

SkillBox: a pilot study

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The aim of this project is to research, develop and evaluate a set of tools that can be used in tertiary subjects to formatively scaffold the skill base of students. The SkillBox instrument uses text, video and quizzes to deliver learning materials and formative assessment to students on a specific topic within a discipline area. A pilot project evaluated the use of a Matrix SkillBox in a Charles Sturt University (CSU) Distance Education (DE) subject and found its use appeared to increase knowledge and confidence in the topic areas covered. These findings will be further investigated in ongoing research involving larger numbers of students.

Keywords: SkillBox; discipline-based skills, web-based learning tools

Introduction

Some university subjects require a certain level of skill in a discipline that may not feature strongly in the students' academic background, such as mathematical or statistical skills in a subject that is not strictly a mathematics subject. An example is Geographic Information Systems (GIS). Some GIS subjects require certain mathematical skills, such as basic understanding of matrices. However, students commence these subjects with a wide range of pre-existing skill levels, ranging from very little to a high level of competency. Often a lot of time is devoted in these subjects to bring all students to the same skill level, rather than focussing on the more important application of these skills to GIS. This is a common issue in subjects requiring mathematics, statistics or other foundation knowledge (Galligan, 2013).

The importance of teaching mathematics and other subjects in an online environment has been explored for at least the past 15 years (Allen et al. 1998; Porter 1997). The types of technology employed in these situations can be broadly described as web-based learning tools (WBLTs) (Kay 2011), which include online whiteboards, video podcasts and tablet technologies. The rationale given for researching and developing such tools includes improving student retention (Anderson and Jacoby 2013; Faridhan et al. 2013), improving subject readiness (Kay and Kletschin 2012) and maximising learning opportunities (Galligan et al. 2010). Researchers have found the use of these technologies to be overwhelmingly positive, particularly in a distance education environment.

The use of online formative self-assessment quizzes has also been shown to improve student engagement, leading to increased subject pass rates (Nagel and van Eck 2012). In addition to using online quizzes, a key aspect of our approach is to curate existing material such as video tutorials alongside purpose-built material such as text-based explanations and online quizzes. Antonio et al. (2012) claim that digital curation can increase student motivation, engagement and learning outcomes.

Based on our observations above and the research mentioned, we identified a need for a set of tools that can be accessed by students independently and as needed, in a non-threatening environment, to learn and scaffold the skills needed prior to or in conjunction with the application of skills in the subject. The need was also identified for the tool to require no active intervention from the subject coordinator and for it to be reusable in other subjects. As such, our pilot study aimed to build students' confidence and skills in mathematical concepts required for postgraduate study of GIS through the integration of a Matrix Skillbox in SPA403 Algorithms in GIS and Modelling.

Methods

Our project used a mix of existing technology to develop a curated set of tools consisting of learning materials and formative assessment tools. As a pilot, the Matrix SkillBox was developed for use by students in the subject SPA403 Algorithms in GIS and Modelling in Session 1 2015 at CSU. The SkillBox is designed to be a self-paced optional module that students can dip in and out of at any time to learn and reinforce basic matrix concepts. For the Matrix SkillBox, the technology and tools used

included Khan Academy videos and quizzes (Khan Academy 2015), textbook explanations and exercises, and specially developed explanatory text with worked examples, and formative quizzes. Students enrolled in the subject were also invited to participate in a research project designed to evaluate its impact and effectiveness (Figure 1). Strategies for evaluating the initiative and measuring its impact included surveys, to measure shifts in attitude and confidence, and quizzes, to measure shifts in knowledge and competence.

The surveys were based on research by Fogarty et al. (2001), who validated a questionnaire designed to measure general mathematics confidence, general confidence with using technology, and attitudes towards the use of technology for mathematics learning. Our first 11 survey questions are drawn from their statements on confidence when learning mathematics. Our remaining survey questions are on confidence with specific matrix operations (see Appendix). Students were asked to complete the survey at the commencement of the subject and again after working through the Matrix SkillBox. Responses were recorded on a 5-point Likert scale, plus a category of Don't Know / Not Applicable.

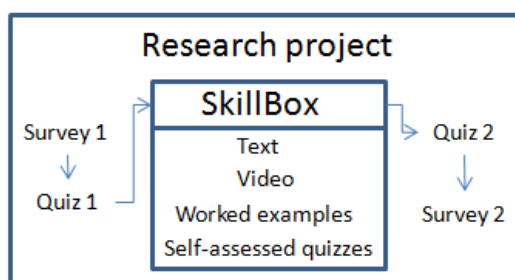


Figure 1. Sequencing of research project around SkillBox

Students were also asked to complete a quiz (separate to the formative quizzes within the SkillBox) to summatively assess their knowledge of the topic area, both before and after engaging with the Matrix SkillBox. Six questions were related to matrix basics (dimensions of matrices and addition and multiplication) and four questions were related to determinants and inverses of 2x2 matrices. Answers in the quizzes were recorded as Incorrect, Don't Know or Correct. The questions in both quizzes were of the same format and type, but with different numerical details, and were taken approximately 4 weeks apart by most students.

Results

The survey questions can be broadly divided into questions about positive attitude towards mathematics, questions about negative attitude towards mathematics, and questions on general understanding and confidence with matrices. Six students (33% response rate) participated in the pilot study. Changes in attitudes towards mathematics were minimal – positive attitudes increased slightly and negative attitudes decreased slightly. However understanding and confidence with matrices increased substantially (44% agree or strongly agree to 83% agree or strongly agree) (Figure 2).

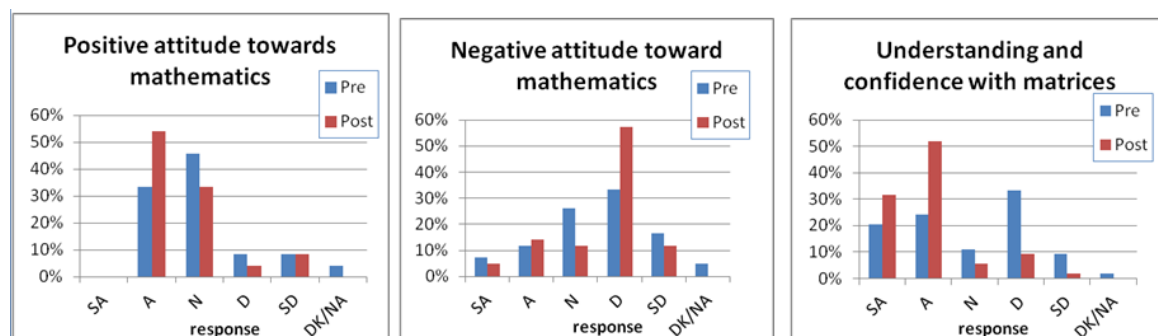


Figure 2. Survey responses pre- and post- intervention with the Matrix SkillBox (SA=strongly

agree, A=agree, N=neutral, D=disagree, SD=strongly disagree, DK/NA=don't know/not applicable)

With a sample size of six it is not possible to draw strong conclusions from these results. We did however test the shifts in responses for statistical significance using the Wilcoxon-Mann-Whitney test (Wilcox 2009). At a 95% confidence level ($n=6$) there was a statistically significant increase in confidence in calculating the determinant of a 2x2 matrix (Q18, $p = 0.11$, $Z = -2.33$) and calculating the inverse of a 2x2 matrix (Q19, $p = 0.11$, $Z = -2.33$). In other words confidence increased after intervention with the Matrix SkillBox, while attitudes towards mathematics only improved slightly.

The quiz questions can be categorised as “Matrix Basics” and “Determinants and Inverses”. On matrix basics, the number of correct responses increased from 50% to 83%, and on determinants and inverses, correct responses increased from 21% to 100% (Figure 3), after intervention with the Matrix SkillBox. This shows that knowledge and competence also increased after intervention with the Matrix SkillBox.

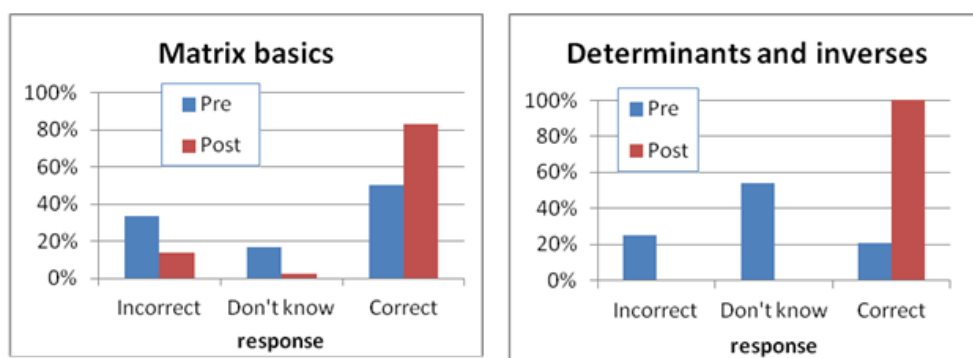


Figure 3. Quiz responses pre- and post- intervention with the Matrix SkillBox

Self-reported time spent on the Matrix SkillBox ranged from less than 1 hour to around 20 hours (median 3 hours). When asked what they found most useful about the Matrix SkillBox, students mentioned the videos, quizzes, accessibility and repeatability. The only response to what they found least useful was a request for randomised questions – this suggestion has since been incorporated into the next version of the Matrix SkillBox. Suggestions for improvements included expanding the Matrix SkillBox to cover more concepts.

Discussion and conclusions

Previous research has identified the importance of using web-based learning tools for developing skills, improving student retention, improving subject readiness, maximising learning opportunities, increasing student engagement and improving learning outcomes. Our pilot study using the Matrix SkillBox suggests similar outcomes. With minimal time cost to students, and no active intervention from the subject coordinator once the Matrix SkillBox was in place, students increased their knowledge, competencies and confidence around matrices. Due to the sample size of the pilot study we have not yet been able to measure impact on student retention or learning outcomes.

The concept of the Matrix SkillBox can easily be translated into other disciplines, with the structure of text, videos, quizzes and other resources remaining constant. In this way the look and feel of the tool is familiar to students who have used a previous SkillBox, and they will know what to expect. This familiarity should mean students will be more likely to engage, if they have found a SkillBox useful in the past. The replicability means that the burden on subject coordinators to implement a SkillBox in a subject is lessened, and should mean that uptake of SkillBoxes in subjects is preferred over each subject curating and developing their own resources for topics that are covered by an existing SkillBox. In addition, because the SkillBox is designed as a module that sits alongside a subject, rather than embedded in the subject curriculum, it can be implemented as a course-wide approach to address potential gaps in students' skills and knowledge. By keeping the SkillBoxes accessible, self-paced, and taking less than 10 hours to complete, student equity is also improved.

In the pilot study, the subject coordinator found that teaching time and resources could be devoted to more advanced topics, knowing that students had the resources in SkillBox to bring themselves up to

speed on matrices if necessary. As a result the subject was able to more adequately cover relevant subject material. In future research, the perceived impact on the subject itself will be elicited by surveying the subject coordinators involved.

This research is ongoing, with the implementation of the Matrix SkillBox in further CSU subjects, and the development of SkillBoxes in other disciplines including statistics and programming. For each discipline, a new SkillBox will be developed, with each SkillBox following the same structure. Each completed SkillBox can then be embedded in multiple relevant subjects, with little ongoing investment from the Subject Coordinator. As the number of students participating in the research increases, we will be able to measure with more accuracy the impact on students of implementing a relevant SkillBox within their subject.

Acknowledgements

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