of the screen of a desktop computer should be placed at the bottom of the screen for a mobile device.

Based on the above criteria the educational content imported into the platform fulfil the technical specifications for images, text, audio and video. The teacher inserts content both for the web user interface and the mobile interface.

These features could be achieved with the use of MUSED and Moodle combined.

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VIII. CONCLUSION

Towards the implementation of the system this deliverable collected and presented all the key elements which led to the design and development of a successful eLearning platform for cultural education. Specifically the next key issues were analysed:

1. Cultural education as a challenge and long term objective in modern life-long learning.
2. State of the art in personalized and adaptive e-learning systems and mobile platforms specifically focusing on cultural education.
3. The MUSED platform analysis. The key advantages and future challenges towards the new EdMuse platform.

Based on this analysis it is concluded that MUSED platform could serve as an excellent basis for further developing and providing services for cultural education for the EdMuse project.

In addition the architecture of the platform has been created and presented based on the MUSED platform and several key improvements were proposed so as the MUSED to be optimized and provide more coherent cultural education services.

The optimizations will be focusing on the next key elements:

1. The platform should be translated to the EdMuse partners' languages (English, Portuguese and Greek).
2. The user interfaces and graphic presentation should be improved and modernized. In addition access to the platform through mobile devices should be under consideration.
3. The exporting procedure for the museum objects content should be enhanced so as teachers to be able to export metadata as xml files accompanied with images so as the content to be used and reused in several curriculum activities and in different multimedia formats (e.g. .ppt, doc, etc.).

These optimization could be achieved with the combination of the source code of MUSED platform and the use of an open source platform such as for e.g. Moodle.???

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