Utilising an Educational Framework for the Development of Edutainment Scenarios

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Abstract: Edutainment may be considered a developing contemporary research field particularly as new and open source game development environments are made available to the research community. Nevertheless, most edutainment scenarios are usually limited in terms of interactivity, design and aesthetics, a fact that may be attributed to the task complexity, which requires an integrated approach addressing all related fields. This work introduces a conceptual/operational framework for the development of edutainment scenarios, which is both game-based and rich-media oriented. The proposed framework, which for the main part must be considered an educational effort, combines theoretical background -within the fields of human-computer communication, interaction/educational design and entertainment studies- and practical solutions and techniques regarding software and digital games development, for the creation of custom edutainment scenarios. These abstract and more or less theoretical scenarios due to the seamless embodiment of technical practices may be easily developed as fully fledged products, be them games, applications or any kind of digital media that provide the unified service of education and entertainment. In such a case the end product (a digital system) permits the user to interact with the environment in a game-like manner, which enhances learnability and contributes to knowledge acquirement as the underlying objective.
The framework, although not a rigid one but rather subjected to ad hoc adjustments, consists of well-defined stages, which include modern educational theories and state-of-the-art development environments. This paper describes in details the proposed educational framework for the edutainment scenarios and presents a recent case study that validates its effectiveness. Despite the fact that the framework is still under development in a continuous feedback process with respect to the scenarios conceived by higher education students who utilise it, the results achieved so far are rather encouraging in terms of creativity, interaction design and aesthetics, thus addressing in a satisfactory manner the above mentioned deficiencies which –in our opinion- characterise a large portion of commercial edutainment scenarios

Keywords/Key Phrases: Edutainment, application development, gaming environments, interaction/educational design, learnability and playability.

1. Introduction

When contrasting the development stages of computer-based edutainment applications to those used for the development of computer games it becomes apparent that they share many similarities. Under both scenarios, implementation teams consist of content experts, designers of static image, audio, video and interaction and programmers, who cooperate in order to develop the scenario-based end product. On the other hand an edutainment system is inherently different to a game, particularly when one examines the underlying complexity of the learning process. In other words, interaction design focuses on the learning process and follows a clearly defined educational path, whereas games allow interactive freedom to the user (Denis and Jouvelot, 2005). It was also reported that '*playing "action" video and computer games has the positive effect of enhancing student's visual selective attention*' (Prensky, 2003). To elaborate further on the previous arguments, one may safely argue that development of an application based on a game-building environment that utilises appropriately adapted educational interaction scenarios, may be catalogued under the edutainment application category. Interaction was identified as an essential characteristic of a game-based edutainment application (Thornton and Cleveland, 1990), while later research revealed that other factors may affect the process: dynamic visuals, rules, goals, challenge, risk, fantasy, curiosity and control (Pivec and Dziabenko, 2004).
The proposed conceptual/operational framework materialises the above analyses in order to furnish the development of well-defined edutainment scenarios through the utilisation of game-development environments (Shea, 2008, Trenholme and Smith, 2008) and multimedia programming environments

(Deliyannis, 2007). These tools offer rich-media support and advanced interaction capabilities, while the availability of high-level languages and extended use of scripting allows users to focus more on the scenario while coding is implemented in an action-based basis. As existing game paradigms are utilised, this introduces less complexities in terms of usability (Ang et al., 2008). Our work discusses and contrasts related edutainment development frameworks and methodologies in the following section, while section three presents the underlying framework. Section four discusses the result of a recent study, which was run during a university course on edutainment. All the examined scenarios have been development according the proposed framework and work as a proof of its validity and flexibility. Finally, section five concludes our paper with further extensions and work suggestions.

2. Game-based learning and edutainment

A wide array of applications that blend computer based games and learning methodologies for multiple content domains are referenced in the literature as examples of user-built edutainment software. Under certain instances, innovative approaches trigger the development of novel learning platforms (Mininel et al., 2009) and frameworks (Embi and Hussain, 2006). These focus either towards the specific requirements of selected user groups (Deliyannis, 2007, Deliyannis and Simpsiri, 2008) or are designed to educate users using particular technologies and methodologies (Deliyannis et al., 2008). Our experience in the field has shown that although content and educational objectives may vary under each case study, many developers utilise existing proprietary or open-source programming environments in order to achieve rapid prototyping and development. In some cases, ready-made games that offer level-editing tools are employed to build special-purpose strategy, adventure or puzzle-based games and educational activities that cover the educational objectives (Moreno-Ger et al., 2008). This approach demonstrates a number of advantages: it reduces development costs and the resulting end-user experience is intuitive as content is delivered through a game environment that users may have experienced earlier.

The first step towards the development of successful edutainment software is the selection of worthwhile learning objectives that meet the pedagogical needs. Design is the driving force that reinforces the learning goals and an appealing implementation that attracts the end user's interest (Alessi and Trollip, 2001). In the case where learning material is not intrinsically motivating, but needs to be taught, digital game-based learning tools are available in order to assist trainers and trainees (Yue and Zin, 2009, Zin et al., 2009). Edutainment games allow players to either practice repetitive skills or rehearse memorised facts following a skill and drill format. Their target audience ranges from primary school students that need to learn or rehearse the basics of language or arithmetic, to professionals that aim to learn new things, or improve their skills (Prensky, 2003).

It's a common practice in edutainment software development frameworks to follow the principles of efficient educational course design: allow students to verify existing knowledge, challenge them to higher learning states, use active rather than passive forms of learning and provide students with frequent and immediate feedback on the quality of their learning. Thus, educational computer-based games can be seen as alternative learning objects and activities, which are considered integral parts of the overall learning process. According to Prensky (Prensky, 2005) during the environment selection or game design phases, developers must take into account several factors such as: the selection of appropriate learning style and game genre to the learning activity and the preference of individuals to different game types. Categorisation of game styles and identification of supported learning techniques and activities are the first steps of the edutainment design process, followed by the association between learning styles and game types (Rapeepisarn et al., 2008). When these stages are completed the developers are in a position to select the most appropriate game type for the target learner group.

Motivation is another critical issue for successful educational game design, from the user perspective (Sandberg et al., 2011). Some researchers consider that the narrative context motivates students (Waraich, 2004, Dickey, 2005) while others believe that setting goals and providing rewards within the game is more intriguing for students (Denis and Jouvelot, 2005). According to them, motivation is a combination of the desire to be competent and the pleasure of being competent. Other features that increase students' interest for the educational game are interactivity, the use of technology and interaction with other players in a multi-player environment. A key question that one may raise at this point is if edutainment may be entertaining also from the developer perspective. Edutainment can be developed and served in a multitude of frameworks and platforms, including systems that require little or no programming. Edutainment applications can be stand alone, online, mobile, robot assisted (Jang et al., 2006) or even served in a virtual environment (Konstantinou et al., 2009). Generic game development platforms, allow for rapid educational game development that serves multiple learning

objectives.
The generic educational game design model that has been developed by Sauvé (Sauvé, 2009) consists of five phases: a) the analysis of the learner groups and the pedagogical and technological requirements and the selection of the generic game structure that will be adapted, b) the design of the game scenario and of the visual model of the game, c) the technical development that comprises programming, and testing of the generic game shell and deployment of the specific game customisation, d) the evaluation of the generic game shell, and e) the evaluation of each individual education game created on the base of the generic game shell. This adaptive process increases the efficiency of the final edutainment process, since it provides customised solutions to each individual learner's needs. In the same direction, Moreno-Ger and co-workers (Moreno-Ger et al., 2008) suggest that edutainment software must first of all serve the pedagogical requirements; it must integrate with the education plan and any available online educational platform, be adaptive to the different learning styles of students and allow the assessment of the progress of the learning experience.
Our framework, which is presented in detail in the following section, takes into account the aforementioned design models. However, it provides a more generic approach to the development of edutainment software, which increases the flexibility in the cooperation between designers, developers and users and promotes the reusability of resources. It focuses on the identification of the different roles that participate in edutainment software development, on the prioritization and distribution of tasks to the participants.

3. Introducing an adaptive edutainment development conceptual /operational framework

Researching the educational potential of computer games is an issue that has already been reviewed in the literature (Egenfeldt-Nielsen, 2007a). Some researchers examine the game-type perspective (Torrente et al., 2009) while some have concluded that we are moving towards a more inclusive generation of computer games (Egenfeldt-Nielsen, 2007b). Frameworks and models mainly focus on the appropriate use of game technologies and environments to support learning (Tan et al., 2007). Our approach is content independent and addresses a wide array of generalised developmental issues that arise under the majority of edutainment-system implementations using the proposed conceptual/process framework. Its value is demonstrated particularly when a rapid, adaptive or non-conventional development methodology needs to be employed for the development of a new edutainment system, based on existing game systems and platforms (Moshirnia, 2007). In this context, various factors are taken into consideration during system life cycle including educational objectives, developer expertise, user background and technological proficiency, underlying system-platform and network requirements to name a few. The non-exhaustive list of factors displayed in Table 1 is organised into three main categories that correspond to the three main participants of an edutainment system: content experts, developers and users, under a balanced proprietary scenario. Each party assumes a clearly defined role during the systems' life cycle. The list of factors is not exhaustive, implying that when necessary it may be adjusted appropriately to represent reality.

Table 1: Participating parties involved in the lifecycle of a typical edutainment application

Content Experts	**Developers**	**Users**
Educational Objectives	Development Experience	Technological Proficiency
Learning Methodologies	Developer Expertise	Cultural Background
Educational Content	Content Encapsulation Issues	Educational Background
Presentation Issues	Presentation Quality	Equipment Availability
Delivery Requirements	Quality of Service	Network Availability

Under this typical scenario, content experts clearly appreciate more than the other two parties the educational content and user requirements that need to be met by the end-system; therefore their role is classified as highly important to project success, hence they are placed in the first table column, or at the top of the graph-representation, figure 1, left. Their choices affect the specification of the educational implementation and the objectives. Part of their responsibility includes the selection of an appropriate learning methodology; content presentation and access issues are additional factors classified as highly influential factors for the end-system. Content experts interact with developers who possess the necessary experience and understand the underlying system limitations, indicated via double arrow in figure 1, right, area B_2. Developer involvement on the other hand in the whole process

affects the overall quality of the presentation, while overlapping graph-representation is used to specify the appropriate interaction modes between content experts, developers and user groups involved in the development process under the proposed framework. Filled area notation is used to denote two-way communication; arrows are employed to explicitly indicate message passing (one-way) or interaction (two-way) while numbers are used to specify the appropriate order of actions. The same notation may be used in a temporal manner, indicating varying communication configurations for diverse system states. The framework describes interaction between participating parties that collaborate for the development of a new edutainment application. It is used to represent the actions of each contributing member, while various tasks are parallelised to reduce developing time.

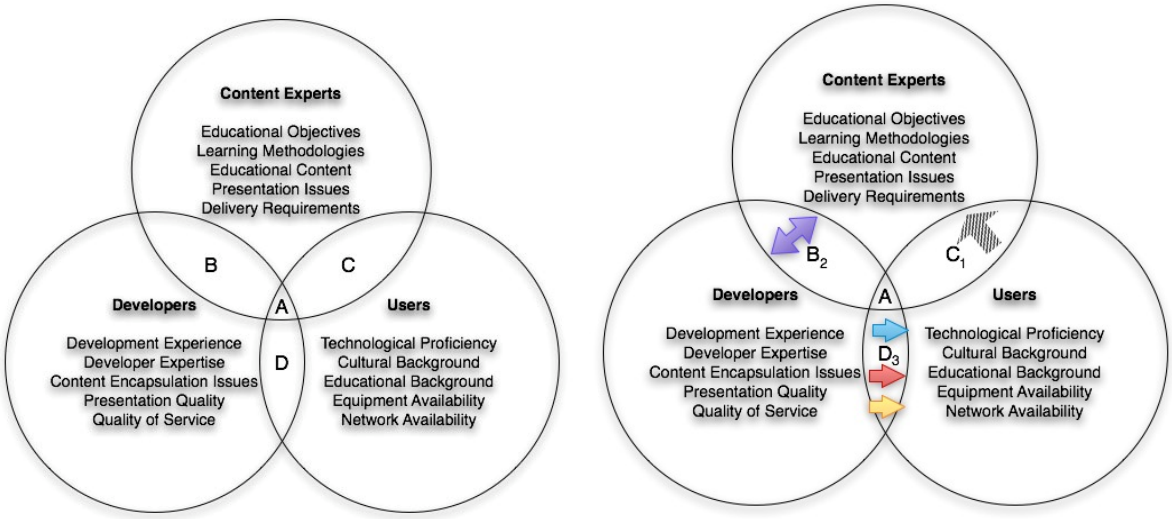

Figure 1: Use of A, B, C, and D define the area-inclusive notation employed in the interaction mode representation of the framework. These areas are used to describe between content experts, developers and users (left) and a typical edutainment software development scenario is displayed (right). Single arrows describe one-way communication between the parties involved, while full interaction is denoted using double arrows

Another interesting aspect introduced via the use of circular graph representation is the lack of particular order in terms of process initiation. This is not uncommon in real-life scenarios as the availability of visual multimedia authoring platforms and game-building environments permits non-experts to get involved, enabling them to either create a new implementation or adapt an existing system to suit their intended purpose (Deliyannis, 2007). This is classified as an important aspect by the authors as beyond content experts other participating parties may also decide to build an edutainment system, a principal characteristic for many edutainment applications (Deliyannis and Simpsiri, 2008, Deliyannis et al., 2008). In the following section, we illustrate an edutainment software development scenario using a real-world example where particular attention is given to the detail on the flow of resources and responsibilities among the various participants of the educational process. This example is used to demonstrate the flexibility of the framework and its appropriateness to rapid edutainment application development.

4. Student-built case-studies

A mainstream scenario involves the case where content experts take up the leading role. In this case by appropriately marking area C on figure 1 (right) it is symbolised that content experts with experience in the field have studied the domain of application and the user characteristics. At the next level, marking area B denotes interaction between content experts and developers. Finally, user-based system testing is indicated appropriately under area D. Numbers next to C, B and D are used to indicate the order of actions.

The above typical scenario was comprehensively described by the area-exclusive representation. It is informative to see how complex cases are handled and identified where the traditional software engineering processes are not followed. At the Department of Audio and Visual Arts, Ionian University, Corfu, Greece where the course entitled “Edutainment” is taught, students were asked to form groups in order to undertake -as an exercise- the development of a full edutainment scenario.

This, in computer engineering terms involves various stages which include the design, implementation and testing of an edutainment application. A variety of original scenarios were proposed, all of which classified as possible edutainment-application candidates as they involved clearly defined learning objectives and a precise game methodology utilising behaviourism as the underlying pedagogical theory. Here one of these game scenarios is examined that aims to educate fellow students about modern art and enable them to recognise it in a museum setting. This is achieved through the development of a first-person “serious” adventure game, concept art of which is shown in figure 2, that beyond the design and development stages, it involves the development of an appropriately designed aesthetical environment. It takes place into gallery rooms where puzzle pieces need to be collected and matched correctly in order to progress to the next level. As the game progresses, the challenges become more difficult as time-based scoring introduced.

Figure 2: The virtual museum graphic (left), the main character (center) and part of the museum labyrinth viewed from the top (right).

Content is sourced from representative works selected to serve the game scenario. The game is designed to be accessible over the World Wide Web, a factor that introduced the need for Java/JavaScript/HTML/CSS technologies for web delivery. The underlying software selected to implement the game involves use of state-of-the-art software packages for graphics/3D: “Illustrator CS5, Softimage 2011, cinema 4d”, sound is composed and processed through “Ableton, Logic, Reason 4” and for the development of each game environment unit “unity 3d” is used.

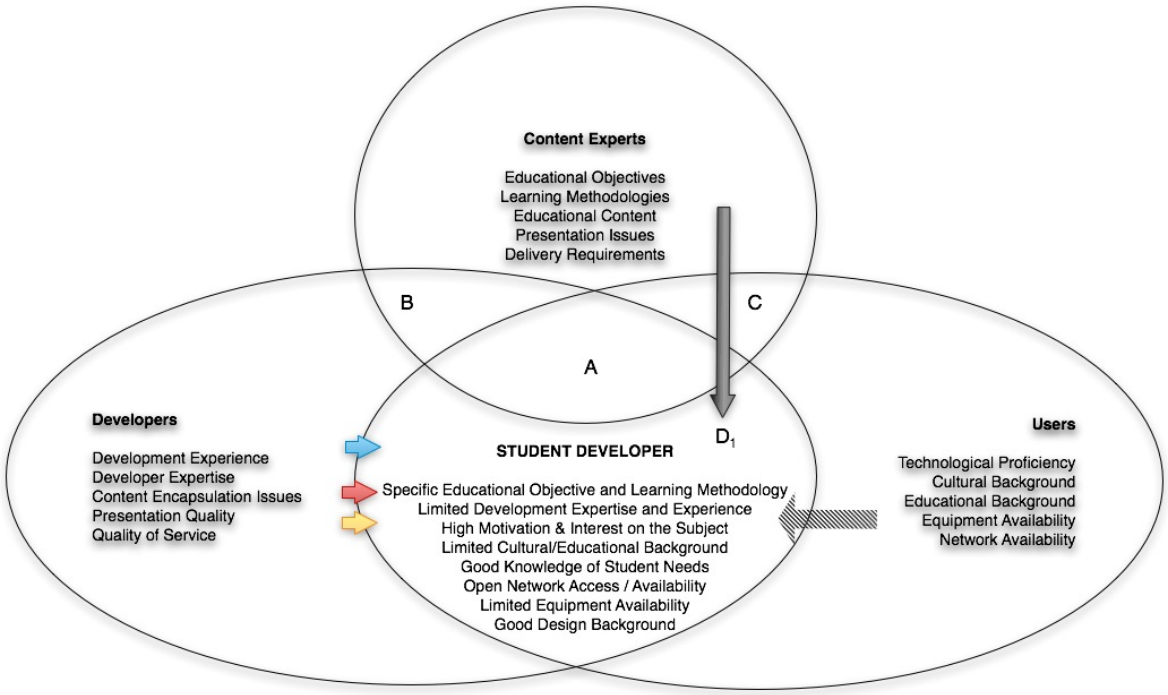

Figure 3: The virtual museum case study is represented using the proposed framework notation. The graph reveals high interaction complexity as students assume key role in the process, while content experts and developers aid in the process.

Under this case study the conceptual/operational framework demonstrates its potential, enabling the shapes to be bent in order to fit in participants with “fuzzy” experience in the domains involved. Students are the main project drivers acting as developers, who do possess partial technical and content knowledge. Figure 3 presents the complex interactive task undertaken by this particular developing team.
Domain D is the inclusive area that embraces limited developer and user experience and therefore it is established first. Content is sourced from the content experts -here from an external expert- while developing instructions, technical, programming and administrative help is obtained from departmental assistants and lecturing staff on demand.

The case study that we presented above, demonstrates the appropriateness of the proposed conceptual/operational framework. Using our framework and the graphical representation that it offers, it is possible to proficiently represent development cases featuring interdisciplinary knowledge. More complex cases may require additional lettering/numbering to be added, while for transient systems more than one graphs may be used.

5. Conclusions

This paper introduced a conceptual/operational framework for the development of edutainment software. The framework abides by the current state of the art principles in edutainment software design and allows any educational game design model to be applied. Existing educational resources and educational game development tools and platform can be orchestrated in order to serve educators’ and students’ needs. The framework defines from the very beginning the interactions between the various participants and assigns roles and responsibilities. It can easily capture simple interactions between participants from the same discipline and assist rapid development of the edutainment software, but can easily extended to cover more complex cases.

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