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## Adaptive Screen Generation for Mobile devices

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### Abstract:

*When one looks at any learning software - eLearning based or not - one cannot sometimes help but think why the authors could not have organized the screens (or the means of navigation) in a way similar to some other piece of software which the user has used or come accustomed to using. In this paper it is hoped to be able to achieve just that. That is, to accommodate the adaptive screen design by building up a profile about the user which can capture the learning styles of the user and personal preferences, and to be able to have the same navigation process over multiple devices and transmission types. With this as the design backbone it is also planned to offer user driven material so as to be able to take full advantage of the user requirements*

### Keywords:

Dynamic screen generation, blended learning, blended screen generation, user centred, assessment, effective learning, WiFi, user profiling.

### Statement of problem

The ability and usefulness of having a mobile device with which to study and learn new skills has been long established and recognised [Soloway E., Norris C., Brumenfelt P., Fishman B.,Krajcik J.,Marx R]. In the case of the Virtual Learning Environment (VLE) the aim is to improve learning effectiveness. This is an aspect that must be addressed, if only to justify the cost of development, maintenance and provision of varied curriculum for such an environment. The typical multiple choice tests, which in themselves present a unique means of automating assessments for large classes, have both advantages and disadvantages. For example, by random selection of one of four answers a student would score about 25% in a test. By using multiple choice assessment we are not examining deeply the knowledge of the student or getting a feel for their understanding of the subject: only a broad examination of the course is possible [Masters, K., et al (1999)]. In designing and managing multiple-choice questions [online], Deming also advanced approaches to assessment with his “decision wheel” [Deming W.E. (1986), “Out of the crisis” New York: Wiley]. Chambers [1998] points out that “self assessment is an efficient and effective learning tool in that students are required to identify their own strengths and weaknesses”. There is definitely some merit in

self-assessment and feedback following on from such assessment, especially timely feedback.  
[Sadler (1998)]

In our model for a learning environment (initially outlined in O’Nuallain, Brennan, Mlearn (2004)), we propose a different approach to virtual learning, which has many implications for screen design, assessment, tracking and profiling for future courseware. Some of these aspects will be discussed and described in this article.

## **Learning**

We all learn in different ways and we all have different preferences for how we learn, the student profile [Fig 2 Listing of profile categories] segmentation is a technique which performs some preliminary probing of the student, requiring them to do a pre-test to establish information regarding such things as their learning styles, preferred environment, device(s) used, and problem solving skills. This serves to establish a baseline for a student’s profile.

Many of the pre-test questions relate to how students prefer information to be presented on the screen, whether on a desktop PC, laptop, PDA, or phone. This allows us to blend material so as to be suitable to the device type and the user (there is little point, for example, in trying to deliver streaming video to a desktop computer or PDA if the required bandwidth or screen resolution is not available: in such a situation this could lead to the computer hanging and/or loss of synchronisation with the rest of the learning material, which in due course leads to student disillusion and, ultimately, possible withdrawal from the course).

Student retention was one of the initial driving forces in advancing the research into this area [May&Bousted, (2002), Retention project final report, Kingston University, internal paper. ISBN 0 10 2178011]. We have already established the effectiveness of the approach with gaming devices which can be used to motivate and hold a child’s attention [O’Nuallain, ITTE02]. Our current research hopes to achieve similar results with adult learners, with particular emphasis on a well designed engaging curriculum which can be effectively displayed and utilised on different devices. Various studies have been carried out in the other areas of learning that are relevant to our project, with the ultimate aim of optimising the learning potential of our system through the use of accepted learning theory and methodology. Having examined :

- Behaviourism [Skinner, B. F. 1969],
- Cognitivism [Mergel, B.1998]
- Constructivism [Mergel, B.1998]

and taken what we considered to be the best of the three, together with some aspects of :

- Gardner’s Multiple Intelligences [Gardner, H. 1983/1993]
- Kolb and Honey and Mumfords Learning style models [Henke, H. 2001]

- Blooms Taxonomy [ Bloom , 56]

a coherent picture started to emerge which, when combined with Blended Learning [Centra software (2003)], allowed for the development of a number of matrices which ultimately formed part of our user profile. This profile improves the delivery of material and enables the creation of a personalised learning environment that is appropriate to the user's preferred learning needs. Ultimately, having taken into consideration user preferences and attributes, and identifying their "current" learning style, we believe we have taken the first steps in being able to fill the profile and be on a pedagogically sound footing.

## **Motivation**

Research by Dunn, Dunn, Barbara (2000) suggests that:

- Only 30% of students remember at least 75% of what they hear in class
- Only 40% of students retain at least 75% of what they read in class

Furthermore Holland, [1998], reported that boys in school spend 25-75% of their time listening passively to teachers. All of the above reveals very poor overall statistics for learning, and indicates that children are given few opportunities to learn effectively (as defined by the higher levels of Bloom's Taxonomy). It is clear that a deeper level of understanding is required which can then be reused in different situations and domains. This is the kind of learning which we should strive for in all learning situations. The core problem is that in schools, VLEs and curriculum are typically not presented in a way that is interesting, engaging, or stimulating the student to think. In this body of research it is our objective to produce an environment that tackles this core problem, and furthermore to prove its effectiveness by presenting curriculum to students and obtaining statistics which relate to levels of achievement and satisfaction with the (highly personalised) material presented. It is known that, through the use of collaboration with tutors, mentors and fellow students, the motivation and quality of learning is increased Edwards M.A.(2000).The International Standards Organisation (ISO) has formulated a number internationally accepted standards one of these Sc36 is for "IT for learning and technology training" and part of this standard is a workgroup 2 (WG2) which is involved with Collaborative technology.

By applying ISO 36 WG2 standard [<http://collab-tech.jtc1sc36.org/index.html>] it is hoped that we can build on a standard collaborative framework and in doing so take advantage of other material which conforms to this standard. we hope to improve our goals in obtaining higher satisfaction from the students, and deeper understanding through brain storming in collaborative discussions. Such collaborative aspects are also part of the dynamic screen makeup, which depends on the bandwidth available, memory, and validity for the material being delivered. [Zen of Palm]

## **Student Profiling**

The student profile in its current state (at the time of writing this article) contains twenty-one sub categories; each category contains approximately ten parameters. Through the use of such extensive data on a user, it becomes possible to deliver material that the student wants. Furthermore, as discussed in the article O’Nuallain C., Brennan A. in *Mlearn 2004*, all aspects of the course are assessed, with particular emphasis on the user’s learning characteristics allowing us to structure the curriculum appropriately.

Our approach is cognisant of the fact that learning styles (like many other aspects of a young person’s personality) change as they develop and evolve. Having established a preferred learning style, we also aim to strengthen the user’s other styles of learning: the ultimate goal is to assist students in becoming comfortable with all learning styles. When this is achieved we have a situation where effective learning can occur, similar to Blooms upper levels of his taxonomy Bloom, B.S. (Ed.) (1956). This we acknowledge and build into our profile base.

This is achieved through the use of reusable learning objects which have various ways of being used and displayed. This depends on aspects of a users profile which indicate ways of optimising the means of learning for various devices to suit the users specific style.

## **Dynamic Screen Generation**

Currently, with a learning curriculum, whether it is delivered to multiple devices or not, the user must typically adjust to the graphical user interface style, and also to the approach used to present the curriculum. This forces the learner to adjust their learning style to the interface, and is at odds with our profile based curriculum which instead adjusts the GUI to the learners style. In studies carried out by Inkpen (1992) it was found that because different environments and GUIs were being used, students needed time to adjust to the different GUIs and to how to interact with them. This is clearly undesirable and should be minimised.

In our model, all screens are initially created blank - we create a “blank slate”. On this blank slate we draw from information stored in the various matrices of our student profile, in order to create screens that present information appropriate for display on the current device being used, but also with functional aspects (e.g. collaboration tools, assessments) which are suitable for the device and more importantly the user. Then, suitable collaboration aspects, screen layout, button location, size, and overall “look and feel” are applied. The area where curriculum can be presented is therefore optimised and the dexterity of the user taken into consideration together with their learning context. When a student has paused their study or changed devices, our system automatically detects this and resumes at the appropriate position in the learning material, and with presentation characteristics that are appropriate to the current device. The profile detects the device type, or can be set by the user, and can adjust all aspects of the screen generation so as to cater for this and not diminish the resulting quality of

the material delivery due to a change of device. Such a change of device is seamless and, as much as is possible, does not lead to a modified “look and feel” or altered navigation process which will help the student focus on the curriculum rather than how to navigate there way around the device and find out how to do things that were possibly more accessible on the previous device.

When a user does decide to change some aspect of their screen layout, (for example, by adding scroll bars where previously they had specified they were not required), they are able to do so. The student’s profile is then updated and the change becomes permanent. The user has effectively changed their style and the system allows them to change that aspect of the screen as they see fit. It allows the change, learns the change and implements it permanently for all further curriculum delivery on any device. Typical scenarios will be examined in the following section.

**CATEGORIES (that go to make up the profile):** User age grouping

1. Gender
2. Background
3. Colour preferences
4. Layout preference (Style Guides)
5. Environment
6. Pre-Test Post-Test
  
7. Device Type
8. Protocol Type
9. Remoteness
10. Type of Group
11. Speed of use/delivery
12. Quality of Service (QOS)
13. Timings
14. Audio Assess
15. History from last use (Pebble Trail)
16. Tracking aspects (what the user has done and how they got there)
17. Input Methods
18. Output Methods
  
19. Collaboration Types
20. Integration of Devices
21. Feedback Assessment/Mentor
22. Assess. Complexity vs Difficulty
23. Server or Peer
24. Internet Access type and parameters
25. GUI Design
  
26. Learning Style
27. Multiple Intelligence
28. Blended Approach
29. Viewing Assess
30. Left right brain style
31. Lateral thinking
  
32. Assessment

**Figure 1: Categories in the Profile**

The above category list shows areas of the profile being developed. Each category has within it in the order of twenty parameters which can facilitate all aspects of that category to the required detail of the reporting of the main application. Through the capturing of data for these parameters significant data mining can lead to the establishment of detecting possible student behaviour such as dropping out or changes in the way the student is learning.

**COLLABORATION TYPES**

1. White board
2. Text message
3. E-mail
4. Chat
5. Discussion board
6. Audio chat
7. Video chat
8. Video conferencing
9. Live face to face discussion

**Figure 2: Collaboration Types**

Through the use of the above collaboration types the teachers and mentors can communicate with the user to establish how they are getting on, provide further tuition, signal further areas of study or alarms if the student is not achieving targets. Through the use of these collaboration methods the student need not feel isolated. The above methods can also be used by the student to contact other members of their class and peer group to discuss material and brain storm each other. Through talking to members of their peer group the student is not under the same pressure as if talking to the teacher as such the learning is more informal and open. Through the assessment methods built into this system to assess the user the effectiveness of the curriculum and the software it is possible for the application to assign individual user marks on the basis their input into a collaboration and on how they may have progressed in follow on assessments. It is hoped that such collaborations lead to higher order learning (as indicated by the upper three layers of Blooms Taxonomy) for the individual and the group which would not be possible with students working in isolation.

**Test and click Trailing**

The author intends to build on the excellent research carried out by O Suibhne, (2004), in which the amount of data collected provided the author with a great insight into K12 students' thinking when interacting with his courseware. In his journal article, "Using ICT as a Tool to Monitor how children read Multi Media Material", regarding user interaction with the screen and timings, he has provided an impressive depth of knowledge into how children interact with ICT. It is this depth of knowledge that

we are capitalising on and further extending in terms of how to capture and analyse user data. Unlike our approach, O Suibhne's delivery was not based on a profile or on multiple device types but, nevertheless, his evaluation of the user interaction and timings can be applied to our project and much information drawn from it - especially where "guessing and testing" analysis is to be carried out (see [Salomon, 1979a] [Healy, 1998] [Burbules, 1998] [Heppell, S, 1995]).

Through the use of profiling, we embrace many of the findings presented while also building a more complete picture of what is going on when a particular student interacts with information on a particular device. The aim is for the material to be intuitive, presented in a way that is suitable to the user's background, age, learning style, colour preferences, and so on. The chance of the user randomly clicking will therefore be reduced considerably and, if it does occur, it will be identified via interaction timings. Certainly all actions and timings will be tracked and more evaluation of the data and findings will be dynamically fed into the profile and the resulting assessments, screen options, learning objects and collaboration options will change.

The article by O Suibhne provides us with an excellent test bed from which to go forward and allows more in depth evaluation to be carried out. However a number of important questions must be asked, namely:

1. Will the personalisation of the material and environment improve the way users interact with the media and reduce "test and click"?
2. A great deal of research goes into the development of a dynamic, customisable interface. Do the results gained justify the cost in man-hours and research?
3. What else can we deduce from the interactions?
4. Can we learn much about the thought process having provided such extensive rich media and collaboration features? (In this application framework the aim is to have built in many ways through which the user can get feedback from mentors and discuss issues with fellow students over an array of mobile devices such as laptops and Personal Digital Assistants (PDA.), which have different characterises and feature lists. These lists and characteristics can, through the Blended Learning methodology, optimise the learning experience through the ability to adapt what collaboration aspects are available based on the users preferences and the features for the devices.)

We have collected data from the curriculum-interactions of approximately 150 students with the Blackboard virtual learning environment, using the same learning material as we intend to use on with mobile curriculum. This will allow us to compare the data from all the environments. Blackboard, just like the environment used by O Suibhne, is static and does not adjust itself to the user's preferences. The comparison with Blackboard, O Suibhne's environment, and our own, will enable a detailed evaluation as to how best to utilise technology so as to optimise the learning experience. It should be



restated that one of the initial driving forces for this body of research was to make material more appealing, engaging and challenging to the users, with the overall result being to increase the level of effective learning, reduce drop out rates, increase high order learning and instil curiosity in all learning.

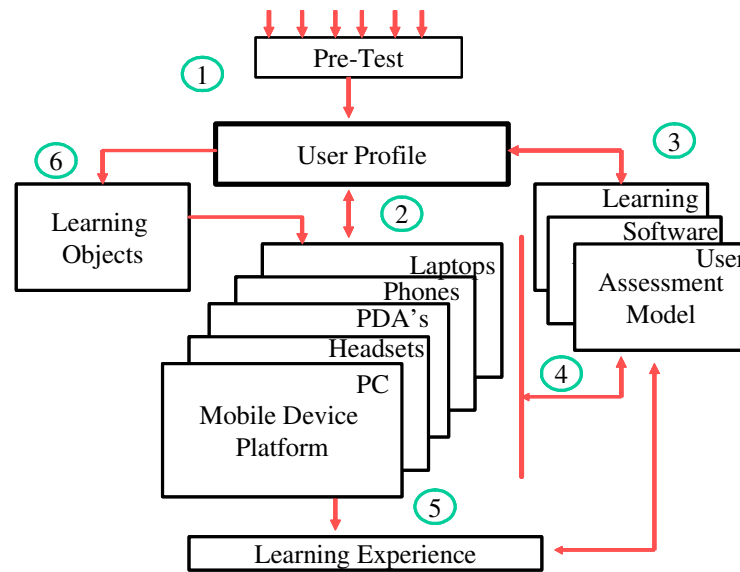


Figure 3: MODCA Model

From the current MODCA<sup>18</sup> model (Figure 3) there are several dynamic aspects to a system, including screen design and layout for individual users and devices, as well as dynamic assessment of the software over the three sub models (i.e., assessment of the user, of the curriculum, and of the presentation of the curriculum).

### Example Scenario

We will now consider a scenario by which we can illustrate the dynamic aspects of our software. User one, John, logs onto the system for the first time. He is offered an initial questionnaire presented in a multi media format. As the questionnaire is on the computer it can be evaluated immediately, and the original entries are entered into John's profile on that device. If he connects to the server or the Internet the information will automatically be distributed, thereby enabling a constantly available and up to date representation of his profile. The second part of the pre-test then takes place: an initially blank screen is presented, and screen aspects immediately begin to form based on the initial information gathered from the questionnaire. Once the screen has formed, some novel curriculum is presented with John's characteristics embedded. Through the use of this material, the interaction type and

<sup>18</sup>Mobile Device Collaboration and Assessment

timings are recorded and measured. Any changes he makes to the screen layout are noted in his profile, and his screen navigation is analysed in order to provide for optimisation, for example depending on whether he is identified as being left handed or right handed. Through the delivery of this part of the pre-test, several aspects of John's learning potential are tested, in order to assess the optimum conditions and compare the results with data gathered from the more formal questionnaire that formed the earlier pre-test. It should again be noted that adjustments to John's profile are constantly being made, just as John himself is developing and changing with each new experience. We hope that by the end of both pre-tests, a high degree of accuracy can be guaranteed in delivering curriculum and assessing the user at that moment of time.

From here, if John then changes to a different device type, for example a PDA, which may have a smaller screen and different characteristics, the profile detects the device change and continues gathering information of his interactions with curriculum in this new environment. It will optimise the experience with all aspects that are both suitable for him and that are available on the device at that time. For example, if the PDA connects to the Internet via a blue tooth connection to John's phone, the system is aware of the bandwidth and what can be delivered with the limitations available. The smaller screen would also be taken into account, while providing, as far as possible, the same "look and feel" and navigation process. John would undergo a minimised learning cycle having moved to the other device and would continue with the curriculum at the point where he left the previous device.

## **Conclusion**

It is only now with the abundance of wireless mobile devices and increasing bandwidth capabilities that mobile wireless ubiquitous learning environments can be realistically considered as a solution to the existing problems involving the capture and challenge of students while providing a high degree of feedback and collaboration and assessment.

The subject matter of the research is very current and can be applied to all but a few curriculum, however there are a few particular domains: for example, computer programming and Maths, which we would like to see this model applied to first, as these are seen as the most important areas with regard to student problem solving and areas that are of most difficulty for students, especially first year students where we aim to target the retention. The impact of losing first year students has many follow-on issues, [Ohio University (2003)] for example, being unable to provide highly skilled staff to meet the country's demand for highly skilled technical staff. Our initial assessments indicate that this may be a very effective model, or at the very least a solid starting point for other research. In either case, our model represents a significant jump forward in terms of delivery, pedagogy, assessment and mobile learning.

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