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An Adaptive eLearning framework – Design Issues and Considerations

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Abstract

This paper discusses the issues and motivations surrounding the design and development of an adaptive e-Learning facility. The problem facing developers is the deliverance of high quality educational opportunities via the web that are equivalent or even better than face-to-face classes. Because of rapid developments in the information and communications technologies with regard to on-line distance education it is possible to improve the quality of the system deliverance. This is where the concept of using individual learning styles is adhered to. If a system is designed where the individual learning style of the student is discovered, the system can then be designed to best suit them. By implementing such a design students can learn in a manner they prefer therefore leading to an increased willingness to learn. Learning styles will be determined through questionnaires. Once these styles are determined it is possible to design appropriate system modules for them. This paper discusses the relevance of learning styles and system design of computer education to prove the question “Is there a link between student learning styles and successful online learning” and “Is the design and development of an adaptive e-learning system an effective eLearning environment”. This is at present a work in progress.

Keywords

Adaptive System, learning Style, learning preference, eLearning, distance education

1 Introduction

eLearning can be described as the convergence of the Internet and learning, or Internet-enabled learning. Implementing eLearning frameworks today is not an uncommon occurrence. In Ireland for example many institutions have adopted eLearning such as University College Dublin, Trinity College Dublin and the Dublin Institute of Technology. The above third level colleges provide computer-based training through a wide range of specialized applications and processes and are only a few of many throughout the country that have introduced this form of Learning

Once implemented these eLearning frameworks are set up with a standard system for all users. All information is presented to the users in a pre-designed format, this format being text, graphics, audio, video etc. There are limitations however with having a standard system for all users. Using a standard system may be effective as face to face tuition for some but may pose problems for others. This paper will attempt to bridge this divide by presenting a solution in the form of an adaptive system for the eLearning framework.

This is where the area of learning styles is introduced and where different learning styles will be uncovered. An attempt will be made to identify and define the attributes of several types of learning styles. The system will be designed solely on what presentation format suits these particular learning styles and their suitability to the learner. The outcome of any teaching process is that the learner learns. What influences most how they learn is their individual learning style and so how an on-line course is designed, developed and delivered depends on that. (Kirkwood 1998).

2 Background

It has only been 10 years since the coding language for the World Wide Web was developed and Wide Area Information Servers became the tools for “surfing the net”. Since that educational institutions, research centers, libraries, government agencies, commercial enterprises and a multitude of individuals have rushed to log on to the internet (Johnson, 1999).

One of the consequences of this tremendous surge in online communication has been the rapid growth of technology-mediated learning at the higher education level. E-learning is the solution to the training challenges the Internet economy has created. E-learning refers to education that is enhanced by or delivered via the Internet. ELearning began in corporate training departments, schools, and universities as a supplement to standard teaching methods. Today, it encompasses a rich set of solutions that can be used throughout an organization from corporate communications and marketing to technical documentation to share information, experience, and ideas. E-learning can give learners the ability to turn change into an advantage by tapping existing knowledge resources and packaging them in a more accessible, customized, learner-centric format.

E-learning systems can enhance traditional teaching methods and materials, such as classroom discussion, textbooks, CD-ROMS, and non-Internet computer-based training. ELearning provides the added advantage for students in that they can develop online communities for providing mutual support and sharing information via discussion rooms and bulletin boards. Teachers can provide feedback and direction to learners, answer questions, and facilitate these discussions. ELearning can provide on-demand audio and video technologies can present material in a stimulating fashion to actively engage learners. Knowing a little bit about learning styles can help an individual in determining if online learning is for them. The interaction and delivery methods used in online classes are dramatically different from traditional classes, so understanding how one learns is a good part of the decision-making process.

The three predominant learning styles are visual, auditory, and tactile/kinesthetic. Broken down further, people learn by:

- Reading (visual)
- Listening (auditory)
- Seeing (visual)
- Speaking (auditory)
- Doing (Tactile/Kinesthetic)

The first three on the list are passive types of learning, while the last two are active types of learning. How much we tend to remember is a function of the type of learning we prefer and our level of involvement in the learning. People often learn through a combination of the ways described above. To a lesser degree, environment is a factor too. Students get only what they need and study at their own pace. Student information requirements vary. In addition, the knowledge and behavior of students with respect to the learning process can change both over time and at the same time (Riding et al 1995). Given this scenario, it is possible to suggest a need to develop interfaces and systems that help each student to reflect on, identify and develop their information needs.

This paper will provide some information into the background of distance education as well as the use of using technology to support eLearning. It will also look at a suitable adaptive architecture.

3 Distance Education

One of the first universities to deliver distance learning in an organized manner was Pennsylvania State University, establishing its first distance learning network in 1886. Penn State used the state of the art technology of the day, U.S. Mail, to communicate with its distributed students.

In the 1960's the UK Labour Government approved the setting up of 'The University of the Air'. This was later to become the Open University. The OU was originally set up to offer degree studies through broadcasts such as TV and Radio in partnership with the British Broadcasting Corporation and later computer mediated communication became a vital ingredient in distance delivery of under graduate taught programmes.

Distance education has walked through many of the problems now facing eLearning has much to offer eLearning. Distance education departments at colleges and universities have spent

decades addressing challenges of creating and designing learning resources to be used by students studying on their own. Many of the concerns currently facing eLearning are a high drop out rate, problems with creating interactivity and fostering community among learners. The outcomes from initial research into these issues suggest that the simple effects of technology on teaching style, learning style, grades obtained, and course satisfaction may not be very robust (Grasha and Hicks, 2000).

Gee (1990) studied the impact of learning style variables in a live teleconference distance education class. Students in the distance learning class who possessed a more independent and conceptual learning style, had the highest average scores in all of the student achievement areas. People with the lowest scores in student achievement in the distance learning course had a more social and conceptual learning style. Students with both a social and applied learning style performed much better in the on-campus class. The outcomes of the Gee study suggested that successful distance education students favored an independent learning environment while successful on-campus students showed a preference for working with others.

Students who study at a distance are separated both from their tutors and their peers. For some this can be a particular problem, and for all, some of the time the separation poses potential difficulties. Social interaction, such as the sharing of ideas, discoveries, successes and failures and general social support, are all to a certain extent, missing from the distance learning environment. Students may therefore feel isolated, start to lose motivation, experience frustration or anger, and a host of other unwelcome emotions.

When designing systems and materials for distance delivery, lecturers must consider not only learning outcomes, but also content requirements and technical constraints. Also to be considered are the needs, characteristics, and individual differences of both the students and the teachers.

The task of the distance educator is therefore to dispose of these problems as much as possible by mixing and matching techniques, creating and maintaining a stimulating environment, and offering opportunities for students to communicate with each other and with the teaching staff on a regular basis.

To mix and match techniques and make a teaching environment more stimulating for a student a good idea then is to teach each student exclusively according to his or her particular choice or style of learning thus making the whole experience of distance education for the student better. It is far more beneficial for the teacher to strive for a balance of the various styles of learning. By discovering the students learning style and designing and presenting information to them in that particular manner will reap considerable benefits.

4 Using Technology to Support Learning

Technology Based Training (TBT) is a computer based training methodology that includes web-based, intranet based, DVD and CD based training on any topic. The content is designed and developed with the same instructional objectives as classroom-based learning. TBT breaks course material into small bites by breaking large blocks of content into modules that can be searched and then completed in a short amount of time. Dissecting a skill into many segments allows users to gain competency quickly. Learning objects also serve as a helpful tool for users who need to brush up on a skill once they're back on the job. Students can quickly scan a course module list and find the lesson they need without wading through pages of unnecessary content. Benefits of TBT include:

1. Enhances retention rate by 25 – 60%. It provides for self-reinforcement. Interactivity improves the retention of the skills being taught and simulations help walk students through actual scenarios helps identify mistakes when they make them.
2. The ability to customize the learning material to students own needs, with more control over the learning process, leads to a 60% faster learning curve compared to instructor-led learning.
3. Saves time. A comprehensive skill assessment performed prior to taking the learning determines which topics you need to focus on. The delivery of content in smaller units, called “learning objects” contributes further to saving time and has a more lasting learning effect.
4. TBT interactivity accommodates different learning styles and fosters learning through audio, visual and testing.
5. Learn at your own pace: Don't feel constrained by an instructor-led class that is too fast or too slow for you. You can learn at comfortable pace, further increasing skill retention.
6. TBT is flexible – students can navigate through the learning to cover topics in whatever order is more beneficial in light of their specific learning needs. This allows students to select learning materials, or to be directed to content that meets their level of knowledge, interest and what they need to know to perform more effectively in their particular activity.

When evaluating TBT, the most important considerations are content and design. Good training requires a preliminary assessment of those needs the training must address. The assessment can be very detailed, focusing on learner characteristics, the learning environment and a variety of other issues. However, the single most important requirement involves the

identification of the standards a properly trained student must satisfy to effectively do the job. Each standard should yield a specific number of learning objectives. These learning objectives define what the trainee needs to know and how the trainee needs to apply that knowledge.

Properly constructed TBT reduces the amount of information the learner/trainee must retain during training to the lowest possible level. To accomplish this, certain characteristics must exist. First, information must be organized in a detailed, sequential fashion from the job, to the duties required to satisfy the job. Good TBT focuses on tasks and sub-tasks. Second, TBT chunks task and sub-task information within an architecture that supports retention and its quick transfer from short term to long term memory.

Technology-based training allows more room for individual differences in learning styles. TBT's interactivity accommodates different learning styles and promotes the growth and development of learning through audio, visual, testing, and by having learners "do what they are learning". TBT also provides a high level of simulation that can be tailored to the learner's level of proficiency.

People can learn at a pace that suits them and review course material as often as since they can customize the learning material to their own needs, students have more control over their learning process and can better understand the material, leading to a faster learning curve, compared to that of an instructor-led course.

Technology based training is changing the way corporations and individuals obtain skills in almost every single segment of the business process. Initially IT training dominated the TBT market. However front office, management, sales, customer service, and professional development training are increasing at a rapid rate.

5 Limitations of Existing Technology

When considering what exists in the area of eLearning today it is imperative to consider ones knowledge, skills, and abilities and what is the individual's academic and professional background. Is the individual comfortable with the media? Is the individual predisposed to self-learning? Is the content appropriate and is it suitable for the individual learning styles of each learner? Although classified as at your leisure and at your own pace it is important that the user of the system does not get bored or generally uninterested in continuing with the course for any reason . One of the problems that plague the eLearning industry today is a high dropout rate. There are no national statistics, but a recent report in the Chronicle of Higher Education (United States) found that institutions are seeing dropout rates that range from 20 to 50 percent for distance learners (Karen Frankola, 2001).

After research by Frankola it was found that some of the reasons for this high drop out rate included lack of management, lack of motivation, problems with technology, lack of student support. An area that also appears to have contributed greatly to this drop out is Individual learning preferences and poorly designed courses. Students with different preferences in how information is displayed to them have problems with how these courses are designed and presented to them. It is these students who then feel isolated from the course and lack the motivation to continue. With the overwhelming amount of information that must be streamlined, the most advantageous opportunity for eLearning will be getting what you want, when you want it, and how you want it .

Each individual learns differently. Some individuals require more direction and guidance from a trainer or teacher than others. The same idea applies to computer based learning. The way that information is displayed online appeals to some and may not to others. This depends on how different individuals perceive the information that is displayed in front of them. The solution to this problem reverts back to how the system is designed

There are few or no guidelines, for what constitutes effective human-computer interfaces for educational purposes. Due to a lack of proper system design guidelines, designers of educational software often use the styles that would have been used for lectures in a college environment. Here the student is handed the lecture notes as well as listening as the lecturer explains them. In an eLearning online environment these can be boring and do not keep the interest of the student. If the problem is the system design and how information is portrayed to the students then a simple solution is to adapt the system. And a better solution is to adapt the system to suit the learning style of the individual.

6 Adaptive Architecture

The major problem that exists is the design of the system used to display the information to these students. If this is so, then solutions to the problem is in determining the learning styles of the individuals taking the courses and understand the display methods that best suit them. Having knowledge of these methods can then allow the adaptation of the standard system engine building the online course. The content management system engine that will be used for this particular project will be WebCT. (6.1).

The next step will be determining the learning styles. There are many questionnaires that can determine individuals learning styles. There are many different styles of learning and these will be studied in detail to decipher what media content would best suit them. The next step then is to adapt the system for each type of style and present the given information in a variety of ways to the users. All of the above constitutes the adaptive architecture that will build this adaptive framework.

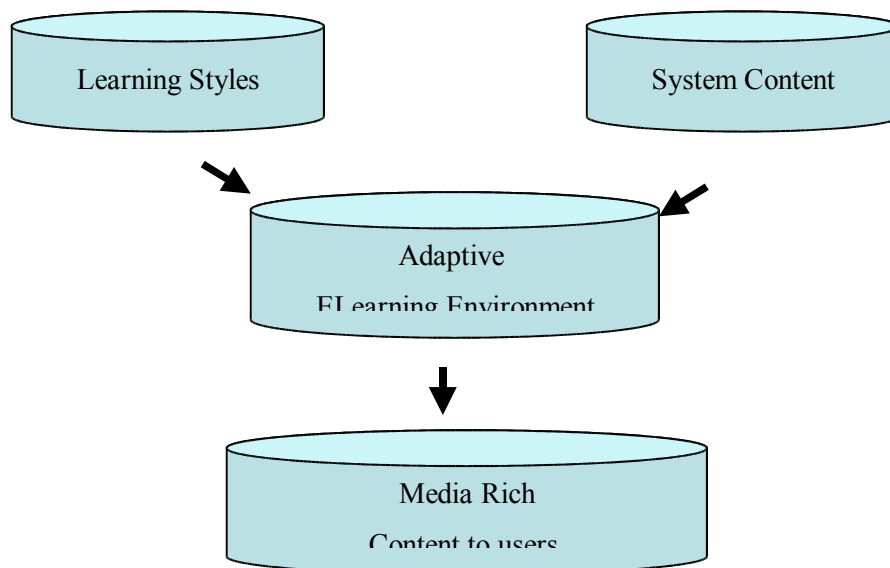


Figure 1: System Architecture

The focus of this project will be to analyze, develop, implement and evaluate an adaptive eLearning environment using chosen proprietary products. These will be course management systems that enable the efficient delivery of high quality online education. Course material will be presented to the students through the adaptive system mentioned above. The material that will be presented to them will include:

- Assignments
- lectures
- Content Module
- Course Map

The above will then be adapted to suit their learning styles.

6.2 Learning Styles

We are all different, and that applies to how we learn information, as well. Research has found that the two major categories of learners are those who learn best in visual ways and those who work better in auditory ways. Your learning style is determined primarily by your brain, whether it relies more on your eyes or your ears to comprehend new data. Those who respond better to what they see are visual learners. Those who respond better to what they hear are auditory learners. Those who are equally as good at interpreting data that they see and hear are known as “balanced” learners. Balanced learners will recognize aspects of what they're good at in both the visual and auditory learning style descriptions.

Of course, everyone relies on their eyes at some times and their ears at others. But when faced with new information, the majority of people fall back on their dominant learning style. And as more is being studied about learning styles, some sub-styles are being identified, such as kinesthetic, the learning style that relies on learning by doing.

Everyone uses both faculties, but most people tend to favor one over the other. In the 1940s Isabel Briggs Myers developed the Myers Briggs Type Indicator (**MBTI**), an instrument that measures, among other things, the degree to which an individual prefers sensing or intuition (Quenk and Wiley 1993). For succeeding decades the MBTI has been given to hundreds of thousands of people and the resulting profiles have been correlated with career preferences and aptitudes, management styles, learning styles, and various behavioral tendencies.

The Myers-Briggs Type Indicator is based on psychologist Carl Jung's theory of psychological types (Boeree, 1997). This indicator is thought to affect many of the behaviors and attitudes of a person including his or her approach to learning. Sensors are good at memorizing facts and intuitive learners are good at grasping new concepts. Sensors are careful but may be slow; intuitive learners are quick but may be careless. Knowing this information teachers and lecturers can present information to these learners in a way that they would understand a lot easier. The *Myers-Briggs Type Indicator* discovers the learning styles that best suits each individual's preferences.

Sensor

Creating web based training that appeals to this kind of learner means including details, well laid out procedures, verifiable facts, and practical applications of the information being presented.

Intuitors

Simulations and the opportunity to explore other web sites would probably be more appealing to this kind of learner. The implication to society or civilization as a whole of the practical application of the information being presented would make web based training of more interest to this kind of learner.

Extraverts

These learners would probably be better served by chat rooms, discussion forums and dialog databases included in their web based training. Interaction with a "virtual" teacher would probably also be useful.

Introverts

The impersonal, almost private, nature of web based training will probably make it very appealing to this kind of learner.

Thinkers

Presenting logical arguments and research results associated with the new material being presented is more likely to be the best kind of web based training for this kind of learner.

Feelers

Showing how the information affects people will make it more interesting to this kind of learner. Devices such as chat rooms that let them know how other learners and the "virtual" teacher respond emotionally to the information are useful.

Judgers

Web based training designed to go from beginning to end over a prescribed route would probably be most appealing to this kind of learner. Keeping them informed of their progress along the route might also be valuable.

Perceivers

Web based training that includes simulations and the opportunity to explore other web sites would probably be most effective with this kind of learner. They may respond best to an open ended learning agenda if one is possible.

Research using the Myers-Briggs Type Indicator, in general, shows that the majority of college students do not have well-developed independent or abstract-thinking learning styles. Their

interests and energy are centered on the world of "people, objects, and events" and not on the exploration of ideas (Grasha 1996; Lawrence 1982). That is particularly true of students attending large urban universities and less-elite, small liberal arts colleges. Thus, teachers employing technology need to understand the learning styles of their students when designing course activities. And those promoting technology in courses must recognize that not every student will easily benefit from its use.

6.3 Media Rich Content

These online educational systems can be improved by methods of dynamically adapting learning content to the knowledge level, and adapting presentation of content to the perception preferences of the learner. Once these preferences have been determined the task is then presenting the same information in a variety of different ways without losing any educational content in the process. It may be possible that if a student is more visual and a series of diagrams are displayed in front of him that he may be deprived of some valuable information that would have been initially presented to him in more textual manner.

The idea then would be to design the system where the content is presented in a way that information is predominantly centered towards a certain learning style and where valuable information is given in added text or otherwise so that valuable information is not lost in the process.

Figure 2 displays various learning styles and their suited corresponding presentation styles. For the sensory and perspective learner the emphasis is on the content of the material. It may be adapted so that they can understand it better maybe by giving better examples. The visual/auditory learning styles preference is that of how the information is presented to them. They would rather a more diagrammatic presentation of information with possible audio content. These include visual as in sights, pictures, diagram and symbols, auditory as in sounds and words.

Active learners tend to retain and understand information best by doing something active with it by discussing or applying it or explaining it to others. They also tend to like group work more than reflective learners. They should then be given the chance here to join discussion groups and provide feedback from them on a given topic; this will make the experience more enjoyable for them. They should also be encouraged to join a chat room to discuss various topics with other students. Reflective learners prefer to work alone so an avoidance of group work for these

learners would be more beneficial. Information presented to these learners should involve diagrams and text and assignments that involve research.

Most college courses are taught in a sequential manner. Sequential learners may have difficulty following and remembering if information jumps from one topic to another. To present information to a sequential learner then it may be necessary to fill in these steps for them or let them fill them in themselves or by presenting them with references. When they are studying, they need to take the time to outline the lecture material for themselves in logical order. In the long run doing so will save them time.

Inductive learners prefer to learn a body of material by seeing specific cases first for example observations, experimental results, numerical examples and then work up to governing principles and theories by inference. Inductive learners prefer less structure in their presentations. Information can be prepared for them in a less structured manner but allows them to work out solutions to given problems so that they do a lot of the work for themselves as they prefer.

Deductive learners prefer to begin with general principles and to deduce consequences and applications. Since deduction tends to be more concise and orderly than induction, students who prefer a highly structured presentation are likely to prefer a deductive approach. Research shows that of these two approaches to education, induction promotes deeper learning and longer retention of information but that most college science instruction is exclusively deductive probably because deductive presentations are easier to prepare and control and allow more rapid coverage of material.

9 Methodology

The proprietary products that will be used to undertake this project will be WebCT and Macromedia Breeze. Using Macromedia Breeze course content will be created in the familiar PowerPoint environment and automatically convert it into rich media experiences through Flash. Before the content is uploaded to WebCT for delivery to the students, each students learning style must be determined. To determine these learning styles a questionnaire similar to that of the Myers Briggs Type Indicator must be filled out by all students. The questionnaire will be in the format of around 12 questions that the student will be expected to answer prior to taking the online course. The questionnaire will be made available online for the student when they log on to the course.

Preferred Learning Style	Corresponding Preferred Presentation
Sensory } perception Intuitive	Concrete } content Abstract
Visual } input auditory	Visual } presentation verbal
Inductive } organization deductive	Inductive } organization deductive
Active } processing reflective	Active } student participation passive
Sequential } understanding global	Sequential } perspective global

Figure 2: Preferred learning styles and their corresponding preferred Presentation

The style of question will be in the following format:

Visual Modality

often seldom

I remember information better if I write it down

Looking at the person helps keep me focused

I need a quiet place to get my work done

Auditory Modality

often seldom never

My papers and notebooks always seem messy.

Pages with small print or poor quality copies are difficult for me to read

Kinesthetic/Tactile Modality

often seldom never

I start a project before reading the directions.

I prefer first to see something done and then to do it myself

I have a difficult time giving step-by-step instructions.

A score of 21 points or more in a modality indicates strength in that area. The highest of the 3 scores indicates the most efficient method of information intake. The second highest score indicates the modality which boosts the primary strength. For example, a score of 24 in the Visual Modality indicates a strong visual learner and such a learner would benefit from text, filmstrips, charts, graphs etc. If the second highest score is auditory, then the learner would benefit from audio tapes and lectures as well to supplement their learning. Furthermore, if your second highest score is kinesthetic/tactile, then taking notes and rewriting class notes will reinforce information.

Once these various styles have been determined then the content of the material can be adapted in a way that best suits the individual's style and in a way that will keep him/her interested in the material. The idea is to adapt the system to each learning style. For example if a student is a more visual type of learner the information can be presented to them in a more graphical format e.g. diagrams and charts. It is the designer and teacher that will predominantly be responsible for adapting the information in this case. WebCT does allow you to adapt the interface and contains a dyslexia screen if needed. As for the format of information that is presented to the student the responsibility lies with the teacher. Students will then be observed to view their progress as a result of this change in information presentation.

10 Summary and Evaluations

This paper has described how distance learning has become an integral part of education systems today. It has also discovered that there are certain problems that exist in this area of education. People have been learning at distance for centuries but not at the forefront of education as we know and are accustomed to. As a result of this there has been a high drop out rate within this form of education. One important reason that has been discussed is the area of preferred learning styles. Many learning styles have been covered and how information can be adapted to suit them. The outcome then is, to determine the learners preferred style and present information to them in an appropriate form. Learning styles will be discovered using a questionnaire designed specifically to determine a user's learning style. The system presented to the learners can then be altered as needed to suit them.

A message to communicate, the ability to write, the proper tools, and an infrastructure to deliver writings are the only requirements for distance education. By reinforcing the system, providing the students with a more adaptable system could prove invaluable for this type of education to expand.

The goal of this project then is to observe eLearning and distance education and to determine the relevance between the design of the system and the significantly successful outcome of presenting different system designs based on the learning styles of each of the users.

It is suggested that the identification and use of learning styles and learning strategies combined with adaptive systems can help facilitate the achievement of the goals of distance education and eLearning. These goals hope to include a lower than average drop out rate. By providing these systems adjusted according to the different needs of different users is hoped to do just that. Such differences present a profound challenge for instructional designers and it is hoped that through further research that the quality of learning material is enhanced if the material is designed to take into account learners' individual learning styles.

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