# AmbiLearn:
## Multimodal Assisted Learning

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## ABSTRACT

*In educational institutions computing technology is facilitating a dynamic and supportive learning environment for students. In recent years, much research has involved investigating the potential of technology for use in education and terms such as personalized learning, virtual learning environments, intelligent tutoring and m-learning have brought significant advances within higher education but have not propagated down to Primary Level. This paper discusses AmbiLearn, an ambient intelligent multimodal learning environment for children. The main objective of this research is to redress the limited use of virtual learning environments in primary school education. With a focus on multimodal presentation and learning environments, AmbiLearn explores the educational potential of such systems at Primary school level.*

*Keywords:* *AmbiLearn, Computing Technology, Learning Environments, Multimodal Interfaces, Serious Games*

## INTRODUCTION

A learning environment is an environment where a person can learn or gain knowledge on a particular theme or topic. Traditionally, learning only took place in a classroom setting where instruction or pedagogical information was provided by a teacher/lecturer. As technology has become more powerful, accessible and more pervasive, learning has migrated out of the classroom setting. In educational institutes today the use of Virtual learning environments (VLEs) has become predominant in providing an online environment for administration of course material and student assessments. However, the use of virtual learning environments in primary schools is very limited. Key findings in a study by Ofsted (2009) may suggest that this is due to the lack of the material available in relation to the range of topics covered. The presentation style of the pedagogical content also contributes to the limited use of VLEs as many of these provide information through static downloadable word documents where interactivity is limited. The focus of this research is to develop a multimodal learning environment assisting learning which is designed specifically for children. AmbiLearn combines successful techniques from virtual learning environments, serious games and multimodal interfaces. As a multimodal learning environment AmbiLearn aims to support collaborative learning with a

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general educational aim of encouraging children in their own learning and enabling them to take responsibly for that learning. This paper provides a review of the literature on learning environments and how they can be used effectively. Preliminary work on AmbiLearn is presented and a sample application, TreasureLearn, is described. The paper concludes by outlining future work.

## VIRTUAL LEARNING ENVIRONMENTS

The term 'technology enhanced learning' is used to cover all methods of using technology as a foundation for learning such as: m-learning, e-learning and web-based learning. O'Malley et al. (2003, p.1), define m-learning as "any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies." Similar to this, e-learning can be defined as electronic learning where the learning is based upon some form of technology including, but not limited to, mobile technologies. All these concepts can encompass the use of the VLEs. In the UK most if not all of the further and higher education institutes are using a VLE such as *Blackboard* or *Moodle*. In this context the VLE is providing opportunities for distant learners, access to course content at any location, any time. Students can catch up on missed lectures/classes, submit assignments and receive feedback at any time. This style of usage enables students to be in constant contact with the course and collaborate with other class members with for example chat boxes and open forums. JISC (2009) provide a comprehensive study of the different uses of virtual learning environments in higher education across multiple disciplines such as economics, medicine, dentistry, business, management and health science. Testimonials from both staff and students indicate high levels of satisfaction with the learning process and many suggest the results indicate a significant improvement in student learning. With each environment suited to a particular domain, it is not easy to identify which learning environment has most educational potential. A common theme amongst each is the method of providing the pedagogical content which makes it effective. An investigation of interactive multimodal learning suggests that "the most effective learning environments are those that combine verbal and non-verbal representations of the knowledge using mixed-modality presentations" (Moreno & Mayer, 2007). Since 2005 Becta has referred to the VLE as a 'learning platform' which suggests a greater emphasis on the presentation of content (Berry, 2005). The different presentation style of pedagogical content can be deemed as the critical feature needed for VLEs to be appropriate for children, supporting both auditory and visual learning styles, as demonstrated by the use of educational games.

### Games as the Learning Environment

In Northern Ireland, all primary and secondary schools funded by the Department of Education and Learning (DEL) have access to the C2K network (C2K, 2010). Within this network there are resources such as educational games compatible with the aims and objectives of the Northern Ireland curriculum. In the past such edutainment software has been met with much criticism as well as some enthusiastic support. There was much hype when educational games were first released, yet educators were reluctant to adopt them. Recent studies suggest that video games promote the development of skills such as strategic thinking and creativity, offering appropriate and adaptive feedback and the embedding of cognitive strategies that can reduce task time, increase achievement and have a positive effect on student learning (Booth, 2009; Rosas et al., 2003). Mc Farlane et al. (2002) suggest that by providing a fun, playful approach games can facilitate learning in three ways: learning as a result of tasks stimulated by the content of the games, knowledge developed through the content of the game and skills arising as a result of playing the game.

## Multimodal Interfaces

As an online environment, the interface to the VLE is essentially a web page. Multimodal output thus plays an important role in such systems as the style in which pedagogical content is provided affects the manner in which a student will process and learn the information. The use of audio and graphic output for portraying information enables users to visualise and further understand certain theories and facts. Using pedagogical agents in learning environments can have a positive impact on motivating students and keeping their attention (Ortiz et al., 2007). The general perception of such animated characters could be that they cause distraction and are irritating, yet certain systems have proven that an embodied agent can have a positive impact on the learning process. Lester et al. (1997, p. 359) state, "the captivating presence of the agents can motivate students to interact more frequently with agent-based educational software. This in turn has the potential to produce significant cumulative increases in the quality of a child's education over periods of months and years." Agents such as Steve (Johnson et al., 1997) and Gandalf (Thórisson, 1996) both provide users with information effectively using verbal and nonverbal communication modalities.

As suggested, providing multimodal output for content delivery has great potential. However, multimodal input also offers many benefits for the user. Multimodal interfaces allow a more natural form of communication while certain combinations of modalities offer ease of use and fluency. Speech and pen/mouse input are arguably the most common combination of modalities as Cohen (1992) suggests and they complement each other by overcoming one's weaknesses with the other's strengths. The rise in mobile learning also strengthens this complementary input approach as device limitations can be overcome by using speech and simple pointing gestures. The use of multiple modalities is ideal within multi-user collaborative environments. A study on children's collaborative interactions suggests that sharing a physical display with multiple input devices may improve collaboration due to heightened awareness of the other user's actions and intentions (Scott et al., 2003).

# AMBILEARN

The motivation for AmbiLearn has arisen from gaps in ambient multimodal learning environments in respect of children's education. In all key areas of related research, investigations have proven successful in respect of particular educational domains. Multimodal interfaces and the use of speech and pen have proven to provide complementary interfaces supporting assistance in predominately navigation and tourist systems. Studies have shown how embodied agents have had a positive effect on student learning by maintaining students' attention and hence improving motivation. Serious games have proven to be successful in motivating students and maintaining their interest in a particular educational domain and the different learning environments have facilitated a more flexible means of providing the educational content suitable to different needs of each individual. A focus of this research is to further investigate the educational potential of AmbiLearn, an ambient intelligent multimodal learning environment. AmbiLearn aims to investigate the potential of integrating multimodality and interactivity within a virtual learning environment. As a multimodal system the user can interact through speech and 2-dimensional gestures, and receive feedback through graphics, non-speech audio, speech and an animated character agent.

## Architecture

AmbiLearn's architecture is shown in Figure 1, with the dialogue manager as the central component. The dialogue manager is responsible for the fusion of input data, semantic representation and decision making based upon user intentions. Here, application models are referred and multimodal presentation is generated and organized

for output rendering. The pedagogical manager and domain manager relate to the pedagogical model and domain model respectively and are essentially the plug-in knowledge/content and application.

## Dialogue Manager

The dialogue manager is in essence the heart of AmbiLearn. Multimodal input is fused together and represented semantically to obtain the users intentions. Based upon these intentions and the current state of application, a decision making module takes appropriate action. This action can be through the domain manager or the pedagogical manager. The domain manager initiates and terminates sessions with the application and requests and responds to information. The pedagogical manager requests, extracts and integrates relevant pedagogical information. The decision making module then sends the relevant information for multimodal presentation to be rendered for the user. In addition, personal information may be obtained by the user modeling module to amend and update a user profile.

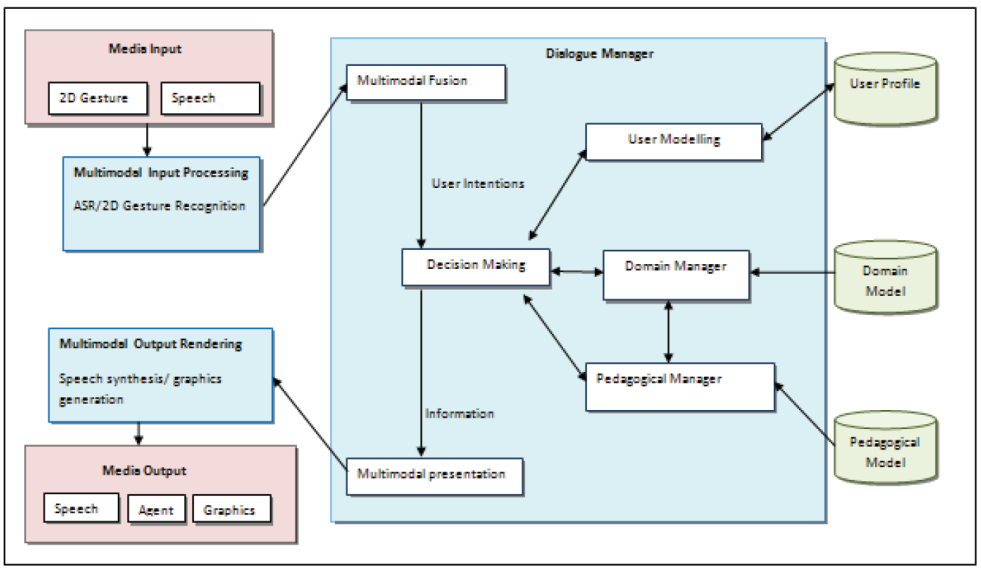
## Application Models

What differentiates AmbiLearn applications from many others is the concept of having the information available in numerous formats. One method is to use Resource Description Framework (RDF) to semantically represent pedagogical information on a particular theme enabling a range of applications to use it. A multimodal presentation system can thus provide content through a conversational style game, where users can interact with a character to gain further knowledge. A fact file may be used to provide a visual portrayal of the information through text, movies or images to support those pupils who prefer a visual style of learning.

## TreasureLearn

The educational approach taken by AmbiLearn is demonstrated by TreasureLearn which is a treasure hunt style game. An activity diagram of TreasureLearn is shown in Figure 2 which highlights the use of multiple modalities throughout the application. General feedback will be through the medium of spoken output

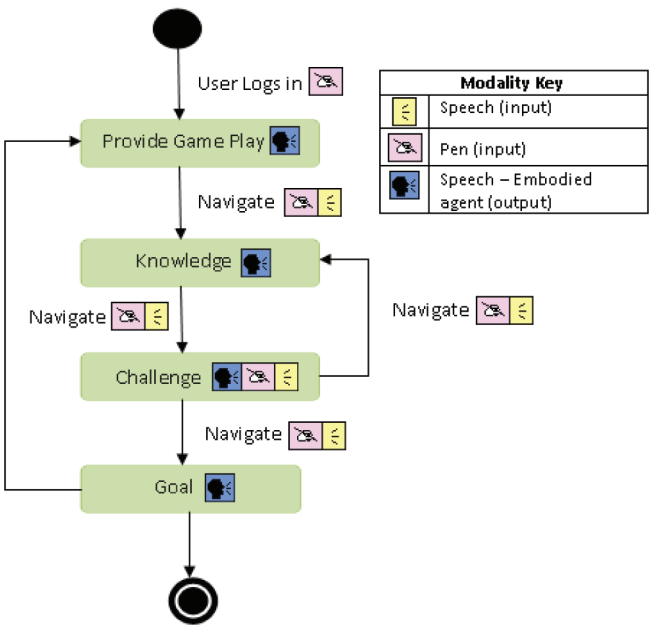
*Figure 1. Architecture of AmbiLearn*



from a character agent. Users will interact for navigation purposes though spoken keywords or mouse/pen inputs or a combination of both. Modules within TreasureLearn are as follows:

- *Gameplay:* In game design the game play module is concerned with the challenges a player is faced with and the actions taken to overcome the challenges. This module will essentially provide the user with the rules and game concepts. This information will be provided through the use of an embodied agent; however limited interaction occurs within this module. Depending on the user and their previous interactions, this module will provide the information regarding the level, or area of game play they are due to commence.
- *Knowledge:* A knowledge module within the game will provide the pedagogical content which will comply with the intended age group and core curriculum. This information can be provided through the embodied agent and simply provides the user with content which will need to be recalled to overcome certain challenges.
- *Challenge:* The challenge module provides the main interaction within TreasureLearn. This module is responsible for accepting the knowledge the user provides and determining whether the user responded to an answer or puzzle correctly. The user input at this stage will be logged for analysis at a later stage.
- *Goal:* The goal module will provide the user with an update on their progress such as moving between levels. This module is concerned with updating the user information. At the end of each game session, i.e. each time the user plays, this module will be invoked to record and update the logged information so that an external user monitoring and assessment facility is available.

*Figure 2. TreasureLearn activity diagram*



## CONCLUSION AND FUTURE WORK

This paper has outlined the work to date associated with AmbiLearn, a multimodal virtual learning environment for primary school education. The multimodality of AmbiLearn will enable the user to employ a combination of speech and pen as input and offer rich feedback through the use of speech, graphics and an embodied agent. An application, TreasureLearn is being developed as a treasure hunt style game to demonstrate and test the educational potential of using multimodal presentation as a dynamic method of providing pedagogical content. AmbiLearn has a general educational aim to encourage children in their own learning and enable them to take responsibly for that learning.

AmbiLearn is being developed as an online environment using ASP.NET and Silverlight 4 as its interface technologies. Further investigation is required into the technologies of Speech recognition and the standards of Voice XML and SALT for the AmbiLearn speech capabilities. Sample pedagogical content will be tagged using the Resource Description Framework (RDF) standards to facilitate the development of a semantic search. The testing and evaluation of AmbiLearn/TreasureLearn will involve children, aged between 7 and 9 as subjects, working with the different functionalities of AmbiLearn. Pre-tests and Post-tests may be used to determine the learning attainment. Through questionnaires using The Fun Toolkit (Read & McFarlane, 2006) an evaluation can be carried out. Additionally using Cloud Computing as a delivery platform can open the opportunity for AmbiLearn to be accessed using mobile technologies in a ubiquitous fashion.

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