AmbiLearn: Enhancing the Learning Environment for Primary School Education

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Abstract. Technology is at a stage where it has infiltrated the education system with the potential to enhance teaching and learning. In Northern Ireland a Virtual Learning Environment (VLE) infrastructure is in place. However, statistics and government reports suggest that VLE use amongst the primary school sector is quite limited. In an attempt to redress the limited use of VLEs in the primary school sector this research investigates the potential of serious games and how they may compliment the National Curriculum with the development of AmbiLearn, an enhanced learning environment with a content neutral game-based approach and content creation and reporting modules. This paper presents the design and implementation of AmbiLearn. Preliminary analysis of data from evaluation of AmbiLearn shows promising results and directions for future work are discussed.

Keywords: Virtual Learning Environments (VLEs), Educational Games, Assessment for Learning, AmbiLearn, Content neutral, Game-based approach

1 Introduction

A Virtual Learning Environment (VLE) is essentially an educational tool which helps monitor students' progress online in terms of assessments and quizzes. In a survey conducted in 2010 within English schools, on behalf of the British Educational Communication and Technology Agency (BECTA), it is reported that 93% of Secondary schools have access to a VLE whilst 67% of Primary schools have access [1]. In Northern Ireland every school and university has access to VLEs. All schools (primary and secondary) funded by the Northern Ireland's Department of Education and Learning (DEL) have access to the *C2K* network [2] which includes a VLE, namely *LearningNI* [3]. Within the Primary school education sector the use of VLEs

is quite limited with the Education Inspectorate noting that fewer than 4% of Northern Irish Primary schools accessed *LearningNI* in the month of February, 2010 [4]. One explanation for this limited use is that the content presentation style is unsuitable for this level of education. Since 2005 BECTA has referred to VLEs as a 'learning platform' which suggests a greater emphasis on content presentation style [5]. Much of the information available to students through typical VLEs is static downloadable documents. In a higher education setting this provides access to the information online and thus can be downloaded and printed. For a Primary School setting this is unsuitable as most worksheets are usually provided by the teacher as children usually don't have the resources to print during class. From a children's perspective downloading documents lacks interactivity. In 2003, Buckingham and Scanlon [6] suggested that most children's primary experience of home computing is that of playing games which in today's society is understandable due to the fact that the gaming industry (across all platforms and genres) is a large worldwide market reported to be worth $74 billion in 2011 [7]. The fastest growing demographic group for playing games is that of children aged 2-17 [8] with those aged 2-5 as the fastest growing contributors to this category [9]. Using computer games in education is not a new concept but this area has gained much attention due to the increased variety of gaming platforms, rise of virtual worlds and serious games. Considering the role both VLEs and games can play in the Primary School classroom leads to the development of AmbiLearn, an enhanced VLE with a content neutral game-based approach and content creation and reporting modules. The content neutral game-based approach provides a game independent of educational content enabling the game to be reusable for any chosen thematic subject unit. This paper presents related work and the design and implementation of AmbiLearn, suitable for supporting Primary School teachers in assessment for learning and for evaluating their own teaching.

2 Related work

2.1 Virtual Learning Environments (VLEs)

A Virtual Learning Environment (VLE) is a system which aids the distribution and management of learning materials. The features of a VLE can facilitate different approaches to learning depending on how the VLE is used. The use of such VLEs has had a positive effect in higher education. In this context VLEs are providing opportunities for distance learners and access to course content from any location at any time. Students can catch up on missed lectures/classes, submit assignments and receive feedback at any time [10]. Studies show that assessment tools, for both formative and summative assessments can lead to improved student learning [11][12]. Communication tools have the potential to support collaborative learning and peer learning, as studies show that the use of wikis can help students when developing group documents [13][14]. Similar to VLE usage in higher education, at secondary level VLEs are providing opportunities for distance learning and collaboration

[15-17]. The nature of Higher Education allows students the time between lessons to further read up on and study materials presented within VLEs. At lower educational levels the freedom for pupils to study the materials at their own pace is reduced. It is common that a pupil in Primary School will spend at least 5 hours in school each day during which many topics are covered and many different approaches to teaching are used. A pupil in secondary education will spend at least 6 hours in school per day where their time is split between separate lessons with different teachers. In Further and Higher education the time requirement for face to face contact between lecturer and student varies significantly depending on the module/course.

2.2 Serious and educational games

Derryberry [18] suggests that serious games are those, "designed with the intention of improving some specific aspect of learning", (p. 3). Similarly, Raybourn [19] states that a serious game is defined as the use of interactive technologies for training and education in private, public, government and military sectors. In education, 'serious games' is one of many terms used to describe the fields of educational games and game-based learning [20]. Studies have shown that the use of video games in the classroom engages and motivates students [21-25]. Gros [25] claims that, "engagement and motivation are interesting benefits of the use of games but they are not enough for educational purposes.", (p. 23) although he continues to point out that environments built on the educational properties of games can be an appropriate way to improve learning. These educational properties can be found throughout the field as pedagogical properties of games, and attributes of serious games/educational games which promote and encourage learning. Charsky [26] outlines such characteristics as competition and goals, rules, choice, challenges and fantasy. Dennis et al. [27] document three key attributes of games as novelty, competition and dynamic interaction.

For educational games to be effective, Fisch [28] suggest that the educational content must be sound, age appropriate, presented clearly and well integrated into the game. Groff et al. [22] conducted a study across Scotland on the impact of console games in the classroom which led to a taxonomy of nineteen educational benefits of console games in schools. One such benefit is that Game-based learning can narrow the gap between home and school. [22]. Mumtaz [29] conducted a study on the use of computers amongst children at home and at school. Results suggest that children make more use of the computer at home playing games than using 'boring' software in school such as word processors. It was concluded that schools should, "learn from what works at home and enable children to work on activities they find valuable, motivational and worthwhile.", (p. 347) [29]. Stone [30] suggests that children today are growing up in an era of fast paced technological change where at home they regard the Kindle as a book and have high expectations of technology. Hence, the classroom must be willing to bridge the gap between home and school in terms of its use of technology [31]. A National survey of 500 Primary (aka Elementary, USA) School teachers from across the USA outlines similar benefits as Groff [22] such as

collaboration, increased motivation, engagement, personalised instruction and assess to knowledge [32].

2.3 Assessment opportunities

Currently, many games within the education system provide educational content specific to one domain or subject such as Mathematics and Literacy. These educational games reinforce core subjects which is appropriate for standardised tests such as InCAS and PIPS [33]. Assessment for learning incorporates formative assessment from a broad range of topics that a child will learn. Overcoming subject specific games, a range of tools are available for an educator to create and determine their own content for activities such as the Black Cat Activity Builder range [34] which enables teachers to input information for science and English worksheets, word search and word games. As standalone software these games do not provide any feedback to the teacher unless he/she is actively observing the child play. Such information is provided within activities in the VLE, e.g. the quiz blocks. Quiz information is logged and a teacher can make judgments based on the scores with their full class data available for that particular activity.

3 AmbiLearn

AmbiLearn follows principles from both *constructivism* [35-37] and *behaviourism* [38- 39] for understanding, remembering (behaviourism) and evaluating and creating (constructivism). Enhancing VLEs with serious games has potential in the Primary School classroom as an assessment tool. AmbiLearn is an enhanced VLE with a content neutral game and content creation and reporting modules. AmbiLearn's game module is content neutral which facilitates the adaption of the game to multiple themes as specified by a plug-in pedagogical model created through the content creation module. In addition, the reporting module provides a graphical representation of game data. Fig. 1 shows a layered view of the architecture of AmbiLearn. The GUI layer provides the visual interface for users accessible through a web browser. The Logic Layer is the VLE scripts which include the VLE libraries, reporting, content creation and game modules. Each of these modules uses common functionality provided by the VLE libraries such as authentication to specify permissions and capabilities. In addition, the game module uses a communication service to access course information from the VLE facilities. The Storage Layer can be implemented via 'plug-in' components. These include VLE database support and all pedagogical model storage which are created through the content creation module. AmbiLearn is implemented with a Moodle VLE as it provides the necessary support (authentication and course libraries) and has the advantage of being Open Source. Additionally, its functionality can be easily extended and customised.

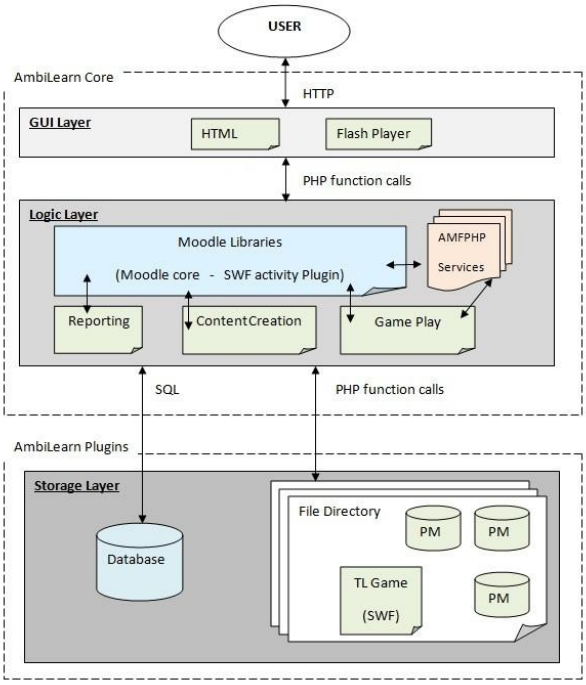

Fig. 1. AmbiLearn Layered Architecture

Typically, a VLE has two main users: teachers/educators and pupils/students. The teachers/educators role in the VLE is to administer pedagogical material whereas a pupil/student's role is to access this pedagogical material. Similarly, as shown in Fig. 2, a teacher/educator accesses the content creation module to define the pedagogical model and administer a game instance to his/her class. The pupil/student plays the game and the teacher can then access game data through the reporting module.

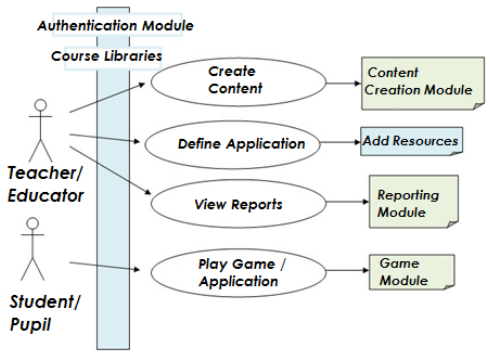

Fig. 2. Component user roles within AmbiLearn

3.1 AmbiLearn's Game Module

AmbiLearn's game module consists of generic activities that are independent of content until a pedagogical model is 'plugged-in'. The game plot is centered around 'Ambi', a character stranded on 'TreasureLearn Island' depicted in Fig.3. By completing an activity the user can collect a piece of his boat. There are six pieces to collect and once all are collected the user has rescued 'Ambi' from the island. The activities within the game module are adapted from popular activity worksheets used within school settings. These include:

- AmbiGuess: This game comes from a `What am I' style game. Users are presented with clues about an object and must identify the object. If a user guesses the object correctly he/she is presented with the next set of clues. On an incorrect guess he/she tries again.
- WordSearch: The second activity is a wordsearch which is a popular activity as it can be easily generated with keywords relating to a particular theme or topic. Users must select the words which are available in the wordlist until all words have been identified.
- FactMatch: Like the game pairs, fact match is a set of cards each with a fact. Users must match the pairs of facts until no cards remain. Users simply click on a card and then click on the matching card. On a correct match the cards are taken away. On an incorrect match users are informed that the match was incorrect and they try again.
- AmbiJig: This is a picture which is split into pieces and scrambled. Users must identify the image and recreate the picture to complete the jigsaw. Users can choose to receive a hint at which point the image will be displayed to aid them in the recreation of the image. If they cannot reproduce the image they can opt to receive help which will result in the pieces being partially arranged making it easier to complete the jigsaw.
- AmbiQuiz: This is a quiz which is multiple choice. Users are provided with the question, and must select the correct answer from a choice of four.

The game was implemented in Flash Creative Suite (CS5) with Actionscript 3 (AS3) as the back end programming language.

3.2 Content Creation Module

AmbiLearn's plug-in pedagogical model defines the content used within the game-based approach for each application. In order to define this pedagogical model the content creation module in AmbiLearn accepts data entry from an educator and builds the content into a structure accessed by the game module. The pedagogical model is implemented as an XML file. XML files enable the developer to specify the structure of the data and the nature of the nodes. A user-friendly interface is designed to input the required data with forms. This enables the educators/teachers who are conducting data entry to have an intuitive interface for creating the pedagogical model. The content creation interface accepts the data entry and creates as output the XML pedagogical model.

Fig. 3. TreasureLearn Island

3.3 Reporting Module

AmbiLearn's reporting module displays game data in a graphical format. Table 1 shows the scope of the reports provided by the reporting module. As there are five activities defined within AmbiLearn's game module, there are five corresponding reports representing their score (AmbiGuess, AmbiQuiz and FactMatch) and game time (WordSearch and AmbiJig). Also, there is an overall game report. In addition to these reports a personal user report is generated which charts the game data for all AmbiLearn user activity. AmbiLearn's reporting module is implemented with a series of SQL statements that select the appropriate data to display. A Fusion Charts PHP class and compiled SWF charts are implemented to display the data is a graphical format to the user. For each game a chart representing game scores is provided. This is in the form of a stacked chart where the user is defined along the x-axis whilst their overall game score is defined on the y-axis. The overall score represented is displayed as a set of 5 scores stacked, each representing an activity within the game.

AmbiLearn's game, content creation and reporting modules are best viewed in terms of their communication within AmbiLearn. Fig. 4 shows internal communication between AmbiLearn's components. When an instructor chooses the Content Creation capability, the resulting communication within AmbiLearn is as shown in Fig. 4(b). This option is available to those who have administration rights in the VLE, i.e. a teacher or course creator. This module enables them to define an application and create the associated pedagogical model. The pedagogical model is saved within

AmbiLearn and becomes a reusable resource. Fig. 4(a) shows communication within AmbiLearn when a user accesses AmbiLearn to play the game (i.e. accessing the game module). Within the VLE the initial authentication process coordinates access to the game. When a game is initiated by the user, the associated course details are passed into the game code from the database. The game module initially makes a request for user information. Once the information is received the game module reads in the data from the pedagogical model and the user can then play the game. When the game is completed, the game data will be saved back to the corresponding AmbiLearn table within the database. Fig. 4(c) shows communication when the instructor accesses the reporting module. This module calls queries directly from the database and reports the data in a graphical format. The authentication of this module is coordinated by the VLE scripts and similar to the content creation module, only an administrator of the VLE can access this module.

Report	*Data Reporting (per given user)*	*Report Format*			
		Stacked chart	*Bar chart*	*Average line*	*Table*
Overall game	Full score categorised by activity	✓			
AmbiGuess	Individual activity score in %		✓	✓	
	Number of incorrect guessed objects in %		✓		
	Incorrect objects guessed				✓
WordSearch	Individual activity game time		✓	✓	
FactMatch	Individual activity score in %		✓	✓	
	Number of incorrect facts		✓		
	Incorrect matches guessed				✓
AmbiJig	Individual activity game time		✓	✓	
AmbiQuiz	Individual activity score in %		✓	✓	
	Number of incorrect answers in %		✓		
	Incorrect matches guessed				✓

Table 1. Reports Generated by Ambilearn reporting module

4 Evaluation of AmbiLearn

To demonstrate and test the educational potential of AmbiLearn evaluation is in progress with Primary School teachers. An evaluation has been conducted for three Primary School classes with their class teacher (Teachers=3, Children=61). The first stage of the evaluation was to create the pedagogical model. The teachers chose their own theme and found it easy to apply the content to the AmbiLearn activities. In this evaluation the themes chosen included *The Water Cycle, Vikings and Rainforests.* The

children then played the AmbiLearn game and completed an evaluation booklet on their perceptions of the AmbiLearn game and activities. Results from the children's perceptions of AmbiLearn are promising in terms of enjoyment where 98.36% responded 'yes' when asked: "Did you enjoy playing AmbiLearn?". Exploratory analysis is currently underway to identify any correlations between the children's perceptions of the activities in terms of Fun, Enjoyment, Ability and Difficulty with their class teacher's perceptions of the activities in terms of how useful the activity is in providing relevant formative feedback. The third part of the study involved teachers viewing the reports generated from their class. One teacher suggested that all the graphs provided a true reflection of her class with one single unexpected result for a child on the FactMatch activity. The detailed table reporting incorrect matches for this activity provided evidence that random cards were clicked due to the initial (first clicked) card remaining the same. One teacher commented that he could easily identify many of his class based on the reports without having to obtain their codes since pupil names were not disclosed.

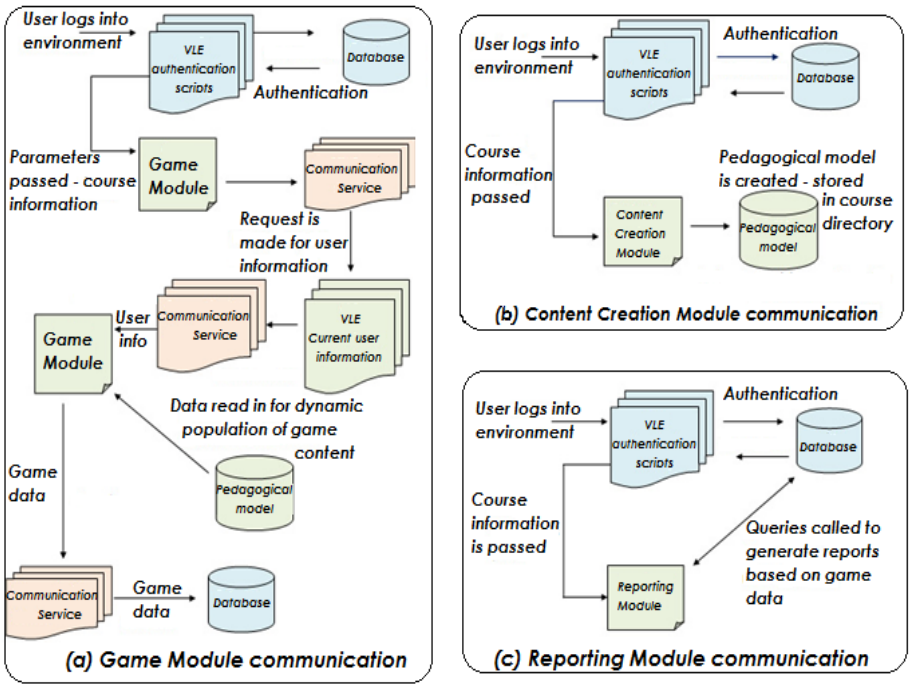

Fig. 4. Communication within AmbiLearn

5 Relation to other work

AmbiLearn relates to PlayPhysics [40] for teaching Physics to third-level students and compliments other work [21, 23, 41] but with a focus on game-based assessment. Many games developed in educational settings employ static content. These are mainly commercial Off-The-Shelf (COTS) games and once completed the novelty and attraction begins to fade. AmbiLearn overcomes this limitation as AmbiLearn's game module is designed as a reusable game with a plug-in pedagogical model. Content neutral games are commercially available for the Primary School classroom [34][42], but do not provide opportunities for user logging. A range of games at Content *Generator* [43] overcome such limitations by reporting individual user scores. AmbiLearn extends reporting for full class data in addition to individual instances. Content neutral games [43] offer a range of independent activities and AmbiLearn differs from these as it offers 5 different activities within the one game, including multiple presentation of the educational content. AmbiLearn also differs from other content neutral games due to the 'plug in' pedagogical model. AmbiLearn's game module exists as a single application and the content is linked as an instance of the application. This enables the theme instances to be compared with each other as a tool for evaluation of teaching.

6 Conclusion and Future Work

This paper has presented AmbiLearn, an enhanced VLE with content neutral game and content creation and reporting modules. The content neutral game-based approach provides a game independent of educational content enabling the game to be reusable for any chosen thematic unit. Preliminary analysis of evaluation results has shown that the perceptions of AmbiLearn from both children and teachers are promising whilst further analysis will provide information relating to all modules of AmbiLearn and game components within AmbiLearn's game module. Results show that data provided in the reporting module shows a true reflection of class capabilities as judged by class teachers. Further work on full data analysis will provide evidence on the potential of AmbiLearn as aneffective VLE for Primary School assessment for learning activities.

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