

ASPs: Snakes or Ladders for Mathematics?

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Abstract

We review our experience at the University of Portsmouth over the past academic year, following a shift from home-grown to mass-produced electronic resources from an educational publisher, Wiley Plus. We present the results of a survey on the way mathematics students taking calculus units in their 1st and 2nd year viewed the shift towards Plus, and the opinions of staff involved in tutoring and supporting them. We discuss whether a personalised approach to teaching and learning can be maintained in a world of global education. Should the shift towards Wiley Plus become total, remain partial or simply be reversed? To what extent should we continue to integrate other resources, particularly assessment questions (e.g. from MapleTA, WebCT/Blackboard or PRS) with Wiley Plus?

Several other publishers of mathematics textbooks are providing comprehensive packages of interactive resources online. Application Services Providers (ASPs) create, store and deliver from their own server. Their resources include an electronic version of the text or e-book, supplementary materials, worked solutions, study guides, applets, formative assessment with extensive feedback and even summative assessment. Lecturers can customise these materials, most significantly by choosing questions for self-assessment tests and exams. Inevitably there are constraints on the extent to which they can modify or add to these materials.

Have ASPs improved the teaching and learning in our large classes of around 150 students? What about smaller classes? The stark choice between open source collaboration and commercial provision often polarises individual academics and even whole institutions. We argue that the ideal is a financially sound, hybrid model, which allows for greater customisation, sustainability, extension and interoperability than is currently available from either commercial providers or open source initiatives.

Introduction

Cleopatra, the last Pharaoh of Ancient Egypt, allegedly killed herself by means of an asp bite on August 12th 30 BC. Over two thousand years later our question is whether the adoption of commercial teaching and learning software products from Applications Services Providers (ASPs) is a suicidal step. Academics cherish their independence of thought and individuality of their teaching, but are they being killed off by the emergence of integrated resources which seem to offer a complete on-line learning package?

In some ways the situation is not new. Lecturers have always had to make decisions about the adoption of standard mathematics textbooks, which chapters to include and how rigidly to follow the printed page. Some write their own in-house notes and ignore textbooks other than for reference or further reading; others develop supplementary materials such as their own notes to provide a digestible overview or worksheets to provide more problems and examples.

While the mathematics textbook has remained the mainstay of learning, some lecturers have invested major effort in developing their own e-teaching, e-learning or e-assessment resources to support their courses. Funded projects, both large and small, emerged in which academics collaborated on the production of electronic resources with or without associated paper resources. The sums of money spent on these projects have often been significant and the products variable in their impact and longevity. A major problem has always been the maintenance and ongoing development of resources, especially electronic resources, when the funding has dried up. The commercialisation of mathematical resources, which started up on public money, is unusual and the majority of "cottage industries" are doomed to long-term obsolescence. It is left to the goodwill and altruism of individual academics, who rarely have the time necessary for production and maintenance of high quality online resources.

Commercial publishers sometimes release new editions of mathematics textbooks every year and often every two or three years. Lecturers who adopt the textbooks are, in some sense, handing over control of their academic content and could even be regarded as committing intellectual suicide. Control can be maintained relatively easily by providing additional printed material to breathe life into a course. As commercial publishers develop increasingly sophisticated online resources to support or even replace textbooks, is the control of content being lost further? Do academics need to adapt their teaching again? ASPs create and store interactive resources for online delivery from their own server. Their commercial products are available from the publishers of several prominent mathematics textbooks: MyMathLab for Pearson, WebAssign for Thompson Learning/Cengage and Wiley Plus for Wiley. Are ASPs to be regarded as a threat or an opportunity, snakes or ladders? We present our own views and those of our students based upon our initial experience of Wiley Plus.

Context: Staff and Students

The number of mathematics students at the University of Portsmouth has increased dramatically between 2002 and 2010 with a greater than five-fold increase from under 30 to over 160 entering each year (Figure 1). In 2010/11 the total number of students exceeded 400 for the first time and the increase in total numbers is set to continue. During this period there were negligible increases in staff numbers and significant changes in staffing due to retirements. The department has often achieved top-4 NSS and league table positions and the entry grades of students have improved. We developed substantial use of Question Mark Perception for assessment during this period.

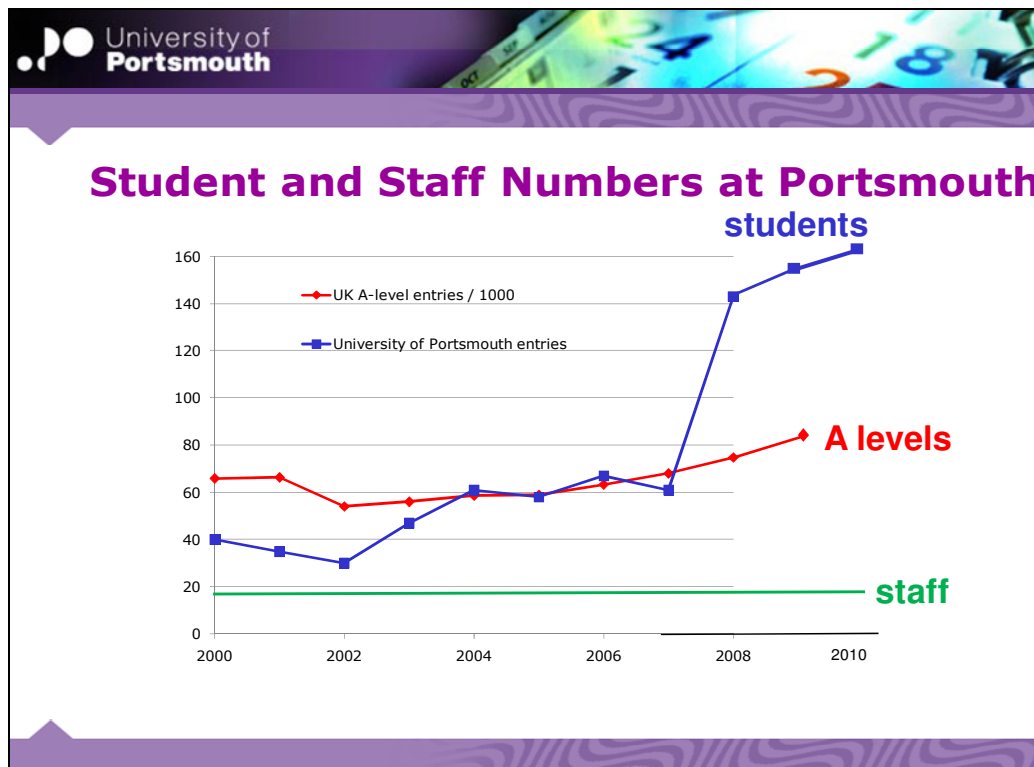


Figure 1: The Growth of Mathematics at the University of Portsmouth

Case Study: Wiley Plus

It is common for lecturers to have limited time to prepare printed resources for delivery of a new course unit/module. It is rare to have enough preparation time for the development of e-learning resources beyond a basic VLE “presence” by uploading notes and presentations. We describe a case study in which there was just two weeks to prepare for the delivery of a first year, second semester, 20-credit unit covering “further calculus and linear algebra” to over 150 students.

Existing resources included two recommended texts from different publishers, written lecture notes, the set of Question Mark Perception e-assessments (see above), in-class question banks for use with “clickers” (PRS handsets) and a minimal presence in the university “Victory” VLE. Weekly delivery was via two 1-hour lectures, one 2-hour “clicker” exercise classes, a 1-hour small group personal tutorial and a 1-hour assessment period during which seven tests were to be completed. Students were allowed to repeat tests to raise their marks, but credit could not be carried over and the same question, answered

correctly at the first attempt, might well have to be repeated during subsequent attempts. Random parameters or algorithms were not available and the QM Perception questions developed over ten years earlier for formative and summative assessment were looking outdated and mathematically limited (Figure 2).

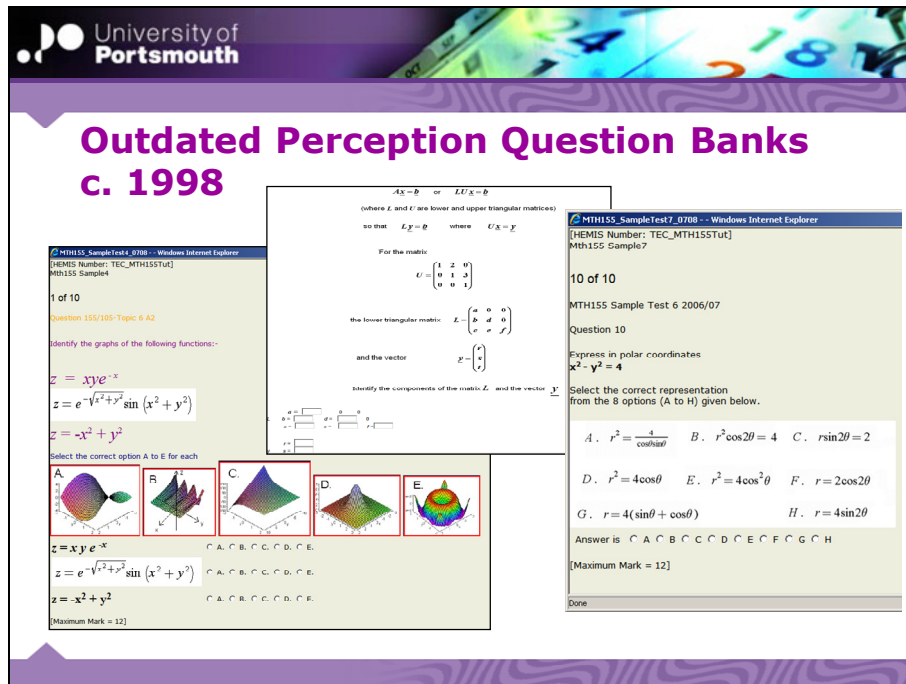


Figure 2: E-assessment Questions in Need of Replacement

With more time the questions could have been updated in QM Perception to eliminate some of the problems or converted to MapleTA to overcome the mathematical limitations. A provisional decision to introduce MyMathLab was switched to Wiley Plus for several reasons:

- it supported one of our adopted calculus textbooks (Anton, Bivens and Davis, 2010)
- its underlying assessment engine was MapleTA, which we already used
- it provided a comprehensive bank of online assessment questions including feedback and random-algorithms
- there was local Wiley support provided at short notice to set up W+ access for road testing and live delivery, to deal with technical, especially assessment, issues that arose and to introduce the product to both tutorial staff and students.

The old QM Perception e-assessment provided our “safety net” in the event of problems and the decision was taken to adopt W+ immediately as a “live pilot”. For the trial semester, W+ was provided free-of-charge, since students had already purchased the associated textbook. There were many advantages of using Wiley Plus:

- a complete electronic copy of the text was available to all student regardless of whether they had purchased a hard copy
- large online question banks with the underlying MapleTA/MapleNet engine

- graded feedback with links from assessments to hints, solutions, tutorials and the book itself.
- learning design underpinning its overall structure
- presentations for lectures including PRS “clicker” questions and summaries
- some applets for interactive activities
- instructor guidance and resources
- extra question banks for use within our “Victory” WebCT VLE (Figure 3)

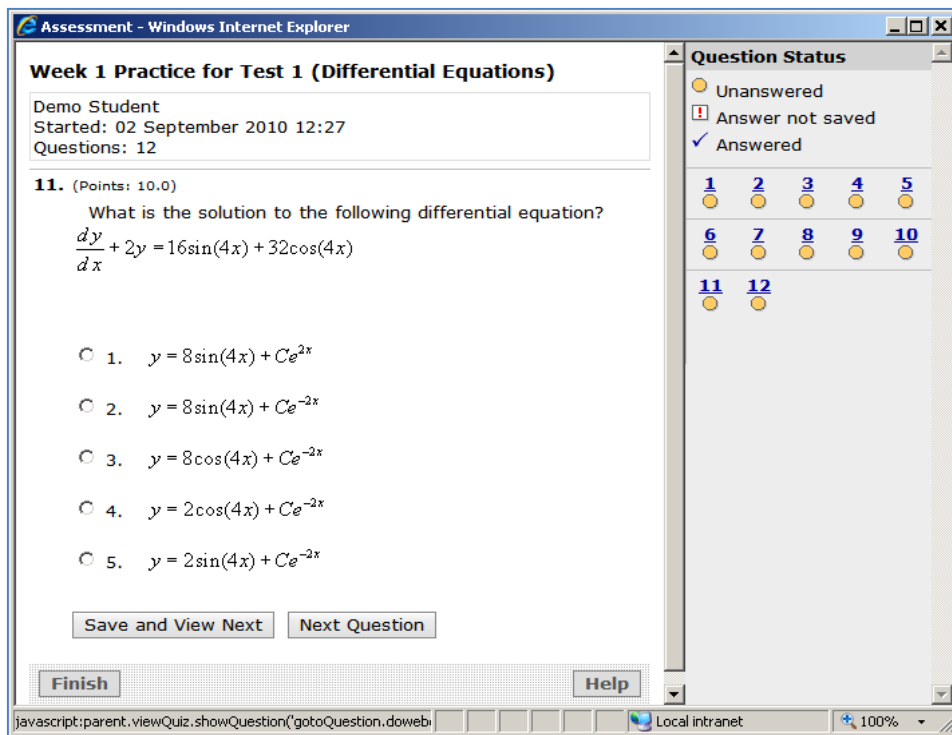


Figure 3: E-Assessment Questions Exported from Wiley Plus into WebCT

The graded feedback (Figure 4) is a particularly strong feature, since it allows progressively more detailed help to be given after each unsuccessful attempt at a question.

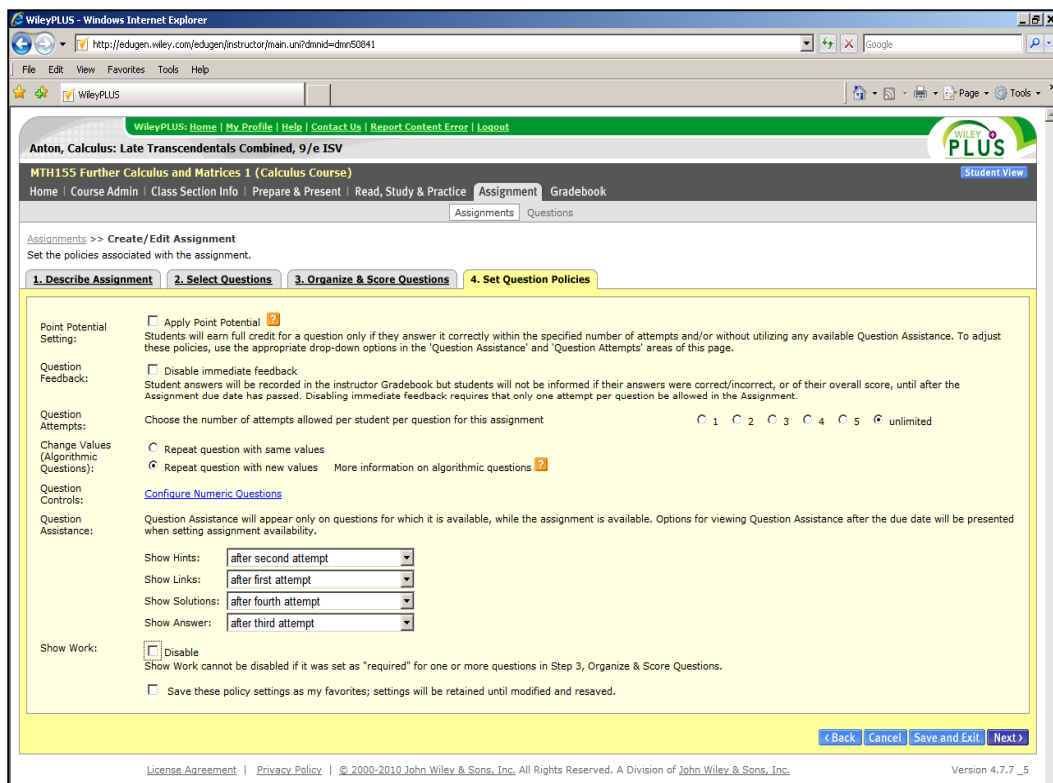


Figure 4: Graded Feedback Options in Wiley Plus

There were also disadvantages in using W+ (Version 4.7.8) :

- the current product is designed for learning not exams, with an emphasis on formative, not summative assessment
- textbook-based lecture slides which look formulaic and uninteresting
- major limitations on question customisation and in-house authoring
- an inability to import existing MapleTA or QML questions
- an inability to correct errors or modify content
- an inability to hide/show content or perform basic VLE operations to modify the display, e.g. for accessibility

When there were mistakes in e-assessment questions, it was only possible to report the error and avoid using them. The response time for having such corrections made was too long.

Both W+ and local resources, including MapleTA assessments, were linked through the VLE, which acted as a one-stop shop for the course unit. Formative W+ assessments <http://wileyplus.com> included:

- standard practice tests for all sub-topics covered in the text
- custom practice tests generated by selecting questions from the bank and setting up appropriate delivery and feedback options
- question selection by difficulty, learning objective or type
- varied answer input, including interactive graphs
- unlimited attempts on algorithmic-randomised questions

Formative MapleTA assessments were authored in-house and are available free of charge at <http://userweb.port.ac.uk/~mccabeem/mapleta>. MapleTA does not include some W+ features, such as interactive graphical questions (Figure 5) and a smart symbolic input palette (Figures 6 and 7), but this drawback can be weighed against the benefits of greater flexibility and control over question authoring, modification and delivery.

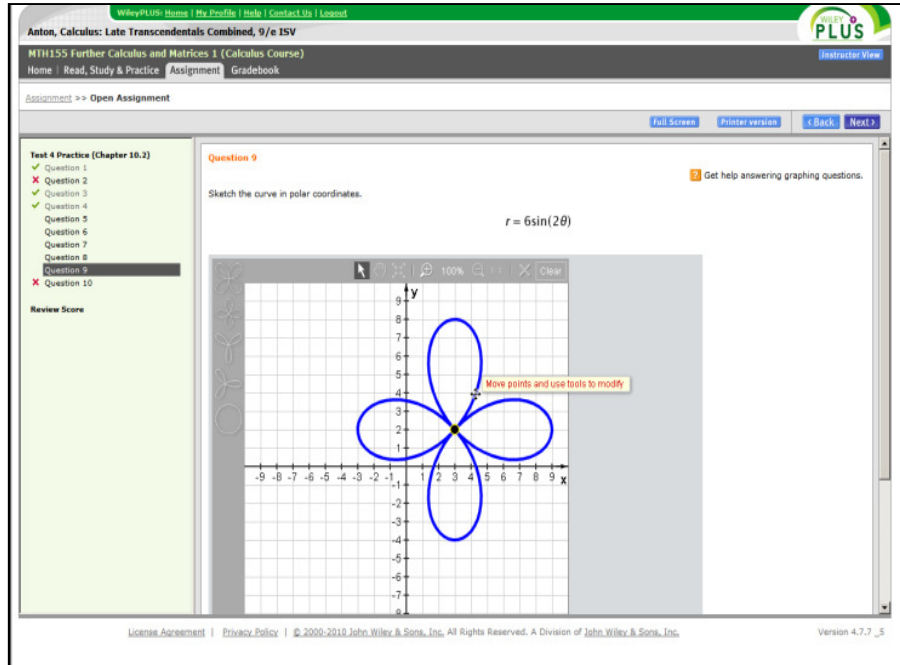


Figure 5: Graphical Input in Wiley Plus

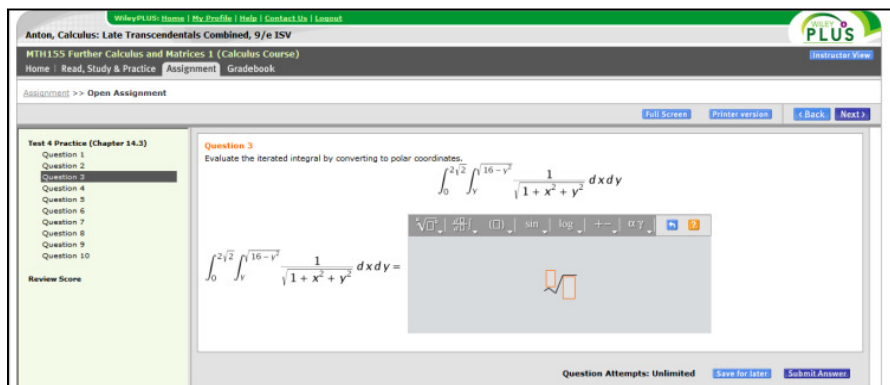


Figure 6: Symbolic Input in Wiley Plus using a Palette

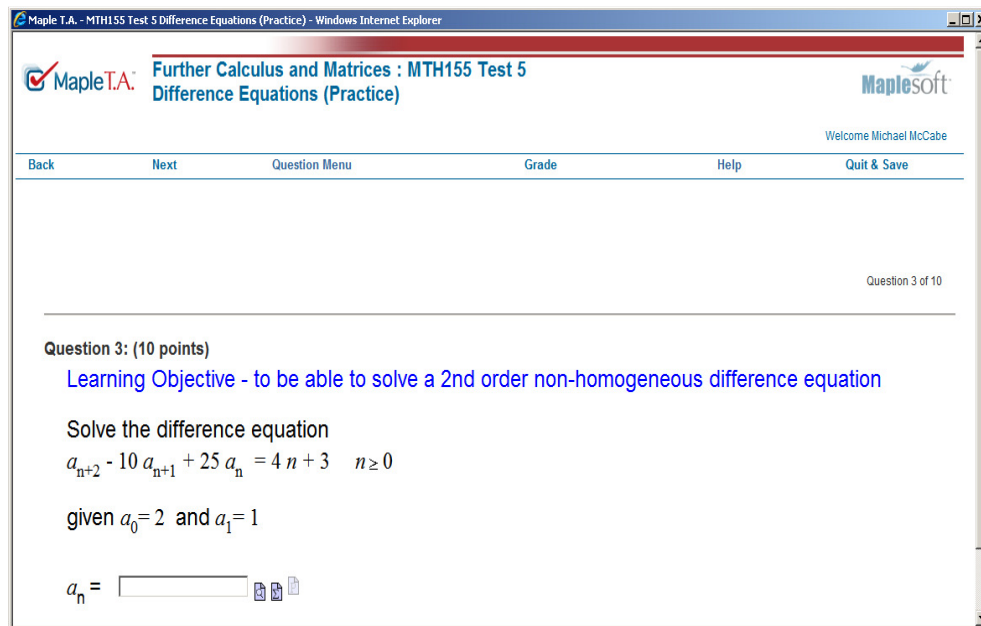


Figure 7: Symbolic Input in MapleTA

Since a large bank of MCQ and numeric formative assessment questions were available to students within WebCT, they were required to deal with three different interfaces for answering questions. The lack of interoperability between Wiley Plus, MapleTA and WebCT prevented any integration of question banks. Given that MapleTA underpins Wiley Plus, that limitation might be overcome in the future, but remains an issue for the present.

Summative Assessment

Of seven exam tests taken by students for summative assessment, four were in Wiley Plus and three in MapleTA. This mix of delivery allowed us to compare their experience in using each of them.

For Wiley Plus:

- custom exam tests were created by selection of suitable questions from the bank
- “baseball” questions were set up so that up to three attempts at each question could be made without any penalty
- each test could be re-entered by students during one or more exam sessions to raise their mark
- questions were selected with a balance of difficulties, learning objectives and types
- administratively time-consuming workarounds had to be developed to account for the lack of test passwords in the W+ system

The cumulative scoring of “baseball” questions was designed to promote student confidence by allowing them to keep marks from all successful answers without having to repeat similar questions. Traditionally a student would have been expected to repeat a “knockout” test in its entirety with any score below the required threshold being effectively the same as no attempt at all.

Little use was made of the limited question authoring available in W+, since it is limited to basic question types (MCQ, text, numeric, essay) using plain text only.

For MapleTA:

- exam security was greatly strengthened through the use of passwords and the administrative overload was reduced
- the setting up of tests with randomised questions was more flexible and easier to control
- all tests were “knockout” in the sense that each one had to be retaken if it was not passed, although it would have been possible to set up similar “baseball” questions to W+ by allowing up to three attempts

Many issues arise in using the resources in W+ and, to a lesser extent MapleTA :

- The products are subject to future development and the release of new versions. There is no control over long-term continuity and stability of existing assessments in the future. Upward compatibility may not be possible and further time may need to be spent in setting up existing tests for annual use.
- The non-uniformity and comparability of questions in terms of their length, time required and scoring
- A need for discrimination between formative questions suitable for learning and summative questions suitable for examination.
- Partial credit for answers which are incomplete or inaccurate

Evaluation Method

We were keen to get rapid feedback from students who were learning from on-line resources, introduced on an extremely short timescale. Since it was a “live pilot” we initially relied on verbal comments, which reassured us that students were benefiting from their Wiley Plus experience and that we did not need to revert to existing resources. The “baseball” questions allowed us to track student progress and results were good.

A simple questionnaire was distributed which sought views on all their e-learning resources, with a particular focus on W+. For each resource they were asked to rate their features on a Likert scale, e.g. 1 = essential to learning 6 = no use at all. A further set of open-ended question sought positive and negative responses. 68 out of 150 “Further Calculus and Matrices” students at level 1, who had used W+ throughout, responded. A smaller set of responses were also obtained from 11 out of 120 “Calculus of Several Variables” students at level 2, who had only used W+ in their final weeks of study in preparation for a final exam.

Evaluation of VLE ('Victory', in WebCT)

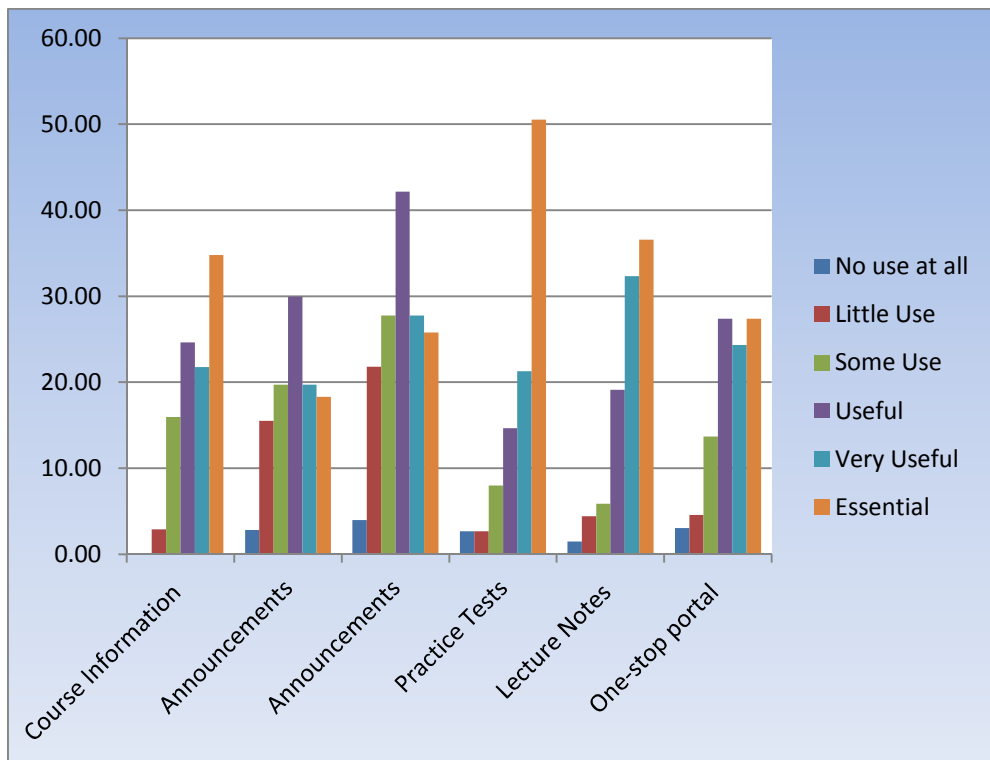


Figure 8: Usefulness of Victory Resources for Learning (%ages)

The Likert-scale questions showed that practice tests were valued most (50% essential for learning), 'just-in-time lecture notes were highly valued, and the Victory (WebCT) site was also valued for providing a one-stop portal and course information. Victory was valued for providing a one-stop portal (27%) and course information (35%).

The open-ended questions invited student responses on any aspect of the VLE, which is used for most course units. The number of responses on a given point are shown in brackets. There were two overwhelming positives:

The VLE provided a necessary one-stop shop linking access to all resources, including W+ and MapleTA. It was the glue which held all the components together. (12)

"Just-in-time" handwritten lecture notes (Figure 8) provided on a weekly basis as PDF files were greatly appreciated. (16) This came as a surprise given that students already had full access to W+ and that the rough notes were simply scanned after lectures. Students may have valued them for their focus on process rather than product, for demonstrating mathematical thinking in a digestible summary, for offering a more personalised approach which could be linked to what was said in lectures or for the local course information included. The responses did not go into more details.

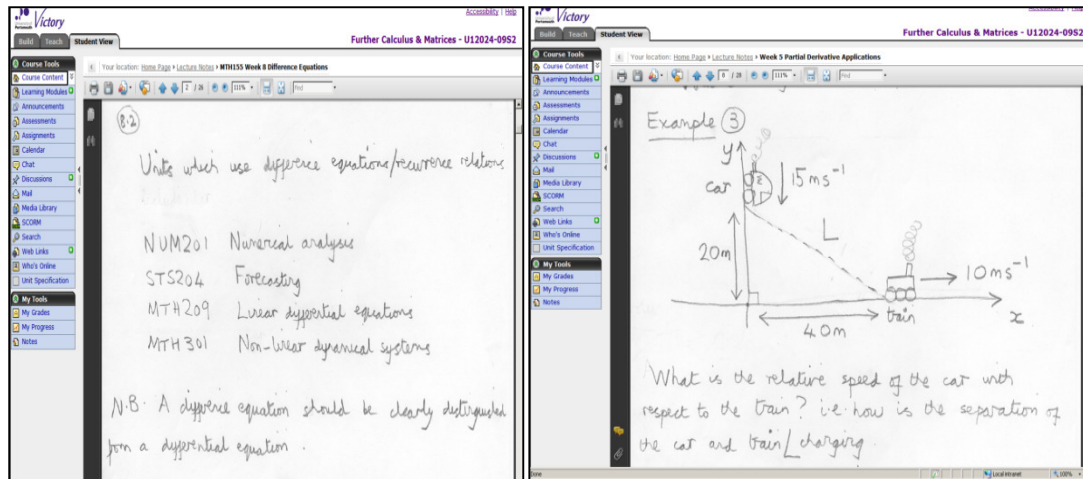


Figure 9: “Just-In-Time” Handwritten Lecture Notes

Unreliability (7) , GUI navigation issues (7) and mathematical limitations (5) featured more predictably amongst the negatives. None commented on the extra e-assessment resources available within the VLE, suggesting that their lack of integration with W+ led to them being largely ignored.

Evaluation of MapleTA

We were interested in comparing student views on our ‘in-house’ MapleTA questions as opposed to the “outsourced” W+ questions. Many commented positively on the value of having a large number of MapleTA practice questions/tests (13) and the ease-of-use (12). The main negative comments were about difficulties with the syntax or format of input, arising from the lack of the palette tool in W+ (10), unfair or inflexible marking and lack of partial credit (5) and limited feedback such as hints, links and full solutions, which were more regularly available in W+ (6). A small number also identified the fact that tests were of the “knockout” variety requiring all questions to be repeated rather than having “baseball” questions allowing them to have three attempts (4).

Evaluation of Wiley Plus

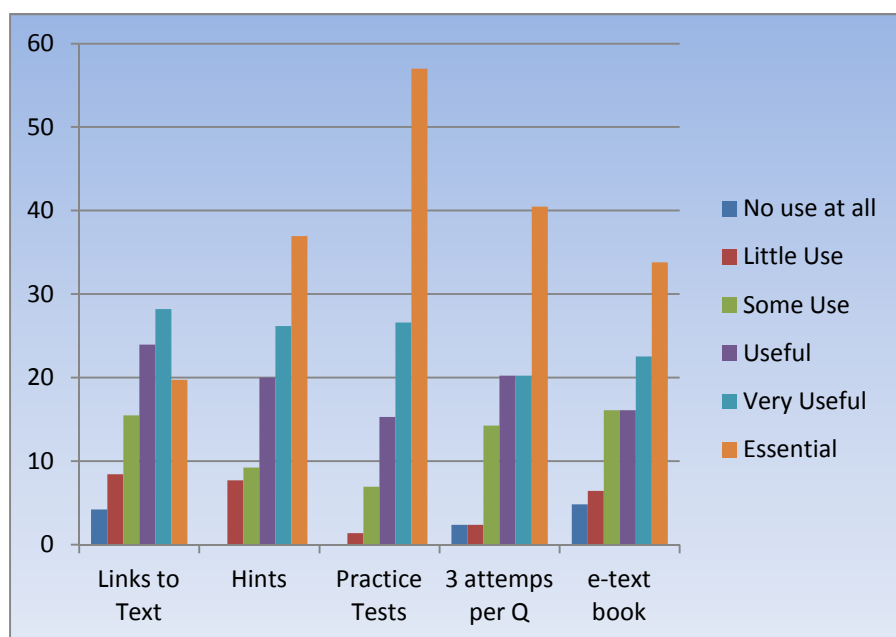


Figure 10: **Usefulness of Wiley Plus Resources for Learning** (%ages)

The Likert-scale responses indicated very high value for the practice tests (60% essential for learning), followed by the 3 attempts per questions, and the hints and e-textbook. The figures for Maple TA also indicated very high value for the Maple TA practice tests (the other questions did not apply to Maple TA).

Amongst all the open-ended responses, it was the availability of “baseball” questions and cumulative scoring in W+ that provoked the greatest positive comment (17). The ability to have three attempts at different instances of the same question without penalty seemed to offer greater encouragement to students and a more constructive approach to learning. Other positive comments were on the extensive feedback through book links, hints, solutions and tutorials (18) and the numerous/varied practice set of questions (9). Negative comments related to input difficulties despite the use of symbol palettes (4), GUI issues, e.g. need for multiple windows, and unfair marking (3). One student made the interesting negative comment that it was not always possible to repeat a question when a given instance had been answered correctly. It had incorrectly been assumed that they would not wish to continue practicing on similar questions to reinforce their understanding. Amongst other one-off comments was a reference to “friendly, calm and helpful invigilators” who support the delivery of e-assessments. Such a simple observation is easily overlooked when the focus of an assessment is on its technical delivery and content.

Future Directions in a Commercial World

Our experience in using W+ for calculus has been sufficiently positive that its use has already been extended to linear algebra (Anton and Rorres, 2010) in 2010/11. It is starting to provide some of the e-learning tools and the content necessary for undergraduate mathematics. At the University of Portsmouth the curriculum for every course, including mathematics, is undergoing a complete revision for 2012/13. Our present expectations are that W+ will continue to be adopted and integrated into our courses as part of that fresh start. This may well coincide with the next major release of Wiley Plus5.0, which it is hoped

will incorporate such features as exam security with password protection and a greater scope for question authoring, customisation and interoperability. The university also needs to change its VLE from WebCT in 2013 and ongoing change can be expected in the way that e-learning is required to be delivered. The question is whether it is possible to maintain “in-house” development of our own e-learning resources or whether we should become increasingly reliant upon those developed by external providers, either commercial or non-commercial.

In a utopian world we would like to adopt open source, free, interoperable, customisable, flexible tools and content. Are ASPs, such as Wiley Plus, to be regarded as snakes to be shunned by the mathematical academic community or ladders which can help them rise up above the technical requirements of developing high quality e-learning resources? “Cottage industries” can work together and the production of HELM workbooks shows that there can be an alternative to commercial publishers. But the development of e-learning resources is far more complex than the printed page. Are there viable hybrid models which could allow the development of integrated resources, which allow customisation and extension through interoperability? Wiley Plus cannot be integrated with other resources in our VLE other than trivially. Wiley Plus can only be customised in very limited ways and the scope for extending its question banks is limited to the most basic type of text questions. The ability to import/export questions through QML, MapleTA or other files is not yet available.

The stark choice between open source collaboration and commercial provision often polarises individual academics and even whole institutions, but maybe there can be greater cooperation between commercial and non-commercial developers. It may be that universities themselves become increasingly commercialised, but few other than perhaps the Open University are likely to have the infrastructure necessary to produce the equivalent to Wiley Plus.

We argue that the ideal is a financially sound, hybrid model, which allows for greater customisation, sustainability, extension and interoperability than is currently available from either commercial providers or open source initiatives. There has always been some degree of hybridisation between commercial and non-commercial tools and resources. Commercial software has often been used to develop e-learning and e-assessment resources for non-commercial distribution within HE. Individuals or small groups have developed e-assessment question banks which are freely distributed, while the underlying software remains commercial. Some commercial publishers develop e-packs for VLEs which can then be freely modified and extended. Non-commercial software can be used as the basis for commercial products.

	free resources and add-ons	commercial resources and add-ons
free tool/package	fully open source STACK, OpenMark Moodle	hybrid Red Hat
commercial tool/package	hybrid MapleTA banks (M ³) Perception (MG) WebCT e-packs Toolbook (Mathwise)	fully outsourced commercial WileyPLUS, MyMathLab, WebAssign, CALMAT ...

Table 1: **Commercial vs. Non-Commercial in E-learning and E-assessment**

Idealists will always argue for completely free and open software development in the academic world, but this is likely to remain an ideal. Yet Wiley Plus is in danger of becoming as inflexible as a textbook, if it limits customisation, modification and extension of its commercial resources. Furthermore any such changes need to be sustainable when new versions of the product become available. The situation is similar to the release of a new edition of a textbook, requiring a lecturer to update notes and supporting material, but only worse. Written notes may only require a revision to a list of recommended exercises or chapter numbers. Significant effort may be needed to revise e-assessments in Wiley Plus.

At the University of Portsmouth the main driver of change has been a sharp rise in student numbers, the demand for modern e-learning resources and need for both formative and summative e-assessment. It makes sound economic sense to buy in affordable commercial products for large first and second year units. We were able to introduce the calculus course to students and tutorial staff on an extremely short timescale with low overhead. Weekly small group personal tutorials were supported by W+ both through printed questions and through direct use of the e-assessments.

Ideally the staff time freed up can become available for tailoring the resources to local need or doing other things. A problem with W+ is the standalone nature of each product in supporting an existing textbook. The printed word remains a constraining factor and it is impossible for a lecturer to mix-and-match e-learning resources or assessments from separate W+ courses. For standard courses such as first year calculus that may be fine, but elsewhere in the curriculum it is likely to be highly restrictive. We have already noted that there is no distinction in Wiley Plus between those questions which are appropriate for learning, i.e. formative, and those questions which are appropriate for examination, i.e. summative. Our experience suggests that clearer guidance on question use would be appropriate when (and if) the product incorporates greater exam security. Identifying questions by their difficulty, question type or learning objective is insufficient.

To sum up, there are two distinct challenges that face universities – in assessment, and in teaching and learning.

In assessment, there is a need for customisation, which includes the provision of:

- Full authoring tools for academics to create additional assessment materials.
- Security access, and administrative processes and rights, for managing summative assessment, e.g. timed passwords for assessments.
- Interoperability, for instance between Maple TA-based provider materials and user-created materials.

These are essentially technical and systems issues and they need to be addressed rapidly by any provider wishing to maintain market share. They require minimal hybridisation and collaboration between private and public organisations, and would provide a possible *modus operandi* for collaboration and integration across university and commercial providers.

The challenges for teaching and learning, however, are much broader, and include the need for:

- Resources to be designed primarily for learning, and therefore assessment needs to be designed primarily as formative benchmarking, rather than summative assessment. (This is, as it happens, already the case in Wiley Plus).
- Summative assessment is also required, but it needs to be integrated as far as possible with formative benchmarking. Portsmouth has developed what is in fact a hybrid between summative and formative assessment over several years, and the use of 'three attempts per question' that we have implemented in Wiley Plus is an excellent extension of that principle.
- The tracking data base, which captures information on the use and progress of learners, needs to be designed to provide reports primarily for teaching and for learning, rather than primarily for administration and for management evaluation (necessary as these are).

ASPs such as Wiley Plus provide quite a lot of useful data, which can, already, be exported to administrative reports (which is good), but very little in the way of reports that are of immediate use to learners, tutors and lecturers, even though much of the data that could be used to generate these reports is already being captured.

If ASPs are to provide an integrated 'service', the real challenge in an age of web2.0 and 3.0 and social software is to provide not only the integration of teaching, learning, benchmarking and assessment, but also to provide wider integration with, and links to the growing wealth of resources and interactive communities available through the Internet.

It is a paradox that people want total flexibility to customise a product such as W+ in a myriad of different ways, but in practice few have the time or inclination to make those changes. W+ clearly has far to go in its development, and it is important that commercial developers are aware of academic needs. Some may regard the adoption of ASPs as intellectual suicide on par with Cleopatra, which limits the independence and freedom of academics. In the future, we would like to maintain the benefits which have arisen from our use of Wiley Plus, while eliminating the drawbacks that we have identified from our own

experience and student survey. ASPs are unlikely to become extinct, but they may need to adapt to survive.

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