THE LAVA PROJECT:
A SERVICE BASED APPROACH TO SUPPORTING EXPLORATORY LEARNING

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ABSTRACT

This paper introduces the Laconia Acropolis Virtual Archaeology project (LAVA), a co-operative archaeological learning environment that has been developed to address the need for students to be able to engage with realistic archaeological excavation scenarios. The practice of fieldwork lies at the heart of archaeology yet poses particular problems for the learning of the subject. The opportunities for students to gain real-world fieldwork experience are limited. Even when available the roles that students can play, and responsibilities that they can take, are constrained.

This paper describes the motivation for, and design of a system that helps students collaborate in exploring virtual archaeological excavations and facilitates them in constructing an improved understanding of the subject. We make use of computer games methodologies to provide an engaging system. We deploy a range of technologies to bring alive resources derived from real archaeological excavation. We provide an infrastructure which supports a group-based exploratory approach and we also integrate 3D gaming technology with a service-based learning environment to provide anytime-anywhere access and thereby support self paced learning. It is not an aim of this project to replace real-world fieldwork practice; rather our aim is to both compliment and enhance that practice.

KEYWORDS

E-Learning, Collaboration, Virtual Reality, Multimedia, Gaming, Groupware, Service-based Architecture

1. INTRODUCTION

One of the biggest challenges for students studying archaeology is attaining fieldwork experience [1]. This challenge has been recognised internationally by a number of governments and higher education bodies [2-4]. The opportunities for students to gain real-world fieldwork experience are limited, therefore it is advantageous to be able to utilise computer technologies to provide realistic virtual fieldwork scenarios that can both compliment and enhance real-world activities. Distributed Learning Environments are often cited as being solutions to the ambitious goals of better education, wider access and lower costs in the education and training sector. It therefore seems reasonable to investigate the role that they could play in the provision of a suitable classroom-based alternative to real-world archaeological fieldwork experience.

This paper introduces the Laconia Acropolis Virtual Archaeology project (LAVA), a co-operative archaeological learning environment that has been developed to address the need for students to be able to engage with realistic archaeological excavation scenarios. The subsequent sections of this paper provide a discussion of the pedagogical goals of the LAVA project as well as the educational and technical challenges associated with its implementation. Before concluding, the paper discusses the design and implementation of the system, and outlines a typical path that a student may take through a virtual excavation.

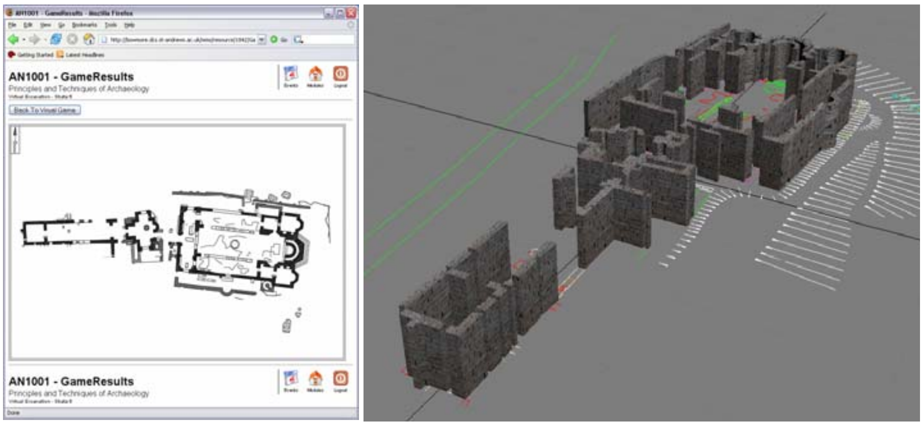

Figure 1. 2D Map and 3D Model Screenshots

2. PEDAGOGICAL MOTIVATION

LAVA aims to provide students with a realistic substitute for real-world excavation experience. As such LAVA essentially allows students to collaborate in planning, undertaking and exploring the findings of a series of archaeological fieldwork activities. The overall objective is to enable students to construct an improved understanding of the subject area. LAVA achieves this objective by focussing on four main tenets: engaging, realism, collaboration, anytime-anywhere access

2.1 Engaging

It is important for the system to be engaging so that it helps motivate students in exploring the subject, developing their technical skills and deepening their understanding of practical archaeological processes. In achieving this we look to borrow from methodologies employed in the development of computer games. Angband [5] was found to be a useful model. It is a text based game that allows characters to develop their skills, acquire artifacts, explore the environment and progress through various challenges before achieving the core goal of defeating Morgorth and saving Middle Earth. In our system characters have varying skill levels, learners have to explore and interact with the environment and progress through a succession of levels is dependent on their actions. The goal of defeating Morgorth is replaced with uncovering and analyzing material culture and ancient architectural features.

Technically this approach does not fit well with Web-based architectures as the progress through and state of the environment needs to be remembered between interactions and sessions. Hence we adopt a service-based architecture.

2.2 Realism

It is important that learning activities, as far as possible, are situated within realistic scenarios as this helps motivate those engaged in the learning process and helps ensure that both the practical and more abstract learning outcomes are realized. We take two approaches to achieving realism; firstly LAVA is based upon a real archaeological site and excavation [6, 7]. A wide range of archaeological resources from this site have been digitized and are made available to the learner. These resources are organized geographically through maps so that learners can click through geographic locations to find relevant artifacts. Secondly they are organized temporally so that learners engage in sequenced activities, the successful conclusion of which yields archaeological finds that are appropriate to that activity. These sequences are discussed in more detail in section 4. The second way in which we achieve realism is by deploying a range of different technologies, e.g. text is used to provide contextual information, 2D maps are used to define location, photographs are used to provide high fidelity images, 3D gaming environments are used to provide a sense of spatial awareness and exploration.

To achieve this we had to meet the technical challenges of adapting 3D gaming technologies to facilitate appropriate interactions and integrate them with service-based learning environments. The architecture used to achieve this integration is discussed further in section 3.

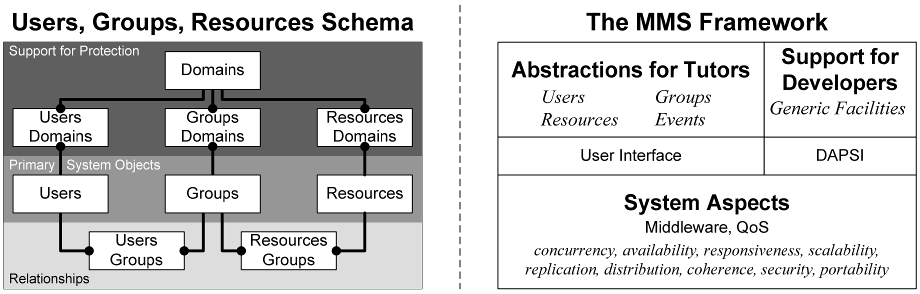

Figure 2. The MMS Users, Groups and Resources Schema and Framework

2.3 Collaboration

The motivation for the system supporting collaborative learning is two fold. On the one hand, real archaeological excavations involve a high level of collaboration. On the other hand, group working is an important transferable skill which is often underdeveloped within traditional educational contexts. In this project, learners are organized into groups that have to agree upon key decisions that are made. Each group has a different view of the environment, each member of a group shares a common view of the environment with the other group members; if a user performs an action which changes the state of the environment, this change will become apparent to all members of the group.

The implication of this requirement is that support for group working should be at the heart of our service-based architecture. This is met by an architecture built around the abstractions of users, groups and resources (as shown in Figure 2). Users are allocated to a group. Each resource that is allocated to that group is automatically made accessible to all the users within the group. Group work is supported through the provision of synchronous and asynchronous communication tools. It is noteworthy that the use of 3D gaming environments naturally lends itself to co-operative endeavors.

2.4 Anytime, Anywhere

Anytime, anywhere access is important so that LAVA will be accessible within lecture theatres, labs and from a student's home computer. This allows learners to exercise control over the learning process so that they can proceed at a pace which is appropriate for them. Using a service-based architecture helps us meet this aim along with using gaming technologies that may be deployed across the Internet without the need for prior software installation on client machines.

3. SYSTEM STRUCTURE

A service-oriented architecture has been adopted to allow learners to make use of the toolset provided by LAVA. Unlike traditional Distributed Learning Environments (DLEs), LAVA couples gaming technologies with collaborative groupware applications, thereby allowing geographically dispersed learners to communicate with each other using the traditional synchronous and asynchronous communication tools provided by many DLEs, as well as the more tailored in-game communication mechanisms which allow team members to coordinate their in-game efforts. In order to achieve this, LAVA has been developed to integrate with an existing DLE – the Module Management System (MMS) [8].

3.1 Module Management System Framework

MMS is a framework for Distributed Learning Environment construction and maintenance. Figure 2 gives an overview of the MMS framework. MMS presents four simple abstractions for end users: users, groups, resources and events. It also provides a developer and application programmer's service interface, which allows educational resource developers to concentrate on content, by supplying commonly needed system services. As part of the LAVA–MMS integration, MMS has been tasked with handling user authentication, resource allocation and the provision of a variety of document sharing and collaborative workspace resources. The LAVA gaming environment hooks into the

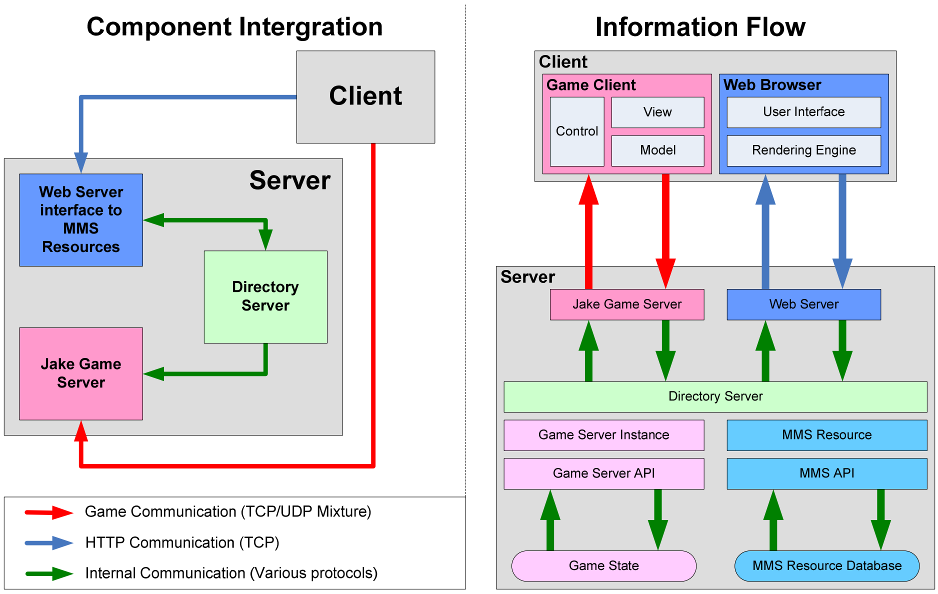

Figure 3. MMS and LAVA Integration

existing MMS framework and provides support for the more advanced 3D gaming featured used during the site exploration and excavation stages of the excavation scenario.

3.2 The Gaming Environment

The LAVA gaming environment is based on the Jake 2 [9] Java port of the popular ID Software Quake 2 games engine [10]. Jake 2 was chosen as the platform for deploying the LAVA gaming environment due to its small software footprint, flexible deployment options and support for client-server network communication.

3.2.1 The LAVA Server

The LAVA server is a modified version of the Jake 2 server which runs on a dedicated server, interfacing with the services provided by MMS as shown in the information flow section of Figure 3. The server ensures that any allowable updates to the virtual world triggered by game clients are replicated amongst all game clients in the same virtual world. The LAVA server is also responsible for sending map updates and other control commands, e.g. increasing light intensity in a certain map area to all game clients. The LAVA server is capable of differentiating between clients joining different virtual worlds, new clients joining who need full map updates and current clients who are already actively engaged in a virtual world and who need a replica of another client's update. In addition to the functionality provided by default by the Jake 2 server, the LAVA server implementation is also tasked with ensuring that learners only join the virtual world relating to their team, thus the LAVA server enforces separation between each of the teams.

3.2.1 The LAVA Client

The LAVA client software is a packaged version of the Jake 2 client software that is automatically deployed by MMS to learners through their Web Browser using Java Web-Start technologies [11]. Unlike applets, trusted Web-Start applications can operate outwith a protection sandbox, and so are fully able to communicate with the LAVA server hosted on a remote machine. All in-game resources are streamed to clients from the MMS system via the LAVA server.

The Jake 2 client software allows clients to run their own 3D visualisation engine that displays the current state of the virtual world. Clients must register at the start of a session and the LAVA server then handles updates to each client's representation of the virtual world. In order to ensure a smooth, fast flowing virtual environment the emphasis on client-server communication is efficiency and speed, with the Quake 2 communications protocol being used to provide rapid updates to the world state maintained by each client.

4. STUDENT WALKTHROUGH

LAVA has been developed around the real archaeological project undertaken at the Sparta Acropolis Basilica, Greece. The excavation reports published by the British School at Athens [6, 7] and information from the director of the project have been used to develop an archaeological project scenario. Loosely guided through each of the stages outlined below, the teams are encouraged to operate as independent units, with each member contributing as required by the team.

During **phase 1** the team is expected to undertake an archaeological survey of the ancient acropolis of Sparta and identify and record the range of sites of significance. Once completed, the learners are expected to use a variety of sources both within and outwith the LAVA environment to determine the most likely location of the Basilica. Once this sub-goal has been achieved, and the location of the Basilica deduced, the team are required to collaboratively draft an outline proposal that seeks an agreement in principle to undertake an excavation of the site. This proposal is assessed by the course coordinator, with feedback and authorization to continue given to the group. Once agreement in principle has been granted, the team automatically progress to the next phase.

The primary archaeological objective of **phase 2** is for the group to collectively develop a firm excavation plan and budget. This goal can be satisfied in any number of ways. The groups are provided with tools that enable them to electronically communicate both synchronously and asynchronously as necessary, as well as a series of resources that are designed to allow them to explore the acropolis. There is, however, no prescribed route through phase 2; the teams are able to organise themselves and undertake whatever exploration activities they see fit. Indeed they can simply submit a firm excavation plan and budget without undertaking any pre-exploration research work, however the level of funding offered (if at all) is highly likely to reflect this lack of effort, just as it would in the real world. Once the group has agreed on a plan and budget, this is once again electronically delivered to the course coordinator, with feedback, authorisation and a confirmed budget being awarded based on the strength of the submitted plan. Now with a firm budget, the team are able to tailor their plans, and obtain the equipment and experts required for the project; the team collaboratively handle this planning process using the Web-based management.

Phase 3 is the most intensive part of LAVA in terms of undirected learning as it is during this phase that the team undertakes the excavation of the site. Whilst the actions of the team will be largely self-directed, there are mechanisms which enable the course coordinator to provide both pre-emptive and on-demand assistance to each team. Whilst undertaking the excavation, the team is able to experiment with the archaeological procedures, range of experts and types of tools that they should have discussed and budgeted for during the previous phases, thereby building a mediated knowledge of the practical aspects of the team's approach as they modify their site environment. Once excavated, the team will be able to discover and record a variety of architectural features and material culture located within the site, with the quality of their findings directly relating to both their initial plan and the way in which the excavation project was undertaken.

To complete the excavation process in **phase 4**, the group will be required to produce a number of publications based on their excavation project, just as they would be expected to following a real excavation. Publications of specific aspects of the project will be authored independently, with each team member taking responsibility for a different section. In addition the entire team will collaboratively prepare an overall report that summarises the entire excavation project. During phase 4 the importance of having maintained accurate site logs and context sheets will be emphasised to the learners: As with a real excavation project, the work undertaken in the virtual world will be destructive [12], thus any information not accurately recorded during the excavation process will be lost, thereby reducing the quality and rigour of the final publications produced. Once completed, the publications will be submitted electronically to the course coordinator for summative assessment.

Phase 5 completes the walkthrough. During this phase learners will be able to analyse their personal and team performance, pose questions to be answered by their peers and the course coordinator and reflect on the archaeological concepts and processes which proved the most challenging to grasp. This phase is very much a reflective exercise, designed to encourage learners to evaluate their own performance, thereby analysing their own learning. It is also an opportunity for any important observations to be made by the course coordinator, and therefore offers the opportunity for misunderstandings and incorrect interpretations to be addressed.

5. CONCLUSION

This paper has presented a discussion of how a current DLE can be adapted to more readily fit a dynamic, learner centred educational model. By readjusting the way in which learners interact with a DLE, LAVA attempts to replace the traditional information transfer paradigm with a constructivist approach to learning. This paper has highlighted the rationale for this paradigm shift and shows how modern gaming and 3D graphics technologies can be integrated into an existing DLE framework.

Archaeology has been adopted as the subject of the initial proof of concept instantiation as it lends itself to the realistic and dynamic collaborative learning environment advocated by the discussion at the start of the paper. By providing a simulated archaeological excavation for learners to engage with, LAVA aims to have a positive effect on a learner's transferable skills. Not only will they become more proficient in the skills most often associated with computer use, but they will also develop more generic team-working, communication, organisation and decision making skills. Additionally they will be able to develop specialist skills associated with the management of archaeological projects, skills that they may not necessarily be exposed to on a real excavation, including; budgeting, scheduling, resource and personnel management and grant application and post-excavation publication writing.

The initial implementation of LAVA was completed in September 2006 and detailed user testing and evaluation is scheduled to occur during the 2006/7 academic year.

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