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Effective and ineffective uses of emerging technologies: Towards a transformative pedagogical model

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Abstract
Although there is an increasing use of emerging technologies (ETs) in higher education internationally and in South Africa in particular, there is little evidence that their use is transforming teaching and learning practice. Anecdotal evidence shows that there is a dichotomy between the technologies supported and used in higher education institutions (HEIs) on one hand, and technologies owned and predominately in use among students. Thus, the gulf between technologies supported and used for teaching and the technologies used by students for learning has created pressure for educators to "play catch-up," resulting in a continuum of pedagogically ineffective to effective uses of ETs. This paper argues that pedagogically sound uses of ETs leverage the broader context of existing practices (cultural-historical context) to design learning activities that transform both the teaching and learning practices. The paper draws data from a national survey on uses of ETs among educators in higher education to propose a pedagogical model of use that has the potential to transform practice.

Introduction

A glance at the international dashboard of trends in higher education suggests that technologies have and will continue to impact the educational landscape in this decade. It is interesting to observe that three influential reports, the Technology Outlook for UK Tertiary Education 2011–2016 Report, the 2011 Global Edition of the New Media Consortium (NMC) Horizon Report, and the 2010 Australia-New Zealand Edition NMC Horizon Report (Johnson & Adams, 2011), report on the technologies/topics that will become dominant in education in the next 1–5 years (see Figure 1).

Although these reports are useful, they do not provide answers to questions of whether the predicted adoption over time will be different for educators and students, and what institutional conditions and pedagogical needs will encourage uptake or accelerate the adoption of the technologies, neither do they provide a model of use to transform practice. For example, many educators at higher education institutions (HEIs), especially those located in developing nations, the context/environment may constrain the adoption of these emerging technologies (ETs), while for educators in resource rich environments, effective use would be constrained by lack of guidelines on uses that transform practice. A precursor to using ETs for teaching is for educators to first be aware of the affordances of ET. However, the challenge is that ETs are not yet fully understood (Veletsianos, 2010). This paper reports on uses of ETs that are pedagogically effective or ineffective and proposes a model of use that could potentially transform the teaching and learning practice.

Practitioners Notes

What is already known about this topic

- There is an increasing use of emerging technologies (ETs) among both educators and learners in education in general and higher education in particular.
- Use of ETs does not automatically translate into effective teaching and learning practices.
- Deep and meaningful learning is an outcome of effective pedagogical uses of ETs.

What this paper adds

- Provides insights into pedagogical uses of ETs that has potential to transform the teaching and learning practice.
- Contributes to the educational community a pedagogical model for enhancing teaching/learning when mediated by ETs.
- Highlights the effect of socio-cultural contexts in ensuring effective teaching and learning practices through ETs.
- The evidence of effective uses of ETs is poorly documented and this paper contributes to this void.

Implications for practice and/or policy

- The activity systems (learning) mediated by ETs impact on and are impacted by the socio-cultural environment in which the activities take place. This understanding of the symbiotic relationship between pedagogy and socio-cultural context is important to effective use of ETs.
- Learners are increasingly connected and therefore are in a constant state of wanting to know what peers are saying, are often eager and comfortable to share ideas and to comment in communities of practice.
- There is a need to come up with strategies for scaling up the use of ETs from projects to the mainstream.
- There is need to document evidence of effective uses of ETs in teaching and learning practices.

Background

The South African higher education is under pressure to provide equity of access to education (Council on Higher Education, 2010), increase throughput (Badat, 2010; Council on Higher Education, 2010), improve first-year attrition and reduce dropout rates (Council on Higher Education, 2010). This is at the backdrop of a "jammed" curricula and high staff workload (Department of Higher Education and Training, 2010). The Green Paper on Post School Education and Training, released in 2012 (http://www.info.gov.za/view/DownloadFileAction?id=157779), calls for improved access to and use of appropriate technologies for effective education delivery. I infer from the above stated pressures that teaching is not an isolated event, narrowly focused on curricula and how best to teach it, but it is about sensitivity to the broader environment.

Teaching perspectives are "garden" focused

This paper aims to uncover the relationships between educators' actions of teaching with ETs and the motives, with particular interest in the understanding of the activities that have potential to lead to the motive of transformation of teaching/learning practice. I adopt Williams, Karousou and Mackness's (2011) definition of transformative learning to mean learning that is an outcome

Short List Topics Across Three NMC Horizon Projects

Technology Outlook for UK Tertiary Education 2011-2016	NMC Horizon Report 2011 Global Edition	2010 NMC Horizon Report Australia-New Zealand Edition
Time-to-Adoption Horizon: One Year or Less		
Cloud Computing	Cloud Computing	Cloud Computing
Mobiles	Collaborative Environments	Electronic Books
Open Content	Electronic Books	Mobiles
Tablet Computing	Mobiles	Social Networking
Time-to-Adoption Horizon: Two to Three Years		
Game-Based Learning	Augmented Reality	Augmented Reality
Learning Analytics	Game-Based Learning	Game-Based Learning
New Scholarship	Open Content	Open Content
Semantic Applications	Visual Data Analysis	Virtual Worlds
Time-to-Adoption Horizon: Four to Five Years		
Augmented Reality	Brain-Computer Interfaces	Gesture-Based Computing
Collective Intelligence	Gesture-Based Computing	Semantic Web
Smart Objects	Learning Analytics	Telepresence
Telepresence	Semantic Applications	Visual Data Analysis

Figure 1: Emerging technologies short list of the new media consortium horizon projects (Johnson and Adams 2011, 1)

of interactions with people, resources and others. The role of ETs in mediating transformative learning is premised on the appropriation of the affordances of these technologies to increase levels of interactions (Garrison & Anderson, 2003) and to encourage deep and meaningful learning (Anderson, 2003). This is in contrast to prescriptive learning, where what learners should know is predetermined (Williams, Karousou & Mackness, 2011). It needs to be stated that educator's context of practice (where actions are undertaken) is not a vacuum, void of external influences that could be well illustrated using the garden metaphor. In his famous garden-as-culture metaphor, Cole (1999) compares a cultural context in which tools are used to a garden that is walled off from the environment in which it is embedded but not walled off from the effects from the environment. Thus, ETs need to be appropriated depending on what the gardener intends to grow (educational goal), type of soil (curricula) and type of students (seeds) and the season which is outside the control of the gardener. It therefore stands to reason that effective uses of ETs may not be generalisable due to being rooted in their context. To this end, I draw on the Cultural-Historical Activity Theory (CHAT) to help make sense of the context.

Analytical framework—CHAT

In the context of CHAT, relational agency can be illustrated as an adult aligning his thoughts to reason with a 4-year old where an adult engages in a sense-making activity that is appropriately pitched. Edward (2007) and Koszalka (2004) describe relational agency as the capacity to work with others in a way that requires alignment of thought so as to make sense of and contribute sensibly (Edward, 2007, 4). Other scholars, such as Koszalka (2004), describe learning in a CHAT paradigm as a process of constant interaction with the environment and others and knowledge as constructed by individual learners, building on existing historical experiences and within the learners' context.

Lim (2002) accentuates that in a socio-cultural approach, "individuals learn with a wide variety of tools, and with people that help them carry out their goal oriented activities" (p. 413). Anderson (2004) proposes that individuals could interact with a wide range of net-based synchronous and asynchronous activities not limited to video, audio, computer conferencing, chats or virtual world. He adds that these net-based activities provide rich environments for acquisition

of social skills, collaborative learning and development of personal relationships between participants. Jonassen and Rohrer-Murphy (1999) argues that activity systems could have a nested dynamic, where its components could be the result of other activities that produced it.

Thus, in this study, our interest was to explore how the use of ETs has enabled interactivity between learners and their environment or individual constructions of knowledge (learning) and whether the enactment of emerging technological tools widened learner's access to multiple perspectives (technology). Thus, in this paper, we focus particularly on the role of ETs in learning. This is accomplished through the analysis of how distributed expertise and intelligence was enhanced.

Methodology

This paper draws on data collected as part of a larger study aimed at investigating ETs and their use in South African HEIs to improve teaching and learning in the sector. During August and September 2011, a survey tool was designed and sent to 22 public HEIs in South Africa to establish the use of ETs by academics and support staff. The survey comprised 30 questions that were a mixture of open-ended and closed questions designed to establish the ways in which ETs were used and whether such uses had any transformative effect on pedagogical practices. Questions explored usage of technologies, innovative practices with technologies, the reasons for use, the effects on teaching and learning, and the constraints and support from the institution.

Convenience sampling was used in this study, whereby members of the research team identified possible respondents including lecturers who were known to be using ETs in their teaching and support staff involved in supporting these technologies in teaching and learning at HEIs. Directors of teaching and learning and senior academics at all South African HEIs were also targeted. The sample was broadened using snowballing method. Respondents of this survey were specifically targeted for their reputation as early adopters of new technologies and might not be representative of all academic staff in the 22 participating institutions.

Overall, 262 educators responded to the survey, and 18 of these respondents, who provided rich data to the questions asked, were selected for an in-depth analysis. CHAT and distributed intelligence theory (Hollan, Hutchins & Kirsch, 2001; Salomon, 1993) was used as an analytical framework.

Participants' consent was sought, and the principle of anonymity was applied in data analysis. Ethical clearance was obtained from Research Ethics Committee of the institution where the principal investigator is based.

Data analysis and discussion

In this section, the results of the survey are reported. For the sake of brevity, only the top 10 results per category are presented. Results as tabulated in Table 1 suggest that educators use more the technologies that support research (ie, research databases [75%]; social media for sharing resources [68%]; and open educational resources [60%]).

The questionnaire asked respondents to list the technologies that they had not heard about, and results are presented in Table 2 below. The results showed that 85% of the respondents had never used remote instrumentation (85%), tablet computers (76%) and web conferencing (66%).

The respondents were presented with a list of technologies and were asked to list what technologies they had never heard about. Table 3 shows that respondents had never heard about argumentation visualisation (27%), reusable learning objects (23%) and RSS feed (13%) just to mention a few.

These results suggest that the adoption of ETs among the respondents was still yet to be realised. This suggests that the ETs short-listed in the New Media Consortium Horizon Projects report, depicted in Figure 1, could be context dependent.

Table 1: Technologies regularly used by respondents

	Technologies used at least once a year or regularly	Number of users	% of users
1	Research databases (eg, Ebscohost; Academic Premier)	149	75
2	Social media (eg, Flickr, YouTube, Slideshare, Picasa, Vimeo)	136	68
3	E-books	132	66
4	Social networking (eg, Facebook, MySpace)	127	64
5	Web-based documents (eg, Google Docs, Google Forms)	124	62
6	Open educational resources repositories (eg, MIT OpenCourseWare—free and open course materials via Internet)	120	60
7	Bibliographic management (eg, RefWorks, Zotero, Mendeley)	118	59
8	Blogging (eg, Blogger, WordPress, Livejournal)	114	57
9	Instant messaging (eg, MSN, GoogleTalk, Mxit)	111	56
10	Wikis (eg, Wikis within an LMS; MediaWiki, Wikispaces, PBWiki)	108	54

Table 2: Technologies never used by respondents

	Technologies never used	Number of users	% of users
1	Remote instrumentation (eg, remote labs)	170	85
2	Games and massively multiplayer online games (MMOGs)	163	82
3	Virtual worlds/immersive technologies (eg, Second Life)	162	81
4	Tablet computers	151	76
5	Student/personal response systems/clickers (eg, Turning Point)	148	74
6	Social bookmarking (eg, Delicious)	142	71
7	Context aware environments and devices (eg, geotagging, data mashups)	139	70
8	Electronic portfolios (eg, Carbonmade, Exabis, Mahara)	139	70
9	Augmented reality (AR)	132	66
10	Web conferencing (eg, elluminate, MS Lync, dimdim, Adobe Connect)	131	66

Table 3: Technologies respondent has never heard about

	Technologies never heard of	Number of users	% of users
1	Argumentation visualisation (debategraph)	53	27
2	Augmented reality (AR)	52	26
3	Learning analytics	47	24
4	Reusable learning objects	45	23
5	Adaptive systems/assistive technologies (eg, Screen readers)	45	23
6	Context aware environments and devices (eg, geotagging, data mashups)	30	15
7	RSS feeds	25	13
8	Social bookmarking (eg, Delicious)	20	10
9	Electronic portfolios (eg, Carbonmade, Exabis, Mahara)	20	10
10	Screencasting (eg, Camtasia, Camstudio, Captivate, Wink)	19	10

Additionally, respondents were asked to list the technologies they had used most in innovative ways. The Learning Management System (24%) was the most used, followed by blogging (8%), podcasting/vodcasting (8%) and microblogging (3%) as shown in Table 4.

The question on technologies used most innovatively was followed by qualitative questions aimed at uncovering the "motive" and the activities in which these technologies were used. In the next section, the qualitative data are analysed.

Table 4: Technologies used in most innovative ways

	Technologies used most innovatively	*Number of user*	*% of users*
1	LMS/CMS	59	24
2	Blogging	20	8
3	Podcasting/vodcasting	20	8
4	Social media	18	7
5	Social networking	16	7
6	Multimedia production; digital stories	13	5
7	Screencasting	12	5
8	Research databases	9	4
9	Instant messaging	7	3
10	Microblogging	7	3

Emerging technologies role in learning

Object analysis 1: distributed intelligence

There was evidence of learner and technology interaction whose outcome resulted in knowledge construction. Some of the evidence of learning from distributed intelligence mediated by ETs included:

> This year I had a student in the exam I had never seen. She achieved a distinction just through keeping up with all the correspondence and submitting her work online. [REF 159804]

The above statement came from an educator who observed his/her student engage in peer assessment tasks and passed examinations. The activity involved students sharing power point presentation through a shared Dropbox. Although the student did not attend the face-to-face sessions, she had access to both her own as well as others presentations and assessment comments. The "intelligence" was therefore imbedded in the original submitted PowerPoint and the comments from peers and the educator.

Some evidence of distributed intelligent is also exemplified in this statement where students were working with teenagers in the community to share experience about their social lives:

> Currently students are working with teenagers to produce films about their issues, which will be edited and bluetoothed back to the teenagers' mobile phones, with the intention that they will then distribute it via Bluetooth. [REF 159857]

The use of mobile phones to document the teenager's stories resulted in collectives of useful digital resources that served as "canned" community-based expertise.

In another activity, students used a Wiki to write an article with many sources that represented an aggregation of distributed intelligence.

> The Wiki project uses Wetpaint.com to produce a wiki site framework on a particular theme. First year students employ academic and journalistic skill sets to gather, verify and write up an effective wiki entry, which is multi-sourced, and fully referenced article. [REF 160828]

An additional example of distributed intelligence was evident through the use of Twitter in the masters in educational technology course. The activity required students to post comments to the course hash tag:

> Students post to the course blog, share and comment through using the course hash tag in tweets, and have electronic readings. [REF 163305]

Consistent with the socio-cultural approach, where individuals learn with a variety of tools and or people, some educators reported on how the use of technologies is changing their practice:

> Teaching chemistry to large first-year classes with a Tablet. I do not prepare my lectures any more by setting up PowerPoint slides. I make notes for the students on my Tablet (Microsoft Journal) as the lecture proceeds

and the comments or questions of students during the lecture are added to the notes. The use of different colours and highlighting functions also adds value to the teaching method. The notes are then converted to pdf format and made available to the students afterwards. [REF 171208]

To the extent that lecture notes were produced with students' participation, the use of a tablet enabled the exploitation of the distributed intelligence in the class to co-create a teaching resource.

Object analysis 2: distributed expertise

In a biodiversity studies course, students used blogs to create hubs of knowledge based on personal experiences of adaptive management. The nodes of blogs represented distributed knowledge in form of blogs:

. . . student were given a fish in a tank to care for and to keep a personal blog journal of how often they changed its water, feed the fish, what plants they introduced, what was the quality of water (involving physical testing) and where they kept the fish. The idea of putting these experiences on the blog was to relate personal experiences in the context of developing the group's overall knowledge capital. [REF 159816]

The use of Ning for students to learn from one another and to engage with expertise from the professional community:

. . . can extend our students' thinking and learning beyond time with them in the classroom, and by being able to facilitate communication between themselves and the kinds of people they are likely to engage with when they enter the professional sector. [REF 159844]

These students accessed the distributed expertise through listening to experts' podcasts and used Ning to engage with experts (podcasters). The use of Ning allowed the commentary on podcasts to persist whereby becoming a distributed resource.

A group Blog using Ning was also used as a mechanism for sharing and commenting by the Podcasters learning community. [REF 159845]

The use of discussion forums, within a learning management system, for creating a community of practice was also reported:

We wanted a strong sense of community in which scholars did not feel isolated . . . also wanted to ensure that there was a community of practice in which key issues pertinent to the field would be discussed . . . a community of scholars who could debate widely on all sorts of issues central to higher education. [REF 160011]

It can be inferred from statement REF 160011 that the discussion forums became a resource of wisdom of the cloud (communal knowledge). The forum also aggregated the distributed expertise that lay in individual students. In yet another case, the aggregation of ideas was done through the course blog:

In the Honours course we use Posterous for our course blog. Posterous allow for group blogging, so each student emails their reading responses, film review, and reflection on their learning process on the course blog. [REF 163305].

The recording of a lecture using Camtasia (TechSmith, Okemos, MI, USA) to enable students to watch and reflect on the lecture was reported:

I have used Camtasia to record some of the screenshots for my class presentations. [REF 164123]

It can be inferred from REF 164123 that Camtasia mediated the capturing of the class presentation for distribution and reuse. This way, students who might not have been present in class would have access to the presentation. The augmentation of pre-recorded presentation with chat room enabled students to engage with the resources and with each other. I argue that this engagement showed that intelligence was distributed in students.

The use of anonymous question and answer (Q&A) tool where students posted and answered questions from peers illustrated how distributed intelligence was harnessed to create a knowledge sharing experience for students:

Q&A—the anonymous submission of queries on a project helped keep the query emails down to a minimum but also allowed others to offer solutions too. [REF 165717]

Individual students consulted with classmates using the Q&A tool and while obtaining help on their individual questions, the aggregations of Q&A from the class became a resource for all students. Through a knowledge-sharing activity, students became teachers of each other and the teacher learned from what students knew. Thus, when the object of an activity is to harness distributed expertise, appropriate use of ETs is likely to have a transformative effect on pedagogy.

Recommendation

This study explored how the use of ETs by higher education educators had enabled interactivity between learners and their environment or individual constructions of knowledge (learning), and whether the enactment of emerging technological tools widened learner's access to multiple perspectives (technology). Results showed that some of the educators used ETs to support prescriptive learning, with a few of the educators using ETs in transformative ways through the use of distributed intelligence and expertise.

So, for the use of ETs to have a transformative effect on learning, the following five-phase pedagogical guidelines for teaching with emerging technologies is proposed:

Phase I: start with an educational goal and not with a technology. This goal is the object of the learning activity, eg, to foster collaborative knowledge production that leverage distributed intelligence or expertise.

Phase II: the learning activity from Phase I should lead to the creation of an artefact (ie, students either collectively or individually create something), for example: a digital story, a mobile learning application, or an e-portfolio. The learning outcome informs the selection of tools to mediate the accomplishment of a task. An educator may prescribe the tool(s) or leave the choice of tools to students.

Phase III: make it a requirement that students, either as a group or individually, present the outcome from Phase II. Ensure that the presentation is persistent (ie, record it) to enable reflection. These recordings could be distributed as podcasts or vodcasts. One of the affordances of podcasts/vodcasts is that students subscribe through the RSS feeds whereby enabling the podcasts to be downloaded to students' preferable devices.

Phase IV: students (group or individuals) reflect on Phase III (presentation) and Phase II (artefact design) in view of the problem statement (Phase I). Ensure that these reflections are publicly visible to the class for subsequent feedback and discussion.

Phase V: students research, write and submit a reflective essay for assessment based on the assigned task.

The above guidelines if used appropriately will promote learner-centred, collaborative and cooperative learning; students' productions of knowledge; students' presentations or articulation of their learning and reflection on the content and the process of learning. These characteristics of good teaching and learning may lead to meaningful and deep learning.

It follows that use of ETs aimed at harnessing distributed intelligence and expertise has potential to transform both teaching and learning practices. The outlined guidelines should assist educators who are exploring effective pedagogical approaches for teaching with ETs.

Conclusions

The activity system in this study is learning, which is facilitated by the educators (subjects) through the use of ETs (artefacts) and with a motive/objective of facilitating effective student learning. Results of the study showed that educators used ETs in various ways, with some of them using these technologies to support prescriptive learning (the dominant way of learning in most

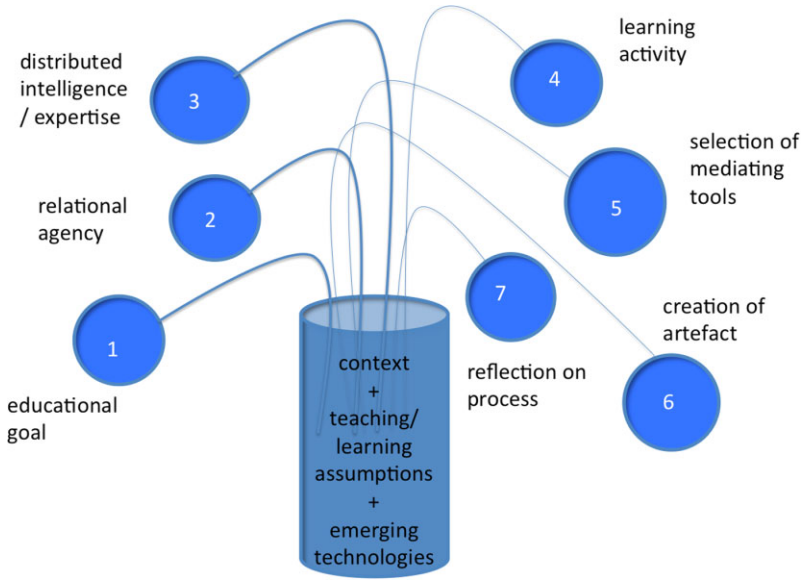

Figure 2: A transformative pedagogical model for teaching with emerging technologies

HEIs) and a few using ETs to achieve transformative learning (learning that is an outcome of interactions with people, resources and others). In view of the results presented in this paper, a model for using emerging technologies to transform teaching and learning practice is proposed (see Figure 2). In this figure, context, teaching/learning assumptions and emerging technologies are like the environment in which a garden is embedded. Inside the garden, educational goals (step 1) are defined, the relational agency (step 2) makes explicit assumptions about learning, distributed intelligence/expertise (step 3) describe the object of the activity, a learning activity is shaped by an awareness of capabilities of available technologies, appropriate tools are chosen (step 5) and students create an artefact (step 6) and reflect (step 7) on their learning experience. It can be argued that the proposed model would serve as a guide to effective pedagogical uses of emerging technologies.

In this paper, educators achieved the objective and the outcome of the activity system in different socio-cultural contexts, characterised by different resource allocations, colleagues who are resistant to use Information and Communication Technologies in teaching and learning, and varying degrees of institutional support for use of ETs in teaching and learning (although all institutions have policies that support the use of technologies supported by the institution). Thus, most of the educators used ETs in their teaching due to their passion for technology and the need to improve their students learning. The low levels of support from most of the HEIs can be in part due to the fear of putting the university as a brand into risk because of the openness and lack of control institutions have on most ETs; and most importantly, due to the lack of ETs pedagogical guidelines to guide institutions in the effective use of ETs in teaching and learning.

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