360-PLAYLEARN: GAMIFICATION AND GAME-BASED LEARNING FOR VIRTUAL LEARNING ENVIRONMENTS ON INTERACTIVE TELEVISION

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ABSTRACT

Online distance learning is becoming more prevalent with increased developments in media content creation, Virtual Learning Environments (VLEs) and telecommunications technologies. Here, we propose the design and architecture of 360-PlayLearn, a software platform for consumers and producers of educational content bringing online education together with gamification and game-based learning (GBL), VLEs and interactive television (TV). 360-PlayLearn is underpinned by 360-MAM for essential Media Asset Management and 360-Cloud for hosting educational content and services. 360-PlayLearn, following a constructivist problem-based/project-centred approach, will widen access to educational content on STEM subjects, history, archaeology and general knowledge for people from all ages and backgrounds. Learning will be provided on desktop, mobile (smartphone, tablet) and TV devices. Future work will include implementation and testing of 360-PlayLearn within the ubiquitous arena of interactive TV.

1. INTRODUCTION

Recent service advancements in the field of interactive television (TV) provide an opportunity for increasing accessibility and user participation during online learning across a range of Virtual Learning Environments (VLEs) [14]. Gamification is the application of game mechanics and game design techniques to enhance non-game scenarios [30]. It has been shown to be successful for encouraging user participation and maintaining user contribution. Developments in gamification [9], serious computer games [15] and game-based learning (GBL) [22] are becoming important for VLEs. These developments are supported by advances in technology for Media Asset Management (MAM) [13] and the Cloud [4]. MAM concerns managing the ingestion, annotation, cataloguing, storage, retrieval and distribution of digital photographs, animations, videos and music. Cloud computing is the use of computing resources that are delivered as a service for storing, managing and processing data. Combining educational and entertainment content, also known as 'edutainment', is an exciting and innovative growth area in the creative industries. Our ultimate goal is to widen access to edutainment by developing software for multimedia, mobile (smartphone, tablet), web and online platforms, incorporating games technology to maximise the interactive potential of TV content.

We are developing 360-PlayLearn, a GBL and gamification interactive TV interface that facilitates VLEs becoming widely accessible to children, adults and older people on desktop, TV and mobile devices. 360-PlayLearn follows a constructivist problem-based/project-centred learning approach [20], [21], [28] in developing user knowledge and motivating self-directed learning [16]. 360-PlayLearn will be underpinned by another software platform, 360-MAM, for performing MAM housekeeping. 360-PlayLearn will be hosted on and supported by 360-Cloud which will handle web persistence, remote storage and platform scalability. This enables the 360-PlayLearn platform to be easily maintained and globally accessible with content available across devices.

Section 2 discusses related work in interactive TV, gamification, GBL environments, MAM and Cloud. In Section 3, we discuss the design and proposed architecture for 360-PlayLearn including 360-MAM and 360-Cloud. Section 4 discusses 360-PlayLearn in relation to other work and Section 5 concludes with plans for future work.

2. RELATED WORK

Gamification is becoming a popular method for analysing user behaviour, improving loyalty and customer interaction and is increasingly employed in product design and marketing [31]. Due to increased uptake in gamification, a

series of companies and organisations are currently taking advantage of its benefits. Gartner, a leading IT research and advisory company has projected that by 2015, 50% of companies will embrace gamification and that more than 70% of the global 2000 will have at least one application implementing gamification.

Distance and online learning is becoming ever more prevalent in society, with more learners seeking to exploit the benefits VLEs bring to structured learning. Offering access to education through the web and other devices is gaining momentum with online learning systems such as Udacity securing over 160,000 students across 190 countries within a few weeks [5]. Udacity is a VLE providing mainly computer science courses, and is an outgrowth of free computer science classes offered at Stanford University with the goal of democratising education [24]. Harvard and MIT have recently demonstrated their desire to open themselves up to more students through online distance learning, developing a project and Open Source platform called edX to facilitate teaching both on-campus and online [7]. There has also been an upsurge in video educational content being made freely available online, e.g. TED [26], the Khan Academy [12] and YouTube [29]. Examples of VLEs having a GBL or game-based approach include PlayPhysics for teaching first year university Physics [19] and AmbiLearn for Primary School general knowledge and STEM education [10].

Media Asset Management (MAM) systems facilitate media management within the media production industry [11]. Currently, ResourceSpace [6] is the most prevalent Open Source MAM platform, and is used by multinational companies worldwide, e.g. Oxfam, WWF, and Fairtrade. A range of new MAM platforms have been launched, including Open Source Razuna [23] with features such as social integration and cloud support. There are also commercial commercial MAM platforms such as TeleScope Enterprise [27]. Cloud computing [3], [25] provides computing resources (hardware and software) delivered as a service over a network and can be employed for hosting and distributing media content. A founder and leader in the field of Artificial Intelligence, John McCarthy, said, as far back as 1961 at the MIT Centennial Celebration, that: “If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility. The computer utility could become the basis of a new and important industry." [1].

Television companies, such as UK Channel 4, are providing services such as social networking (Facebook, Twitter, Google Plus) supporting a ‘second screen’ (laptop, smartphone, tablet) and augmenting ‘first screen’ (TV screen) programme viewing by enabling TV audiences to interact with TV content. A key example of this approach is their ‘Million Pound Drop Live’ game show programme where viewers can play along online during viewing with statistics on their performance appearing on screen. This concept of ‘second screen’ is also relevant for online education through interactive TV.

3. DESIGN OF 360-PLAYLEARN

Our proposed architecture design for 360-PlayLearn is shown in Fig. 1. 360-PlayLearn has four sub-components: (1) Virtual Learning Environment (VLE), (2) Gamification API, (3) Media Asset Management (360-MAM) and (4) Cloud Services (360-Cloud). Fig. 1 shows the interactions between these sub-components and content consumers. Each 360-PlayLearn sub-component and respective modules is designed to operate autonomously in order to maximise compartmentalisation of functionality. 360-PlayLearn's modular approach enables sub-components and modules to act independently, with minimal dependences on other system components. The modular approach clearly delineates each component and adheres to the `separation of concerns' design principle [18] enabling each component to be independently optimised and easily maintained. Each 360-PlayLearn sub-component offers a web service façade, providing external systems and users methods of interfacing with and consuming the functionality supplied. Interactions between each of the sub-components occur through the web service layer.

Cross-platform client applications are built on top of available web services enabling content consumers to interface with services and underlying components in a user friendly fashion. Interaction and communication between modules is enabled through REpresentational State Transfer (REST) based web services across HTTP. Each client is tailored to its underlying functionality. We are developing interfaces for 360-PlayLearn sub-components and modules which maximise communication. Each sub-component and module also includes a cross-platform web client enabling customisation and configuration from a range of devices offering comprehensive mobile and web access.

3.1. Virtual Learning Environment (VLE)

The 360-PlayLearn VLE sub-component draws upon the strengths of the other three sub-components and provides a platform for creating and hosting custom VLEs with a suite of GBL and user assessment modules. GBL will comprise tools for generating a series of game-based scenarios explaining concepts to, and testing, learners. The user assessment modules offer a range of tools such as those for creating bespoke quizzes and questionnaires that can then be hosted and consumed by 360-PlayLearn. Combining a selection of the available user assessment modules users can produce tailored solutions providing an accessible interactive learning system facilitating flexible, configurable learning for learners of all ages across a range of devices. Content created and made available through the VLE

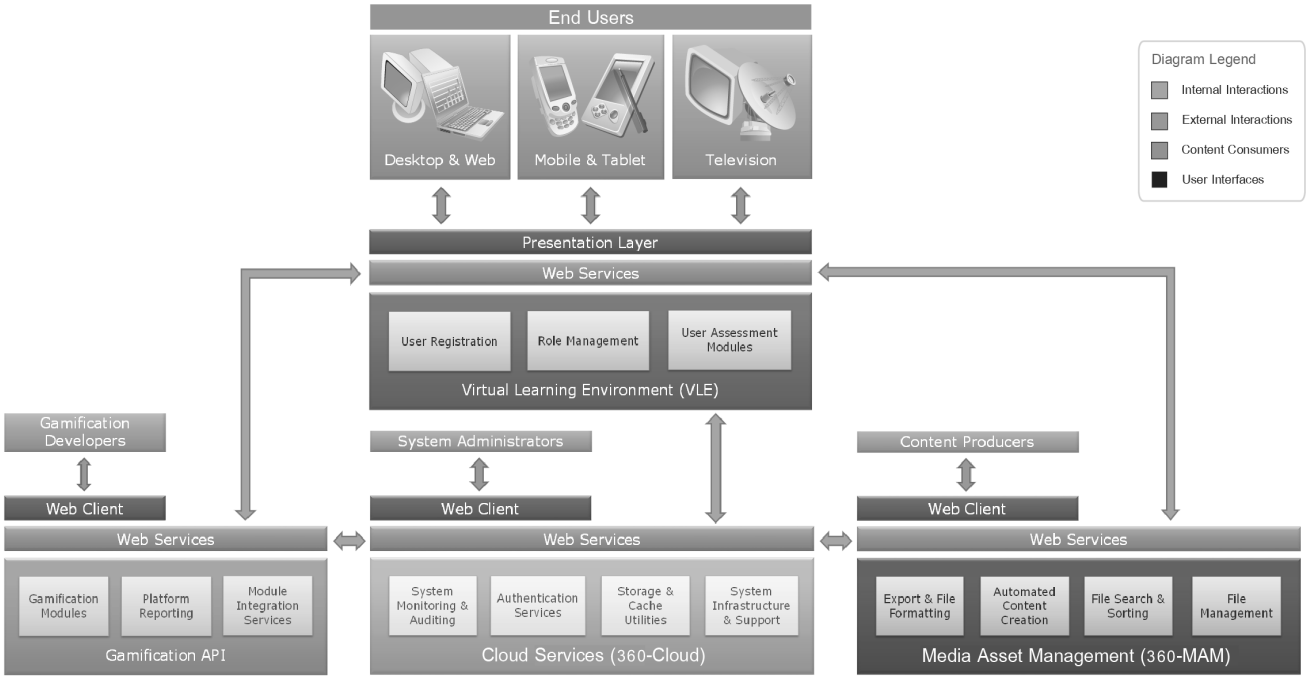

Fig. 1. Architecture of 360-PlayLearn.

platform will be accessible through the presentation layer for a variety of sources, such as web, mobile (smartphones, tablets) and television.

3.2. Gamification API

360-PlayLearn's gamification API sub-component provides a library of functions for implementing cross-platform gamification through customisable elements that can be tailored to suit various scenarios. A structured library of integrated reusable gamification elements such as *leaderboards* and *achievements* can be configured and combined to gamify a huge range of scenarios, with support from 360-PlayLearn. *Achievements* are included within applications to extend longevity and provide users with the impetus to interact more with them. *Leaderboards* visually display where a user stands with respect to other users, driving competition, and in turn fuelling deeper engagement. 360-PlayLearn includes comprehensive reporting features for receiving feedback on user actions and content across the system. The key goal of the gamification API is to enhance users' experience by engaging with and encouraging users to adopt 360-PlayLearn.

3.3. Media Asset Management (360-MAM)

Virtual Learning Environments (VLEs) can be comprised of a wide range of resources, with a wealth of multimedia assets. 360-MAM is a 360-PlayLearn sub-component for Media Asset Management (MAM) facilitating the organisation and management of large libraries of media assets. 360-MAM is concerned with managing the ingestion, annotation, cataloguing, storage, retrieval and distribution of digital photographs, animations, videos and music. Standard facilities associated with MAM platforms are categorising, sorting and searching media assets including exporting and formatting. Integrating and customising a MAM software platform to enable automated content creation based on digital metadata will provide 360-PlayLearn content producers with an effective interface for automatic content creation. Enhancing a standard MAM platform augments the process of creating automatically populated VLEs, which is the central function of 360-MAM. A tailored 360-MAM platform provides content producers with an array of functionality for MAM. The associated web client will offer media asset producers a portal facilitating preparation and management of media assets for populating VLEs. We are developing 360-MAM on top of existing Open Source [6] and commercial [27] MAM platforms.

3.4. Cloud Services (360-Cloud)

The 360-Cloud sub-component provides a foundation platform for 360-PlayLearn, including the core infrastructure and facilities on top of which the accompanying sub-components are built. Cloud computing and distributed systems are key to 360-PlayLearn's operation. 360-PlayLearn's architecture can be supported through traditional cloud computing infrastructure and platform services [4], offering a layer of abstraction from the underlying operating

system. Edutainment content will be hosted on a secure storage 360-Cloud and may utilise for content distribution, Project Kelvin, a secure, high capacity dedicated broadband link (10 G. LanPhy), direct to Canada, USA, Europe and rest of the island with a delay of only 2 milliseconds. Third party cloud storage will store assets such as images, video, audio, and documents fundamental to 360-PlayLearn, providing widely accessible scalable storage. An established database hosted on the cloud will provide quick, effective queryable storage that can support 360-PlayLearn's system hierarchy. Each 360-PlayLearn transaction is monitored and reported through the selected client for auditing and error tracking purposes.

3.5. Implementation of 360-PlayLearn

We are currently developing 360-PlayLearn's GBL VLE employing the Unity 3D game engine integrated with Moodle and Sloodle and game and assessment for learning scenarios with PlayPhysics [19] and AmbiLearn [10]. 360-PlayLearn's gamification API can be implemented as a series of web services, packaged as a JavaScript library for access. Fig. 2 shows a gamification API interface scenario employing standard web-based technologies displaying the envisioned interface layout style for the API.

360-PlayLearn will utilise Open Source and commercial third party software platforms interfacing in particular to 360-Cloud and 360-MAM. 360-MAM can be implemented with Open Source platforms such as ResourceSpace [6] and Razuna [23] or with commercial options such as Telescope Enterprise [27]. Fig. 3 shows a 360-MAM interface scenario employing ResourceSpace displaying the potential content management facilities available through 360-MAM. There are a number of possible cloud computing software providers that could be selected in implementing 360-Cloud including Google App Engine [8], Microsoft Azure [17] and Amazon EC2 [2]. Fig. 4 shows a 360-Cloud interface scenario generated with the Google App Engine displaying the potential level of reporting available through 360-Cloud.

4. RELATION TO OTHER WORK

Widening access to interactive online learning is a key goal of 360-PlayLearn. The architecture of 360-PlayLearn is designed to be generic and adaptable for a variety of applications in STEM subject and general knowledge domains with the facility to create custom applications for tailored needs.

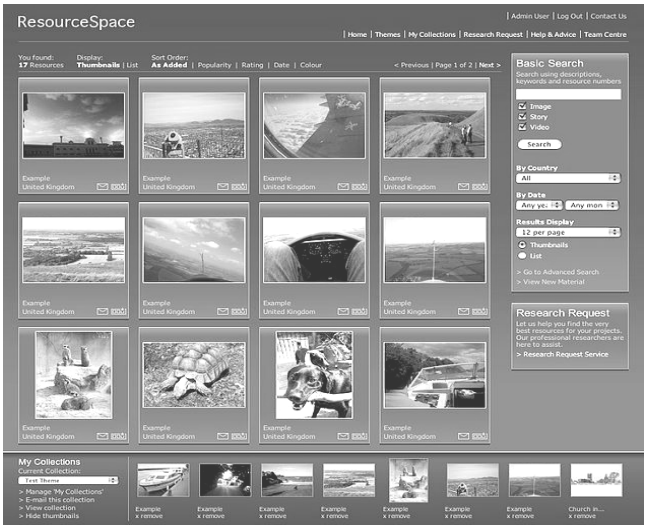

Fig. 3. 360-MAM interface scenario employing ResourceSpace.

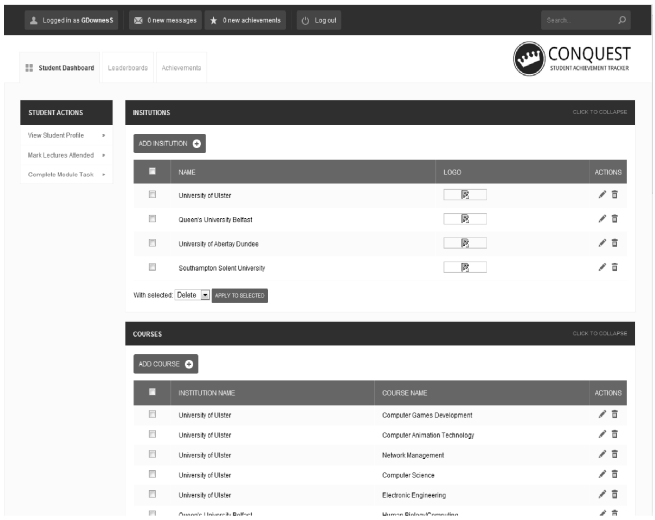

Fig. 2. Gamification interface scenario employing web technologies.

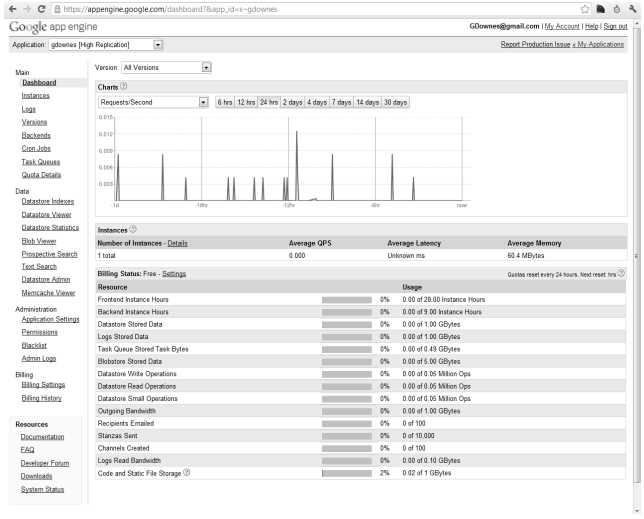

Fig. 4. 360-Cloud interface scenario employing Google App Engine.

360-PlayLearn's enhanced interface augments off-the-shelf VLEs for developing user knowledge and motivating self-directed learning.

Implementing core gamification functionality such as user *achievements* and *leaderboards* is readily applicable to 360-PlayLearn. Gamification relies on the social aspect of implemented features and hence it is essential that 360-PlayLearn be closely linked and marketed across social networks. Elastic cloud services offer the processing power and storage needed to enable 360-MAM and 360-PlayLearn to cope seamlessly whatever the demand. By combining 360-MAM and 360-Cloud we can develop advanced VLEs.

5. CONCLUSION AND FUTURE WORK

Here, we have discussed the development of a platform called 360-PlayLearn, bringing together innovative technologies such as gamification, GBL, VLEs, MAM, Cloud and interactive TV to provide accessible learning for producing advanced VLEs. Easing the creation and distribution of education through Virtual Learning Environments (VLEs) has global appeal. Future work includes refining 360-PlayLearn's architecture, user requirements, software analysis and implementation of 360-PlayLearn. In respect of requirements analysis, our goal is to develop a firm user base to enable the acquisition of user generated content. This will be facilitated through employment of social media platforms. 360-PlayLearn will be implemented as a comprehensive software solution for creating widely accessible learning environments on the ubiquitous platform of interactive TV.

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