

https://dspace.org/

Managing social activity and participation in large classes with mobile phone technology

Thatcher, Andrew; Mooney, Gillian

2011-05-06
http://hdl.handle.net/10539/9670
International Journal of Interactive Mobile Technologies, 2(3), 87-98

Downloaded from a DSpace repository. https://dspace.org/

Managing Social Activity and Participation in Large Classes with Mobile Phone Technology

A. Thatcher[1] and G. Mooney[1]
[1] Psychology Department, University of the Witwatersrand, Johannesburg, South Africa

***Abstract*— Within the context of a developing country, such as South Africa, access to technology is severely limited. However, most South Africans have relatively good access to mobile phone technology in relation to other portable and mobile technology. In this initiative, students were encouraged to use mobile phone text messaging to send questions to the lecturer during classes or between classes. A total of 86 text messages were sent to the lecturer during a 7-week, second year psychology course. At the end of the course 136 responses to questionnaire distributed in class was obtained. This data was analysed using activity theory as a framework for the discussion. The results indicated that students had strongly favorable perceptions of this initiative and respondents had spontaneously suggested other uses of mobile phone technology to enhance the learning experience. Activity theory provided a useful framework for evaluating the use of mobile phone text messages to enhance student participation and learning.**

***Keywords*—large class teaching, mobile phone messaging, activity theory; m-learning.**

I. INTRODUCTION

It has been argued [1] that mobile and portable technologies will be the most influential technologies for teaching and learning in the next decade. Traxler and Kukulska-Hulme [2] highlight some of the important considerations for adopting mobile technologies for teaching and learning. These include the issues of cost of the technology (including implementation costs), the appropriateness of the technology for the target students, the relative novelty of the technology (where novelty might be considered to be a limiting factor), and the requisite level of efficient interactivity. These factors were important in choosing an appropriate technology for this study.

It might be argued that one of the appropriate uses of technology within educational systems is for building information technology skills for future workforces. There has been extensive research at both contact and distance tertiary institutions concerning the role of technology in teaching and learning. These studies have largely focused on computer and Web-based technologies, although there are also studies that have looked at using PDA/mobile phone hybrids [3] [4] and a small number of studies that have examined mobile phone text messages [5] [6]. In fact, Attewell [1] found that using a mobile device for teaching and learning encouraged students in their sample to use other technological devices.

There are a number of large-scale projects that are extending the boundaries of mobile and portable teaching and learning. These include the m-learning project [5], the MOBIlearn project [6], HandLeR [7], skoool™ [8], and the WiTEC project [9]. In addition, a recent South African initiative, MobilED [10], used mobile phone technology to allow learners to access online content using text messages. Only a limited number of studies have investigated the role of short text messaging for educational purposes. Some projects have involved using text messages as a method of English language instruction [11]. In another project, Garner et al [3] used simple alert messaging to inform a (relatively) small class of psychology students about course information (e.g. test dates), emergency information (e.g. cancellation of a lecture), and information prompts (e.g. essay collections). Students' perceptions of this use of short text messages were highly positive. Smyth [6] also found that short text messages were useful in providing study and examination tips to learners. Learners (especially border-line poor performers) responded positively to short text messages. Perhaps the studies that most closely parallel this study are those that use classroom response systems to facilitate classroom discussions. One of these initiatives was the MAPLE project [8]. The MAPLE concept involves the lecturer posing questions and the students responding immediately using mobile devices designed specifically for this purpose. Roschelle [12] refers to this as a classroom response system. A classroom response system, such as ClassTalk [12], is far more structured than the initiative that we attempted in this study. Nevertheless, there are some useful outcomes that parallel what we were attempting to achieve. According to Eboueya et al [8] MAPLE "actively promotes equal opportunities … giving them an opportunity to contribute anonymously and on an equal footing" (p. 156). However, the results of the MAPLE project had not been published at the time this paper was written. Other studies on classroom response systems have found positive improvements in students' academic results and classroom engagement [13]. In short, Roschelle [12] has noted that lecturer-controlled communication and short communications have successfully dominated other forms of mobile and portable teaching and learning.

A. M-Learning

The origins of m-learning are sometimes traced back as far as the work of Kay and Goldberg [14] in 1977 working on early designs of notebooks. M-learning essentially refers to learning taking place through the use of mobile devices and wireless technology [15]. A number of different terms have been used to characterise learning with a mobile device, including wireless learning, ubiquitous learning, network learning, and mobile

learning (usually abbreviated as m-learning) [16] [17]. M-learning is characterised by learning that is synchronous, spontaneous, and where communication responses are potentially immediate [17]. Furthermore, m-learning can also be geographically dispersed with reduced travelling time, and offers students greater flexibility in when and where they learn. M-learning is associated with a number of technologies including laptops, palmtops, hiptops, PDAs, iPods, MP3 players, hand-held gaming tools, and mobile phones. The advantages of m-learning include mobility and portability (i.e. having access to learning material and initiatives in multiple locations), increased literacy and numeracy skills, removal of formality from the education transfer process, collaborative information sharing, and increased self confidence and self-efficacy, [3] [18]. However, mobile technology (in particular access and the use of technology) does not occur in a vacuum. Instead, m-learning takes place within a particular social and cultural context. Barriers to m-learning, especially in developing countries include the high costs of technology and telecommunications services, prior exposure and experience with technology, and the fact that not all pedagogic practices lend themselves to effective m-learning [18]. M-learning theorists argue that contemporary views on adult learning (i.e. personalized, learner-centred, situational, collaborative, and lifelong) match the qualities of emerging mobile technology extremely well (i.e. personal, user-centred, mobile, networked, and durable) [5] [7].

B. Mobile Phone Use in South Africa

Before considering what types of technology might be feasibly applied in teaching and learning initiatives, it is worthwhile to consider the availability of information and communication technology within the South African environment (where this study was carried out). South Africa's Apartheid history (formally terminating in 1994) meant that the vast majority of the population was systematically denied access to resources (especially educational resources, but also financial and property resources). Parties within the higher education system in South Africa are therefore acutely aware of how access to technology for education purposes might further entrench existing disparities and increase the digital divide [19]. However, some authors have argued for a social inclusion policy whereby the adoption of technology [20], particularly wireless technology [6] is, in fact, an important remedy to the digital divide.

Compared to other forms of information and communication technology, mobile phones have the highest penetration rate in South Africa. According to the Vodafone Policy Report [21] South Africa had a mobile phone penetration rate of 36% for mobile phones compared to an 11% fixed line penetration rate in 2005 (note that these numbers may be significantly higher for the mobile phone users two years later given the rate of growth in mobile phone provision and access). It has been estimated that up to 70% of mobile phone subscribers do not have a fixed line at home. The Internet penetration rate is similar to that of fixed lines at approximately 10% of the population [22]. The OECD [23] provides similar statistics for 2005 with 4.7 million fixed line subscribers (10%), 33 million mobile phone subscribers (72%), 5.1 million Internet subscribers (11%). However, the majority of mobile phone users do not have access to the Internet from their phones. According to the OECD [23] there are only 60 000 broadband (e.g. 3G or GPRS) subscribers (or < 1%). Even access to computers (let alone mobile computing) is low in comparison to developed countries with the OECD report [23] estimating that there were only 3.7 million personal computers (8%). No figures were provided for mobile computing in the OECD report although anecdotal evidence puts mobile Internet access (via mobile phone technology) at 11% in South Africa. The OECD report [23] notes that while the growth in the number of fixed lines, Internet users, and personal computers has remained fairly static in South Africa as a proportion of the population from 2000 to 2005, the number of mobile phone users has continued to grow.

According to Samuel, Shah and Hadingham [24] South African mobile users have been characterised as young (40% of mobile phone users in their sample were younger than 25 years old), have at least secondary education as their highest qualification (64% have finished a secondary education or higher), but yet earned less than $170 per month (95% of users). These qualities are strongly reminiscent of university student characteristics. It has been argued that it would be extremely useful to consider the use of mobile phones as a learning tool in developing countries [18]. Given the relative ubiquity of mobile phone use, especially amongst the youth in South Africa (and the relative paucity of access to other forms of mobile technology), this study focuses on the use of "low-tech" mobile technology, in the form of mobile phone short text messaging, as a tool in teaching and learning in a university class.

C. Issues in Large Classes Teaching

Large class sizes forms a second reason why one might want to use technology to facilitate teaching and learning activities. South African classes are, on average, substantially larger than university classes internationally [25] [26] [27] [28] [29] [30]. Interaction in large classes is thought to be limited [31] or assumed not to be possible [32]. When interaction does occur, particular gender and racial groups dominate classroom discussions. Accordingly, males [33] [34] [35], particularly White males [28] [36] have been found to be dominant in classroom interactions. The primary explanation for the dominance of White males is the notion that the majority of university lecturers are White males and behaviourist explanations of modelling and identification are thought to be influential [36] [37].

Problems resulting from large class teaching include that students lack advice on how to improve, students lack opportunity for discussion, and the lecturer is unable to cope with the diversity of students [38]. In addition, lecturers receive lower ratings for classroom interaction in large classes [27] and experience more difficulties in classroom management [30] [39]. This rather pessimistic view represents a particular challenge to the present study where large, diverse classes (of approximately 227 students) were present.

Diversity in students, as a challenge to pedagogic practice [40], is conceptualised in different ways. Diversity has been conceptualised in terms of gender and racial differences between students. On this topic, gender differences in class participation have been found [41] [42]. Race has also been a factor that has been investigated in studies of diversity, with Black students

experiencing a sense of alienation in university classes [43]. However, the use of racial categories has been a contested debate in which racial categories have been criticised as ignoring individual differences [44]. Gravett and Henning [45] understand diversity in terms of the way students view the lecturer and believe that these notions often encompass strict notions of authority. They also, perhaps more importantly, uphold that there is necessarily student diversity in participation in class. While technology has the ability to ameliorate some of these differences, one must recognise that there is also diversity in access and use of technology [19].

D. Vygotskian Theory and the Relationship Between Task and Tool

This study is based in a Vygotskian approach to activity theory in order to examine the impact of the technology in this educational setting. It is therefore worthwhile to review the Vygotskian approach. Vygotsky's ontological argument regarding the importance of tools was based on Marx's technological determinist theory of the development of society. Both Marx and Vygotsky used the dialectical historical materialist method (epistemology) in order to investigate society (Marx) and the mind/ cognition (Vygotsky). The importance of historical development to this analytic method cannot be over-stated. Vygotskian theory, and the activity theory approach adopted by Russian theorists, suggests that tools and artefacts shape the way in which we interact with the world around us and that this idea should be viewed within a particular social/cultural and historical framework. From an historical perspective, a tool or artefact is a result of its historical development. In turn, from a social/cultural perspective how we use tools/artefacts is based, in part, on the social context as well as the cultural meaning for how the tool/artefact should be used. The historical development of a tool/artefact and its current use within a particular cultural milieu determines behaviour and mental functioning. It is the tools, or the things that we have created to control our environment, that demonstrate the creativity of humans and serve as the frameworks and patterns of our internal processing, or cognitive functioning. Any new form of technology will structure the ways in which individuals think and interact with world. Individuals are attached to many ideological practices or the relations of power in the production of knowledge [46] [47] [48] [49] [50] [51]. In other words, the type of information that one is exposed to, and, thus, the ways in which one's thinking will develop, depends on many factors, including, but not limited to, those that relate to the language that one speaks, ability to use a computer or mobile phone, and economic resources. Language and technology are the tools, or the things that we use to accomplish tasks. It is the use of tools that represents the higher forms of thinking that characterise human development.

These tools are "cultural" or "ideological" in the sense that they are used by distinct groups of people and are related to the exercise of power in society, or between groups of people. Ideology, in this sense, is a system of ideas and ideals forming the basis of a political or economic theory and is, more generally, the set of beliefs or ways of doing things that are characteristic of particular social groups. Students who use mobile phones have access to far more information and ideas than those who are not and are able to communicate with others in novel ways.

Vygotsky conceptualised the ways in which individuals in societies interact with one another as cultural development. The most central part of "culture" was the role of language, both as a mechanism for interaction between individuals and as framework for the structure and content of consciousness. Communication between individuals, or social interaction, is "based on rational understanding, on the intentional transmission of experience and thought, (which) requires some *system of means*" [47, p. 48]. The importance of historical factors in Vygotsky's theory cannot be over-emphasised. Semiotic systems have evolved in societies over time from grunts and gestures to the multiple ways in which we communicate today, including mobile phones. Signs and tools are two facets of the same phenomenon. "Signs" indicate the inward movement of objects in the social plane (external) to the individual plane (internal) and are psychological in nature. While "tools" are technical in nature and indicate labour operations, or an outward movement from the individual as he/she engages with the environment [52]. This exposition of Vygotsky's work utilises the concept of the tool, following the Russian interpretation, because tools accord the individual an active role and demonstrate that the individual has actually appropriated the way of thinking. Signs only indicate ways of thinking that are externally present, or exist in the world, and do not adequately indicate that the sign has been incorporated into the individual's consciousness.

Tools alter the characteristics and course of mental processes. These instruments of learning re-create and re-organise the entire structure of our thinking and behaviour [48]. It was in the concept of the tool functioning to re-organize our thinking that Vygotsky separated himself from the circular forms of logic proposed by the Behaviourist school of thought. Vygotsky [46] represented this re-organisation of thinking and interacting in the world in the following manner (see Figure 1). The dotted line between the task and the response to the task represented the explanation provided by the Behaviourists – a simple stimulus-response bond. For Vygotsky, this dotted line represented an individual's automatic response, encompassing the ways of thinking that the individual had already acquired. Vygotsky was interested in determining how the individual learnt new ways of thinking (as depicted by the solid lines). These new ways of thinking incorporated new cultural tools, which altered the way in which tasks were understood and how problem-solving occurred. What is of central importance to Vygotsky's ideas is that the new cultural tool fundamentally alters the process of responding to tasks. Vygotsky was attempting to describe how the use of cultural tools becomes automatic in an individual's functioning, or how we automatically use the tools of thinking. The tool used by the individual could not be separated from the response to the task using that tool because the tool would represent a different way of thinking. If two individuals used two different tools in order to solve the same problem, then their responses to the same task would be qualitatively different [46].

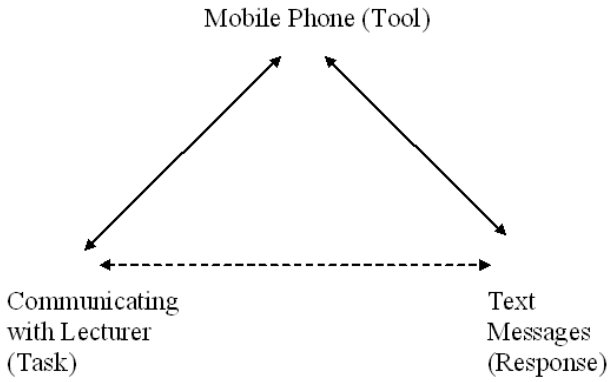


Figure 1. Vygotsky's original organisation of behaviour, adapted from Vygotsky [46, p. 420].

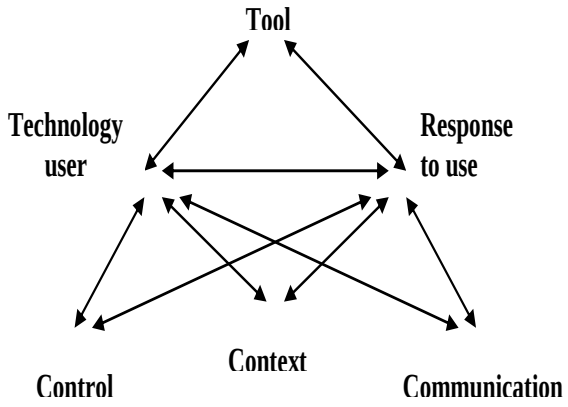


Figure 2. A framework for understanding mobile learning adapted from Sharples et al. [5]

Vygotsky [46, p.424) provided a "complete cycle of cultural development of any one psychological function". There were five phases in the cycle of tool acquisition as the tool, which is externally present is internalized and, consequently, restructures cognition. Thus, students may have internalised the mobile phone as a tool for the performance of a wide range of tasks, assuming that students in a university currently make use of a mobile phone. In addition, being a mobile phone user has already structured the way in which these students think and interact with others. However, the tool (mobile phone) is being utilised in a novel way (due to University policies preventing mobile phone use in class), or to perform a new task, namely to communicate with the lecturer within a large class environment. Even if the student is a mobile phone user and is one who normally participates in the large class interaction, the task (i.e. communicating with the lecturer) is performed in a new way.

Vygotsky's ideas were developed by Leontiev [54] into a general activity theory and more recently have been applied to understand information systems [55] and human computer interaction problems [56]. Activity theory understands human activity and behaviour as part of the socio-technical environment. Sharples et al [5] have already proposed a model for understanding m-learning adapted from Engeström's [57] activity model. This model is represented in Figure 2. This figure is essentially the same as Figure 1 except that a third level is introduced to acknowledge the contextual factors, renamed (from the original of rules, community, and division of labour) by Sharples et al [5] as control, context, and communication. Control refers to the degree of influence (e.g. delivery mode and access to learning materials) that learners have on the learning process as well as the social rules and conventions that govern acceptable interaction with the learning technology. Context refers, in this instance, to the learning context (i.e. large class lectures in a developing country context) as well as the communities of people (e.g. students, colleagues, and lecturer) involved in the interaction. Finally, communication refers to how students might adapt their communication and learning interaction with the introduction of a particular technological system [5].

E. Study Rationale and Research Aims

This study reports on a modest attempt to use short text messaging for in-class interaction within a developing country context. The primary mode of teaching delivery for the course where this initiative was used involves full-time, contact lectures, supported by an online teaching system, WebCT. Therefore, a blended learning approach [58] was adopted, where traditional classroom delivery methods were integrated ('blended') with other education delivery methods (in this study the focus of the investigation was on mobile phone text messaging). There were two primary reasons for introducing mobile phone text messaging into the classroom. First, the class size was large (more than 200 students were registered for this course). This study intended to investigate whether using mobile phone text messages to ask questions in class might have an impact on the number and type of questions as well as who was asking questions during classes, bearing in mind that there have been observed biases in who asks questions in large classes at this University [29]. Second, given the nature of the social context, a developing country, it was necessary to be sensitive to the equitable availability of information and communication technology. Mobile phone technology was chosen due its widespread availability and use amongst the target population. This study therefore aimed to investigate the role of this technology within the framework of Vygotskian theory. Unlike the majority of neo-Vygotskian interpretations, we have examined both semiotic mediation (text messaging) and social activity (large class interaction). In particular we were interested in how the control, context, and communication might influence the users (i.e. the students) in their interactions with the lecturer and with the learning material.

II. METHOD

A. Procedure

During a large, second year cognitive psychology course (taught over seven weeks), students were encouraged to send a short text message to the lecturer during class or between classes. Students were encouraged through two primary means: (a) on the bottom of each PowerPoint slide presented, a short message was displayed encouraging students to send a message (to the number displayed) if they wished to ask a question; (b) at various points during class the lecturer would ask a

question and invite students to respond verbally in class or through sending a text message. The lecturer explained that these messages would only be answered during class and would not be answered via return message or through sending or receiving a voice call. The mobile phone was kept on silent mode (so as not to cause an auditory disturbance while lecturing) but using the battery vibration function to alert the lecturer to incoming messages. The lecturer ensured that all messages were read out and answered during class. After each class, the short text messages were captured electronically with the lecturer making a short note explaining the context of the message. In the last week of the course a questionnaire was distributed to all students present in class and students were invited to complete the questionnaire in class. A total of 136 usable questionnaires were returned (a response rate of 59% of the total class enrolment).

B. Sample

The sample was taken from a second year psychology course of 229 students. From the 136 students who responded to the questionnaire, 98 were female and 37 were male, 75 students had English as their home language with 60 students indicating a range of different home languages including Setswana (N=14), Sesotho (N=10), isiZulu (N=8), Sepedi (N=6), iXhosa (N=6), or other African (N=12) or European (N=4) languages. The majority of respondents had received their secondary education in English (N=129) although a small minority had received their secondary education in an African language (N=6). Most respondents were completing this course with the intention of completing Psychology as a major (N=103), although some respondents were completing a Social Work (N=22), Human Movement Science (N=8), or a Speech and Hearing Therapy (N=6) major. The average age of the respondents to the questionnaire was 21 years and 6 months. The details of respondents' use of mobile phones are provided in the results section. One must bear in mind that the students who responded to the questionnaire may not necessarily be representative of all students taking the course.

C. Analysis of the Text Messages

The short text messages were analysed by two raters working independently. A 100% inter-rater agreement was achieved. The primary method of analysis was thematic content analysis. For the purposes of categorizing the content questions Bloom et al's [55] cognitive abilities and skills taxonomy of comprehension, application, analysis, and synthesis was used. Other categories that spontaneously emerged during the thematic content analysis were: assignment questions, interaction management, social issues, direct responses to the lecturer's questions, and a single response about the use of a mobile phone for learning.

D. Questionnaire

The questionnaire consisted of the following sections: biographical information (e.g. age, gender, home language, and subject-area), mobile phone usage data (e.g. length of time using a mobile phone, frequency of use, and type of use), the use of a mobile phone for the target course (e.g. frequency of text messaging, facilitators of text messaging, and inhibitors of text messaging), and an open ended section where respondents could provide any additional information of using a mobile phone during lectures. Finally, there was one close-ended question that asked respondents to indicate whether "Having a cellphone [mobile phone] number to SMS [text message] for this course was an excellent idea". This question was scored on a Likert-type scale from "Strongly disagree" to "Strongly Agree" with a higher score indicating strong agreement with the statement.

III. RESULTS

A. General Mobile Phone Usage

Only 2 (1.5%) of the 136 respondents indicated that they had never used a mobile phone. The majority of respondents had used a mobile phone for longer than 5 years (N=102; 75%) and usually sent a few text messages per day (N=57; 42%). While the largest proportion of respondents used a mobile phone for sending and receiving text messages, and sending and receiving voice calls, it was also evident that there was a large degree of sophistication in their use of the mobile phone. Mobile phones were also commonly used as a camera, as a diary, for playing games, for listening to music and the radio, for accessing the Internet and as a cheap instant messaging service. Certainly, these results suggest that (apart from a very small minority) the use of a mobile phone is not unusual for this sample of students. More details on general mobile phone use are given in Table I and Table II.

B. Use of a Mobile Phone During this Course

Due to the fact that it was the intention of the researchers for the text messages to be anonymous it was not possible to directly gather any biographical information from the 86 short text messages received from 52 unique mobile phone numbers (please note that this does not necessarily imply 52 unique students) during the course. However, in the questionnaires we asked respondents to indicate whether they had sent a text message to the lecturer. Forty five respondents indicated that they had sent at least one short text message to the lecturer. The self-reported number of times that respondents indicated that they sent a text is contrasted with the actual recorded number of text messages (based on the unique mobile phone number) in Table III. While

TABLE I.
GENERAL MOBILE PHONE USE

Length of time using a mobile phone	**N**	**%**
Longer than 1 year but less than 2 years	1	< 1
Longer than 2 years but less than 5 years	31	23
Longer than 5 years	102	75
Frequency of sending a text message		
A few times a week	24	18
A few times a day	57	42
More than 5 per day	15	11
More than 10 per day	12	9
So many per day I can't remember	19	14

TABLE II.
USES OF A MOBILE PHONE

Mobile phone uses	Have used N	Use Regularly N
Send and receive text messages	131	125
Send and receive voice calls	127	99
Camera facility	106	45
Diary facility	91	42
Games	87	27
Send and receive images	83	23
Link to the Internet	76	34
Listen to music/MP3s	70	39
MXit[a]	63	38
Listen to the radio	49	24

[a] Instant messaging service for mobile phones sent via CSD, GPRS or 3G

TABLE III.
NUMBER OF TEXT MESSAGES SENT TO LECTURER

Number of text messages	Self-reported	Actual
1	17	35
2	14	8
3	3	6
4	3	1
5	5	1
6	1	0
7	1	0
9	0	1

the figures do not match up exactly they show a similar trend. The majority of students sent only one (or two text messages) and a minority of students in this sub-sample sent text messages on multiple occasions.

In this group there were proportionally (in comparison to the group that indicated that they didn't send any text messages) more males than females (33% males in this group compared to 24% in the group that didn't send a text message), more respondents whose first language was English (62% compared to 52%), they had used a mobile phone for longer (87% of the respondents in this group had used a mobile phone for longer than 5 years compared to 71% in the group that didn't send a text message), and used short text messaging more frequently (54% of this group sent at least 5 text messages per day compared to 25% for the sub-sample that did not send a text message).

C. Facilitators and Inhibitors of Sending Text Messages to the Lecturer

The most common cited reasons that encouraged respondents to send a text message were issues related to not having to speak in a large class (N=37), providing anonymity for asking questions (N=32), and the ability to catch the lecturer's attention (N=24). Surprisingly few respondents indicated that sending a text message was a cheap means of communication (N=6). This can easily be explained when compared to the relatively negligible financial and time costs associated with asking the lecturer directly in person or by sending an email question to the lecturer from an on-campus location (which is free).

Respondents only indicated two reasons that facilitated sending a text message: the mobile phone number on the PowerPoint slides (N=28) and reminders from the lecturer during class (N=4). These results are supported by the most frequently cited reasons for not using text messages which included: easier to speak to the lecturer in person (N=41), the relatively high cost of sending a text message (N=28), not actually having any questions to ask (N=21), easier to email the lecturer (N=16), it takes too long to type out a text message (N=13), or the questions have already been asked by other class members (N=11).

Overall, the majority of respondents strongly agreed with the statement that using text messaging during this course was an excellent idea (96 students strongly agreed with the statement, a further 31 students agreed with the statement, and only 3 students disagreed or strongly disagreed with the statement). There was therefore overwhelming support for this initiative.

D. Qualitative Responses to Sending Text Messages to the Lecturer

The qualitative responses largely provide support for the quantitative results. Most respondents indicated that they found the use of text messages in class useful because it enabled shy students to ask questions and provided some form of anonymity. Respondents indicated that this was especially so in large classes. The following student statements capture the essence of these responses: "Some people don't feel comfortable asking questions in a big class and by using the cellphone [mobile phone] to SMS [text message] the lecturer can get those peoples' questions answered without having to speak in front of the class" or "They would work better for courses with big classes as some people do not have the confidence to speak out in class but can make important contributions or ask good questions by means of an SMS [test message]". Some respondents felt that sending text messages had increased the quantity and quality of discussions in class: "The quality of questions being asked is highly improved, having to send them via SMS [text message] seems to make people think before sending, and detect those people who simply wish to be heard without actually adding anything to the class" and "A lot of people ask a lot of questions now because of the SMSs [text messages] made." In general, respondents felt that using a mobile phone for text messaging in class was a useful teaching and learning innovation: "I think it is an extremely innovative and effective way of allowing everyone in the class to participate, without feelings and inhibition", "Cellphones [mobile phones] are resourceful in class as it allows you to contact the lecturer during the times that you are not present in [sic] varsity", and "It saves time and allows other students in class to also be included in what is being discussed (the question) and makes them to gain knowledge about the things they might have been clueless about."

Respondents also provided a number of suggestions for additional uses of a mobile phone, including reminder notifications about test or essay dates and providing other class interaction information: "Notifications about essay/test dates can be sent via SMS [text message] to students as a reminder, as well as other important notices such as cancellation of a specific lecture." Other suggestions included using the mobile phone as a data capturing device to voice record the lecture or to take pictures of particular PowerPoint slides.

Not all the comments made by respondents were positive. One respondent felt that using a mobile phone to send text messages discriminated against economically disadvantaged students: "Some students don't have the financial resources to engage in this venture, it may make them feel out of place and inferior, it is indirectly discriminatory towards them." Other students felt that using a mobile phone in class is useful only if the phone is switched to the vibration mode otherwise the mobile phone has the potential to disturb lectures rather than facilitate discussion. One student felt that typing out a text message distracted them from listening to the lecturer or the class discussions and one student felt that text messages actually decreased the level of debate in class.

E. Content Analysis of the Text Messages

The single largest use of the text messages was for specific requests about the assignments (N=26); a test and an essay. Typical questions including information about the structure and content areas to be covered in the test, information about the content areas and relevant readings required for the essay, and information about how to deal with specific referencing in the essay. The second largest use of text messages was for interaction management (N=21). Typical interaction management issues included requests to take a break, for other students to stop talking while the lecturer is speaking, for assistance with accessing the course website, and information on whether scheduled lectures would take place. Only a very small number of text messages (N=6) were related to social issues. Social issues included requests to make social announcements (an engagement of one student; a birthday of another student) and questions about whether a certain television programme or sport event had been seen. Surprisingly, only three text messages were direct responses to questions asked by the lecturer in class. It is only possible to speculate on the reasons based on the responses to the questionnaires, but it is possible that students found it easier to respond verbally in class rather than to spend time typing out a text message (and possibly missing out on the class discussion).

An analysis of the text messages based on Bloom et al's [55] taxonomy demonstrated that the majority of text messages, were at a fairly low order; either at the level of comprehension (N=16) or application (N=9). Questions at the level of comprehension were usually requests to repeat content material that had already been covered in the lecture or for clarification and elaboration of explanations. Questions at the level of application were usually applications of theory into different practical domains, usually to check whether their assumptions of the practical implications were correct. There were only a small number of text messages at the higher order. In questions at the level of analysis students not only theory into a new domain but demonstrated that they could critically question the application. At the level of synthesis (N=1) the student the student demonstrated that they could evaluate the new application on the basis of related knowledge (incidentally, this was based on content that we had not yet covered in class, so the student had evidently read ahead in the syllabus). Details of the frequencies of text messages based on Bloom et al's [55] taxonomy are provided in Table IV.

TABLE IV.
TEXT MESSAGES BASED ON BLOOM ET AL'S [55] TAXONOMY

Bloom's taxonomy	N
Comprehension	16
Application	9
Analysis	4
Synthesis	1
Evaluation	0

IV. DISCUSSION

The results are discussed using Sharples et al's [5] activity analysis (Figure 2) model as a framework.

A. Technology User/s

The target tool for this study was the mobile phone. When considering the technology users, one must consider those students who used the technology (a mobile phone) for the intended purposes of this study (specifically to send text messages to the lecturer). The demographics of the text message senders were inferred from the responses to the questionnaire. The technology user group was slightly biased towards English-speaking male students (when compared to the general demographics of the class). This said, the majority of respondents who sent short text messages were female (this is unsurprising since the majority of students in the class were female). Respondents in the group that indicated that they had sent a text message were also slightly more experienced with a mobile phone and used text messaging slightly more frequently.

One of the intentions of adopting this initiative was to look at a possible means of realigning student demographics with active student participation in class (approximately half the class was English-speaking and almost three quarters of the class was female). Previous studies have indicated that class participation is dominated by White males [28] [36] and that this is partially a result of social modelling of the lecturer [36] [37] (in this study the lecturer concerned was also a White male). Based on the demographics of respondents who indicated that they had sent a text message, the results of this study therefore do not fully support the claims of the MAPLE project [8] that m-learning initiatives can promote more equitable participation. In fact, one respondent claimed that the initiative used in this study was inadvertently discriminatory.

However, basing equality only on racial or gender criteria alone may disguise some of the other individual differences between users [44]. In particular, the quantitative and qualitative responses demonstrated that students felt that sending text messages to the lecturer allowed students who were shy or who wished to remain

anonymous to contribute to discussions. In fact, these responses were specifically targeted at large class interaction situations. These results therefore demonstrate that fixations on race and gender, without considering other differences between students (e.g. shyness when speaking in front of large groups), may be misleading.

B. Responses to Use

The students' response to the initiative was not overwhelming but was encouraging (86 text messages from 52 unique mobile phone numbers over a 7 week period). Even if we accept the argument that some students are too shy to speak in class, it is possible that these comments and questions might have been addressed by other students during lectures. While the actual number of text messages sent was modest, the vast majority of respondents to the questionnaire felt that the initiative was an excellent idea. When we examined why students did not send a text message the most common responses were that students either preferred to speak to the lecturer in person or preferred to send an email. Within the context of large class teaching this initiative effectively divides the class into smaller units to facilitate greater class participation [59] with some students preferring to send a text message, other students preferring to speak in class, and other students preferring to send an email. Overall, it is likely that participation generally increased. It is evident that different sections of the class preferred different communication technologies to actively participate in class discussions.

It is not surprising that the majority of questions raised through text messages were at a fairly low level of Bloom et al's [60] taxonomy. There are three reasons for this. First, it is likely that second year students might emphasise lower order cognitive abilities and skills. Second, the reminder on each PowerPoint slide invited students to send a text message if they wanted to ask a question. This probably inadvertently discouraged students from sending comments and other critical input that might have been at a higher level. Third, mobile phone text messages are usually limited in length (both in terms of physical mobile phone capacity and network capacity, and in terms of the time it takes to input a text message). Length limitations might have made it difficult for students to formulate comprehensive and critical responses.

C. Control

For this initiative the lecturer specified a number of controls. First, the lecturer specified which technologies were acceptable for in-class communication (i.e. direct questions by raising a hand and by text message). Second, the lecturer decided on the rules for how these communication technologies should be used (i.e. for text messages, these could be sent at any time to the number provided but responses to text messages would only be addressed during a lecture). Third, the lecturer maintained control over whether a text message was read out and addressed during a lecture. One other point noticed by the lecturer was mobile phones did not typically ring during classes (two times across the whole course compared to two or three times each week previously). It would appear that foregrounding the technology heightened students' awareness of the pedagogic uses and abuses of the technology.

There is also evidence from these results that the initiative provided students with some perceived control over their learning. Providing students with multiple means to contribute to discussions and to ask questions was perceived positively by respondents to the questionnaire. Students were also able to send a question to the lecturer when they thought of the question and not only when they were in class (although only 16 text messages were sent outside of lecture times for this course). Additionally, the most common theme from the thematic content analysis of the text messages was interaction management. The interaction management text messages were used by the students to control social aspects in the classroom. For example, one aspect of the interaction management involved students requesting breaks. Combined with the fact that many of the comprehension level questions were requesting the lecturer to repeat material that had already been covered in class, the text message system therefore provided students with some control over the pace at which content was delivered. Another aspect of the interaction management involved informing the lecturer about people who were talking during class and disturbing the lectures. This was essentially a "naming and shaming" exercise mediated through the authority vested in the lecturer. Further, some students used the text messages to obtain information about whether an upcoming scheduled lecture period would be used. These questions provide an element of control for students since they enable forward planning and scheduling. Finally, it would appear that for a number of students the mere presence of an additional communication medium was sufficient to engender perceptions of control. The attitudes towards the introduction of mobile phone text messaging in class were highly positive with students indicating that they felt the initiative was valuable despite never having used text messaging in this class.

D. Context

The obvious observation about the context being a large class teaching situation within a developing country with relatively low access to many forms of technology (compared to European, North America, and Far East Asia) has already been made earlier in this paper [21] [22] [23]. Within this context, access to and use of mobile phones is relatively high. The majority of student respondents in this study indicated that they used a mobile phone (98.5%). This is probably far higher than the general South African population with an estimated 36% penetration rate [21]. The respondents in general (i.e. not just those who sent a text message) came from a variety of different educational and language backgrounds. Given this diversity, and the historical socio-economic differences, this study only attempted a modest use of mobile technology appropriate to the students own past experiences and access to technology.

Obviously there are many different types of mobile phones with various different key and peripheral features. In this study, the issue of various different brands and functionalities of mobile phones used by the students was not directly assessed in the questionnaire. However, we are able to infer the use of different mobile phone applications from an analysis of the different ways in which mobile phones were used by this sample of students. It was also clear that students were very familiar

with this technology. Most respondents had used a mobile phone for longer than 5 years, sent text messages regularly and were familiar with a wide range of mobile phone applications. In fact, it was quite surprising to note the relatively sophisticated mobile phone applications that respondents were utilizing (e.g. 34 respondents who used their mobile phone to link to the Internet on a regularly basis).

According to Sharples et al [5], the lecturer in this study also forms part of the context. The lecturer was highly experienced with integrating technology into teaching and learning including receiving the University's Vice-Chancellor's award for teaching and learning and has published on this topic [61]. The lecturer's attitude towards this intervention was obviously critically important. The lecturer was the primary driving force behind the initiative ensuring that each PowerPoint slide had a standard statement inviting questions in the form of text messages, verbal invitations during lectures, and by purposefully ensuring that text messages were read out to the whole class. Two of these behaviours were mentioned by the questionnaire respondents as important in facilitating text messages.

E. Communication

The communication aspect in activity theory refers to the ways in which the technology is adapting communication strategies (within the classroom) [5]. For a small group in the class, the text messages initiative enabled the formation of a community of learning that also involved sending text messages on social issues. In this way, other students in the class were included in the interactions between student and lecturer. Many respondents to the questionnaire noted that reading out the text messages and discussing the answers in class enabled students who were interested in finding answers to similar questions were also able to feel included and could learn from the questions being asked. It is perhaps too early to determine whether this initiative has fundamentally changed the classroom interaction, but there were signs that students were starting to think about other ways in which the technology could be used for pedagogic practices. For instance, some students noted that mobile phones could also be used as recording devices (recording audio and/or video from lectures) and students also suggested that text messages should be used as an information service, a use that has shown to be successful in other studies [2] [6]. Clearly this initiative has encouraged students to start thinking how this technology might enhance their learning activities and not just its use as a social communication and entertainment device.

F. Study Limitations

Educators scarcely need to be warned that allowing students to bring their own mobile technology into an existing formal classroom situation has the potential to be disruptive rather than facilitative to the education process [11]. Indeed, the most common negative response from respondents to the questionnaire was the potentially disruptive role that ringing mobile phones might cause in a classroom situation. In addition, there was also the fear that the mobile phone would be used for non-educative purposes (although only a small proportion of the text messages in this study were used for this purpose).

Some authors have argued that it is the user that must be considered mobile, not the technology [6] [58]. In the context of this study it might therefore be argued that the mobile technology is being adopted for a non-mobile use. In this case, this study is therefore not referring to m-learning at all. However, within an activity theory approach one must bear in mind that one is interested in seeing how the technology might be adapted for multiple uses. In this study there is evidence that classroom interaction is changing and that students are beginning to see new possibilities for how this technology can enhance their learning (e.g. the mobile phone for message alerts and as data capturing devices). Further, students were able (even encouraged) to send text messages to the lecturer outside of normal lecture times. While only a small proportion of the text messages were sent outside of lecture times for this course (N=16, i.e. 19%), these text messages were sent in addition to those questions asked via email or face-to-face.

In this study we only collected data on the text messages, but not on the number and type of face-to-face questions. It is difficult to evaluate whether this initiative had a significant effect on changing the traditional social activity and class participation for this course.

G. Recommendations and Directions for Future Research

Students, in their responses to the questionnaires, made a number of suggestions for future use of mobile phone technology in the classroom. One recommendation for a future initiative would be to use text message quizzes [3]. This involves students being given a paper-copy of a quiz and responding to questions via text messages to a text message quiz engine that provides the student with an automatic reply. Using text messages as an alerting and information service is also worth pursuing in addition to the purposes used for this study. Our future investigations should also collect data on the face-to-face classroom discussions. Of course this would be far more resource intensive than collecting the mobile phone text messages as it would involve a research assistant to collect data during each class. The presence of a research assistant in the class might be disruptive to the normal classroom interactions, particularly if students are made aware of the data collection (as would be required by ethical research procedures).

V. CONCLUSIONS

As Roschelle [12] has noted, small-scale mobile pedagogical interventions are often as effective as expensive interventions. This paper has reported on an example of a small-scale mobile phone text messaging intervention to assess the impact of classroom participation and pedagogic interaction in large class teaching. The initiative was analysed using activity theory as a framework for the discussion. The results from the questionnaire suggest that students were overwhelmingly in favor of the initiative despite the fact that only a relatively small number of students participated by sending a text message (i.e. at most 52 students from a class of 227 students). This is borne out in a quantitative and a qualitative assessment of questionnaire responses. Despite the limitations of activity theory for designing learning technology found in the critique by Taylor et al [62] we found activity theory

to be a useful evaluative tool for the mobile phone text message learning initiative. While Taylor et al's [62] critique is certainly valid; it largely outlines some of the limitations of a Western interpretation of activity theory. The results are sufficiently positive to strongly recommend that other courses attempt similar initiatives.

REFERENCES

[1] J. Attewell, *Mobile technologies and learning. A technology update and m-learning project summary*. London: Learning and Skills Development Agency, 2005.

[2] J. Traxler, and A. Kukulska-Hulme, "Evaluating mobile learning: reflections on current practice," *Proceedings of mLearn 2005, 4th World Conference on m-learning*

[3] I. Garner, J. Francis, and K. Wales, "An Evaluation of the Implementation of a Short Messaging System (SMS) to support undergraduate students," In *Proceedings of the European workshop on Mobile and Contextual Learning Birmingham*, UK, pp. 15-18, 2002.

[4] Z. Ezziane, "Information technology literacy: implications on teaching and learning," *Educ. Techn. & Soc*., Vol. 10, pp. 175-191, 2007.

[5] M. Sharples, J. Taylor, and G. Vavoula, "Towards a theory of mobile learning," in *Proceedings of mLearn 2005, 4th World Conference on m-learning*..

[6] G. Smyth, "Wireless technologies bridging the digital divide in education," in *Proceedings of mLearn 2005, 4th World Conference on m-learning*.

[7] M. Sharples, "The design of personal mobile technologies for lifelong learning," *Comp. and Educ*., Vol 34, pp. 177-193, 2000.

[8] M. Eboueya, D. Lillis, J. Jo, G. Cranitch, and P. Martin, "Mobile participative learning environments for the 21st century classroom: the MAPLE project," in *Proceedings of the 2nd EUI-Net conference on European Models of Synergy between Teaching and Research in Higher Education*, pp. 155-158, May 3-6, 2006.

[9] T.C. Liu, H.Y. Wang, J.K. Liang, T.W. Chan, and J.C. Yang, "Wireless and mobile technologies to enhance teaching and learning," *J. Comp. Assist. Learn*., Vol. 19, pp. 371-382, 2003.

[10] M. Ford, and T. Leinonen, "MobilED – A mobile tools and services platform for formal and informal learning," in *Proceedings of mLearn 2006, 5th World Conference on m-learning*.

[11] R. Godwin-Jones, "Emerging technologies. Messaging, gaming, peer-to-peer sharing: language, learning strategies and tools for the millennial generation," *Lang., Learn.& Techn.*, Vol. 9, pp. 17-22, 2005.

[12] J. Roschelle, "Keynote paper: Unlocking the learning value of wireless mobile devices," *J. Comp. Assist. Learn.*, Vol. 19, pp. 260-272, 2003.

[13] R.J. Dufresne, W.J. Gerace, W.J. Leonard, J.P. Mestre, and L. Wenk "Classtalk: a classroom communication system for active learning," *J. Comp. High. Educ.*, Vol. 7, pp. 3-47, 1996.

[14] A. Kay, and A. Goldberg, "Personal dynamic media," *IEEE Comp.*, Vol. 10, pp. 31-41, 1977.

[15] H.U. Hoppe, R. Joiner, M. Milrad, and M. Sharples, "Guest editorial: wireless and mobile technologies in education," *J. Comp. Assis. Learn*., Vol. 19, pp. 255-259, 2003.

[16] B. Alexander, "Going nomadic: mobile learning in higher education," *Educause Review*, pp-29-35, September/October, 2004

[17] Y. Laouris, and N. Eteokleous, "We need an educationally relevant definition of mobile learning," in *Proceedings of mLearn 2005, 4th World Conference on m-learning*.

[18] A. Barker, G. Krull, and B. Mallinson, "A proposed theoretical model for m-learning adoption in developing countries," in *Proceedings of mLearn 2005, 4th World Conference on m-learning*.

[19] M. Warschauer, "Demystifying the digital divide," in *Sci. Am.*, 289, pp. 42-47, 2003.

[20] E.O. Mashile, and F.J. Pretorius, "Challenges of online education in a developing country," *South Afric. J. High. Educ*., Vol. 17, pp. 132–139, 2003.

[21] D. Coyle, "Africa: the impact of mobile phones," in *The Vodafone Policy Paper Series*, No. 2, pp. 3-9, March 2005.

[22] Internet World Stats. *Internet usage statistics for Africa*. Retrieved from the WWW, 20 March, 2007: http://www.internetworldstats.com/.

[23] OECD, *Information and Communications Technologies, OECD Outlook 2007*. OECD, 2007.

[24] J. Samuel, N. Shah, and W. Hadingham, "Mobile communications in South Africa, Tanzania and Egypt: results from community and business surveys," in *The Vodafone Policy Paper Series*, No. 2, pp. 44-52, March 2005.

[25] N.J. Allers, and N.J. Vreken, "Active learning in physiology practical work," *South Afric. J. High. Educ*., Vol. 19, pp. 853-863, 2005.

[26] C. Nel, and C. Dreyer, "Factors predicting English second-language students' use of Web-based information systems: implications for student support," *South Afric. J. High. Educ.*, Vol. 19, pp. 129-143, 2005

[27] D. Kember, and A. Wong, "Implications for evaluation from a study of students' perceptions of good and poor teaching," *High. Educ*., Vol. 40, pp. 69-97, 2000.

[28] D.S. Pollard, "Gender, achievement, and African-American students' perceptions of their school experience," *Educ. Psychol.*, Vol. 28, pp. 341-356, 1993.

[29] P. Stein, and H. Janks, "Collaborative teaching and learning with large classes: a case study from the University of the Witwatersrand," *Persp. in Educ.*, Vol. 17, pp. 99-116, 2006.

[30] E. Walker, and A.E. Wright, "Medical education begins in first year: problem-based, community-oriented teaching in a pre-clinical curriculum," *Acad. Devel.*, Vol. 2, pp. 17-29, 1996.

[31] C. Thomen, and J. Barnes, "Assessing students' performance in first-year university management tutorials," *South Afric. J. High. Educ*., Vol. 19, pp. 956-968, 2005.

[32] D. Jaques, D. *Learning in Groups (2nd Ed.)*, Essex: Kogan Page, 1991.

[33] J.B. Kahle, L.H. Parker, L.J. Rennie, and D. Riley, "Gender differences in science education: building a model. *Educ. Psychol*., Vol. 28, pp. 379-404, 1993.

[34] D.J.S Mpofu, M. Das, T. Stewart, E. Dunn, and H. Schmidt, "Perceptions of group dynamics in problem-based learning sessions: A time to reflect on group issues," *Medic. Teach*, Vol. 20, pp. 421- 429, 1998.

[35] J. Scott-Jones, "The complexities of gender and other status variables in studies of schooling," *Hum. Devel.*, Vol. 45, pp. 54-60, 2002.

[36] P.J. den Brok, J. Levy, R. Rodriguez, and T. Wubbels, "Perceptions of Asian-American and Hispanic-American teachers and their students on teacher interpersonal communication style," *Teach. & Teach. Educ*., Vol. 18, pp. 447-467, 2002.

[37] R.S. Feldman, "Nonverbal behaviour, race, and the classroom teacher," *Theory into Pract.*, Vol. 24, pp. 44-49, 1985.

[38] I. McGill, and L. Beaty, *Action learning. A practitioners' guide*. London: Kogan Page, 1992.

[39] R.D. Pea, "Learning scientific concepts through material and social activities: conversational analysis meets conceptual change," *Educat. Psychol.*, Vol. 28 pp. 265-277, 1993.

[40] A.L. de Boer, T. Steyn, T., and P.H. du Toit, "A whole brain approach to learning in higher education," *South Afric. J. High. Educ*., Vol. 15, pp. 185-193, 2001.

[41] R.L. Dukes, and G. Victoria, "The effects of gender, status, and effective teaching on the evaluation of college instruction," *Teach. Soc.*, Vol. 17,pp. 447-457, 1989.

[42] S. Saunders, "Market segmentation using quality perceptions: an investigation into a higher education institution," *South Afric. J. High. Educ*., Vol. 19, pp. 144-154, 2005.

[43] C.M. Loo, and G. Rolison, "Alienation of ethnic minority students at a predominantly White university," *J. High. Educ*., Vol. 57, pp. 58-78, 1986.

[44] B. Rogoff, and C. Angelillo, "Investigating the coordinated functioning of multifaceted cultural practices in human development," *Hum. Develop.*, Vol. 45, pp. 211-225, 2002.

[45] S. Gravett, and E. Henning, "Teaching as dialogic mediation: a learning-centred view of higher education, " *South Afric. J. High. Educ.*, Vol. 12, pp. 60-68, 1998.

[46] L.S. Vygotsky, L.S. "The Problem of the Cultural Development of the Child," *J. Gen. Psych.*, Vol. 6, pp. 26-39, 1929.

[47] L.S. Vygotsky, *The Collected Works of L.S. Vygotsky. Vol. 1, Problems of General Psychology*. New York: Plenum Press, 1987.

[48] L.S. Vygotsky. *The Collected Works of L.S. Vygotsky. Vol. 2, The Fundamentals of Defectology (Abnormal Psychology and Learning Disabilities.*. New York: Plenum Press, 1993.

[49] L.S. Vygotsky, *The Collected Works of L.S. Vygotsky. Vol.3, Problems of the Theory and History of Psychology*. NewYork: Plenum Press, 1997a.

[50] L.S. Vygotsky. *The Collected Works of L.S. Vygotsky. Vol. 4, The History of the Development of Higher Mental Functions*. New York: Plenum Press, 1997b.

[51] L.S. Vygotsky, *The Collected Works of L.S. Vygotsky. Vol. 5, Child Psychology*. New York: Plenum Press, 1998.

[52] L.S. Vygotsky, *The Collected Works of L.S. Vygotsky. Vol. 6, Scientific Legacy*. New York: Plenum Press, 1999.

[53] H. Daniels, *Vygotsky and Pedagogy*. London: Routledge, 2001.

[54] A.N. Leontiev, "Principles of child mental development and the problem of intellectual backwardness," In B. Simon and J. Simon (Eds.), *Educational Psychology in the U.S.S.R.* pp. 68-82, London: Routledge and Kegan Paul., 1963.

[55] B.A. Nardi, (Ed.), Context and consciousness: activity theory and human-computer interaction. MIT Pres: Cambridge, MA, 1996.

[56] L. Bannon, and S. Bødker, "Beyond the Interface: Encountering Artifacts in Use," in J.M. Carroll (Ed.) *Designing Interaction: Psychology at the Human-Computer Interface*, pp. 227-253, New York: Cambridge University Press, 1991.

[57] Y. Engeström, *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit, 1987.

[58] D.R. Garrison, and H. Kanuka, "Blended learning: uncovering its transformative potential in higher education," *Internet and Higher Education, 7*, pp. 95-105, 2004.

[59] R.M. Felder, and R. Brent, "Navigating the bumpy road to student–centered instruction," *Coll. Teach*., Vol. 44, pp. 43-47, 1996.

[60] B.S. Bloom, M.D. Engelhart, E.J. Furst, W.H. Hill, and D.R. Krathwohl, *Taxonomy of educational objectives. The classification of educational goals. Handbook 1, cognitive domain*. New York: David McKay Company Inc., 1957.

[61] A. Thatcher, "Using the World-Wide Web to support classroom lectures in a psychology course," *South Afric. J. Psych.*, Vol. 37, pp. 345-347, 2007.

[62] J. Taylor, M. Sharples, C. O'Malley, G. Vavoula, and J. Waycott, "Towards a task model for mobile learning: a dialectical approach," *Int. J. Learn. Techn*., Vol. 2, pp. 138-158, 2006.

AUTHORS

A. Thatcher is with the Department of Psychology, University of the Witwatersrand, Johannesburg, South Africa (e-mail: Andrew.Thatcher@wits.ac.za).

G. Mooney is with the Department of Psychology, University of the Witwatersrand, Johannesburg, South Africa (e-mail: Gillian.Haiden-Mooney@wits.ac.za).

Manuscript received 26 May 2008