PARTICIPATION RATES IN CS: ONE INTERNATIONAL ISSUE OR A MULTIPlicity OF NATIONAL ONES?

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ABSTRACT
The proportion of female students studying Computing related subjects at undergraduate-degree level is decreasing. This decline in the number of female applicants for Computer Science (CS) degree programs is undoubtedly worrying. In the early 1980s some 35% of applicants for CS degrees at UK Universities were women, but now the figure is closer to 10%; this statistic is not confined to one country. Some countries such as Ireland and India do buck the trend, but is there a commonality between the decreases seen in many countries?

As individuals, we undertake work based upon our own students, or students from our own country but rarely if ever seek international comparisons. If we are to work effectively together across nationalities we need to determine whether we are all suffering the same problem or different problems with the same symptom. This paper presents the results of an international comparison of student interviews.

Keywords
Gender, recruitment.

1. INTRODUCTION
The image of computer scientists and programmers is well known in the media: the brilliant but socially inept mumbler who could use a few tips on hairstyles and clothes. Claudia Morrell suggests that “girls in particular don’t want to be perceived as geeks and nerds” [1]. Increasing numbers of girls are using the internet and email for personal reasons, but still they are not interested in higher level education or careers in Computing. As a discipline we need to harness the best available talent, male or female, and encourage them to make the transition from using computers for personal reasons to considering Computing as a career.

In 2001, a UK investigation was undertaken into why Computing degree programs were attracting fewer and fewer female applicants [4, 5]. Many female students were interviewed, and an understanding of why we were attracting declining numbers of female applicants began to emerge: female students were choosing academic disciplines with a visibly social dimension and where female role models are more readily accessible.

Several years later, student numbers on Computing courses are much lower; the proportion of female students is starting to decline further and they are part of a much smaller cohort.

2. THE PROJECT
In order to determine whether our students perceive the same issues affecting their subject choice, and the importance they attach to them we have interviewed students from our own institutions. This represents six institutions from three different countries. It should be enough to further our understanding and provide guidance for further research in the area.

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2.1 Methodology
We applied a qualitative methodology to the study, undertaking semi-structured interviews with six pairs of first year students. The questions we asked were based upon an agreed list of themes for consistency and comparability. The students were interviewed in same-sex pairs; four female students and two male from each institution. The questions were based loosely around the following themes: why they chose their Computing course; what they were expecting it to be like; what it is actually like; did they know the gender ratio before arriving at university?; is it a problem / issue?;

The students’ responses were recorded and transcribed to provide direct quotations. This allows a comparison between students from different countries. Previous work has shown that it is profitable to pool information gleaned from students from different institutions [2, 3, 4, 6]. Respondent validation was essential in order to ensure that the data collected by the interviewers was accurate. We compared and contrasted their comments within the contexts of the different institutions and national educational systems.

3. WHO ARE WE?
Here we provide a brief introduction to the institutions involved to illustrate the contexts in which we use the student responses.

3.1 UK
There are three UK universities involved in this study: the Universities of Kent and Leeds (England), and the University of Ulster (Northern Ireland).

University of Kent – The University of Kent’s Canterbury campus was granted its charter in 1965, with other sites being more recent additions. The Canterbury campus supports student community of 10,000 undergraduate and postgraduate students from over 120 nationalities.

University of Leeds – The University of Leeds came into being in 1904 but its origins go back to the nineteenth century with the founding of the Leeds School of Medicine in 1831 and then the Yorkshire College of Science in 1874. It is the second largest university in the UK, with over 30,000 students from over 130 countries.

University of Ulster – Over 23,000 local, national and international students study at the four campuses: Coleraine, Jordanstown, Belfast, and Magee. The School of Computing and Mathematics is based at the Jordanstown campus, which was founded in 1972.

3.2 USA
The United States does not have a central authority exercising control over colleges and universities; instead each state is responsible for governing the institutions that reside within their borders. Most colleges and universities use the results of two privately developed admissions examinations – the SAT and ACT in their acceptance process.

There are two US universities involved in this study: Central Connecticut State University and the Rochester Institute of Technology.

Central Connecticut State University – CCSU was founded in 1849 and is the oldest and largest publicly supported institution of higher education in Connecticut, with more than 12,000 undergraduate and postgraduate students.

Rochester Institute of Technology – RIT was founded in 1829. It is a private university that enrols approximately 16,000 undergraduate and postgraduate students from over 90 countries.

3.3 Australia
The Australian university application system is similar to the UK’s, although each state has a different Admissions Centre. Bachelor degree courses are usually offered out of universities, other qualifications from TAFE (Technical and Further Education) Institutions, which may be aligned with a university or stand alone. The selection process is generally based on students’ VCE marks, called their ENTER score.

Swinburne University of Technology – Swinburne University was founded in 1992 although it has existed as an educational institution since 1908. Swinburne’s operations are conducted at six campuses across Melbourne, catering for approximately 10,000 undergraduate and postgraduate students.

4. STUDENTS’ RESPONSES
Students from five of the six institutions (CCSU, RIT, Kent, and Leeds, Ulster) were interviewed towards the end of the 2007/08 academic year. The Swinburne students were, however, interviewed over a two-year period, as part of a “Women in Computing” Research Project. Several papers have already been published related to this research [7, 8, 9, 10, 11, 12]; the interviews have been data-mined for responses.
4.1 Why Choose CS?
The students we interviewed were asked about their reasons for choosing a CS degree programme. Some mentioned favourable job prospects upon graduation:

- My father is a programmer and both he and my mom, who is a Music teacher, encouraged me to look into computer science and programming more in-depth, since I enjoyed it and it would be a well paying career. [US F]
- Computers are an area where I believe there will be work in the future, as well as many opportunities to work for myself and to travel. [UK M]

For others, their decision to pursue a CS degree was influenced by a strong role model:

- My biggest influence is my brother. He’s nine years older than me. He graduated from this university with a CS degree. [US M]
- My father is a programmer and encouraged me to pursue this field. [US F]
- I originally wanted to do psychology, but the A-level was boring. My boyfriend did Computing at the boys’ school and it seemed interesting. [UK F]

A number of students mentioned a significant exposure to Computing in their pre-university career, which had influenced their subject choice.

- I have been taking computer-related classes every year in high school since the 7th grade. [US M]
- The reason was that I had a job doing Web design and really liked it. [UK F]
- I became interested in computers in middle school and high school. [US F]

4.2 What Were You Expecting it to be Like?
Students were asked to think back to when they applied for and were about to start their degree programmes. We wanted to know what they were expecting when they walked into their first lectures and classes. Many weren’t entirely sure what to expect:

- I really had no idea whatsoever. [US M]
- I just wanted to do it, so I didn’t think too much about what it would be like. [UK F]
- I guess I just thought it would be the same for all subjects, with lectures and stuff, only the content would be different. [UK M]

Some students expected it to be interesting and mentally stimulating:

- Interesting and learning new things! [UK F]
- Covering a wide dynamic of the cutting edge I.T industry [UK F]

4.3 What is it Actually Like?
The majority of the students held a positive outlook towards their chosen degree programme. One female student commented that she liked the independence of university study, although another mentioned the high workload as being problematic.

- I thought it might be like the A-level, only harder. But there is actually even more stuff that I didn’t even know about before. [UK M]
- There are loads more topics than I thought there would be. I can’t wait to do the web module next year. [UK F]
- When I got here it wasn’t as horrible as everyone made it seem. [UK F]
- It has pretty much been what I expected. [US F]
- I didn’t know there would be so much work … it makes you think your brain is going to explode. [UK F]

4.4 Were You Aware of the Gender Ratio?
The students were asked for their thoughts on the gender ratio within the CS student body; most had expected it to be a male-dominated demographic. The students said that they were not surprised that there were very few women in CS programs:

- I had an idea because all of the high school classes that I took that were in CS there was one girl who was a friend of mine and like 20 or 30 guys. [US M]
• My expectations were that I would see a girl in a CS class every now and then. [US F]
• How would I know? I went to a girls’ school in another country. It could have been all female and I wouldn’t have known about it. [UK F]
• An area dominated by males. [Aus F]

4.5 Is the Gender Ratio a Problem / Issue?
Whilst talking to the students we decided to find out what they thought about the gender ratio and whether or not they perceived it as a problem. Responses relate to both local day-to-day issues and the broader picture.
Local Issues:
• I feel a bit under pressure in tutorials ... I think for me it’s more of being one of the few girls in a tutorial full of confident boys. [Aus F]
• I sometimes feel like the guys in the back row are getting annoyed because I’m holding things up and they can’t go and do complicated stuff, but then sometimes I’ll hear one of them say “that’s a good question” so I guess it’s just in my head. Well I hope it is. [UK F]
• We want more girls to join in. If we see a new girl in the lecture room we make sure we go and talk to her and encourage her to stay. [UK F]

Broader Picture:
• I just think it never comes up – as you are growing up, guys play with blocks and the girls play with dolls. And it continues – for most girls, I guess, it just never comes to their mind to [even consider] being a CS major. [US M]
• Speaking from the women I know of – computers are scary and I don’t know why. [US F]
• You see [women using computers] in the movies, you see it in the media – you see the men as the hacker, as the tech freak. You hardly see a woman doing it. When you see a woman doing it, it’s more of a sexual connotation rather than – OK, that’s normal, that a woman can fix a computer. [US F]

4.6 Do You Have Any Suggestions?
Many students, regardless of gender, said that role models are extremely important. They focused on two kinds of role models: family and friends; current celebrities, business and political figures.

None of the students mentioned any historical role models. The female students all agreed that there is a lack of contemporary female role models to help them picture themselves as being successful in Computing. All students, regardless of gender suggest that stereotypes play an extremely important role; they unfortunately generally portray people in Computing in an unattractive light.

5. DISCUSSION
This work revisits and expands a 2001 UK-only investigation [4, 5] to include the USA and Australia. The results show that little has changed during the intervening seven years. They also suggest that the students from all three countries share very similar opinions. Overall student numbers have fallen and on top of this the proportion of female students has also decreased marginally. The students that we do attract, however, are still happy to be with us. It appears that similar issues are seen in all three countries represented here.

There are a number of fundamental differences between the ways students apply to study at university in our different countries. The UK and Australia have a similar application system whereby students apply to a university to study a specific program. Should the student subsequently decide they want to change direction and chose a different program they have to jump through many hoops and in most cases start again from the beginning, which is not a simple process. In the US however, students can often apply to an institution without identifying a specific program they intend to study. During the first year they can chose to study a variety of subjects and only decide on a ‘major’ at the beginning of year two. In spite of these differences, all three countries suffer the same problems with student recruitment and more specifically with recruiting females to study CS.

A common thread is the influence of parents and peers. This can be seen throughout all countries and is therefore something we can state as not unique to one nationality. The students we interviewed cited a range of role models who had a direct influence on the study and career path they chose. Parents have a great deal of influence and parents holding degrees in a science subject are particularly open to Computing as a good career choice; we need to target the parents as well as the students. Parents better appreciate the benefits of a professional, well paid career rather than a fashionable degree based on a whim.
Friend and sibling role models are much more difficult for us to influence, since teenagers often follow others rather than formulate their own opinions. School pupils making a decision about the degree program to study at a university are subject to significant influence from their peers. One useful strategy to combat this situation may be to involve current university students studying CS in the recruitment process. A university student from a CS program may appear much more believable and produce a significantly more positive impact if they were to appear at a school recruiting event.

6. WHAT NEXT?

One aspect missing from the questioning was that of career choice upon graduating. Much discussion about attracting more students is based upon obtaining undergraduate students, not about attracting students to the discipline. Perhaps we need to think a little more broadly about attracting a greater diversity of students – not just female – and attracting them to the world of Computing rather than just to our degree programs. Nobody undertakes a degree in dentistry for the sake of it – the degree is a route to the career they want to pursue. We need to stop thinking of a Computing degree as an end in itself and consider the discipline as a whole. Questions need to be posed to academics and computing professionals such as “What is a degree in computing?” The responses would be as varied as the individuals, however the historical baggage is that computing = programming, just as medicine = doctor; the most pervasive and difficult perception to influence.

7. ACKNOWLEDGMENTS

Thanks are due to the students who agreed to be interviewed and participated in this project. We couldn’t have done it without you.

8. REFERENCES

PARTICIPATORY PATTERN IN ASYNCHRONOUS DISCUSSION FORUM: A CROSS-CULTURAL PERSPECTIVE

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ABSTRACT
In this paper, we demonstrate that students’ cultural issues influence participation and engagement in online asynchronous discussions. We argue that student participation can be enhanced if discussion topics are carefully constructed taking into consideration the culture and local experiences gained by students in their country of origin. In order to elicit how cultural issues impact participation, a number of focus groups were created to study the participatory patterns of students. The observations of the study suggest conceptualisation of cultural factor elicits a set of constructs which can assist in formulating a discussion topic.

Keywords
Asynchronous discussions, online teaching, participatory patterns, cross-cultural issues.

1. INTRODUCTION
Asynchronous discussion forums have been used as learning and teaching tool in Education from as far as 1980s [1]. In the online environment, asynchronous group discussions have proven to enhance learning experiences [1, 2, 3]. However, it has also been observed that the successful engagement of learners in asynchronous discussion depends on a number of different cognitive indicators, such as, collaborative knowledge building by spontaneous interaction, and the ability of critical analysis. Collaborative knowledge building and achieving a high level of critical analysis through online discussion not only depend on the students’ interest on the topic under discussion but also on factors that influence their pattern of participatory behaviour [4]. There is evidence that already certain investigative research has been carried out on various aspects of online asynchronous communication. For example in [5] the authors discuss various work carried out on participation, content, and structure of online conversations.

Despite the fact that research indicates many benefits of the effective use of discussion boards [6, 7] our experience shows that motivating students to participate still remains a challenge. One gap we have observed in the existing literature is the critical issue of arriving at the best structure for a given forum which will encourage participation. According to [8] participation in asynchronous discussion can be increased by increasing the level of motivation. This motivation is relative in nature and can be externally or internally driven. However, the authors do not indicate what these instigating factors are or provide any guidelines as to how we can arrive at them. This further substantiates the need for the study presented in this paper.

In [7], the Worcester Polytechnic Institute presents a set of guidelines which it considers to be good practice of how to improve the use of discussion boards. The website however, does not specify which is best for what purpose. So far we have not seen any literature which guides us through the quagmire of qualitative issues involved with using discussion forums to improve students’ learning experience.

In this paper, we argue that, the participatory behaviour of students is largely influenced by the practices in their own country of origin, their national culture and their educational background. Middlesex is a multicultural university. In the School of Engineering and Information Sciences, sometimes almost 90% of the students at the postgraduate level are from overseas. This brings a rich cultural diversity to the classroom where students bring their own experience and different perceptions on a given topic. As Hopperton [1] states, this culturally diverse resource is not only useful in educational information, but also in eliciting the diverse approaches of the students. It offers challenges to the tutors. Cultural diversity needs to be an asset rather than a hindrance.

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So, how do we overcome the cultural barriers? As Markel [3] points out, 'What role does culture play in individual participation and communication styles?'

Some research focus on the cultural issues in asynchronous discussion, for example, [9], but none has provided conclusive framework as to how cultural issues can be dealt with to enhance learning and teaching experience. Although, online learning is offered in many countries, and discussion forums are a common tool in almost every virtual learning environment (VLE), little research is carried out to demonstrate how cross-cultural issues can impact on the behaviour of participation in discussion forums. This paper will strive to ascertain the participatory pattern and online discussion behaviour of students from different cultures, and backgrounds in asynchronous discussions. The findings of this study will facilitate setting up discussion forums aimed to make the learning experience of all students richer irrespective of their cultures and backgrounds.

2. METHODOLOGY

In order to understand the determinants which enhance the participation of culturally diverse students, four focus groups (F1, F2, F3 and F4) were created. The purposes of these focus groups were to: i. monitor the behaviour in asynchronous discussion forum (F1 and F3); ii. receive continuous feedback from F1 on the design and implementation of the asynchronous discussion forum and to observe the participatory behaviour of F2 (See Table 1); and iii. observe participatory behaviour of the focus groups in a complete online teaching environment where classroom based teaching is not offered at all (F3 and F4). Table 1 shows the composition of the focus groups.

Table 1: The composition of the Focus groups

<table>
<thead>
<tr>
<th>No.</th>
<th>Participants</th>
<th>Countries</th>
<th>Participatory Programmes</th>
<th>Participatory Institute and Teaching Method applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>15 nos.</td>
<td>Indian: 6; Sri Lanka: 4; Kenya: 2; Ghana: 1; Nigeria: 1; Pakistan: 1</td>
<td>M.Sc. in Business Information Technology (BIT)</td>
<td>School of Engineering and Information Sciences, Middlesex University. Teaching Method: Blended Approach</td>
</tr>
<tr>
<td>F2</td>
<td>20 nos.</td>
<td>Cyprus: 6; Egypt: 14</td>
<td>MSc. In Business Information Technology (BIT)</td>
<td>Collaborative Partner Institute of Middlesex University, UK (i) University of Nicosia, 46, Makedonitissas Ave., P.O. Box 24005, 1700 Nicosia – Cyprus (ii) Regional IT Institute, 11-A Hassan Sabry St., Zamalek, Cairo, Egypt Teaching Method: Blended Approach</td>
</tr>
<tr>
<td>F3</td>
<td>9 nos.</td>
<td>UK: 1; Germany: 2; Switzerland: 1; Netherlands: 1; Timor Leste: 1; Japan: 1; Iceland: 1; Canada: 1</td>
<td>MSc. Information Technology (IT)</td>
<td>Liverpool University, in Partnership with Laureate Online Education. Teaching Method: Distance Learning and online teaching environment</td>
</tr>
<tr>
<td>F4</td>
<td>16 nos.</td>
<td>Ghana: 1; Saudi Arabia: 2; Luxembourg: 1; Netherland: 2; Switzerland: 1; Nigeria: 2; Greece: 1; UK: 2; Qatar: 1; Rwanda: 1; Japan: 1; Uganda: 1</td>
<td>MSc. Information Technology (IT)</td>
<td>Liverpool University, in Partnership with Laureate Online Education. Teaching Method: Distance Learning and online teaching environment</td>
</tr>
</tbody>
</table>

Further to interviewing and observing the focus groups, a questionnaire based survey was conducted among 180 culturally diverse students. The aim of the survey was to find out the preferences for online discussion forum structure and preferred stimuli for engaging in online participation.

2.1 Experiment Design

To explore the cross-cultural affect on the students’ participation we design a number of interlined activities which are described below.

A1: The aim was to explore the participatory patterns of the group. To understand the cross-cultural perspective, the focus of this activity was on a group of participants from the same cultural background, rather than the individuals. The duration of the activity was 4 weeks. The students received a topic of discussion
each week. The minimum requirement was to post an initial response to the discussion topic and at least one response to a peer. Participation to the discussion was made a part of the assessment criteria, although the participation itself was not evaluated. The aim was to observe the students participatory pattern when a minimum requirement is set for participation.

**A2:** Members of F1 were interviewed at the end of the participation period (four weeks) of A1. The focus of the interview was to find out the determinants of participation for different cross-cultural individuals. A questionnaire based survey was also carried out among 180 students to find out their preferences of participation to online discussion forum. The individual responses were then consolidated into cultural responses to understand a correlation between individual response and cultural preference.

**A3:** The online learning environment structure was revised based on the feedback from A2. The focus group F2 was asked to participate in online discussion using the new structure. The participation period was three weeks with two new discussion topics.

**A4:** The participation behaviour of F3 was observed. This focus group participated in the module where on ground class contacts were not required and only engaged in online discussion forum.

**A5:** Feedback from A2 and survey response from A3 were incorporated in the second run of the programme and applied to focus group F4.

3. **OBSERVATIONS AND CONCEPTUALISATION OF PARTICIPATION PATTERN**

We aim to demonstrate that determinants and stimuli influenced by cross cultural factors have better effects in online environments. In order to test the hypothesis we use our findings elicited from the five activities (A1-A5) described in Section 2.

Outcome of Activity 1 is presented in Table 2.

Table 2: Outcomes of Activity 1 (A1)

<table>
<thead>
<tr>
<th>Discussion topic type</th>
<th>Frequency of participation by nationality (at least in 50% cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week1: Open discussion</td>
<td>India, Sri Lanka, Pakistan, Kenya, Rwanda, Ghana, China: Initial response, response to peer ranging from 1-2 Egypt, Cyprus, Nigeria: Initial response, a multiple response to peer ranging from 3-5</td>
</tr>
<tr>
<td>Week2: Case study based problem and solution solicited</td>
<td>Pakistan, Rwanda, Kenya, China: Initial response, response to peer ranging from 1-2 India, Sri Lanka, Nigeria, Ghana, Egypt, Cyprus: Initial response, response to peer ranging from 3-5</td>
</tr>
<tr>
<td>Week3: Case study based problem and solution is provided for discussion</td>
<td>China, Rwanda: Initial response and response to peer ranging from 1-2 Pakistan, India, Sri Lanka, Kenya, Nigeria, Ghana, Egypt, Cyprus: Initial response and response to peer ranging from 3-5</td>
</tr>
<tr>
<td>Week4: Problem is given after the topic is introduced and discussed in the class. Solution is solicited.</td>
<td>China, Pakistan, Rwanda, India, Cyprus, Egypt, Sri Lanka, Nigeria, Ghana, Kenya: Initial response and response to peer ranging from 3-5.</td>
</tr>
</tbody>
</table>

**Observation (O1):** Experience and background of the participants create an impact on the participation and engagement pattern in online discussion forums.

The individual selection of the discussion topic reflects the background experience and knowledge which a student has gained in his/her country of origin. Although discussion board participation was mandatory, since it was declared that this component will not be assessed it is assumed that the participation is partially spontaneous. Frequency of participation and the contents further confirmed this assumption.

In Activity 2 (A2), during the interview when the students were asked to select a discussion topic they preferred to be posted in online discussion forum out of 10 different types, the following were observed: Indian students preferred a topic where they expect a business case will be provided for analysis; Sri Lankan students preferred a topic where that provided a real life business scenario in which they can apply their previous experience; and Chinese students preferred a topic that focused on a specific problem. The overseas students did not show an interest in the type of questions where they have to formulate and identify a solution for a research question, whereas this type of discussion topic was selected by the local matured
students who had working experience. Chinese students specifically did not prefer to join in an open discussion.

**Observation (O2):** The preference for discussion topic is not same but similar for a specific culture.

The feedback from F1, e.g. preferences for discussion topic selection, was incorporated in constructing discussion topics and it was observed that the participation by the Cyprus and Egypt students (F2) were increased several folds.

When the students were asked what they expected from a discussion forum, Indian students reported that they prefer solutions to their problems to be provided in the discussion forum and very similar expectations were exhibited by the Pakistani and Nigerian students. Cypriot students on the other hand showed that they were interested in sharing views and to reach to a common agreement.

It was also observed that socialisation played an important role in engaging students in the discussion forum. When the international students were asked to join in an online chat folder it was observed that the students increased the level of participation in discussion forum significantly.

**Observation (O3):** Expectation from discussion forum varies from culture to culture.

The cultural implications were also evident in focus groups 3 and 4 (F3 and F4). When the participation pattern of F3 and F4 were analysed where the students only participated in mono-mode online distance learning environment, it was observed that participation frequency varies ranging from 4 posts (average) to 6 posts (average) in a week (it was confirmed that there were no personal issue reported to their Programme Support Managers) respectively. It was observed that the international students tend to participate less in online discussion forum compare to the local students if on ground classes are available. This is because they believed the contributions became publicly available to the peers and it also may elicit their level of understanding on a concept.

**Observation (O4):** Local working environment and national competency influence significantly on engaging in online discussion.

Different types of discussion topic were selected for F4 to engage them in online discussion forum. It was observed that the discussion topics that matched with the international participants’ previous working experiences were selected mostly for further discussion in online forum. It was also observed that a large group of international students preferred the discussion topics which included the working environment setting of the students’ own country of origin, i.e. title, terms, activity flow for case study, and the local knowledge base, i.e. numeracy or literacy skill, for further discussion in online forum.

It was also evident from the survey that less familiarity to online learning environment, tools and their formats also affected students’ performance in online discussion participation.

Based on the observations a conceptualization of the cross-cultural factors which influence the participatory pattern is proposed in Figure 1.

**Figure 1:** Cultural factors to determine constructs for discussion.
4. CONCLUSION
This paper demonstrates that students’ participation pattern and their engagement in asynchronous discussion varies due to their preferences and enthusiasm on the discussion topic. It is evident from the study that these preferences are dominated mostly by their cultural background which includes social, individual, functional and expectation factors. Based on our observations we propose conceptualising these factors and attempt to derive a set of constructs which can assist in designing an engaging discussion topic. These constructs will enable the e-learning facilitators to enhance the engagement of the culturally diverse students in asynchronous discussion forum.

5. REFERENCES

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INVESTIGATING THE USE OF PODCASTS TO SUPPORT BASIC AND INTERMEDIARY SKILLS DEVELOPMENT, IN EXCEL, AT UNDERGRADUATE AND FOUNDATION LEVELS

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ABSTRACT
Audio or video podcasts can offer students different ways of learning and can add value by providing access to learning materials ‘on the move’. This paper presents an initial investigation into the use of excel podcasts for undergraduate and foundation level students in different faculties at a single university. The podcasts were shown in lecture and seminar settings and uploaded to an online server for all students to access in their own time; either via a web browser or portable video player such as an iPod.

Results for the on-going study were positive with the majority of students using them for developing their understanding of excel and exam revision. Students expressed an interest in having similar supplementary learning materials for other modules. Such conclusions drawn from this study highlight the need to investigate the use of podcasts further in the teaching and learning environment.

Keywords
Podcast, screencast, educational multimedia, iPod, mobile media player

1. INTRODUCTION
As part of the CETL AliC (Centre for Excellence in Teaching and Learning: Active Learning in Computing) initiative this paper discusses one of many projects being conducted across Leeds Metropolitan University within the area of technology enhanced learning. CETL ALiC is a collaborative HEFCE funded project between the universities of Durham, Leeds Metropolitan, Leeds and Newcastle [1].

In this paper we will discuss findings from an on-going investigation into the use of podcasts as supplementary learning materials to support students in their development. ‘Podcasts’ are digital audio or video files that can be played on a computer or downloaded to a portable player, such as an iPod [2]. Podcasts have the benefit of being continuously available and can be used flexibly by the learner, either via mobile or fixed technologies, which may enhance both learning and motivation [3].

Podcasts can be implemented as reusable learning objects to explain concepts to students. They have the advantage that the podcasts can be viewed repeatedly by students to aid understanding and for revision purposes [4]. They can also be beneficial for teaching staff as they can be reused for different student cohorts and for distance learning students. In addition, research [5] has demonstrated the potential that podcasts can offer to students for whom English is the second language.

2. BACKGROUND
In the academic year 2008/09, we introduced a series of podcasts to students studying on modules that covered Microsoft Excel skills as part of their course content. The modules were based in three different faculties at Leeds Metropolitan University at different levels of study.

Each module was a one semester taught module:
1. Module A: Foundation level, i.e. on a pre-university course (approximately 130 students)
2. Module B: Undergraduate Level 1, HND (approximately 180 students)
3. Module C: Undergraduate Level 1 BA (Hons) (approximately 470 students)

[780 total student numbers; not accounting for non-attenders]

Modules A and B were taught exclusively in computer labs, Module C was taught in computer labs and lecture theatres. The short video clips, or podcasts, were developed specifically for students with varying levels of Microsoft Excel experience from basic through to intermediary level. The podcasts were designed to support the learners in acquiring, developing and maintaining excel skills.

We produced a series of ten podcasts to explain basic elements of excel, such as naming sheets and inserting columns/rows, through to excel functions such as SUM and VLOOKUP - see Figure 1. The podcasts varied from one to six minutes in length to not exceed the attention span of the listener. Module A was designed as an introductory course to excel whereas Modules B and C covered more advanced functions. Hence a subset of podcasts was used for Module A with an additional podcast based on creating charts. All ten podcasts were used for Modules B and C.

2.1 Development and delivery of podcasts
The podcasts were produced using screen video capture software¹ which allowed the recording of on screen movements and voice over. This footage was then exported to an ‘editing studio’ in a chosen file format, such as MP4 or MOV, edited and then finally saved as video files. These short video tutorials were then made available via the university’s virtual learning environment (Blackboard Vista). The podcasts could be viewed directly through a web browser or downloaded to the computer’s hard drive. In addition, the files were uploaded to the university’s podcast server, which enabled students to subscribe to the podcasts via RSS feeds and RSS readers such as Apple iTunes. This meant that once a student had subscribed to the podcast series, new episodes of the podcasts would be automatically downloaded to the student’s computer via the iTunes software and could then be automatically transferred to their mobile multimedia player.

The podcasts were shown to the students in the lab sessions (Module A and B) and lectures (Module C), and the students were encouraged to view them again in their own time.

¹ We used Camtasia Studio (http://www.techsmith.com/camtasia.asp) but free open source software is also available, such as http://camstudio.org/
Members of staff teaching on the modules used the podcasts in different ways; some offered the podcasts as supplementary materials to be viewed in addition to the course material, whereas the majority of staff used them to demonstrate excel concepts within the class environment.

3. **DATA COLLECTION AND RESULTS**

Shortly after the students had completed the excel section of the module, they were encouraged to complete a short online survey (ten questions) or module evaluation survey to gather their views about the podcasts. Information was sought on issues such as how useful the students found the podcasts and whether they accessed the podcasts outside university. Ethical approval had already been confirmed via the university ethics committee.

Data was collected from Module A and Module C at similar points in the academic calendar. The data collected was analysed and as a result additional questions were added to the survey for Module B in order to collect richer data, such as in what ways they used the podcasts, i.e. as a reminder or for development of skills. Response rates to the surveys were as follows: Module A (53 out of 130 students) 41% return rate; Module B (66 out of 180 students) 37% return rate; Module C (86 out of 470 students) 18% return rate.

**3.1 MODULE A  (Foundation Level)**

From the results collected for Module A, 64% of the respondents stated that the podcasts were ‘useful’ or ‘very useful’. 56% of the respondents said that they would like to have similar podcasts in other modules.

Having been shown the podcasts in the classes 44.5% of the respondents went on to view them again in their own time either at home or on university campus. Figure 2 shows the number of times that the excel podcasts were viewed by the students on the module. The podcasts were accessed a total number of 159 times with ‘getting started’ viewed the most (58 times).

<table>
<thead>
<tr>
<th>Excel podcast episode</th>
<th>Visits</th>
<th>Length of podcast (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting started</td>
<td>58</td>
<td>01:36</td>
</tr>
<tr>
<td>AutoFill Insert Col</td>
<td>41</td>
<td>01:08</td>
</tr>
<tr>
<td>Creating charts</td>
<td>35</td>
<td>03:19</td>
</tr>
<tr>
<td>Dates Times</td>
<td>25</td>
<td>01:58</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>159</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2: Usage statistics for excel podcasts Module A**

**3.2 MODULE B (Undergraduate Level 1 HND)**

Responses to the evaluation for Module B showed that 79% thought the podcasts were ‘fairly’ or ‘very easy’ to view. However, outside of the lessons, only 1.5% viewed them on their iPod as stated in the questionnaire. 44% of the sample had viewed them again on their home PC, 15% of the sample had revisited them on a campus computer and 45.5% of the respondents had not viewed them again outside of the lesson.

With regard to how the podcasts were used, 74% found that they aided their understanding of the information better, and 26% used them if they happened to miss the lecture or tutorial. A high proportion of students, 83%, said that they would like to have similar podcasts for other modules.

The podcasts were accessed a total of 544 times by the students on Module B. Figure 3 shows a breakdown of the number of visits per episode, as well as the length of each podcast. It is worthy of note that the ‘Getting started’ podcast received the most number of hits (136).
### Excel podcast episode Visits Length of podcast (minutes)

<table>
<thead>
<tr>
<th>Episode</th>
<th>Visits</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting started</td>
<td>136</td>
<td>01:36</td>
</tr>
<tr>
<td>Updating Formula Results</td>
<td>70</td>
<td>01:24</td>
</tr>
<tr>
<td>Dates Times</td>
<td>62</td>
<td>01:58</td>
</tr>
<tr>
<td>Auto Fill with Cell References</td>
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<td>02:40</td>
</tr>
<tr>
<td>Auto Fill 4 Formulas</td>
<td>45</td>
<td>02:32</td>
</tr>
<tr>
<td>COUNT IF Function</td>
<td>44</td>
<td>01:51</td>
</tr>
<tr>
<td>VLOOKUP</td>
<td>43</td>
<td>05:28</td>
</tr>
<tr>
<td>IF Function</td>
<td>37</td>
<td>02:41</td>
</tr>
<tr>
<td>Creating Charts</td>
<td>29</td>
<td>03:19</td>
</tr>
<tr>
<td>SUM IF</td>
<td>25</td>
<td>01:59</td>
</tr>
<tr>
<td>AutoFill Insert Col</td>
<td>7</td>
<td>01:08</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>544</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3: Usage statistics for excel podcasts Module B**

### 3.3 MODULE C (Undergraduate Level 1 BA (Hons))

Of those students who responded to the evaluation for Module C, 23% made the extra effort to provide further written feedback stating that the excel component and how it was delivered was one of the elements of the module that they had enjoyed the most.

Usage statistics for Module C showed that the podcasts were accessed a total number of 871 times during the module, November 2008 to January 2009 - see Figure 4 for breakdown. In line with the other two modules (A and B), the ‘Getting started’ podcast was viewed the most times (198). Out of the total number of viewings, 673 hits (77%) occurred the week leading up to the module exam demonstrating the popularity of the podcasts for revision purposes. In addition the podcasts were viewed 15 times the week before the reassessment module exam which was sat by 20 students.

### Excel podcast episode Visits Length of podcast (minutes)

<table>
<thead>
<tr>
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<tr>
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<td>01:58</td>
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<tr>
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<td>Updating Formula Results</td>
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</tr>
<tr>
<td>Auto Fill 4 Formulas</td>
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<tr>
<td>AutoFill Insert Col</td>
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<td>01:08</td>
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<tr>
<td>IF Function</td>
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<td>02:41</td>
</tr>
<tr>
<td>VLOOKUP</td>
<td>59</td>
<td>05:28</td>
</tr>
<tr>
<td>SUM IF</td>
<td>58</td>
<td>01:59</td>
</tr>
<tr>
<td>Auto Fill with Cell References</td>
<td>54</td>
<td>02:40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>544</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4: Accessing excel podcasts for Module C (November 2008 - January 2009)**

Teaching staff from all three modules teams reported positively towards the podcasts as a teaching resource. In addition, they stated that their students commented that they liked watching the podcasts and found them useful and relevant.
4. CONCLUSION AND FURTHER RESEARCH

Results gained from our initial investigation were positive towards the use of podcasts for excel teaching. The students on the whole spoke favourably about the short video clips in the survey responses and in addition spoke with enthusiasm to the teaching staff on the modules.

A significant outcome for the research team was the demand for similar podcasts for other modules from each of the student cohorts surveyed. Additional use of the podcasts, outside of the classes, varied from revision to developing knowledge of the skills required. The podcasts for Module C were accessed the most in the week preceding the final module exam indicating their popularity for revision purposes. The usefulness of podcasts for exam preparation has also been found by other studies (see for example [5], [6]).

With regard to viewing the podcasts in their own time, only 1.5% of the students in one module (Module B) downloaded podcasts to a portable device. However as this was not explicitly mentioned by most staff teaching on the modules, this figure is not surprising. Other studies, such as [7] also found that podcasting does not equate to learning via mobile devices, even though podcasting technology supports the possibility of mobile learning. Further research on this will be undertaken.

Although we did not look specifically at the use of the podcasts by international students; Module A was delivered solely to international students and hence we can draw some positives from this resource for non-native English speakers. Research in other case studies at our university strengthens this finding in that podcasts were particularly perceived to be useful as they allowed re-listening to the learning materials and provided further support in learning the language [8].

With an emphasis on demand by the students for similar podcasts in other modules the need to investigate the use of podcasts further in the teaching and learning environment is warranted. We are currently in the process of producing more podcasts for additional modules in order to conduct further evaluation with a focus on potential benefits for international students. In addition we are planning to investigate student preferences with regard to accessing podcasts, such as via a web browser or mobile device.

5. REFERENCES


ABSTRACT
This paper aims to crystallize recent research performed at the University of Worcester to investigate the feasibility of using the commercial game engine ‘Unreal Tournament 2004’ (UT2004) to produce ‘Educational Immersive Environments’ (EIEs) suitable for education and training. Our research has been supported by the UK Higher Education Academy. We discuss both practical and theoretical aspects of EIEs. The practical aspects include the production of EIEs to support high school physics education, the education of architects, and the learning of literacy by primary school children. This research is based on the development of our novel instructional medium, ‘UnrealPowerPoint’. Our fundamental guiding principles are that, first, pedagogy must inform technology, and second, that both teachers and pupils should be empowered to produce educational materials. Our work is informed by current educational theories such as constructivism, experiential learning and socio-cultural approaches as well as elements of instructional design and game principles.

Keywords

1. INTRODUCTION
This century has witnessed the emergence of a digital culture of gaming [1], which has dramatically changed the way in which children play and learn. If learning is to be effective, then it should be congruent to this digital culture [2]. It has been suggested that most present day learners can be described as ‘engage me or enrage me’, who challenge the nature of contemporary education [3]. Such a view of education is seen as one factor contributing to the decline in interest in science and engineering studies. [4,5]. The use of computer games in education is believed to be an approach which will re-engage our learners and re-invigorate learning situations [6,7,8]. While initial research suggests that computer games can improve acquisition of cognitive abilities and learner understanding [9,10], this research is preliminary. There is currently little hard evidence that computer games actually work in education, and there is also a lack of understanding of how serious games should be designed and used to obtain effective learning. A first step to address these issues is to work with schools and teachers to produce demonstrator EIEs which are informed by educational theory and classroom practice. At Worcester we have developed materials for physics education in UK secondary schools, materials for UK primary school literacy teaching and materials suitable for the training of architects. These applications are extensions of a generic framework which has emerged from our work on ‘UnrealPowerPoint’ a new instructional medium which liberates the instructor from a sequential mode of instruction.

This paper is structured as follows: In Section 2 we discuss examples of EIEs based upon the UT2004 technology. Section 3 summarises a preliminary theoretical basis for our approach to design. Conclusions from our research and directions of future research and development are indicated in Section 4. We have been guided by many principles; perhaps the most important is encapsulated in our motto ‘from pedagogy to technology’. Here we suggest that the development of any new educational technology should be driven by pedagogy, educational theories, instructional and game design principles, but also by collaborating with teacher-practitioners in the development process. In the design phase of EIEs, these factors are mapped onto the affordances of the computer game technology.
2. Creating Educational Immersive Environments

A typical EIE aimed at physics education is depicted in Figure 1. This example captures several important elements. The learner, the girl, is immersed in a world where physics is faithfully reproduced. Other learners may enter this world on-line (equipped with headsets), and so collaborate in a learning activity. The EIE also contains ‘non-player characters’ (NPCs), the boys, whose behaviour is programmed to dynamically interact with the learner, to provide help, guidance or to engage in discourse, i.e., they are artificially intelligent.

2.1 UnrealPowerPoint: A new instructional medium

There are many ways to characterise learning, as a neurophysiological process, as a social activity or directed by the curriculum defined by government policy. Within this arena, cognitive science provides a middle ground, the theory of ‘knowledge structures’. This theory attempts to capture the way concepts known to the expert can be assimilated by the novice learner. Learning is a process of transformation from the sophisticated knowledge structures of the expert, into the developing structures of the learner. We employ ‘concept maps’, graphical devices proposed by Novak which display a hierarchy of concepts for a particular domain, linked by relationships between these concepts. A concept map distilled from the expert can define the EIE topology, specifying which rooms (concepts), are connected to other rooms by passageways (relationships). We have used this theory to devise the ‘UnrealPowerPoint’ presentational technology. Here, various concepts introduced as PowerPoint slides are embedded in a 3D world, each concept located in a different room or place within the world. As the learners walk through this world, they are effectively traversing the concept map of the expert. The medium is ‘nonlinear’, allowing the instructor to select a path through learning materials based on the real-time state of the students as they respond within the lecture theatre [11].

2.2 Physics Education

There is an emerging feeling within educationalists that physics education is in a state of crisis [12]. This is shown by a falling recruitment in A-level and University courses, and a shortage of specialist physics school teachers. This issue has been addressed by the Institute of Physics [13], and their recommendations have motivated our construction of EIEs intended to rejuvenate interest in physics as a domain of study, and also of scientific progression as a collaborative activity. Our proposal is that EIEs can provide a useful domain of physics education, supported by sound pedagogical principles and by the high-fidelity UT2004 physics engine component realizing a metaphor of true scientific enquiry. Our research has moved through several phases. First we constructed various qualitative experimental EIEs where students were able to make observations (e.g., of simple harmonic motion), to change parameters, and to reflect on the consequences. Measurements of ‘attitude’ indicate a positive impact of our approach [14]. Second we have conducted an in-depth numerical investigation into the fidelity of the UT2004 physics engine to reproduce virtual experimental results in accordance with physics theory [15]. These investigations have been positive, although there are some caveats. Third, as a result of this research, we have designed and developed educational resources suitable for senior high-school classes [16]. We have also identified several strategies for the deployment of physics instructional materials. These comprise (i) teacher-based, (ii) learning by enquiry, (iii) becoming a ‘scientist for a day’. In the latter strategy, pupils are taught how to construct EIEs and so are able to devise and investigate their own experiments.

2.3 Architecture Education

Through a study of architecture, and with the help of teaching architecture to second-year undergraduate games-development students, we have identified various concepts and principles of architecture and have mapped these onto the affordances of the UT2004 game engine. Unwin gives insight into architectural concepts [17], which can be taken together as a definition of architecture: (i) An intellectual structure. (ii) Places are defined by function. (iii) There exists a ‘language’ of place. (iv) ‘Place’ is continually re-defined by its inhabitants. (v) Inhabitants’ beliefs and desires must be taken on board. These concepts can be realized in an EIE, first, through appropriate topological design, points (i) to (iii). Also, through the use of ‘non-player characters’ (NPCs), points (iv) and (v). Coding NPCs to move within and between buildings is useful to architects, since it provides a realistic visualization of ‘circulation’ of people within the architectural space. Students working in a level-5 game development module at Worcester studied architecture over a period of 4 weeks and were then able to craft realistic EIEs. Figure 2 shows an example of circulation where NPCs have been coded to move around a series of paths, where their circulation is based upon individual interactions.

Through extensive consultation with teachers at a local primary school, which involved an initial demonstration of an EIE, it was decided to adopt the classroom approach of ‘VCOP’ (Vocabulary, Connectives, Openers and Punctuation) where each of these elements of literacy is highlighted and discussed. These four elements were complemented by the ‘Library’ and the ‘Big Writing Room’ which reflects a particular classroom activity which
takes place as a synoptic activity at the end of the week. The resulting topological structure is shown in Fig.3. This structure was realised as a ‘Roman Villa’ (Fig.4) which contained a high number of interactive elements. Details of this research are available in [18].

![Figure 1](image1.png)  
**Figure 1.** A typical IE used in physics education. The player (girl) is engaged in dialogue with the NPCs (boys) about a physics experiment, concerning the motion of objects in a gravitational field.

![Figure 2](image2.png)  
**Figure 2.** Example of circulation in architecture. The three boys have been programmed to move along set paths, but must deal collectively with any interactions.

### 2.4 Primary Literacy Education

![Diagram](image3.png)  
**Figure 3.** The topological structure of the Primary Literacy EIE showing central atrium, ‘VCOP’ rooms the Library and the ‘Big Writing’ room. The ‘Castle Map’ was an area devoted to

![Screenshot](image4.png)  
**Figure 4.** This screenshot shows part of the realization of the topology (Fig.3) using UT2004. It shows the central atrium and gives an indication of textures and objects in

This EIE was deployed in the local primary school and was evaluated through formal observations of 11 pairs of pupils. The main conclusions from these observations are (i) Pupils were highly engaged with this EIE and were motivated to use it in their free time. (ii) There was often a lack of efficient information flow where pupils did not read instructions or listen to instructions spoken by the NPCs. (iii) The separation of the ‘fun’ area, the ‘Castle’ map from the primary VCOP learning areas was not ideal. (iv) The EIE’s structure was configured by the teacher according to a specified lesson plan. This could perhaps be relaxed, allowing pupils to choose their own learning pathways. Nevertheless, the EIE remains in the school and is being further investigated as a learning resource.
3. Establishing a Theory of Educational IEs

The literature around ‘serious games’ has yet to come to terms with establishing a pedagogical theoretical basis for the design of EIEs. We have attempted to address this deficiency in our research. There are many issues thrown up by both contemporary thinking in education and also by the technological affordances of computer game engines. Our guiding principle of ‘from pedagogy to technology’ attempts to equilibrate these tensions. As discussed below, we have identified several fundamental issues: (i) The nature of learning, from a cognitive perspective. Here we mean both the acquisition of knowledge as a structure by the human mind, and also the dynamic process of learning. (ii) The nature of collaborative learning according to constructivist and socio-cultural theories. (iii) Adaptive learning, a neo-computer aided instruction paradigm. This can be contrasted with the computer game design principles. Designers tend to work intuitively and focus largely on ‘game play rules’ without consideration of effective learning.

The Spatial Metaphor. In our age of pervasive computing and the assertion of ‘computational thinking’ as a new epistemology, we cannot forgo our circumstantial culture [19]. One middle-ground is to draw on cognitive science, the discipline which attempts to establish a conversation between the machine and the human. Within this theory, the concept of ‘knowledge structures’ has been advanced to capture the nature of human knowledge representation and of thinking. Realized as ‘concept maps’ [20] such structures capture the understanding of both novice and expert, and suggest that learning involves a transformation from one to the other [21]. Our research into the use of EIEs invokes the spatial metaphor. We suggest that EIEs (rooms, textures and objects) should be constructed as a homeomorphism of the knowledge structure of the expert. The EIE rooms are identified with concepts; the communicating passageways are identified with interactions or relationships between concepts. As the learners move through the EIE rooms, they are effectively traversing the knowledge structures of the expert.

Learning Dynamics. Learning is a dynamic activity. It is a process, not a procedure. Piaget sees learning as a ‘middle ground’ between activity and thinking, a structured system in equilibrium. The ‘Experiential Learning Theory’ of Kolb [22] is also situated in this middle ground. We have instantiated Kolb’s four-stage cycle of concrete experience, reflective observation, abstract conceptualization and active experimentation as a ‘cluster’ of rooms within an EIE centered on a particular concept. Students entering a ‘Kolb cluster’ are presented with materials and activities to address each stage of the whole cycle.

Collaborative Learning. A multi-player EIE as realized by a game engine such as UT2004 is pregnant with technical opportunities for collaboration. Learners, equipped with headsets and microphones, may enter an EIE via their avatars and communicate with voice or text in the first order. Collaboration implies a common context, some problem or issue to be resolved, and a motivation to collaborate. But most fundamental is the channel of communication, and within this channel lies conversation, which can be factored as: (i) Narrative, (ii) Discourse, (iii) Dialogue, [23].

Adaptive Learning. There has been a renewed interest in learning environments that adapt to the state of the learner [24]. A good classification of adaptive methodologies has been proposed by Burgos and Specht [25]. We have constructed EIEs which are adaptive in their presentation of materials and activities to the learner. In one example, the EIE space is extended according to a run-time assessment of the learner, via tests or via monitoring their engagement with learning activities. This assessment is used to open up additional remedial or extension rooms.

4. Conclusions and Future Work

Our work has been disseminated in various contexts. UnrealPowerPoint has been used for three conference presentations and other informal events. The physics materials have been trialled, on a small scale, with local school children. The approach to architecture has been evaluated through discussion with a number of architecture bureaus. The primary school EIE has been evaluated through observations of pupil activity within a local Primary School. The next phase of our work involves a large scale scientific study of our EIEs which aims to evaluate the learning efficacy of our materials as well as the learners’ attitudes towards these. In addition, new areas of research have been identified. These include (i) the use of EIEs to provide art galleries or art installations, (ii) the design of EIEs for business simulations, (iii) the use of EIEs to explore the learning of music.
5. ACKNOWLEDGEMENTS
The author would like to thank students at the University of Worcester for contributing to this research. Special thanks go to June S. Moore for her work on developing the Primary Literacy EIE. Thanks are also due to the "Cherry Orchard" primary school (Worcester), the Headmaster (Mr. Harwood) and the key stakeholder (Mr. Miles) for supporting our research.

6. REFERENCES