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Addressing Learner Diversity by Promoting Flexibility
in e-Learning Environments

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Abstract

e-Learning has opened a multitude of possibilities for teaching and learning. As the market matures there is a demand for more effective and cost-efficient learning interventions that meet the learning needs of the diverse learner population. Currently, however, very few teaching attempts have been made to match the pedagogical styles underlying e-Learning interventions to students' diverse learning styles. Information and communication technologies can provide a variety of ways for adapting learning environments to students learning styles, although they are not often used to their full potential.

In the Global Campus (GC) project at Middlesex University, we studied the differences in the learning styles of our distance and classroom students. We then examined the electronic learning resources and underlying pedagogical approach to establish how effectively they accommodate the diverse learning styles of the students. Finally, we proposed some measures to improve the e-learning environment in a way that matches the students' learning styles more effectively.

1. Introduction

e-Learning has opened a multitude of possibilities for teaching and learning. It is believed to offer unique educational advantages, including allowing anyone, anywhere with a computer to follow the same course and providing amore personal learning experience [7].

Successful e-Learning requires understanding the diversity of the learners and their learner needs, paying attention to learner-centred design principles, and building an electronic environment that meets the learner needs. The diversity of the learner population can be expressed in terms of the following characteristics [14] [15]:

- ethnicity, gender, religion, disability;
- language, culture, communities;
- prior domain knowledge, pre-determined learning style, and individual approach to learning;
- personal motivation, and expectations; and
- social contexts of education, and learner's personal life style.

In order to address the learner diversity, e-Learning developers need to have sufficient understanding of the learner population and the way they learn and use learning technologies. There is a wealth of evidence in the literature that learning is an idiosyncratic process and that people preferentially perceive different types of information, tend to operate on perceived information in different ways and achieve understanding at different rates. The way students learn has been characterised by a variety of learning styles. For example, Felder and Silverman [6] define four dimensions of learning style: sensory/intuitive, visual/auditory, inductive/ deductive, and active/reflective, whereas Biggs [1] define three types of learning strategy: surface, deep and achieving. These describe the fundamental differences students have in their approaches and motivation for engaging in learning tasks.

A growing body of research also suggests that attention to learning styles and learner diversity has been shown to enhance students' academic achievement, as well as their attitude towards the course, interest and motivation [10] [13]. Dimitrova et al. [4] also found that in e-Learning there is a correlation between the learning behaviour of students and their learning performance.

A number of researchers have, therefore, advocated the need to adapt pedagogical styles to better accommodate the broad range of learning styles [5] [9]. To address the diversity of student learning styles e-Learning developers need to develop flexible learning environments that provide rich information represented in redundant formats, support to learning communities where participants complete assignments independently or in a group, and interact with tutors and other learners in real or asynchronous time.

In this paper, we first introduce the GC learners and the learning environment. After that we present the differences in the students' learning strategies and learning styles. The effectiveness of the learning environment in accommodating these styles is then

discussed, and finally ways for enhancing the flexibility of the e-Learning environment are proposed.

2. GC Project and the GC Learners

The Global Campus (GC) project at the School of Computing Science at Middlesex University, London, UK, has been delivering distance learning Masters programmes in Electronic Commerce and Business Information Technology to students in Asia and North Africa since May 1999. Over 1000 students in Hong-Kong, Shanghai, Singapore and Cairo have followed or are currently undertaking a GC distance learning course. The two programmes also run in classroom-based mode in London using the same electronic learning environment to complement lectures and seminar activities.

The students who follow the GC programmes come from different educational, ethnical, religious and cultural backgrounds. Their ages, motivations and expectations also vary. There are also differences between the distance and the classroom students. These were studied and Table 1 illustrates the gender and age attributes for both modes, showing their relative comparability.

Table 1. Comparison of gender and age attributes of distance and classroom learners

| Attribute	Distance mode (n=34)	Classroom mode (n=60)
Gender:		
Female	8 (24%)	24 (40%)
Male	26 (76%)	36 (60%)
Age:		
Mean	32	27
STD	5.74	3.96
Minimum	24	22
Maximum	45	38

3. GC e-Learning Environment

The GC project uses a combination of electronic learning materials. The resources include CD-ROM and web-based versions of the taught course material in a virtual learning environment (WebCT), online assessment and monitoring of the student progress, and synchronous and asynchronous communication tools (e.g. bulletin boards, virtual chat rooms and whiteboards).

The pedagogical framework of the GC courses includes a modular structure, where the content of each module is divided into learning *units*, which are individual sections of learning material. Each unit represents a pedagogically complete lesson that can be completed in about nine hours. This is roughly the equivalent of the time students would be expected to devote if they were to accomplish the same tasks in the classroom-based mode of study.

Each unit is divided into five components according to Hoffman & Ritchie's [8] *I CARE* instructional model. These components are: *Introduction, Connect, Apply, Reflect* and *Extend*. A departure from the original I CARE model is that the 'Connect' component was changed to 'Content', as it was assumed that 'Content' would have a more obvious meaning for students [17], as shown in Figure 1.

Students are encouraged to work through the learning units sequentially, however, they are free to browse the components of each unit in an order that suits their learning needs.
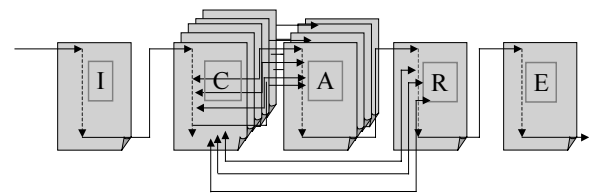
Figure 1. GC pedagogical structure

4. Flexible Use of the GC Learning Materials

The learning strategies and learning behaviour styles of both distance and classroom students were examined using an online questionnaire. The questionnaire contained the following two main sections:

- *Learning strategy*: a condensed version of Biggs' Student Process Questionnaire (Biggs [1]) was used to establish whether students tend to adopt a deep, surface or achieving strategy to their studies in general. These strategies describe the fundamental differences students have in their approaches and motivation for engaging in learning tasks. Surface strategy students are those requiring verbatim recall with little personal engagement, and concentrate only on what is required for assessment. Deep strategy students aim to attain personal meaning and reconstruction of knowledge by critical interaction with knowledge content and relating ideas to their previous knowledge. Finally, achieving strategy students can adopt either deep or surface approaches that are most suitable to attaining the highest grades.
- *Learning behaviour*: an examination of the students' preferred medium of study, the amount of time and effort spent on each I CARE component, the frequency of browsing of specific sections, participation in group discussions and use of online communication tools.

The results showed that the distance students exhibited one of four distinct learning styles: *the Traditional Learner, the Achieving, the Interactive Learner, and the Struggler* [4]; whereas the classroom students adopted one of five learning styles: *the Ideal Learner, the Struggler, the Reflector, the Shallow Learner and the Social Learner*. Although there are some similarities between these types of learning, they seemed to have used the learning resources differently, and are therefore considered separately to preserve these differences. Each learning styles is briefly described below:

- *The Ideal Learner:* covered the majority of all I CARE components, and actively participated in group discussions during seminars;
- *The Traditional Learner:* focused their effort on reading the materials given in the 'Content' component and covered more than half of the materials suggested in the 'Extend' component;
- *The Achiever:* focused their effort on performing the quizzes provided at the end of each unit and on the review questions in the 'Reflect' component;
- *The Reflector:* covered almost all of the 'Content' and 'Reflect' components and read considerable proportion of the recommended book chapters;
- *The Interactive Learner:* focused their effort on interacting with peers and tutors and formed the highest number of friendships;
- *The Social Learner:* actively participated in group discussions, read most of the 'Content' sections and performed many of the 'Apply' exercises.

- *The Shallow Learner:* covered almost all of the 'Introduction' and the 'Content' materials but did very few of the quizzes and the 'Apply' activities, and rarely participated in group discussions;
- *The Struggler:* studied less frequently than all other students, and spent on average the least amount of time studying each component.

All these types of learner require different kinds of learning resources and different types of learning support to suit their individual needs. Table 2 shows on average what proportion of each component of the e-Learning environment each type of student covered, illustrating their preferences.

As can be seen from Table 2, the learners used the materials in different ways to suit their varying learning styles and learning strategy. For example, the majority of the Deep strategy students favoured the Apply and Reflect activities in the learning environment, which helped them to connect what they have learned to practice and also to reflect on new knowledge and skills. These students seemed to have spent less effort on performing the quizzes which contain past exam questions. The Achieving strategy students on the contrary, completed the highest proportion of the online quizzes in an attempt to maximise their exam marks. Finally, the Surface strategy students spent much less effort on all learning tasks than the other students. Some of these students spent most of their time reading the learning content and the recommended book chapters.

Table 2. Proportion of each learning resource used by each type of student

Learning Style	Resource Learning Strategy	Content	Apply	Reflect	Extend	Quizzes	WebCT bulletin board	WebCT email	Private email
Ideal Learner	Achieving	80%	80%	70%	70%	60%	38%	33%	57%
Traditional Learner	Deep	75%	40%	40%	55%	30%	25%	25%	88%
Achiever	Achieving/ Mixed	34%	50%	77%	26%	83%	33%	0%	100%
Reflector	Deep	65%	60%	75%	35%	45%	16%	32%	68%
Interactive Learner	Deep	35%	45%	47%	21%	33%	14%	14%	100%
Social Learner	Mixed	70%	65%	50%	40%	40%	27%	18%	55%
Shallow Learner	Surface	50%	40%	40%	25%	25%	0%	14%	57%
Struggler	Surface/	28%	28%	26%	26%	21%	38%	16%	50%

While studying, the learners could communicate with their peers and tutors either face-to-face during their weekly seminar sessions or online in chat-rooms, via bulletin boards and email. The results indicated that most students preferred to communicate either face-to-face or using their personal emails. As can be seen from Table 2, the communication facilities incorporated in WebCT were not used actively by the students. Computer mediated collaborative learning is believed to promote critical thinking [3] as co-operative teams are found to achieve higher levels of thought and retained information for longer than students who worked quietly as individuals. Therefore, students need to be encouraged to actively engage in online discussions and more learning tasks need to be incorporated in the course materials to stimulate small group discussions. As the results indicated, two types of students, the Interactive Learner and the Social Learner, have a tendency to actively interact with their peers and tutors as part of their learning approach. These students will particularly benefit from more active collaborative learning tasks. Furthermore, all distance learners will also benefit from more active online discussions with peers, as currently they have limited opportunities for face-to-face interaction with other students during weekly tutorials.

From the studies, it also became clear that although some students seemed to have easily adapted to the learning environment, others did not. In particular, there were the Strugglers who persistently performed poorly in comparison to the other students, which had an adverse effect on their learning. One reason for the poor performance of these students might be that they could not easily adapt to the flexible open mode of learning in which the Masters courses are delivered. Perhaps these students were more accustomed to traditional approaches to teaching and needed further help in adapting to the novel learning environment.

5. Towards Building Flexible e-Learning Environments

Roberts [12] defines a 3 by 3 model of 'flexible learning', where on one side the author describes the flexibility in terms of the learning process, the administrative process and assessment process, and he juxtaposes them with the flexibility of learning in terms of location, time and method. Flexible learning, therefore, implies different modes of interaction between the teacher and the learner [11] choice of traversal paths through electronic learning materials, choice of medium in which the materials are represented (both part of the method of the learning process) as well as choice in place and time of learning.

The results from the studies presented in this paper have shown that the GC learning environment is used in a flexible way. The systematic structure of the e-Learning environment only provided students with guidance through the available materials. Despite the teacher recommendation the students did not always traverse the material in the recommended sequence and spent more time using certain learning resources depending on their learning styles and individual learning strategies.

In order to facilitate students with various learning styles in their learning, a number of improvements can be introduced to the e-Learning environment. Some of them include:

- Present learning materials in redundant formats so that students can choose the ones they feel would benefit their learning style most. This implies the use of static and dynamic visual media and audio to complement textual representations of course content.
- Provide students with a selection of learning tools and resources that develop different cognitive skills and allow them to select those that suit their learning strategy better. This can be achieved by developing an adaptive hypermedia interface, such as the one described by Carver et al. [2], that provides dynamic tailoring of the presentation of course materials on the basis of the student's individual learning style.
- Losen structure to provide more control on the part of the learner and kless on the part of the teacher to dictate the learning process. One common approach is to utilise 'learning objects' which can be classified by type (allied to one or more learning styles) and manipulated via well-defined Learner management systems [16]. This will enable students to exercise the preferences dictated by their own learning styles, the learning materials they have access to need to be structured so as to provide focus and also flexibility.

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- Promote the adoption of Deep strategy to learning. One way of achieving this is by developing learning activities which engage the learner in active processing of the subject matter content rather than mere knowledge acquisition.
- Develop learning tasks and online facilities that encourage meaningful online communication and collaboration between students as well as between tutors and students.

6. Conclusions

Because of the learner diversity of e-Learning applications, there can be no single model of learning that can ensure the design of e-Learning environments accommodates the learning needs of all students. This paper presented an examination of an educational e-Learning environment and its ability to accommodate the diversity of the learning styles of the students who use it. The investigation showed that the students use the learning environment in different ways and showed preferences to different learning resources depending on their individual learning styles and learning strategies. The current design of the learning environment does not effectively accommodate the variety of students' approaches to learning, and therefore some suggestions were made as to how to enhance its flexibility to meet the needs of the students.

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