Web 2.0 Support for Activity Led Learning in Computer Science

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Abstract— **Web 2.0 provides a number of technologies that democratise the development and use of computer applications. Many of the new applications are social. Prominent examples include Facebook, Wikipedia, Twitter and YouTube. In education we might draw upon the popularity of these new technologies amongst our learners to enhance their learning experience. In the Faculty of Engineering and Computing at Coventry University we are investigating an approach which we have termed Activity Led Learning (ALL) to promote better engagement and an enhanced experience amongst our learners. Group work is an important part of ALL where the focus is on students learning through self-directed investigation, discovery and doing, rather than through the traditional approach of listening to lectures followed by associated supported tutorials or laboratories. Web 2.0 technology provides important support mechanisms for our new approach as well as constituting and important skill development area for our Computing students. The Web 2.0 technologies that we have utilised so far include discussion forums, wikis, twitter and mash-ups.**

Index Terms: **activity-led learning; problem-based learning; VLE; Web 2.0; wiki; discussion forum; mash-up**

I. INTRODUCTION

For many years teaching at Coventry has been supported by a Virtual Learning Environment (VLE), initially WebCT, then Blackboard Vista and currently Moodle. Most universities in the UK now provide similar facility. A typical VLE provides a range of tools. As well as facilities to make material available to students, VLEs provide a discussion forum and email facilities. The VLEs which Coventry has adopted have allowed other tools to be integrated (such as file uploading facilities and access to the TurnItIn plagiarism detection application) providing a seamless interface for students. Whilst this suite of tools has been useful, and an institution-wide VLE will continue to provide a very important core facility, it can be limited or restrictive.

Students use various social networking applications (such as Facebook, flickr, YouTube, blogger) as a fundamental part of their lives. They see them as being simply 'normal' and part of life. They are the so-called Generation Y: those who have grown up with the internet. They inevitably compare their experience of using the institution's VLE with their internet experiences in their leisure life.

The desire to improve the students' experience has led to the use of Web 2.0 sites to support the teaching or learning functions. However the move to adopting these technologies has been encouraged by the Faculty's move to changing its teaching pedagogy: moving towards delivering student learning using Activity Led Learning (ALL).

Over recent years there has been an increased interest in engaging students more directly in their learning. Early innovations were delivered under the name of 'active learning' and were a response to recognising that students often learnt more if they were physically involved in their learning: practical activity to support material delivered in class. Such delivery mechanisms have been developed and have evolved, with a spectrum of different approaches emerging. There are many variant approaches, with names which are interpreted flexibly, including problem-based learning, enquiry-based learning and activity-led learning.

The approaches differ in a number of dimensions. The student activities and learning may be tightly controlled or may be open-ended; the students' role may range from being an autonomous learner to being more directed as a member of a project team; the tutor's role can be that of a task-setter and guide, through to active 'hands-on' facilitator; and the learning activity can range from being very prescriptive (finding a specific solution to a given problem) to students working towards achieving their own individual goals [1]. The role of the activity in the learning can vary from being supportive (practice) to being exploratory (application of theory) to being the core driver of the learning. Linked to that is the role and nature of tutor input. This can vary from a formal, pre-planned, tutor-delivered series of lectures (or similar) to ad hoc, on-demand input to informal advice and guidance only. In regimes termed as being 'led', such as 'activity-led', then the activity is usually the driving force and provides the motivational impetus for students' work and learning.

The introduction of ALL at Coventry is just leaving the pilot phase and moving on to a broader implementation. This paper thus describes ALL activities which are either part of the pilot or pre-existed the ALL project and also provides an exposition of collaborative technologies used to support ALL.

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II. ACTIVITY LED LEARNING (ALL) AT COVENTRY

The Faculty of Engineering and Computing at Coventry University has embarked on introducing some Activity Led Learning into all its courses. In line with very many UK universities, retention rates and student satisfaction of students in these disciplines are not as good as would be desired. The ALL initiative is designed to enhance the student experience and address these twin challenges. Following this initiative, Iqbal *et al* (2008) have considered how ALL might be applied in the Computer Science field [2].

To support staff in their work towards this pedagogical change, the Faculty developed their own definition of ALL, as follows:

"ALL is a pedagogic approach in which the activity is the focal point of the learning experience and the tutor acts as a facilitator. An activity is a problem, project, scenario, case study, research question or similar in a classroom, work-based, laboratory-based or other appropriate setting and for which a range of solutions or responses are appropriate. Activities may cross subject boundaries, as activities within professional practice often do. Activity Led Learning requires a self-directed inquiry or research-like process in which the individual learner, or team of learners, seek and apply relevant knowledge, skilful practices, understanding and resources (personal and physical) relevant to the activity domain to achieve appropriate learning outcome(s) or intention(s). To be appropriate, the learning outcomes or intentions must be consistent with the aims, outcomes and intentions of the programme of study with which the student is engaged." [3]

ALL embraces many of the principles of Problem-Based Learning. Like PBL, learning is driven by problems [1, 4, 5]. It also aims to enable graduates acquire vital employability skills such as problem-solving, team working, critical thinking and lifelong learning [6].

One of the key factors in improving retention is believed to be enhancing student engagement. By adopting ALL it is recognised that the roles of both staff and students will change. Students will need to become more in control of their learning activities. By basing their work around the requirements of a given activity students will need to decide what they need to find out about. By providing students with projects and tasks which they are likely to find interesting they ought to be motivated to doing the investigative and research work necessary to find out how to solve it. Wenger (1988) describes that if learners' participation is too limited then they do not engage in a deep way but that their engagement remains superficial, literal and procedural [7]. He builds on Vygotsky's social constructivist model of learning in which deep learning requires interaction with others, in order that ideas can be discussed and explored in order to be fully understood [8]. For this to happen, a developed learning community, a community of practice of learners needs to exist.

Whilst it is not inevitable, ALL is usually undertaken with groups of students. This provides each individual with a source of direct, continued support: they need to find solutions collectively not individually. Requiring students to work in this way encourages them to form social bonds. When ALL is being used in its pure form, lecturers have a role of supportive facilitator rather than the traditional role of 'expert'. It is expected that this pedagogy will lead to the development of a learning community: a community of practice in which staff and students all have roles in helping students solve tasks set.

III. TECHNOLOGICAL INITIATIVES

Group Project: Trade Fair

Second year computing students take a 'Professional Skills and Group Project' module: this is a common feature, part of many UK computing degrees. The main aim of the module is to develop students' professional skills: communication, inter-personal and project management skills. During the module students create a computer system but any technical skills which they develop are a side-benefit.

1) Pedagogical Approach

The main element of work in this module is the group project, in which students design and develop a system to suit to a given case study. The project is deliberately open-ended allowing a range of possible systems to be developed. The group project has a number of assessment elements but most particularly each group presents and 'sells' their system at a Trade Fair [9, 10]. This work requires groups to work autonomously: it requires students to apply their existing knowledge and extend it into new areas as and where they require for their system.

2) Technology used

The discussion forum provided within the institutional VLE is used in many modules. It permits communication within the module 'community' of students, lecturers and support staff. The VLE allows sub-groups students to be set up. Thus each group can be provided with their own forum, private from other students, which they can use for internal communication. It can be used for work sharing by attaching work to postings. Despite its restrictiveness, this facility has been usefully employed in several contexts, including the Group Project.

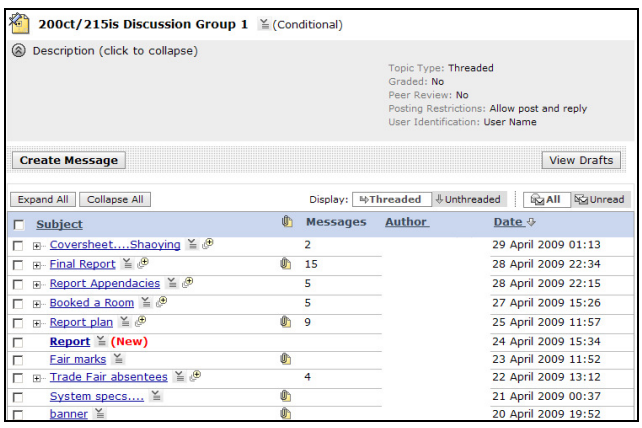

Figure 1. A sample of private discussion forum showing postings with attachments

3) Student Support

Students are provided with support through weekly supervisory meetings with module tutors. In addition they are asked for specific deliverables spread through the project period, for assessment. They must submit plans and requirements and later they must deliver a formal presentation of their design. The Trade Fair event provides students with copious feedback from their many and diverse visitors. The project completes with the delivery of their system and a full project report. The phasing of deliverables keeps up the momentum and provides feedback at each stage.

4) Assessment

A Group Project module almost inevitably requires students to be assessed as a group. However, as has already been mentioned, it is an important element of fairness that students' marks reflect their personal contributions. In this module this is achieved by adjusting most parts of the group mark, based on a number of factors. This adjustment uses, amongst other factors, a weighting factor proposed by their peers.

5) Student Feedback

Almost all students enjoy the Group Project module and the Trade Fair. Many comment favourably about the experience and the learning which it has led to. They refer to the creativity and the novelty, but more importantly, to the development of teamwork, leadership and communication skills.

"I like the idea of working as a group. I feel this is going to be essential in later life and is good to be a part of a team. I like that we are given time in the tutorials to work on our coursework, and I also enjoyed the trade fair. I felt it was enjoyable to see everybody's ideas and to see each other dressed smartly etc."

6) Evaluation

The Group Project module has been run for very many years: since about 1993 the output has been demonstrated at a Trade Fair. This is effective in promoting the students' ideas and achievements. It also provides a sense of occasion and an event which involves the entire department. Students in all years of their course are encouraged to attend: it fosters a sense of community. Most work students are given in other modules is quite prescribed. For them to be given some flexibility to be creative and imaginative is a valuable experience. Some students find this unnerving; some are enlivened by it; but almost all come around to enjoy the creativity of the event.

Finding a topic to use each year is not easy though. The topic needs to have enough scope for a range of solutions but it also needs to interest the students and be authentic, realistic and achievable. These qualities are important for all student work to encourage a constructivist approach to learning [11] but particularly important for work of such an extended duration.

Group Project: Sustainability content

The Group Project module also delivers material on legal, ethical and sustainability issues. An understanding of ethics is assessed by asking students to apply both the BCS (British Computer Society) and a fictional Code of Conduct to a case study scenario: to perform an ethical analysis. The BCS requires that students are introduced to environmental issues and globalisation. These are presented as under the umbrella of sustainability.

1) Pedagogical Approach

Sustainability issues are introduced to students in a lecture: this is designed to show students the scope of the topic. Students are then given an assessment which asks them to provide sustainability advice to a fictional organisation, to assist with the 'greening' of their IT. This requires them to do some research, develop ideas and gather relevant information on behalf of the organisation [12].

2) Technology used

The University's VLE is employed for much sharing of materials within the department's modules. Also, there are a number of web servers and shared drives which are sometimes more appropriate or convenient. But for some tasks these facilities are not very supportive. A facility which allows students to collaborate remotely can be useful: sometimes it helps if it permits synchronous editing, or almost so. For the sustainability assessment students are introduced to wiki technology.

There has been some adoption of wikis in universities but they have only recently started to be used for teaching purposes [11, 13, 14]. Parker & Chao (2007) provide a review of such applications [11]. Mostly they have been used for writing assignments, group projects, collective research and distance learning support [11, 14, 15]. Some authors note that wikis are useful in writing activities, encouraging reflection and review [11, 16].

Wiki technology was used in part for students' convenience and in part to motivate students to the topic, allowing students to investigate the topic amongst themselves and present their findings. Although the institution's VLE does provide a wiki facility each individual site must be set up for the student groups. In the timescale available, this is impractical. A free, public wiki farm has been used instead, on which students can create their own private group wiki. Each student group thus has to create a wiki which provides the sustainability advice and supporting evidence for the assessment.

3) Student Support

The wiki itself provided students with a support mechanism. Its accessibility allowed the group with a ready route for internal communication.

4) Assessment

Assessment was conducted online, reviewing the wiki sites each group created. Students were asked to submit little more than their sites' URL. The wiki allows permissions to be set so that only permitted users can read or edit a particular site. This allowed staff to access work online, without there being any risk of other groups accessing (and copying), another group's work. For assessment purposes particularly, it was useful to be able to track the work of individual students, as provided by many wikis.

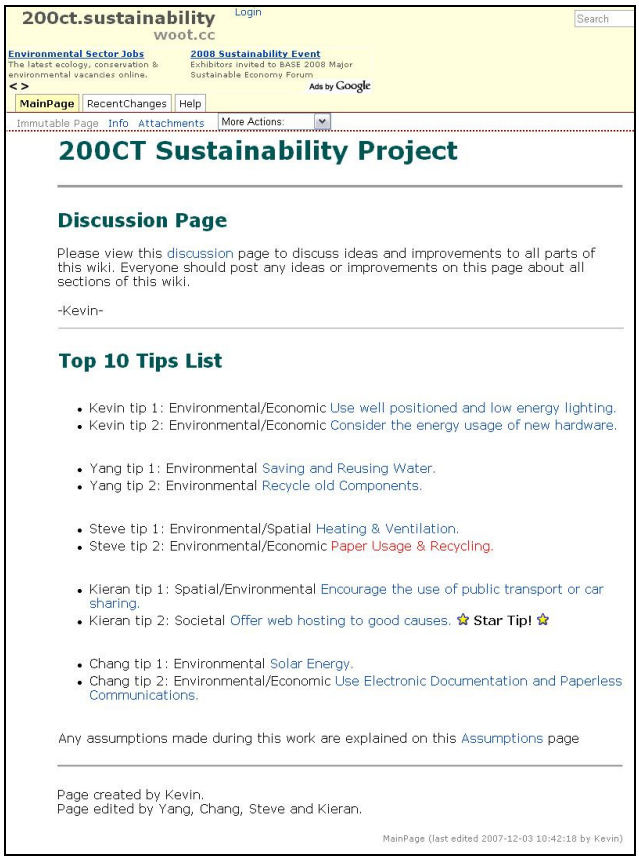

Figure 2. A sample student wiki submission

5) Student Feedback

As anticipated, students welcomed using the opportunity to use a wiki, as providing a valuable experience in its own right.

"Good idea for us to learn about wikis and experience creating one. Good to understand how they work"; "Was useful to learn about wikis, as I now know they are useful tools for group work and I have [subsequently] used one for other university group projects. ... So this was a useful experience."

Students appreciate the convenience of being able to work on different parts of the wiki simultaneously, yet remotely. Importantly of course, students also report that the arrangement helped them learn about the topic of sustainability [17, 18].

"Students can insert their writing without [meeting] face to face"; "We were able to use the time we had effectively"; "Learnt more about the concepts that link the environment and computing world."

6) Evaluation

Using a wiki proved to be very useful for collaborative development of a text-based artefact. The particular wiki used with the first cohort (2007/8) proved to be unreliable but the one adopted in the following year was more robust. Using a wiki not only permitted convenient collaboration but also encouraged the debate which fosters a learning community or community of practice [1, 4, 10, 20].

Network Planning and Management

The aim of this module is to introduce students to all the activities that have to be performed to create a successful network plan as well as providing a sound coverage of techniques and tools of network management. This module is delivered using a 'two strand approach' i.e. the two overlapping threads, one based on lectures and the second one based on ALL [4].

After setting the context and providing coverage of the issues and constraints involved in computer communications through lecture based delivery, the students then learn how to recognize the business needs of the customer and how to balance the parameters of the network against those and the resources available. Various aspects of network structure, planning, architecture and equipment are introduced. Students learn how to use this knowledge to produce an optimal network plan and how to successfully document such systems while engaging the user in the process.

Finally aspects of network management are covered. Problems of security, network failure and its impact as well as network management equipment, software and protocols are discussed.

1) Pedagogical Approach

In this module, we adopt ALL. Through this approach students not only gain a set of technical skills but also business knowledge and practice some of their soft skills on real life situations. Instead of a set of lectures where students are passively presented knowledge, the knowledge is developed by them during the process of solving case studies. Case studies and their deliverables are designed in such a way to make sure that all the outcomes of the modules are achieved through the case study. Such an approach is proven to increase the engagement level of students increasing the level of retention. Furthermore, because of the fact that the knowledge gained during the case studies is not limited by the choice of the tutor in selecting material for lectures and lecturing time, the amount of knowledge the students gain is significant. This approach has the additional advantage of stimulating students' critical and analytical thinking skills as well as study and group work skills.

The process is not simple though and students are not being left without help and control. To enhance their efficiency and guide them in the process, the concept of cycle is introduced. The cycle applied to the 5 case studies (topic areas) involves the following steps:

The case studies along with lectures and lecturers' direction guide students through the content of the module. The following steps are involved: an introductory lecture, an assessment briefing, group based research and discussion phase, support sessions with online resources and a final assessed seminar or discussion session. Moreover, the last case study allows individual students to be assessed through online interaction. The following five case studies meet the intended learning outcomes of the module. Details of these case studies are omitted due to space limitations.

a) Case Study 1

Requirements Analysis and success criteria: The goal of students is to create a plan that in a real life situation would help them to understand the technical and non technical requirements of their customer. Secondly based on the discussion with simulated players (customers, customer employees) they create a requirements specification supporting them in the further work.

b) Case Study 2

Analysis of existing networks and security: In real life situations the existing networks can dramatically simplify the redesign process. Thanks to the information gathered from the existing networks potential problems of the network can be predicted and avoided in the new design. The observation of the existing network also helps to understand the need of the customer better. As a deliverable, students are asked to design a plan of approaching the existing network and highlight the tools and procedures that will help them analyse the existing network. Finally students are asked to create a flow analysis of the network that will help them to understand the design requirements in the later stage of the project.

c) Case Study 3

Logical structure of the network and planning: At this stage the students' goal is to create a logical diagram of the new network supporting the design decisions with customer requirements and flow analysis done in the previous part. They present the logical layout plan but also the addressing and naming conventions as well as the means to introduce redundancy and elements of guaranteed service into the network.

d) Case Study 4

Physical structure of the network and implementation: At this stage based on the logical plans done in the previous case study students are supposed to choose the equipment and create the implementation plan that would not only minimise the budget but also offer scalability proportional to the customer requirements.

e) Case Study 5

Network Management: At this stage students are asked to propose the manageability plan covering the procedures and tools that will be used by future managers of the network.

2) Technology used

For the delivery of the Network Planning and Management module, we use the University's virtual learning environment (VLE). The VLE provides a range of tools as well as facilities to make material available to students. It provides a discussion forum and email facilities. The lecture slides, handouts, assignments are available on the VLE for students to download.

A "Twitter" account (see Fig. 3) is embedded with the University's virtual learning environment and updated regularly with news events, blogs, discussion items to promote and stimulate debate; it also enabled the "following" of other Twitter users particularly with the "real" Networking community enabling access to resources external to Academia.

For the Network Planning and Management module, students are given five case studies, as discussed above, simulating the real life scenarios. For the first four case studies students were supposed to have co-located discussion which is also informally monitored and facilitated by a tutor while for the fifth case study students were asked to use a private discussion forum to provide the solution to the problem. Each and every member was encouraged to contribute to their assigned private discussion forum. The contribution was assessed quantitatively as well as qualitatively. The public discussion forum was used by all students to discuss general issues which were not directly related to the case study. We used the VLE discussion forum as well as a Google discussion forum. Sometimes, it was noticed that the university VLE was not working due to several reasons; because of this, students were encouraged to use the Google discussion forum. The discussion forums were monitored by a tutor. An example of a discussion forum which took place on the VLE is shown in Figure 4.

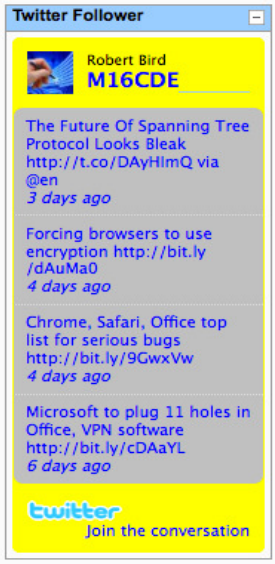

Figure 3. Twitter embedded in the VLE

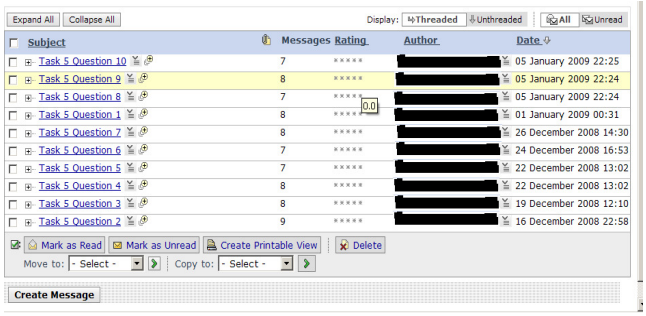

Figure 4. A sample of private discussion forum showing the number of tasks posted by the group leader for further discussion.

Figure 4 illustrates an example of discussion that was part of the case study 5. The case study 5 consists of 10 sub tasks which were given and explained to the students. Students were asked to discuss the given task one by one,

opening a new question only when the previous one is closed. A group leader was responsible for management of the tasks, so posting and making sure that they are closed. A question was considered as closed when a summary post was placed on the discussion forum and all the participants approve the summary post. The summary post became a base for the group mark whereas the discussion itself was used to mark the individual contribution. The group summary requirement was introduced mainly to encourage cooperation between the students and to encourage discussion rather than a long monologue.

3) Student Support

a) Developing learning communities

Through the ALL approach in the Network Planning and Management module, students are encouraged to investigate the case study problem, in groups of 4-6 thoroughly and thus gain the subject knowledge about the domain as well as develop their soft skills such as management and communication skills. Their ongoing progress indicates the level of knowledge and competence they are gaining.

The problem-solving students investigate relevant resources and critically evaluate them. Each student spends about 40 hours on each task. The simulated environment encourages the students to work and practice in order to increase their knowledge and improve their problem-solving skills.

The problem-solving students and teachers become a community of learners; they share ideas and discuss different aspects of the problem. They communicate synchronously as well as asynchronously using different collaborative tools including discussion forum.

b) Group formation

Group formation is an essential component of ALL. Failure in creating balanced groups will lead to problems in cooperation and decrease the quality of the provided solutions. Therefore for the Network Planning and Management module we have created the groups based on the initial survey handed to the students on the first meeting. The survey has given us enough knowledge about the academic background of the students and the networking experience they have.

The students were divided into groups of four or five each. These groups did not change throughout the semester. Students were briefed about the roles and rules of the method used. Groups were provided with private discussion forums on university's VLE where they could communicate, store work, record decisions and arrange meetings. Google discussion forums are also used for this purpose. Students were encouraged to work cooperatively in their groups to discuss and 'solve' the case study.

c) Feedback given to students

Throughout the module the amount and nature of feedback given to the students changes along with the role that the staff play in the project. At the beginning of each case study the member of staff plays the role of lecturer who provides background knowledge to the students introducing new concepts and pointing out valuable resources and thus building domain knowledge. Following the introduction of the problem to the students, the role of the member of staff changes to the business oriented client. Students are given very high level overview of the problem as well as the deliverables of the project. As students progress through the case study they discover missing information which is being delivered to them through the discussion. At this stage the member of staff plays a role of technical customer, resolving any doubts students might have concerning the existing customer infrastructure or technical requirements. Once they establish this knowledge the role of the member of staff changes to the facilitator (or project management) keeping the students on track. Finally the role changes to business focused customer who evaluates the quality of the submitted documentation and pays for a solution.

At the end of every case study there was a session devoted to providing extensive feedback to the students. During the session a member staff simulated multiple roles (such as client, member of management staff or technical advisor) as described above, talked to every group separately discussed the work produced to date pointing out its technological and business weaknesses, better solutions, compromises and technological choices.

Informal feedback is given throughout the semester on each and every case study. Informal feedback is not only given in the sessions but also sometimes through emails, chatting and the discussion forum and quite frequently informal chatting on the corridors of the university.

4) Assessment

The Network Planning and Management module places an emphasis on team working skills. Therefore every student group elects a team leader who is responsible for managing the group work documentation. The rules of group work are described in the introductory lecture and a document containing such rules and procedures is given to students for their reference. This document also covers rules of peer assessment and mark allocation and grievance procedures.

The Network Planning and Management module is developed to be assessed based on groupwork. However, in order to ensure that all students equally contribute to the solution and most importantly they develop enough technical as well as soft skill, we assess the students based on their group solution as well as their individual contribution offered to group. Each of 5 case studies attracts 20% of the final mark. For each case study, 10% of the mark is given for the case study report. Group marks are adjusted based on peer assessment. For each case study 5% of the mark is given for the critical assessment of the presented work. The critical assessment describes flaws and limitations of the chosen approach. Also alternative approaches are also included in this section. For each case study 5% of the final mark is given for presentation or discussion. In order to get 5% mark each group member must contribute to the presentation proving his engagement to the case study. The group marks were linearly peer assessed basing on

the marks all participants gave to each other evaluating their contribution.

5) Student Feedback

Figure 5 shows the results obtained as part of module evaluation. More than 80% students evaluated positively the Activity-Led Learning approach and the way it was implemented. Importantly, they highly appreciated the feedback given on each case study which helped them to improve the next case study. They commented:

"it brought together individuals of different levels of network knowledge and experience", "gain more knowledge from different people", "excellent approach", "detailed feedback on each section of the case [study] shows your strengths and weaknesses and helps to improve further" [students].

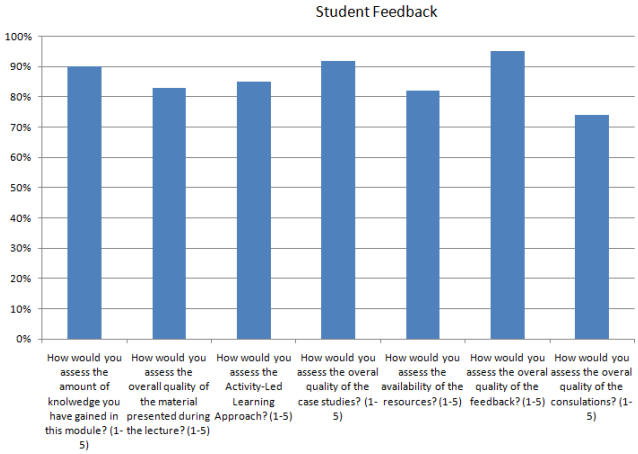

Figure 5. Student Feedback

6) Evaluation

One of the main difficulties we have faced with the discussion forum was that some of the students, for various reasons, were denied access to the VLE discussion forum including other resources. Immediate actions were taken to help students to use the virtual environment and an alternative discussion forum technology e.g., "Google Groups" was used for two groups whose members had issues with accessing the system. The second problem was related to group work as few students mentioned that they should have a freedom to choose their own groups. The third problem was related to the lack of background knowledge of some of the group members. This issue was addressed by increasing the amount of consultations to help the weaker students to compete in the group.

Distributed Applications Development Module

Many of our final year students take a module called "Distributed Applications Development". It builds on a year two module entitled "Internet Technology". The aim of this module is to provide students with the theoretical and practical knowledge to design and produce computer applications which consist of an assembly of distributed objects collaborating via the World Wide Web. It covers the process of developing applications based on Web Services and delivering functionality using appropriate software technology. The module makes extensive use of case studies and practical programming examples.

1) Pedagogical Approach

The teaching pattern is usually as follows. At the start the students are given a general two week introduction to Distributed Applications Development followed by around six weeks of lectures and laboratories on the practical aspects of Visual Studio .NET development. Next there is around eight week of Web Services tuition in the form of lectures and laboratories. As well as fundamental concepts and philosophy of Web Services, the typical technologies of XML, XSLT, XPath, SOAP, UDDI and BPEL are covered in this period. The final five weeks or so is spent looking at SOA in the large, including consideration of large scale composition, orchestration, and enterprise systems development. Thus in this module, in terms of application development, we move from the lower level, through the middle level to the higher level.

For the practical development part of the module, we have adopted a mash-up approach. Mash-up in web development refers to the development of composite web applications by integrating, mixing and matching other individual publicly available web applications, services or functions. The integration is achieved through the use of APIs. An example of a well-known mash-up is CoolFlick. The CoolFlick site [21] says "Cooliris one of the best ways to flip through photos, enabling you to scroll through hundreds of photos effortlessly. Flickr is one of the best sites to search for photos. Combine the two and you've got CoolFlick, a service that lays Cooliris' thumbnail scrolling on top of Flickr - all from within the browser window…….".

The teaching methods in this module include lectures and laboratories. We have not at this stage on this module gone fully to ALL but we are moving in that direction. Certainly not everything the students need to know to complete the assignment is given in the lectures. Investigative skills have to be used. The assignment is fairly openly specified and requires a certain amount of creativity, design and technical skills. The assignment is a combined group and individual project which involves the integration of various web services into a composite application, or in other words a mash-up. However the students on this module are not just mashing-up, if we define mash-up as only using ready-made services. First the students make the services and then they get mixed and matched by other students to create composite applications. Ready-made services available elsewhere and not created by the student body may also be used to create the composite application. One can consider the assignment as comprising of three parts. In the first part groups meet to decide a general application area and the types of service each individual should develop. In the second part, each individual develops their own web service which typically involves raw programming. For the third part of the assignment the students work in groups again to create a composite application. The groups are formed at the outset so that the individual students have some frame to work to for developing the

individual services. Groups have a completely free choice on the application to develop. This forces creativity. Some students said that thinking up the application was the hardest part. Having made the application decision, each individual student will need to design and develop a suitable individual service for it. Once the individual services are developed, the groups come together again to integrate the individual parts. This final stage sometimes proves difficult. After the formal submission of the work, each group is required to demonstrate the integrative application and explain the development approach, including an account of the individual developments. During this demonstration the students are given feedback from the assessors. As well as technical skills we feel we are also developing good transferable skills on this module, including team working skills, investigative skills and communication skills. Figure 6 shows an overview picture of a composite application developed by one group, in this case a Winter Ski Resort application. Here one student developed the car rental service, another the ski rental service, another the tourist information service and the final one the room booking service. All these services also may use of an externally available ready-made calendar service. Figure 7 shows a sample screenshot from the same application demonstrating integration of a student-grown (room booking)and an externally available ready-made service (calendar)

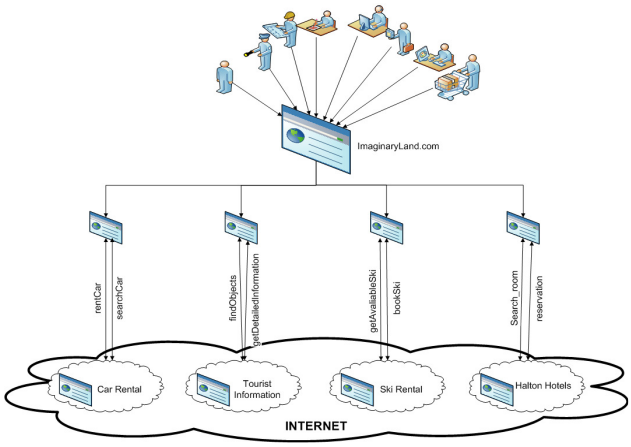

Figure 6. Example Mash-up Application Design

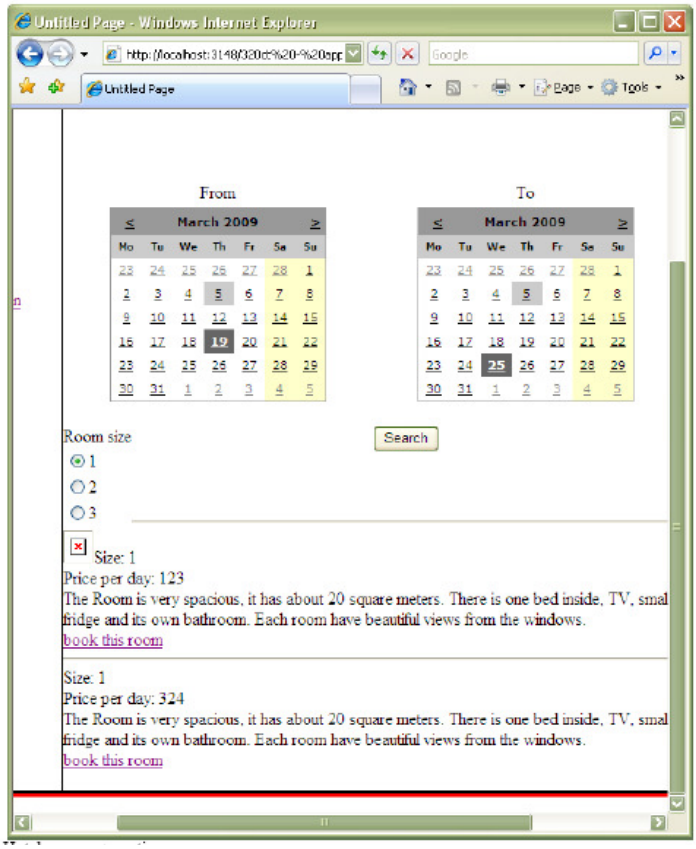

Figure 7. Example Screenshot showing Service Integration in Mash-up Development

2) Technology used

Visual Studio.NET is taught in the module and is then usually used as a development platform for the web services but this is not essential. The essential aspect is that a web service is developed that can be utilised by students in the second part of the project to create a composite web application. Students may make the individual web services using any technology they wish. Most choose Visual Studio.NET as they have received lecture and laboratory support in that. Some choose a Java environment but in that case they need to do more self-directed work to discover the ins and outs of the required coding methods. All the students have learnt Java in previous years but not in the context of Web Services development. This year one group chose Python for the development.

As a supportive technology for the group element of the coursework, the University's VLE is used which provides a discussion forum and allows discussion sub-groups to be set up. This makes communication easier within groups. Most students did not make use of this support mechanism preferring to communicate face-to-face mostly. However some found it very useful.

3) Student Support

The students are supported in laboratories on a weekly basis by laboratory assistants. Some laboratories are classified as "activity" laboratories where students are given a specific activity to carry out based on the module

syllabus and usually but not always based on the lecture given that week. The other laboratories are classified as "surgery" laboratories. Here the students engage in self directed work associated to the module such as finding out about technologies and getting on with the assignment. Students may make appointments to see the lecturers to discuss their progress on their assignment as necessary. The lecturers communicate frequently with the laboratory assistants to advise them about laboratory content and to receive information about student progress in the practical aspect of the module. There is only one formal submission of the work. After the formal submission of the work, each group is required to demonstrate the composite application and explain the development approach including an account of the individual developments. The demonstrations are viewed twice, firstly by the laboratory assistants and secondly by the tutors . This gives the students chance to practice their demonstration and discussion once before demonstrating to the tutors who do the formal assessment. Feedback is given to the students at the demonstrations.

4) Assessment

The assessment is by examination (50%); in class test (20%) and assignment (30%). The assignment includes a written submission and a demonstration. The written submission contains individual components and group components. The group mark may be adjusted to an individual mark for each individual according to effort and contribution made. Any adjustment is determined by the module leader who takes into account the views of all group members through a peer assessment submission.

5) Student Feedback

The students seemed to appreciate the module and, on the whole, the approach. Some good things that they mentioned about the module were the technologies learnt and the subject matter, for example comments included , "*technologies learned*", *"I learnt about web services"*, *"interesting subject", "advanced topic",* "*using .NET and ASP.NET"* and "*making own web service*". An area where the students felt there was room for improvement was in the area of frequency and content of laboratories, for example *"Labs, there should be tutorials and tasks to do on labs"* and *"more labs"*. These comments are probably a reflection on the ALL direction we took. Although the module was not entirely ALL, it was not possible to cover every topic the students needed know to complete the assignment formally in the lectures or activity laboratory. A certain amount of self directed investigation was necessary. It is argued that this type of approach provides a good foundation for future careers where graduates will have to be self reliant. Another improvement suggested was "smaller coursework". In fact, whilst the students found the coursework interesting and rewarding, some did find it too large and rather demanding. Some typical general comments on the coursework are below. We notice that most commented on the group relationship and the advantage it gives favourably. However the theme of more direction being desired by the students comes through in most comments. This is an area we will need to consider carefully in future , especially in the context of the move to ALL.

"We all worked well and effectively as a group, which allowed us to over come many of the problems that we faced."; "Overall I feel that we should have had a few more lessons on how to use the program, which would have made it easier for when we came to do the coursework."; "Good communication and team work throughout the team, and a lot of effort put in to the overall project."; "I felt we had good communication skills and completed the task successfully overall. This assignment has helped me understand how to develop web services and applications and for them to connect together to make a successful assignment"; "The task was quite hard to understand. But working together as a group we figured it out. "

6) Evaluation

Overall the tutors feel that the subject taught and approach used in this module is most valuable. Web 2.0 technologies have enhanced the capability of the students to build quite professional applications in a relatively short space of time. As well as building the required skills and knowledge, this characteristic also develops student confidence, group skills and appreciation and gives a strong sense of satisfaction. The collaborative aspect develops not only the technical skills but also the transferable skills of investigation, team working and communication. The tutors were impressed with the standard of application developed.

In future years it is planned to consider more fluid or different group formations and patterns. At present we form the groups first. Students are allowed to choose their own groups. The groups think of a general application area. The individuals develop the individual services. Then the group reforms to develop the composite application. Another approach might be to just allow the students to develop individual services, perhaps with the frame of a few topic areas. At this stage individuals would need not give a thought to groups. Then the individuals can advertise their services in some way to the others. Afterwards students form groups to develop composite applications around available services including both the student developed ones and others just generally available on the web. Another approach might be to set the groups up first and specify precisely a service for each group to develop. At the moment the individuals choose the service themselves. After the development of the service, individuals can be given the task to integrate some or all of the services into a composite application together with additional services provided externally. We can see that there are a number of variations on a theme within this general approach.

IV. CONCLUSION

The piloting of ALL in the Faculty of Engineering and Computing has introduced a number of initiatives and changes in teaching approach. In general these have been designed to improve students' engagement in their own learning. Some of these have exploited novel technologies to provide students with an effective

communication or collaboration channel. Some of these have used Web 2.0 techniques or applications to produce an artefact which is submitted for assessment. These initiatives have been well received by students. Students recognise these technologies as being current but, more importantly, they provide supportive, flexible facilities which are valuable to students' learning. Many questions remain, however, about the status of integrating Web 2.0 tools in an institutional context – the tools are outside of institutional control, particularly in the domains of privacy, data protection and technical availability. There are difficult issues regarding advertising on public tools that are at odds with the 'non-commercial' environment in UK institutions. Perhaps most difficult to surmount is the issue of professionalism, the persona of the tutor, and professional practice within a highly informal public space. These are challenges that we as educators face when embracing the new social technology that is proving so attractive to our learners.

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