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Paving the way for institution wide integration of Tablet PC Technologies: supporting early adopters in Science and Engineering

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The implementation of a new technology into an institution can be challenging when faced with limited support and restricted procurement procedures. Academics in the Faculty of Science and Engineering at Curtin University have been using tablet PC technology for several years to transform passive presentations into media rich, collaborative and engaging learning experiences. Recent advancements in tablet PC technology have stimulated new interest in tablet technology but also raises the question of how a university responds to the support and procurement of such new technology. In addition, what professional development is required to ensure that staff are comfortable and competent when teaching effectively with these devices. This paper presents the experiences and findings from a Community of Practice at Curtin University that embarked on evaluating and implementing three models of tablet PC at the university. The Community also engaged in a number of different professional workshops that demonstrated various strategies and fostered communication around current practice. The outcomes presented in this paper indicate the need to support academics using tablet PC's in a responsive way rather, rather than being prescriptive on tools available through service agreements. The collaborative approach to investigating an educational technology situation used in this project could be seen as a model applicable to other contexts that involve many stakeholders across an institution.

Keywords: Tablet PC, Technology Integration, Science and Engineering, STEM, Tablet Technology

Introduction and context

Tablet PC's have been used in science and mathematics education for more than ten years with academics utilising a stylus to annotate lecture slides and tutorial questions to illustrate progressive problem solving through the unique digital inking capability (Mock, 2004). The method of real time problem solving and worked solutions, are said to be an integral part of learning and understanding mathematical concepts (Loch & Donovan, 2006) and therefore practiced by many educators. Academics from Science and Engineering at Curtin University have also used tablet technology to solve mathematical concepts in a virtual classroom (Dong, Lucey, & Leadbeater, 2012) and to create screencasts of worked examples. However, despite the positive effects that tablet PCs have had on student learning (Choate, Kotsanas, & Dawson, 2014; Graves & Plant, 2010) it was found that internal support (Garrick & Koon, 2010), institutional infrastructure and quality of tablet PCs are all factors that may influence the success of implementing desired strategies (Stewart, 2013).

A new generation of tablet PCs has generated an increased demand for this technology. Between 2012 and 2013, sales of tablet devices increased by 68% (Rivera & Meulen, 2014) which was likely to have been fuelled by marketing the device as a replacement for laptop computers (Jones, 2014). Improved processing power, coupled with an operating system and productivity software optimised for a touchscreen interface has increased functionality and suitability for teaching. Consequently, academics are looking to these new generation tablet PCs to address teaching and learning needs. In response to this it becomes important to investigate how an institution responds to the procurement and support of the technology as well as providing professional development for effective teaching.

Within the Faculty of Science and Engineering academic staff were keen to adopt tablet PC technology in their teaching but faced institutional hurdles when dealing with Information and

Communications Technology (ICT) Procurement or support from Curtin Information Technology Services (CITS); a common challenge faced (Weaver, 2006). In order to address the requirements of academics and alleviate any concerns from these stakeholders, a collaborative project was established that brought together staff from CITS, Curtin Teaching and Learning (CTL) and academics from Science and Engineering into a Tablet PC Community of Practice (CoP).

Communication and professional learning methodology

The project utilised a CoP framework (Wenger, 2006) in response to an identified need within the Faculty. This framework was established to bring like-minded academic and professional staff together in order to facilitate discourse around the use of tablet PC technology to address teaching and learning needs (McDonald & Star, 2008); as well as to provide a supportive environment to trial and problem solve tablet PC enabled teaching and learning strategies.

CoP participants were strategically selected based on their experience or interest in trialling tablet PC technology. Staff involved in this project (n=20) were predominantly academics teaching in Science and Engineering (14), with additional participants drawn from Curtin IT Services (CITS) (two) and Curtin Teaching and Learning (CTL) (four). It was believed that an inter-departmental CoP would allow for the contribution of a variety of perspectives.

The Tablet PC CoP was facilitated through a number of communication and professional learning strategies (Table 1) including an online community hub (Blackboard), structured workshops, and email correspondence. Selected articles were posted on the public Curtin Teaching and Learning blog [http://blogs.curtin.edu.au/cel/?s=tablet+PC].

The online hub was set up as a Blackboard Community in which CoP participants could self-enrol. The hub contained PnTT project documentation and resources as well as a discussion board and group blog. Participants were encouraged to access the hub regularly to share their experiences and discuss any issues or successes that they encountered while trialling the devices.

Workshops were designed and facilitated by CTL staff to encourage discussion on the use of tablet PC's to address teaching and learning needs and to explore the capabilities and performance of the different models. During the project, academics engaged in five activities described below.

Table 1: PnTT CoP Activities

Activity	Description and Objectives
1 – Out of the Box (Workshop)	In the first workshop participants were invited to unpack, examine and briefly trial all four tablets and associated peripherals. At the end of the workshop tablets were distributed to CoP participants.
2 – Technology evaluation	The performance of each tablet was evaluated and documented throughout the duration of the project. The evaluation criteria was collaboratively derived by CoP members based on the tablet PC features they considered important when completing daily tasks and teaching activities.
3 – Tablet PC Use cases in academic practice (Workshop)	In the second workshop participants were invited to respond to the question "What are the ways tablet PC's could be used in academic practice?" The GroupMap tool was used to facilitate the documenting of ideas and participants use their tablets to engage in the activity.
4 – Blackboard Collaborate (Workshop)	In the third workshop participants explored Blackboard Collaborate (virtual classroom) using their tablet PCs. The aim of the workshop was to: • Trial Blackboard Collaborate (virtual classroom) and its features on the range of tablet PCs • Specifically test the stylus capabilities of the tablet PCs when using the interactive whiteboard in Blackboard Collaborate
5 – Transforming teaching with tablet PC's	In the fourth workshop participants discussed Ruben Puentedura's Substitution, Augmentation, Modification and Redefinition (SAMR)

Activity	Description and Objectives
(Workshop)	Model (Educational Technology and Mobile Learning, 2014) in relation to tablet PC enhanced teaching strategies. The aim of the workshop was to: • Present the concepts of the SAMR model and example transformations • Capture how academics have or would like to transform their teaching with tablet PC technology • Showcase OneNote features and applications

Following each workshop, a set of summary notes were distributed to all participants. The notes captured topical discussions, including tablet PC performance, and were published via the Curtin Teaching and Learning blog [http://blogs.curtin.edu.au/cel/?s=tablet+PC]. Outcomes of the CoP activities are referenced in the remainder of the paper.

Technology procurement

At the start of the project, a range of tablets and associated peripherals were identified in order to evaluate the affordances of each. Initial advice and recommendations on which devices to purchase was sought from both CITS and academic CoP participants who were tablet PC enthusiasts and already possessed some level of expertise in using tablet PC's in their teaching. Although one of the recently released tablets had received poor reviews from early adopters it was agreed that they be trialled as part of the project because they aligned with the University's procurement agreements.

The tablet specifications from the four vendors are detailed in Table 2 below.

Table 2: Tablet specifications

Tablets	Specifications	Tablets purchased
Dell Venue 11 Pro	2 x Win8.1Pro/i5 Processor/ 8GB RAM/ 256GB SSD 3 x Win8.1Pro /i5 Processor/ 4GB RAM/ 128GB SSD	5
Microsoft Surface Pro 2	Win8.1Pro/i5 Processor/ 4GB RAM/ 128GB SSD	5
ASUS Taichi 31	Win8/i5 Processor/ 4GB RAM/ 128GB SSD	2
Sony Vaio Duo 13	Win8/i5 Processor/ 4GB RAM/ 128GB SSD	2
	Total	**14**

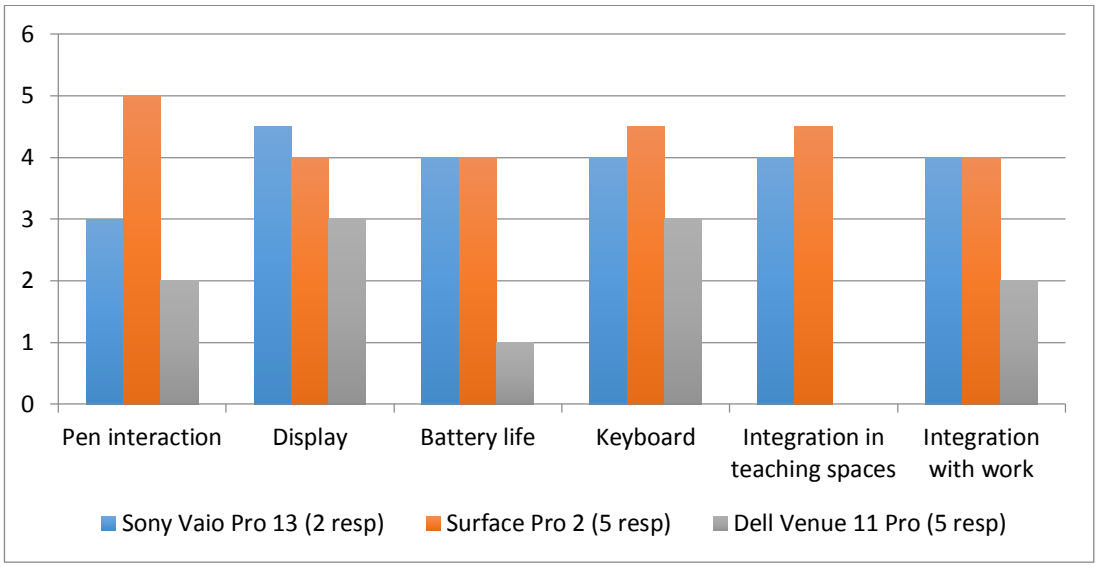
Ultimately, after initial receipt of four tablet models, only three formed part of the full evaluation and CoP process. The two ASUS Taichi 31 tablets were returned to the vendor three weeks into the trial due to hardware malfunctions.

Technology evaluation

Proven performance and stability of any given technology is integral for the successful uptake by academic staff. In addition, the technology must also integrate with the existing university infrastructure and IT systems. Project participants contributed to a technology evaluation activity that spanned the duration of the project and served as an avenue for documenting the performance of their tablet PC. The evaluation criteria were collaboratively derived from CoP members based on what was considered important for daily work tasks and teaching activities. These included pen interaction, monitor display, battery life, integration with teaching spaces and work tasks.

An "at a glance" quantitative summary of the technology evaluation activity is presented in Table 3. Based on participant feedback, the tablet PCs were given a score out of five. Please note only three of the four models initially purchased were evaluated and the number of models purchased varied hence it is important to note the number of responses for each device shown in the key.

Table 3: Tablet PC performance ranking



Pen interaction

Academic staff considered pen interaction to be the most important criteria in the evaluation because of the value of handwritten annotation. The Surface Pro 2 was the highest performing model in terms of responsiveness, latency (lag), calibration, pressure sensitivity and palm detection. The only concern was the weak magnetic attachment for the stylus, which caused it to detach from the tablet when not in use. This issue has been addressed with the Surface 3 series. The Sony Vaio Duo 13 underperformed due to poor palm detection leaving residual marks on work. The Dell Venue 11 Pro was said to be slippery, like writing on glass; furthermore at times the stylus was unresponsive due to poor battery connection in the stylus.

Display

Overall the performance of all displays was said to be satisfactorily clear and sharp. The Sony Vaio Duo 13 performed better due to the larger screen dimensions and the Dell Venue 11 performed lower due to malfunctioning adaptive brightness settings, a bug carried over from the Dell Venue Pro 8 (Tablet PC Review, 2014). General feedback regarding the display mainly focused on screen resolution and zooming capabilities rather than clarity. This was more an issue of app optimisation rather than the quality of the screen. For complex desktop applications it was recommended that a secondary display be used via the HDMI adaptor. Alternative suggestions were to adjust the resolution of the screen or, where possible, use the app version of the product that has a touchscreen optimised user interface.

Battery life

Battery life impacts the amount of time an academic can facilitate learning and be mobile without relying on charging cables and power supply. The Surface Pro 2 performed satisfactorily with feedback indicating minimal battery drain whilst in sleep mode, longer performance when in power saving mode, average seven hours battery life, and two to three hours to become fully charged. Sony Vaio Duo 13 users were also generally satisfied with battery performance. The Dell Venue 11 Pro experienced considerable battery issues including battery drain whilst in sleep mode, inability to hold charge and frequent crashing. These faults were also identified by external purchasers and this contributed to the vendors' decision to recall and replace the product.

Keyboard

The physical keyboard is a popular peripheral tool used to facilitate text and numeric input, access quick functions via shortcut keys and inbuilt mouse track pad. A physical keyboard is often used as the onscreen keyboard occupies half the screen, which significantly reduces the amount of screen allocated for viewing applications. Feedback indicated that users had the physical keyboard attached to the device most of the time. Each model of tablet PC approached the physical keyboard differently. The Dell Venue 11 Pro had two keyboards on offer. One came with a built-in battery to extend the duration of mobility however this doubled the overall weight of the device. The Dell slim keyboard exhibited poor tactile response and frustrating typing delays. The Sony Vaio Duo 13 is an all in one unit where the keyboard is permanently attached. Users of this device were satisfied with the design and weight of the device and responsiveness of the keys. It was recommended that an additional cover would protect the device from wear and tear but was not available for that model. Users of the Surface Pro 2 were satisfied with the physical keyboard. The big keys, tactile feedback, backlit keys and doubling up as a screen cover were features that made the keyboard enjoyable to use. Some users did however experience a conflict with the onscreen pop-up keyboard such that it did not automatically popup or hide. This issue was resolved.

Integration in teaching spaces

Performance in existing teaching spaces is integral to ensuring a seamless student learning experience. Existing infrastructure in many teaching spaces includes access to wifi, power supply, and presentation via VGA, HDMI and AirMedia. The Surface Pro 2 was used in a variety of settings resulting in successful presentation via VGA, HDMI and AirMedia, however in one case the clarity of the display via AirMedia was a little distorted and could detract from the accuracy and legibility of the content. The Sony Vaio Duo 13 also integrated well into teaching spaces. None of the Dell Venue 11 Pro users responded to this criteria. Users stated that the device was not stable enough to use with students.

Integration with work

The integration with work criteria is fundamental in determining how the devices performed in carrying out desired tasks. The Sony Vaio Duo 13 performed well however one academic chose not to modify the device's default set up meaning the Windows 8 OS was not upgraded, it was not connected to the university's network and it could not connect to site wide licensed software. The rationale was that the academic wanted to use applications that would be accessible to students. Despite this academic noted that:

> The nature of interaction with students has changed and annotating student graphics is possible as are conceptual diagrams and line images. Daily tasks that are completed on other devices are finding their way onto the tablet device, as touch screen interface is a major plus!

The second academic stated that carrying out work tasks was limited until the device was upgraded from 8 to 8.1 OS, and access established to site wide Microsoft applications. Feedback for the Dell Venue 11 Pro was limited as the devices were regularly faulty or out of commission.. It was noted that the device efficiently manages native windows productivity tools but only intermittently accesses files on shared network drives. The Surface Pro 2 was used for a variety of tasks including resource development, office productivity, research tasks, meetings, conference presentations and off-campus access. The feedback was also positive highlighting the benefit of accessing network drives, ability to run native windows applications, the ability to play Flash (including iLectures) and valuable annotation applications.

Email from CoP member

> the surface has been terrific and I find so, so much greater flexibility and usefulness than iPad (which I have used for years and thought I loved more than my children!) the windows platform is more functional and the recording of mini lectures using Camtasia has transformed how I give feedback as well as lectures e.g. Mini solution tutorial or feedback video rather than uploading a 'solution'. But of course, journal and OneNote then PDF the section gives the written solution of anything I scribe onto the tablet.

On the down side one academic did experience issues installing MATLAB (windows based discipline specific software) however “overall I am very happy with it”. What was noted is that logging in from home takes a few minutes and that the networked devices are slow to reconfigure to a wireless configuration after being connected to the domain via an Ethernet cable. This may be related to University device authentication protocols.

Technology support

It was agreed that CITS would provide limited support. Support included initial set up for all devices (i.e. upgrade OS if required, connection to the network drives and access to site wide licenced software) and full support for the Dell Venue 11 Pro (i.e. service jobs for hardware malfunctions). CITS support for the MS Surface Pro 2, Sony Vaio Duo 13 and Asus Taichi 31 was not required beyond initial setup and initial troubleshooting was resolved by phone. An exception to this was the Dell Venue 11 Pro that generated over 25 X-ITS job requests far exceeding the basic jobs logged to connect any of the other tablet PCs to the network.

The poor experience with the Dell Venue 11 Pro spanned the length of the project. It took three months to receive the Dell Venue 11 Pro’s due to a recall of the stylus, difficulty in deploying initial setup, followed by a complete engineering hold prior to deployment and further delay to obtain the docking stations. The Dell Venue 11 Pro was deployed in March 2014 and by May (two months into the project) numerous faults were experienced as reported by users. The issues were wide spread resulting in Dell placing a hold on shipments to Australian and New Zealand and recalling all affected devices. Based on their recall parameters only three out of the five Dells were affected, however those that were not recalled still experienced various faults. One month later (June) new tablets were issued however two of the replacements still experienced various faults. Two weeks later (July) all five Dell docking stations were recalled and replaced. The string of events was extremely onerous for everyone involved, particularly for CTL staff as they were unexpectedly coordinating significant technical issues for each device and its accessories. It was evident that the stability of the device was not satisfactory and therefore in July a refund was requested. A detailed report outlining reasons for the refund was submitted which required ongoing follow up correspondence. In September (two months later) ICT procurement approved the refund of the Dell Venue 11 Pro’s and all accessories. After what seemed to be a very complicated process, the refund was eventually received in November.

The two Asus Taichi 31 devices experienced significant issues regarding the primary methods of interaction, the stylus, mouse and touchscreen interface. They were deemed unusable three weeks into the trial; were returned to the retail outlet and a full refund was issued.

Institutions negotiate service level agreements with technology vendors with the aim of streamlining the procurement process, building in extended support and insurance and getting the best value for money through negotiated fee schedules. Comparing the cases previously described, the devices supplied via the service agreement required considerably more time and red tape compared to the externally purchased devices. Curtin University has acknowledged the need to be more flexible with regards to vendor and contract management and it is hoped that this study can contribute to the discussion and inform the decision making process.

Integration with teaching

The following discussion regarding the integration of tablet PCs to enhance teaching strategies refers to CoP activities three, four and five as detailed in Table 1. Activity three was a brainstorming workshop entitled Tablet PC in Academic Practice [http://bit.ly/1GQp2Uy] that facilitated the documentation of how the tablet PC technologies are currently and potentially used in academic practice. Seventeen Tablet PC CoP members participated in the GroupMap activity generating 71 ideas. Details of all ideas can be viewed at http://bit.ly/NRHGGShttp://tinyurl.com/TabletPC4Teaching. A broad range of use cases were identified including:

- Synchronous problem solving with annotated explanation
- Annotating lecture notes

- Annotating diagrams
- Ability to present concepts in a highly visual and progressive manner
- Reviewing student work and providing annotated feedback
- Collaborative student problem solving
- Capability to retain digital record or generate videos
- Recording from both front and rear camera (e.g. peer-client consultation activities)
- Recording videos to support flipped classroom approaches
- Facilitate research activities (electronic record keeping)
- Facilitate fieldwork activities
- Mobility in the classroom enabling small group facilitation
- Academic administration

Of these applications academics were primarily interested in using tablet PCs for resource development and classroom facilitation with stylus input and portability of the devices as enablers of this. It is important to note that integration with university systems such as student enrolment and management systems or finance systems do not feature in this study, as academics did not wish to use the tablet PC for this purpose.

A selection of specific University supported applications were explored using the tablet PCs including Blackboard Collaborate, AirMedia, Echo360 Personal Capture 5.4 and MS OneNote (not supported).

Blackboard Collaborate

Blackboard Collaborate facilitates synchronous distributed learning opportunities enabled by functions such as audiovisual presentation, video conferencing, interactive whiteboard, polling and application sharing. A workshop was held to evaluate the effectiveness of Collaborate using tablet PCs. View workshop notes [http://bit.ly/1zNUXIm]. In summary both audio and video output was loud and clear, however pen output on the interactive whiteboard was very jagged. The low resolution of the tablets made it difficult to interact with user interface, particularly those features that require precise stylus/mouse interaction with smaller icons (e.g. raising a hand or selecting a polling option). For this reason some academics preferred using the mouse interaction over the stylus. This application has not been optimised for the tablet PCs and hence would benefit from using an additional display.

AirMedia

AirMedia enables wireless presentation in teaching spaces. Mobility in the classroom is an aspect that academics have not had much exposure to. Traditionally presentation occurs from a lectern distanced from the students. During the Out of the Box workshop connection to AirMedia was straightforward. As soon as they were connected one academic promptly made themselves comfortable in the middle of the room and commenced live problem solving (via Windows Journal) that was clearly displayed via the projector. During the Transforming Teaching with Tablet PCs workshop [http://bit.ly/1cpmTYA] AirMedia was used to wirelessly display activities conducted in MS OneNote application. Connection to AirMedia was straightforward however projection was not accurate such that table lines and text were broken as though it was a dotted line. Further investigation regarding screen resolution and AirMedia transmission needs to be carried out.

Echo360 Personal Capture

Echo360 Personal Capture enables academics and students to record camera and screencast videos that are published directly into the iLecture hosting system. There are a variety of applications for video based learning resources including enabling flipped learning approaches or student created videos. Version 5.4 of the application had only just been released but it was known that it would be rolled out after platform testing. Echo360 Personal Capture performed well across the board in terms of installing the software, recording and processing the video; however the small resolution of the user interface at times required some precision to interact with. Adjusting the screen resolution resolved this.

OneNote

OneNote is a productivity tool that has been optimised for tablet devices. OneNote files can be accessed from any platform however functionality will vary with maximum productivity features available on the Windows desktop version. This tool was used to facilitate the Transforming Teaching with Tablet PCs workshop [http://bit.ly/1cpmTYA]. Each participant contributed to the OneNote document synchronously using the stylus or text input with changes appearing without delay on participants' devices. The document was easy to set up through self-created templates and a variety of sharing permission options. One observation was that annotations appeared out of alignment when working in the desktop version and then viewing in the web version of the product. OneNote was considered a sound productivity tool that caters for resource organisation and collaborative activities.

Current projects

The demand for Tablet PCs within Curtin University has increased through the current projects described below.

Tablet PCs on field trips

In 2014 a team in the School of Environment and Agriculture received a grant that funded the purchase of 16 Lenovo tablet PCs to facilitate student engagement and an interactive learning experience whilst on field trips. This project feeds into four Bachelor of Science course majors including Environmental Science, Coastal and Marine Science, Environmental Biology and Agriculture.

Tablet PCs in laboratory's

The Department of Chemistry are planning to use tablet PC's to facilitate new curriculum initiatives in response to industry standards and graduate expectations. The goal is to embed the use of Electronic Laboratory Notebooks (ELN) across the Bachelor of Science (Chemistry Major) course. The approach is to be trialled in a core first year unit with an intake of over 300 students. Outcomes of the project will inform the way ahead for establishing it in other units.

The tablet PC technology will be used holistically throughout the unit to increase the student learning experience. The Unit Coordinator is currently exploring strategies to facilitate lecture and laboratory classes including live annotation and recording worked examples. Students will use the technology to conduct the electronic record keeping aspect of their laboratory experiments. In order to achieve this, a laboratory will be equipped with approximately 12 tablet PCs. A variety of tablets will need to be evaluated to ensure their fitness for purpose in terms of cost and performance. The outcomes of the project will inform the technical requirements for rolling out the use of tablet PCs across two additional laboratories.

Touch screens in collaborative learning spaces

The university has redeveloped a number of teaching and learning spaces into collaborative teaching spaces equipped with a variety of technologies. Live annotation is a recognised teaching strategy reflected in the facilities deployed in these new teaching spaces including whiteboards, interactive whiteboards, document cameras, and a few interactive tablets. There is an opportunity to review these technologies and explore how tablet PCs could further enhance the classroom experience including:

- Classroom mobility – Facilitating problem solving at student tables increasing personalised support and teacher student interaction.
- Resource development – Capacity to record class videos that include discipline specific software mixed with handwritten workings.
- Enhanced annotations – Choice of pen colour, thickness, opacity and an output that is smooth and clear at a high resolution.

Conclusion

This project demonstrates how a collaborative effort between stakeholders has resulted in the successful evaluation and implementation of a range of tablet PCs across Curtin University. The product evaluations revealed a wide disparity between the quality and functionality of tablet PCs on the market and highlighted the importance of engaging with the end user (customer) when deciding what product to procure. Furthermore, the documented outcomes and relationships formed through CoP activities have provided a stepping-stone for new users wishing to adopt such technology.

The university needs to be confident in the technology they are procuring to address academic demand. Vendors are always improving and introducing new products based on market demand, resulting in an ever-changing landscape of available options. Therefore the channels of communication that have been opened between stakeholders including procurement, IT services, the academic and teaching and learning support should continue in order to foster innovation and meet the needs of the end user.

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