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Introducing location-based services into information technology curriculum: reflections on practice

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Abstract

This paper describes how Location-Based Services (LBS) was introduced into the Information Technology curriculum at the University of Wollongong in 2004. The inquiry is based on two academic reflections on practice. The results indicate that students found the course experience both intellectually challenging and rewarding. Academics linked to the project found the topic aligned well to their research interests and stimulated new ideas for grant applications. And industry representatives found the experience advantageous, a vehicle for collaboration, and subsequently a way to give something back to their local community. In summary the dynamic exchange of knowledge between staff, students, and industry was very successful.

1. Introduction

In the Spring semester of 2004, undergraduate and postgraduate students at the University of Wollongong were given the opportunity to enroll in a special topic under the subject code IACT 422/922 "Case Studies in Information Technology". The author had just completed writing several papers on Location-Based Services, when the opportunity to teach IACT 422/922 arose [1-6]. After some consideration, she decided to use Location-Based Services as the technology theme running throughout the subject, mainly because she believed students would benefit from studying an emerging service. Having previously worked for a telecommunications company, Nortel Networks (on the University campus), that had created a niche for itself in Mobile Location Centre (MLC) technology, she quickly contacted her old colleagues and ran them by a few of her ideas. The author sent a draft subject outline to her former employers for vetting and another to team teacher Holly Tootell (who received the 2004 Vice Chancellor's Award for Outstanding Contribution to Teaching and Learning) [7]. Some senior colleagues made a few suggestions, but for the greater part the curriculum was set. After the course content was approved by the Head of School of IT & Computer Science (SITACS), it was full steam ahead.

Nortel Networks was keen to get involved, after all their very presence on campus was to encourage the exchange between academia and industry. Of the thirteen scheduled lectures planned for the session, Nortel employees in specialist areas of LBS delivered four. Many thanks must go to Senior Managers David Evans and Martin Dawson, and senior engineers James Winterbottom and Peter Nicholson. It was quite an experience for the students to be listening to some of the global technical experts in LBS. All of the speakers had spent time abroad, had been working in telecommunications for over 15 years, had experience in working parties, and were submitting papers to a variety of industry and government bodies including the Internet Engineering Task Force (IETF).

2. LBS Course Components

The lecture schedule can be found in Table 1.

Table 1 IACT 422/922 Lecture Schedule

1.	The Wireless Internet r(E)volution
2.	The LBS Value Chain (Stakeholder Identification)
3.	Business Strategy and Market Segmentation
4.	LBS Applications: Consumer, Business, Other
5.	Three Positioning Technology Case Studies
6.	LBS for Homeland Defense Security
7.	Portals and Geographic Information Systems
8.	Pervasive End-User Devices
9.	Mobile Networking and Location Architecture
10.	Standards and Protocols
11.	Mobile Network Security
12.	The Business Case for LBS
13.	Social and Ethical Implications of LBS

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2.1 LBS Background, Value Chain & Market

The course was deliberately designed to follow a pre-sales/technical orientation. It began with a discussion on technology evolution, the coming together of the Internet and mobile solutions. It was important to give students an insight into how what we now know as "location services" came to fruition. LBS is unlike any other end-to-end telecommunication service, its value chain is detailed and highly complex, and there are many different players involved in the successful delivery of a given application. LBS relies on numerous stakeholder interactions, including mobile network providers, software/application developers, content providers, portals and end-user device manufacturers. The LBS market segmentation was also discussed and newer adopter categories were defined.

2.2 LBS Applications

A long list of LBS applications were presented using a variety of classifications- push/pull, consumer/business/government, emergency services, and other niche areas. The students were challenged by the plethora of applications that was presented before them. LBS was opening a whole new suite of capabilities in the sector that could lead to a considerable number of efficiencies in varied contexts. Students began to think about how LBS worked, what technologies were relevant, and the limitations and accuracy of location identification. Students were then given the opportunity to concentrate on three exploratory case studies: AT&T Wireless (mMode), WherifyWireless (Personal Locator), and Applied Digital Solutions (VeriChip). From the 2G location solution offered by AT&T Wireless allowing one to find the nearest restaurant, to the GPS-based WherifyWireless solution that allows the user to generate a precise breadcrumb of their son or daughter on a web-based map, to the VeriChip RFID implant for emergency services. By this stage students were particularly astounded by the invasiveness and accuracy of positioning technology available today and were beginning to ask questions like, "can you switch this technology on and off." For a number of students it was the first time they had had an opportunity to learn about the global positioning satellite (GPS) system. Following the three LBS cases was a vertical case linked to homeland defense. A series of recent terrorist events was presented to students using popular media. The students were subsequently asked to consider how LBS could be used to prevent or respond to breaches in national security.

2.3 LBS Devices, Networks & Security

Given the course had no pre-requisite subjects, though assumed knowledge of basic telecommunications and information technology systems, it took some students until midway through semester to grasp exactly where LBS fit. It was at this point, that students were confronted with detailed technology issues. Bit by bit, each part of the "newish" and "evolving" LBS architecture was introduced to them. Some of the less technical students felt overcome with the number of logical diagrams presented by our guest lecturers, others thrived on each element in the network. It was important here to convey to students that the primary aim of the technical exposure was to help them learn about the major elements of a mobile location centre (MLC), not to mesmerize them with configuration-level details. It was more about exposure to industry practices. The second half of semester explored different technology aspects of the LBS value chain; from portals to the importance of geographic information systems (GIS), to mobile networking and security. The difficulty for the guest speakers was to strip-away the *specialised* technical language and number of acronyms that had become engrained in their vocabulary. Many students took copious notes during the guest lectures, even though presentation material was available for download.

2.4 The Business Case for LBS & Implications

Finally it was time to consider whether LBS was commercially viable and how much people were willing to pay for services. It was at this point that some students developed awareness that new applications were more than just making the technology work, they were about making money too. And if there was no money to be made in a given business, then one might as well abandon the idea altogether (at least until the market was more mature). In the lecture we considered the various types of billing models that could be introduced; but beyond the standard revenue questions we also considered the capital expenditure costs and operational expenditure costs. Again, students were challenged… what were we doing talking financials in an IT course? But this got many of them brainstorming, already considering how they would complete their degrees and specialize in the development of LBS solutions. The final lecture in the course was spent discussing the social and ethical implications of LBS. Students were presented with a variety of scenarios in the areas of privacy, legal concerns, regulatory issues, and health. The majority of

the discussion focused on the implications of RFID transponder implants for humancentric applications. A small minority said they would not mind being implanted, but the majority felt it was an invasion of their basic human rights.

3. Assessment Tasks

Assessment and subject content particularly in the Informatics domain needs to reflect changing technologies and world views to be relevant to today's students and their diverse backgrounds [8].There were three major assessment tasks in this course: a report, a presentation, and a proof of concept (POC) designed to help students apply the knowledge they had gained in lectures and tutorials. The assessment tasks were designed in a holistic manner to give students an opportunity to enhance their all-round business and technology skills. Beyond the subject content on LBS it was important students gained confidence in formal report writing, learnt to communicate effectively with an audience, and felt comfortable working within a small project group where they had to set and meet their own deliverables.

3.1 LBS Company Value Chain Report

You are required to write a report on a company that is a stakeholder in the Location-Based Services value chain. The report is meant to inform an audience about the value that the company has in the LBS market and where it fits in the LBS value chain.

The LBS value chain report was more challenging to students than we had anticipated (table 2). Many of them found the idea of a "value chain" difficult to grasp and had to go back to consult basic IT strategy texts. Others found the position of their company case in a given LBS area to be unclear. So are they a content provider or content aggregator, and what is the difference? Students were also given the option of choosing their own company case and some of them did so, settling for what they considered to be an "easier" report. Others performed exceedingly in identifying where there company fit on the LBS value chain but found that they needed to conduct some primary research or rely on lots of little bits of scarce secondary research. Overall we found that this assessment task really made students think a great deal; it was not a straightforward assignment, the answer could not be found in a dusty textbook in the library or by a single Google search. In fact, there were few texts with chapters on LBS, let alone a whole volume on the topic [9-10].

Table 2 Select Stakeholders in the LBS Value Chain

LBS Company	URL
_@road	www.atroad.com/main.html
12snap	www.12snap.com
Accutracking	www.accutracking.com
AIM Global	www.aimglobal.org
AT&T Wireless	www.attwireless.com
Cambridge Positioning Systems	www.cursor-system.com/cps/default.asp
Carcom	www.carcom.com.au
Cell-Loc	www.cell-loc.com
CellPoint	www.cellpoint.com
Championchip	www.championchip.com
Child Locate	www.childlocate.co.uk
Cingular	www.cingular.com
CNN	www.cnn.com
Destron Technologies	www.destronfearing.com
ESRI	www.esri.com/industries/locationservices
EveryPath	www.everypath.com
FleetBoss	www.fleetboss.com
GPS Industries Inc	www.inforetech.com
Ianywhere	www.ianywhere.com
International Standards Organisation	www.iso.org
Internet Engineering Task Force	www.ietf.org
Java Location Services	www.jlocationservices.com
Kyocera Wireless	www.kyocera-wireless.com
Mobile Devices	www.mobile-devices.com
Mobile Tracking Systems	www.mobiletrackingsystems.com
Network Car	www.networkcar.com/networkcar/pub/main
Nokia	www.nokia.com
Nortel Networks	www.nortelnetworks.com
NTT Docomo	www.nttdocomo.net
Olivetti	www.olivetti.com
OpenWave	www.openwave.com
Orange	www.orange.co.uk
Qualcomm	www.qualcomm.com/qis/qpoint.html
Recognition Systems	www.handreader.com
Reuters	www.reuters.com
Sensormatic	www.sensormatic.com
Sky Eye	www.sky-eye.com
SnapTrack (QALCOMM)	www.snaptrack.com
StarMax	www.starmax.ca
Tagmaster	www.tagmaster.com
Texas Instruments	www.ti.com/tiris/default.htm
Trace a Mobile	www.traceamobile.com/demo.php
Track Your Truck	www.trackyourtruck.com
Track-point	www.track-point.com
TrackWell	www.trackwell.com
True Position	www.trueposition.com
VeriChip	www.4verichip.com
Vindigo	www.vindigo.com
Webraska	www.webraska.com
WhereNet	www.wherenet.com
Wherify Wireless	www.wherify.com
Xybernaut	www.xybernaut.com

3.2 LBS Company Sales Presentation

You are required to give a professional seminar presentation on a Location-Based Services company stakeholder. The purpose of the presentation is to persuade your audience to purchase the services/ product offerings (whatever these may be) of the company you have been allocated. You are selling the value of the services/ products, thus you must ensure that your audience understands what these are at a sufficient level of detail. One of the key components of this assessment is to be able to describe the services/ products at the right level of detail within the allotted time.

The individual LBS value chain presentation assessment gave students the opportunity to listen to company cases and gain exposure to the many different reports that had been written earlier on in the semester. These presentations took up a segment of each tutorial and were meant to enhance the communication skills of students. Whereas the report had the main purpose to "inform" the reader, the presentation on the LBS value chain was meant to "persuade" the audience. Some students found switching between the "informative" and "persuasive" style difficult, while others performed exceedingly in the persuasive style of delivery as it required oral skills instead of written language skills. For students for whom English is a second language the activity was challenging but rewarding, as they successfully completed their seminars and received personalized tutor feedback.

3.3 LBS Proof of Concept (POC A+B)

You are required to write a Proof of Concept (PoC) for a NEW LBS application in the area of homeland defense security OR any other area of your choice. The PoC will be completed in two phases. Part A will record the conception of ideas. Part B will demonstrate these ideas in a 'mock' scenario. You are NOT required to build, develop or implement anything. A POC is what is used to refine a design before more resources are dedicated to making it happen in actuality.

The POC assessment was a highlight. Students were placed into groups of two (postgraduate level) or four (undergraduate level), and asked to conceive of a completely new LBS application in consultation with their tutors. This set students off on a mission. "I've got a new idea" one would say; and after tutor consultation were left back at the drawing board. This assignment was challenging, really challenging- students were being asked to "invent". Students conducted in-depth reviews of literature, searched for hours on the Internet conducting competitive intelligence, even downloaded theses and papers on the topic. In all, the tutors and I were amazed at the level of commitment shown by almost all the groups. Each week groups were allowed to meet during scheduled tutorials to discuss the progress of their project and to communicate their findings with their tutor. They would receive timely critical commentary. They were also able to meet with the lecturer during consultation times to discuss the novelty of their idea. A representative list of projects conceived by students can be found in Table 3.

Students were given the opportunity to complete their POC in two parts. Part A was the preliminary submission upon which students were marked and then given feedback for improvement and direction. Most groups had to update their POC-A before submitting both POC-A and POC-B together at the end of the semester. There was a big emphasis on the presentation style of the final document, as well as the clarity of the business language used. We were impressed by the outcomes of this final assessment. Many of the projects would have made for suitable brochureware in industry. In fact, some of the groups even submitted their POC in reply to government tenders on homeland defense. I ran a feedback session after the examination period was over (during student holidays), and over 30 of the 150 students turned up to a tutorial that had nothing to do with their final grades. They did not want the course to be over… some were even inspired onward to doing postgraduate research.

Table 3 POC Assessment- Example Projects

1.	Automatic Machine Locator System
2.	B-Navigation
3.	Bio Track
4.	BorderPatrol
5.	CarParkFinder
6.	Emergency Service Integrated System
7.	ExpIt+
8.	eXtreme Combat Uniform System (XCUS)
9.	GPS Traffic Eye
10.	i-Trade
11.	IamHere™
12.	iCar
13.	Integrated Risk Assessment Guide (IRAG)
14.	Intelligent Furniture
15.	Loc-8
16.	Medical Emergency Locator (MEL)
17.	MediCare
18.	National Security
19.	Scubatrack
20.	SeeNav
21.	Senior Citizen Health Care System
22.	Smart Safeguard- LBS for Worker's Safety
23.	Smart Wristwatch
24.	Sports Match Guide System
25.	TrueCaddie

4. The Results of Student Learning

The University of Wollongong is committed to providing continued and independent learning, intellectual development, critical analysis and creativity [11]. As we strive toward the goal of helping students acquire highly developed graduate attributes the assessment tools and strategies that define or measure the extent of these learning outcomes need to be

evident [12]. Formative assessment was used to provide valuable feedback to enable students to progress and learn through experience as was exemplified by the Proof of Concept task [13]. For most students this was an opportunity to see the importance of the work they had created and ways to improve. Formative assessment also allowed students to reflect on their work in positive ways. The more feedback they received the more effort they wanted to put into refining their work. The success of this method is evidenced below.

4.1 Discussion Forum on WebCT

One measure of the success of IACT 422/922 was the number of discussion messages posted by students and staff on the subject's online forum in WebCT (the University's Online Learning platform). This was indicative of their on-going commitment. Students did not wait for the final week to start discussing implications of LBS technologies; they got right into it from very early on. The tutor coordinator also saw this as an opportunity to explore ethics during tutorials with creative student-centered activities. Students began offering their opinions on the benefits and costs of LBS technology. At times discussions were exchanged in the early hours of the morning, fuelling controversial debates between students who held extreme viewpoints. LBS was going to be the enabler of a myriad of medical breakthroughs versus LBS signified the end of privacy. In the first few weeks the lecturer posed a number of questions in a variety of topics/directories she defined on the discussion forum. As time went on, students began to ask questions of each other and source material (both popular and academic) supporting their argument for this or that stance. Students were teaching students; and in some instances informing their instructors as well. Perhaps what was especially endearing in the whole discussion forum was the amount of effort that students went to to share material on LBS, especially when no marks were allocated to the number of messages posted or read. About 700 messages were posted- some students took more advantage of the forum than others. This worked to form a community, complementary to that which was forming in the classroom.

4.2 Teacher Evaluations

Formal teacher evaluations can be conducted at any time during a subject delivery at the University of Wollongong. The surveys were given to students in the final lecture. The overall results indicated that the course went exceedingly well. One student wrote: "[c]ongratulations on a very well run semester. Thank you for a complete session plan which was well structured and assessments that were very much kept in line with learning." Another student wrote: "[t]hank you for a great and interesting class." And yet another wrote: "[t]hank you for such an excellent subject… I can honestly say that this has been the most enjoyable subject I've completed at University."

A summary of the feedback provided by students included:

- The course material was interesting and followed a logical order.
- The lecturer conveyed concepts clearly and was always prepared and committed.
- The tutor coordinator was skillful and always ready to help with queries.
- The assessment tasks were challenging and different to most other assignments at university.
- The guest lectures were very insightful.
- Students had fun in tutorials.

4.3 Informal Feedback via Email

It is over three months now since the course was completed and I am still receiving messages from students (some whom have even completed their degrees) about the value the course brought them. Some students even email URLs of the latest LBS trials and applications that are taking place. A former postgraduate student wrote from Germany on the 18th of February 2005: "I just found some interesting articles about the usage of LBS at a Californian school. These guys track there students with RFID there. I thought it may be interesting in case you run the LBS subject again." Other students write about their experience on reflection. They are particularly appreciative of the fact that the POC gave them an opportunity to be creative and practical. One student wrote: "I hope that when I go back to China, I could find a job in the area you teach me. If I am successful, I will tell you by email."

5. Annual Software Projects

IACT 422/922 was not the first occasion in which Nortel Networks had collaborated with the author. In 2003, David Evans had presented a guest lecture on Mobile Commerce, in IACT 304 Principles of eBusiness. This industry link then developed into a collaborative software project titled "Mobile Location Centre" which was run as part of a final-year annual software project (CSCI 321). The author and Dr Koren

Ward supervised two teams of students working on implementing a Mobile Location Request Manager (MLRM) using the Nortel Networks Software Development Kit (SDK) [14]. Students in these two groups found the project required a very steep learning curve but performed above our expectations. Throughout the project, staff from Nortel Networks met with the students and offered their feedback on progress-to-date. Students also got the opportunity to ask questions that were causing bottlenecks, and gain advice on ways forward. At the conclusion of the project two of the ten students, Rodney Witham and Daniel McCabe (who had by then completed their studies) were offered contract positions with the company which they accepted). Both software developers are now working offshore for global telecommunication vendors in location services.

In 2004, the author again ran a similar project, co-supervised with David Evans. This time the results were even more spectacular. The four students, lead by Michael Green, with Mitchell Stiles, Brent Gorton and Matthew Hendy, titled their project "Universal Entity Location System" and received the Runner Up Award at the University of Wollongong SITACS Trade Show [15]. Part of their User Manual can be found below.

The Mobile Entity Tracker (MET) is an application used to track the geographic co-ordinates of mobile phones on a graphical interface. The approximate location of each mobile entity can be displayed on the map, along with any major landmarks in the area. The MET is also able to display the current velocity and the direction in which a given mobile is traveling. To maintain all of this information at run-time, the program connects to the Mobile Location Request Manager (MLRM). When an entity is added, the user requests a service based on that entity whether it be tracking a single entity, alerting when an entity is near another entity or entities, as well as checking whether an entity is near a landmark. Once a service is requested it periodically receives information from the MLRM based on the user input and displays the information.

In 2005, Nortel Networks has agreed to continue working with third year undergraduate computer science students. There are now two LBS-related projects which students are involved in; a Fleet Tracking Universal Entity Location System (UELS) application and the Location Intelligence System (LIS).

6. Honors Students Researching LBS

In 2002 when the author joined the University of Wollongong as an academic staff member she met four students who responded to her CSCI 321 Software Project on Geographic Information Systems (GIS). The team developed computer software titled: "MapWorker Pro" based on the MapInfo application [16]. The project team leader, Amelia Masters, went on to do an honors thesis with the author as her supervisor in 2003 [17]. Her thesis was titled: "Humancentric Applications of RFID Transponders" and she gained inspiration from her supervisor's PhD thesis titled: "The Auto-ID Trajectory" [18]. Amelia has gone on to publish her work internationally [19]. In 2004, Luke McCathie completed his thesis on the "Advantages and Disadvantages of Bar Code and RFID in Supply Chain Management" [20]. The momentum on LBS research continues as students find the topic interesting. Beyond the interest is also the tangible realization that RFID and other location technologies will play a big role in the future of all industry.

In 2005, the author has eight students dedicated to researching a variety of RFID aspects: from positioning technologies and homeland defense, GPS tracking 24x7x365, geographic information systems management issues, to privacy and ethical implications of RFID tags, to predictive studies of RFID applications for humans. Researching LBS is definitely exciting; and when an academic is given the opportunity to align their research to their teaching endeavors, the results are positive all-round. The classroom in fact can and should be used as a foundation learning environment to encourage students to further higher degree studies and/ or work placement.

7. Conclusion

As an employee of Nortel Networks between 1996 and 2001, the author understood the whole idea behind the formation of technology parks co-located on university campuses. In the past, Nortel has provided numerous scholarships for students on campus, given undergraduate students the opportunity to do paid vacation work, sourced local undergraduate and postgraduate talent from the Faculty of Informatics, continued collaborations with research institutes like the Telecommunications and Information Technology Research Institute (TITR), and contributed to subject delivery wherever appropriate with guest lectures or software project topics. The dynamic exchange between academia and industry is vital to teaching and learning. Students recognize the benefits that come from exposure to industry and are better able to make the link between their studies and practice. As shown in this inquiry, the real-life relevance of subject content,

assessment task definition, and personalized feedback all influence the level of student commitment to a particular course. Academics too can benefit from collaboration by fine-tuning their research directions to meet a variety of stakeholder expectations, whether these are internal academic boards, external industry partners, government agencies providing grants or even students wishing to do further research.

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