Using real-time/live data to enhance teaching and mlearning in higher education

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Introduction

"...This places a particular responsibility on universities to adopt a dynamic approach to teaching and research around environmental science"

Council for Higher Education (2013) report that: "The conditions on the ground dictate a fundamental systemic review of the undergraduate curriculum"
Since 2011 we have attempted to link agro-environmental measurement systems to information and their display via graphs and tables that are easily accessible at any time or place to undergraduates and postgraduates and staff for a range of disciplines even in the lecture room – mobile learning (mlearning).

The work described here has redefined the teaching and learning approaches – specifically those used for agrometeorology teaching at undergraduate level – and redefined the approach used for undergraduate and honours projects, and research.

Often, university students have:
- a poor conception of the agro-environment and of climate change
- poor numeracy ability
- poor interpretation of graphical data
- limited application of statistically manipulating large datasets

Often, this is due to a lack of exposure to data, including graphical display of data, representing the environment in a meaningful manner.

Often, university students:
- lack a basic understanding of concepts (e.g., temperature, temperature scales)
- have difficulty in displaying data graphically
- have difficulty in interpreting a graphical display of information – i.e., "reading" graphs/tables.
Visual literacy

- An essential component of science and technology education – also relevant to human sciences students
- Seeing the unseen – in data (tables and graphs)

Seeing the unseen – in data and graphs

- Sharpens understanding
- Serves as a springboard for questions difficult to formulate
- Quickly illustrates trends and data error – understanding of scales

Graphics, data and language

A picture paints a thousand (unwritten, unspoken) words

A picture paints a thousand (unwritten, unspoken) words in many languages

Graphics, data and language

Use of graphics and data in teaching and mlearning may transcend language differences between students and between student and staff, more than does written text and other resources

Graphics, data and language

Story of the Dutch visitors

AIM

Agrometeorology Instrumentation Mast
A presentation of nine parts
1. Why did we do it?
2. How did we do it?
3. What did we do?
4. So what?
5. Evaluation of use of AIM

1. Why did we do it?
- Increased awareness in contemporary agro-environmental issues
- Class sizes increased but not space nor equipment/technical support – needed a system for undergraduate/honours projects

1. Why did we do it?
- Lacked a permanent, multidisciplinary, near real-time data and information resource for teaching, mlearning and research
- Needed a system for near real-time data/graphics display in a lecture room via PC/laptop/tablet/cellphone using wireless/LAN, and in a corridor

Background
- Previous history (1970s): blackboard display of daily weather data
- Previous history (1980s): chart recorder display of hourly weather data
- Weather stations: weekly visits for data collection and maintenance (1990s, 2000s)
2. How did we do it?

- Purchased a vehicle – for transporting masts, concrete bases, equipment: March 2011
- Software/set-up mlearning curve: April 2011
- Installed pilot mast system: April 2011

2. How did we do it?

- Identified http port and applied for use of port 5355: May 2011
  http://agromet.ukzn.ac.za:5355
- Proposal (applied for funding through UTLO): June 2011

3. What did we do?

- Tested radio equipment and dataloggers
- Defined datalogger network map
- Defined datalogger schedule
- Installed "backbone" for connecting other field systems to existing system

Field-based measurement system

System 2
System 3
System 4
System 5
System 6
System 7

Radio
RS-232
Radio (on building)
GSM modem (static IP address)
Internet
Server

RadioNet (scheduled for data collection)
RTMC (layout and design)
WebServer (publish Web files)
Tablet/cellphone (web-enabled)
Internet (http://agromet.ukzn.ac.za:5355)
Laptop (with WiFi)
LoggerNet database
PC:
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Defined network map

Defined datalogger schedule

No problems found with settings for the selected device

Defined activity associated with each data file

Parallel and continuous activity:
1. Mast 1 (teaching, research, extension)
2. Mast 2 (teaching, research)
3. Air temperature station (teaching, research)
4. ICFR nursery (honours, staff, environmental control)
5. Radiation station (teaching, research)

mLearning: all masts

4. So what?
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23 July 2014
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Introduction
Temperature is an important parameter in the growth and development of plants, animals, and many organisms. In agriculture and environmental sciences, it is crucial to understand how temperature affects growth and development. Temperature influences the rate of processes such as photosynthesis, respiration, and transpiration. It also affects the distribution of species and the overall productivity of agricultural systems.

Agronomy and Environmental Biophysics

Temperature and Associated Indices

- Name:
- Group:
- Date:

Introduction
Temperature is an important parameter in the growth and development of plants, animals, and many organisms. In agriculture and environmental sciences, it is crucial to understand how temperature affects growth and development. Temperature influences the rate of processes such as photosynthesis, respiration, and transpiration. It also affects the distribution of species and the overall productivity of agricultural systems.

Conclusion
The utilization of real-time data in higher education and mLearning can enhance the learning experience. By integrating real-time data into the curriculum, students can gain a better understanding of the complexities of temperature and its impact on various organisms and processes. This approach not only enhances the educational experience but also prepares students for careers in fields that require a deep understanding of environmental biophysics.
Nowcasting
Complex event processing (CEP) is used for the observation and management of business processes

Nowcasting: at most six hours ahead

Nowcasting of the daily minimum grass-surface, grass, or air temperature is needed if active methods for combatting frost are to be effective

Parton and Logan (1981) described a sinusoidal and exponential model for daytime and night-time air and soil temperature variation

For the nighttime hours, $T(t) = T_{\text{min}} + (T_{ss} - T_{\text{min}}) \exp \left[-b \left(t - t_{ss}\right)/N\right]$

5. Evaluation of use of AIM
Three open questionnaires were designed to gauge the response to usage of the system as well as to obtain feedback for improvement

1. 197 respondents (about 65/questionnaire)
2. About 70% return
3. Six-monthly intervals
4. SURV1: undergrad, postgrads and staff
5. SURV2, SURV3: undergrads

Respondents said they benefited from system use and their appreciation of ranges of various weather elements improved (60% of respondents, > 82% for SURV2, 3)
5. Evaluation of use of AIM

Ability to manipulate data, in a spreadsheet and/or display data in graphic or table form, improved their appreciation/awareness of global climate change and/or global warming aspects (85.5 % for SURV3)

5. Evaluation of use of AIM

System use improved their appreciation/awareness of the graphical display and trends of agro-environmental data (79.6 % for SURV3)

5. Evaluation of use

Graphical display of data enabled further understanding of the agro-environmental concepts irrespective of language (75 % of respondents, SURV2, 3)

5. Evaluation of use

Respondents comfortable with English even though the 27 out of 41 that replied to question are isiZulu mother tongue (78.2 % of respondents, SURV3)

5. Evaluation of use of AIM

Many scientific/technological terms do not exist in isiZulu – e.g., meteorology, agrometeorology, condensation, adiabatic, emissivity

5. Evaluation of use of AIM

There is an urgent need to create a list of isiZulu technical terms specific to Agrometeorology and allied disciplines
### 6. Where to now?
- Additional http port? ICT
- Addition of other campus and off-campus sites?
- Early warning systems (fronts, frost, flood, fire?) – honours/masters projects

### 6. Where to now?
- Increased use outside Agrometeorology?
- Urgent need for software upgrade
- More interactive research use, using TeamViewer for example

### 6. Where to now?
- Weather prediction? – funding: MSc/Honours
- Project on Agrometeorology terms in isiZulu
- Involve other disciplines and junior/high schools more directly – funding?

### 6. Where to now?
- Addition of off-campus sites?
- Additional administration
- Requirement: SIM card that gives the modem a static IP address – connection directly to datalogger with a permanent GPRS connection
- Other sensors? Funding?

### 7. Problems with AIM?
- Requires infrastructural support
- Needs daily checking: web-link disconnects?
- Site maintenance – access to technical support

### 8. AIM research outcomes?
This work, initially designed for undergraduate teaching and mlearning, has spawned other activities – many fruitful
8. AIM research outcomes?
- Teaching and mlearning research on system use by undergraduates
- Three honours projects (two with distinction)
- One MScAgric
- Three masters students registered
- Three publications, one paper accepted
- Two national awards
- Six conference presentations, one poster

9. Summary of AIM
AIM (interdisciplinary teaching, mlearning and research)

Student
Near real-time data
Environment
Language
Visual literacy

AIM (interdisciplinary teaching, mlearning and research) system
Near real-time data
Enquiry
Environment
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9. Summary of AIM
While the STUDENT is mlearning through an ENQUIRY using the AIM system, they are also DOING RESEARCH – the missing element AIM: integration of mlearning and research processes with lectures providing directed teaching.

Conclusions
Successfully developed a web-based teaching, mlearning and research open system for real-time data and information for the agricultural, earth and environmental sciences.

Conclusions
Web-based system developed is 1. unique, 2. a permanent, multidisciplinary, near real-time instrumentation and online data and information resource for teaching, practicals and projects and 3. accessible practically anywhere.

Conclusions
- Requires infrastructural support
- Needs daily checking: web-link disconnects?
- Site maintenance

Acknowledgements
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