Effectiveness of on-line resources to enhance student learning and engagement

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BACKGROUND

For engineering graduates to be work-ready with marketable skills they must not only be well-versed with engineering science and its applications, but also able to adapt to using commercial software that is widely used in engineering practice. Hydrological/hydraulic modelling is one aspect of engineering practice which demands the ability to apply fundamentals into design and construction using software. The user manuals for such software are usually tailored for the experienced engineer but not for undergraduates who typically are novices to concepts of modelling and software tools. As the focus of a course such as Advanced Water Engineering is on the wider aspects of engineering application of hydrological and hydraulic concepts, it is ineffective for the lecturers to direct the students to user manuals as students have neither the time nor the desire to sift through numerous pages in a manual. An alternative and efficient way to demonstrate the use of the software is enabling students to develop a model to simulate real-world scenario using the tools of the software and directing them to make informed decisions based on outcomes.

PURPOSE

Past experience of the lecturer showed that the resources available for the students left a knowledge gap leading to numerous student queries outside contact hours. The purpose of this study is to assess how effective purpose-built video resources can be in supplementing the traditional learning resources to enhance student learning.

APPROACH

Short-length animated video clips comprising guided step-by-step instructions were prepared using screen capture software to capture screen activity and later edited to focus on specific features using pop-up annotations; Vocal narration was purposely excluded to avoid disturbances due to noise and allow different learning paces of individual students. The video clips were made available to the students alongside the traditional resources/approaches such as in-class demonstrations, guideline notes, and tips for efficient and error-free procedural descriptions. The number of queries the lecturer received from the student cohort outside the lecture times was recorded. An anonymous survey to assess the usefulness and adequacy of the courseware was conducted.

OUTCOMES

While a significant decline in the number of student queries was noted, an overwhelming majority of the survey respondents confirmed the usefulness of the purpose-developed courseware.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The survey and lecturer's experience indicated that animated demonstration video clips illustrating the various steps involved in developing hydrologic and hydraulic models and simulating design scenarios is an effective supplement for traditional learning resources. Among the many advantages of the custom-made video clips as a learning resource are that they (1) highlight the aspects that are important to undergraduate learning but not available in the software manuals as the latter are designed for more mature users/learners; (2) provide short, to-the point communication in a step-by-step manner; (3) allow students flexibility to self-learn at their own pace; (4) enhance student learning; and (5) enable time savings for the lecturer in the long term by avoiding queries of a repetitive nature. It is expected that these newly developed resources will be improved to incorporate students' suggestions before being offered to future cohorts of students. The concept can also be expanded to other relevant courses where animated demonstrations of key modelling steps are beneficial to student learning.

KEYWORDS

On-Line Learning Resources; Screen Capture Software, Annotated Video Clips

Introduction

The ability to use industry standard modelling and simulation software to aid engineering decision making and adapt to evolving suits of such software prevalent in the engineering industry are becoming increasingly useful graduate skills. Recognising this need, most tertiary education institutes have incorporated the use of software into the curricula, for example engineering surveying (Dib & Adamo-Villani, 2014), civil engineering construction (Katsanos, Taskari, & Sextos, 2014) and robotics (Lopez-Nicolas, Romeo, & Guerrero, 2014). Most such software have been developed for specific purpose of tertiary education where the fundamental concepts underpinning the operation of the software can be delivered in the form of instructional courseware while well-structured demonstrations are available to assist learning the features of the software (Liu, 2011). An effort to use video tutorials to introduce the SPSS statistical analysis software in a master's level statistics course reported that they were an effective component of the course (DeVaney, 2009); however, comparisons of sections with and without access to the video tutorials showed no significant difference with respect to academic performance.

In civil and environmental engineering practice, a range of commercial software products is used by engineering consulting services. Among those products, software focusing on hydrologic and hydraulic modelling of catchments and river systems provide exemplar features in terms teaching generic modelling skills. The relative ease of adapting modelling software to replicate a complex set of natural processes and wide range of conditions prevalent in river systems has made it a popular tool in river management (Fernando, Gebreselasie, & Capiral, 2010).

Typical river system modelling software consists of two basic components; a hydrologic model and a hydraulic model. The hydrologic model simulates the conversion of rainfall into surface runoff. Results of a hydrologic model include hydrographs that represent the catchment generated flow that becomes inflow to a stream or river at a given location. These flow hydrographs are then used as inputs to the hydraulic model as inflow hydrographs. The hydraulic model simulates flow of rainwater in a natural river with specified characteristics of topography, roughness and constraining infrastructure such as bridges and culverts. Outputs of a hydraulic model provide information critical for engineering decision making such as water surface elevations, flood extent and runoff rates and volumes.

Hydrologic and hydraulic modelling is a powerful technique of catchment and river system investigations for practising engineers in the disciplines of planning and development of integrated water resources management. Due to this reason, hydrologic and hydraulic modelling skills are becoming a prerequisite in engineering practice and considered as increasingly valuable for environmental engineering graduates. As such, tertiary institutes in both New Zealand and Australia have incorporated hydrologic and hydraulic modelling into their curricula at senior levels. This incorporation not only facilitates the convenient platform to understand underlying principles of hydrology and hydraulics for students, but also generic capabilities of modelling and simulation including swift adaptation to the industry needs and application of knowledge relating to similar software environments.

Purpose

Commercial software available for modelling and simulation are not typically tailored for teaching and learning activities. Their technical manuals and user guides are typically directed towards professionals, who know both the underlying theories and capabilities of software well. This leads educators to incorporate purpose-build strategies and resources in educating students. Such purpose-build strategies and resources should bridge the learning gap between students and professionals while forming a complementary resource set with the typical user guides. The purpose of this study is to assess the effectiveness of purpose-built video resources in supplementing several hitherto commonly used learning resources to enhance student learning outcomes in use of commercial hydrological/hydraulic modelling software.

Background

The suit of commercial software introduced to enrolees in advanced water engineering at Queensland Institute of Technology (QUT) are MOUSE-NAM (hydrologic model) and MIKE11 (hydraulic model) by DHI Software. Both these software have widespread use in Australia and New Zealand. The user- guides for these software are tailored for the professionals but not for the uninitiated who are new to concepts of modelling and simulations. Additionally, because the focus of the unit is on the wider aspects of water engineering, it is ineffectual for the lecturer to direct students to user guide. Although simplified step-by-step instructions have been prepared for the specific purpose of the unit, past experience of the lecturer showed that the resources available for the students left a knowledge gap leading to numerous student queries.

An effective supplement to standard instructional media was deemed necessary.

The engineering problem the students have to solve to achieve the learning outcomes require them to understand, critically analyse a real-world scenario of catchment/river system, develop models, and simulate rainfall-runoff-river flow scenarios; the model simulation outcomes direct them to make informed decisions as solutions to engineering problem at hand. In the previous offering of the modelling module of the course, summarised instruction sheets supplemented by lecturer/tutor instructions and contact time were adopted to accomplish the modelling and simulation tasks. The feedback received by the lecturer indicated that many students practice the use of the software in their own time and pace. They would appreciate if resources were more descriptive, that demonstrated software use by simple animations and that were available for use outside scheduled lectures or laboratory hours. An alternative but more efficient way to demonstrate the use of the software was needed.

There were 15 students enrolled in advanced water engineering unit in 2013 and 32 in 2014. The theories underpinning hydrologic and hydraulic modelling were covered in two 2-hour lecture sessions. Two 2-hour computer laboratory sessions were also used to demonstrate the use of software. The discretization, algorithms, and solution schemes used in the software as well as typical application procedures that include calibration and verification were assessed as part of an assignment worth 20% of the unit.

Methodology

In addition to the written guides, notes, and in-class demonstrations provided to the cohort in 2013, the 32 students enrolled in Advanced Water Engineering in 2014 were also provided with purpose-developed animated videos illustrating the various stages of model development and simulation.

The animated videos were prepared using Camtasia® screen-capture software. Camtasia® provides all the primary features expected from a screen capture tool such as region capture, export to other formats, timeline editing and closed caption support. The courseware developed for the current study used caption support to edit and insert the guiding captions in the form of pop-up messages.

The reason for inclusion of onscreen pop-up messages rather than verbal instructions through audio was to ensure that the students were (1) not disrupting others, who may be learning at staggered learning paces, with the noise of the audio narrative, (2) still able to hear and follow verbal instructions from lecturer as they do not need headphones during sessions, and (3) able to pause the video and read the pop-up messages repeatedly until full comprehension to carry out the required operation. An example clip will be shown in the conference presentation, but the screen dumps shown in the figure 1 illustrate examples of developed clips. The pop-up messages used were not limited to instructing students but also to explain the reasons for operations and the purpose of tools. This was to help novice users to stay connected with seemingly mechanical procedures in modelling and underlying model-development procedures. This is more than the user manuals of the software developers provide and are useful specifically for the uninitiated.

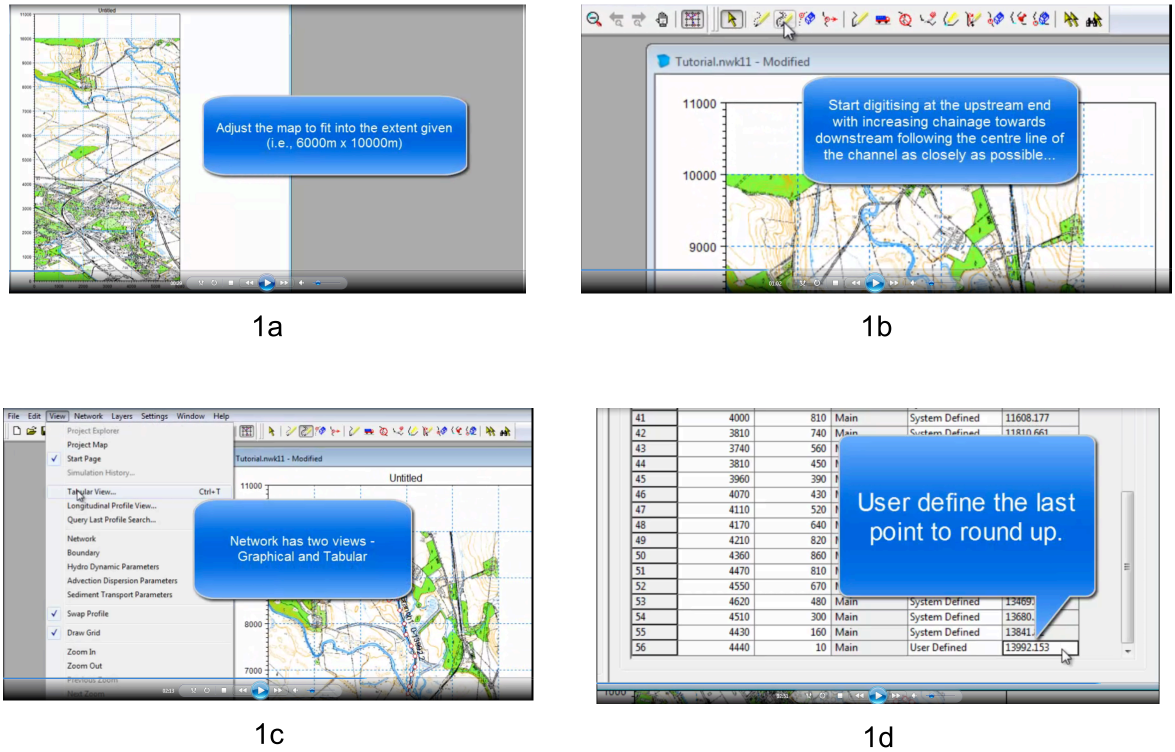


Figure 1: Examples of video clips; (a) pop-ups in catchment layout, (b) instructions for river network digitisation, (c) explanations of pull down menus and (d) important specific instructions

For the hydraulic modelling module, seven main courseware components were developed as listed in Table 1 in MP4 video format. These videos were made available to students on the learning platform (Blackboard®). They were designed to provide adequate direction for efficient model development and flow simulation through step by step guidance. Helpful advices on best practices, hints for possible pitfalls and strategies to avoid them were also incorporated. These were to be treated as blended learning tools with seamless amalgamation of face-to-face instructions by the lecturer.

Table 1: Purpose developed courseware video modules

Courseware video name (.MP4)	Role/Comprehension
1A_Creation of all files	Creating the Modelling Project within MIKE11
1B_Opening files via SIM file	Meaning and management of associated data files
2_Network Data input	Setting up of river network topography and initialisation
3_Cross sectional data input	Specifying geometrical properties of the network
4_Long section profile view	Detection of topographic data input errors
5_Time Series data input	Assimilation of observed data (Rainfall, water levels etc.)
6_Boundary Conditions Hydrodynamic parameters and simulation	Allocation of appropriate boundary conditions followed by flow simulation with appropriate hydraulic parameters

The videos listed in Table 1were provided in addition to the standard instructions and notes provided to the students in MS-word and pdf formats during demonstrations. The students were also requested to complete an anonymous survey designed to receive feedback on the usefulness of the videos with a view to incorporate the positive comments to the courseware and teaching methods in the future.

Results

The survey intended to gather students' perception of the value of the video clips in helping them to complete an engineering problem representing a real-world scenario. It consisted of eight items, four of which required the respondents to express their agreement on a psychometric Likert scale. Three were with multiple choices and one was open-ended. Twelve students responded to the survey (37.5% of the total cohort). Key outcomes of the feedback survey are presented below:

(1) Statement: MIKE 11 instructions and tips to model development given in an MS-Word document/pdf document were useful. (Choices: Likert scale)

The response to this statement overwhelmingly confirmed that the instructions provided to the students in the traditional way – printable notes and instructions – were useful (Figure 2) with 83% positive responses.

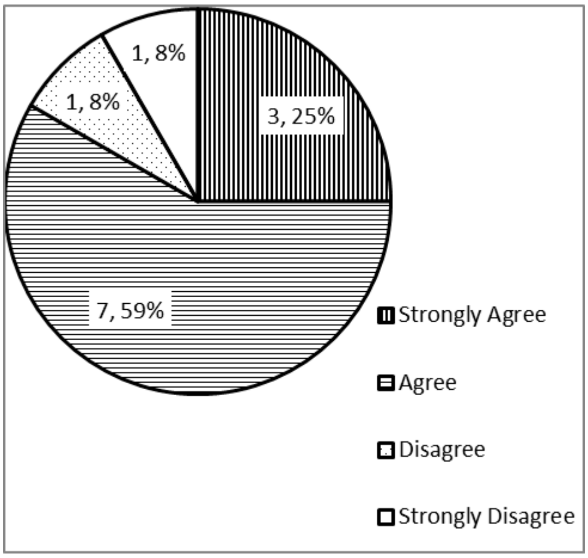


Figure 2: Feedback for Statement 1

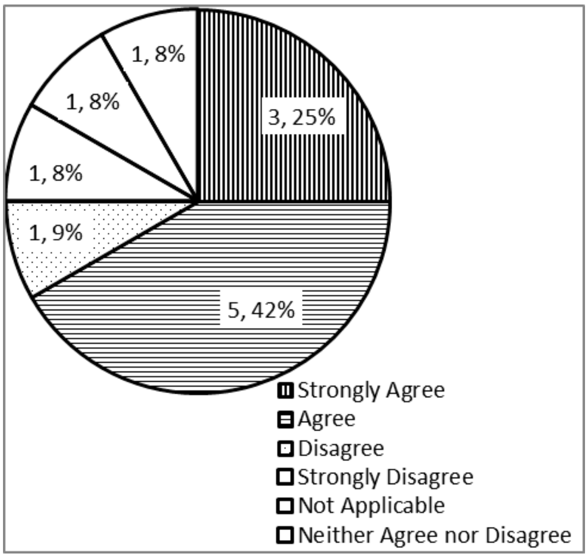


Figure 3: Feedback for Statement 2

(2) Statement: MIKE11 model development instructions described verbally with a demonstration by the lecturer during the lecture were useful.

As shown in Figure 3, a majority (8 out of 12) found that the verbal instructions useful but 2 found it not useful while another two remained ambivalent. Demonstration by lecturer alone seems an unsatisfactory mode for at least some of the students.

(3) Statement: MIKE 11 (hydraulic modelling) instructions and tips given in a combination of word document for later reference, an in-class demonstration by the lecturer, and video animations with pop-up messages were all useful and adequate. (Choices: Likert scale)

The Figure 4 below confirms that overall, all the resources put together have been found to be adequate (except for one respondent).

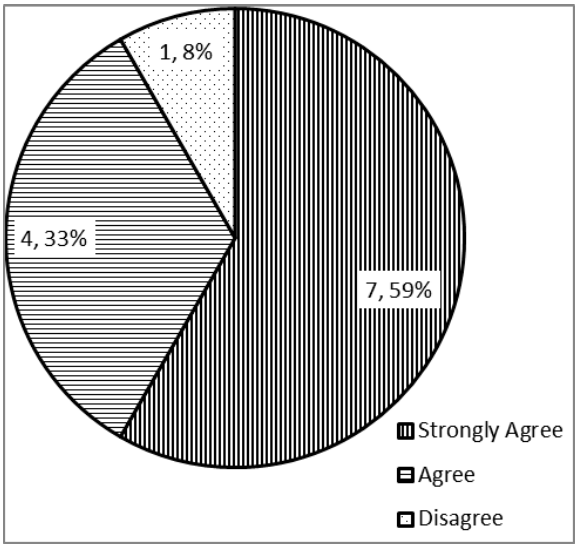


Figure 4: Feedback for Statement 3

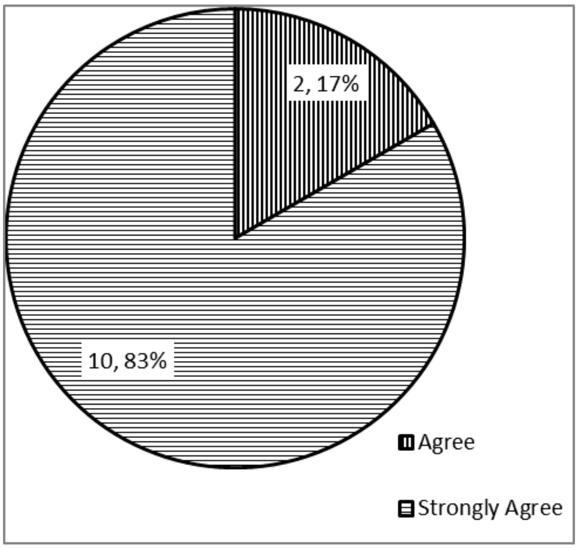


Figure 5: Feedback for Question 4

(4) Question: We believe that an in-class demonstration is essential but it also must be supplemented by other resources enabling the students to follow the approaches outside the lecture times. Do you agree? (Choices: Likert scale)

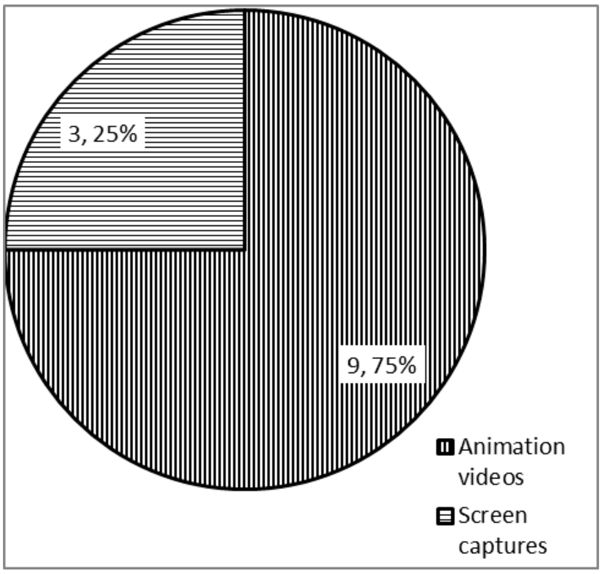
The strongly held belief of the need for availability of learning resources outside the contact hours for independent learning is confirmed by all the respondents (100%) as shown in Figure 5.

(5) Question: If the in-class demonstration by the lecturer is to be supplemented by one other resource, which ONE will be MOST useful to you? Choices given for this question were:
- Printed notes handed out during the session.
- Electronic notes (word or pdf) placed on Blackboard.
- Screen-captured video of the lecturer's demonstration (similar to videos of regular lectures).
- Animation videos of the step by step demonstrations with pop-up messages (similar to the ones you received for MIKE 11 hydraulic modelling in Week 8), or
- None of the above are needed.
- Not applicable.

Results for this question are shown in Fig. 6 which indicates that the demonstrations, either as videos or screen captures, are the preferred mode of guidance. Of these two, the purpose-developed videos are more acceptable to the participants.

(6) Question: If MIKE 11 (both Hydraulic and Hydrologic modelling) instructions are to be given to a future student cohort using ONLY ONE of the following methods, which one would you recommend? The choices given were:
- Printed Notes.
- Electronic notes (Word or pdf)
- Screen captures of video animations of the demonstration with pop-up messages. Or
- Demonstration in class by the lecturer.
- MIKE11 User Manual
- Not Applicable

The intention of this question was to determine if the considerable investment in time to develop the video animations with pop-up messages was worthwhile. An overwhelming majority confirmed that they are the more useful form, which in turn justifies the effort.



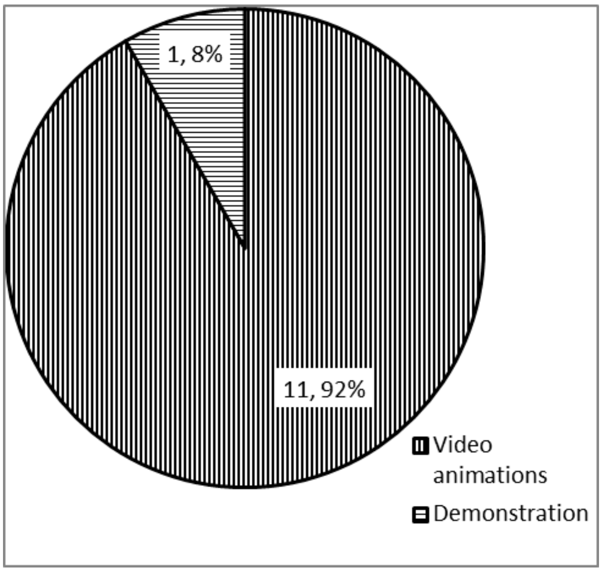


Figure 6: Feedback for Question 5

Figure 7: Feedback for Question 6

(7) Question: If you did not attend the lectures on MIKE11 modelling (Week 8 and/or 9) but completed the Assessment 3, which one of the following resources did you find MOST useful in completing the assignment? (Answer this question with "Not applicable" if you DID attend the lectures). The choices were:

- Electronic notes (Word and/or pdf) for MIKE11 software use instructions and tips.
- Animated screen capture videos demonstrating the steps to develop MIKE11 model.
- Help from friends.
- MIKE11 user manual.
- None

Feedback to this question, as shown in Figure 8, indicates that three of the survey participants have not attended at least one of the two laboratory sessions for learning the modelling modules. It is noteworthy that all these absentees have benefitted mostly from the animated videos.

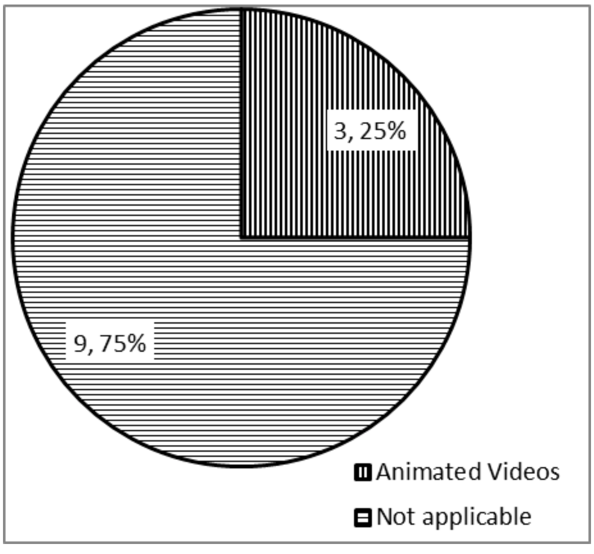


Figure 8: Feedback for Question 7

(8) Question: Tell us anything you want to add that will be valuable in helping us to enhance the learning ability of the students in the future: What worked for you, what didn't, what you would like us to stop doing, and what you think we should continue to do. Use the space below to type in your feedback.

This open-ended query invited varied responses; of them, the ones that were relevant to the additional resources available this year were all positive, ranging from

- “The first tutorial (*where the video clips were used*) was terrific”,
- “I believe the videos were a great way………..as I have never used that software before and simple commands aren't that simple when they aren't second nature.”,
- “I found them very easy to understand”,
- “The step by step video on blackboard was very useful in case we have forgotten a simple step from the lectures and tutorials’,
- “Videos were extremely helpful” etc.

There were also suggestions to make the videos available at the beginning of the semester so the students can prepare in their own time. Other related suggestions included requests for more videos for results viewing platform MIKEVIEW and additional videos illustrating common modelling and simulation errors/warnings and strategies to deal with them.

It should be noted that there was only one query at the lecturer’s inbox related to the use of the software, a substantial reduction from the previous year. However, one response “It would be nice to have a few assignment drop-in session where anyone can come and ask a few questions.” suggests that time savings for students perhaps were not optimal.

Assessment completion rate was high at 100% with a marginal increase in the average mark of 77% in the previous year to 80% indicating only a slight improvement in students meeting the learning outcomes. This is consistent with published experience of using video tutorials to use commercial statistics software SSPS (De Vaney, 2009).

Discussion

Technology-mediated education or e-learning is growing globally both in scale and delivery capacity due to the large diffusion of the ubiquitous information and communication technologies in general and the web technologies in particular (Benchicou, Aichouni, & Nehari, 2010). Exploiting these technologies is the key to enhancing the teaching and learning efficiencies. The courseware that was developed proved to be useful for the students in general and in particular for the absentees. The number of participants in the survey is low at 37.5%. Yet, it still permits some insight into the students’ perception of the newly introduced learning tools. Very little or no evidence in tertiary engineering education literature exist concerning the challenges, successes, or general experience of adopting animated tools to teach undergraduates the effective use of commercial hydraulic modelling and simulation software. The findings of this exercise revealed a success with room for further improvement.

Conclusion

Incorporating more animated courseware videos purpose-developed for hydrological and hydraulic modelling using MIKE-11 and MOUSE-NAM software will be to the advantage of the student as well as the academic staff; they provide tools for the student to learn independently at own pace and enable the academic to increase the efficacy of the face-to-face time. The feedback reveals that it may be the tool most useful to those who could not attend the sessions. The results of the efforts in terms of assessment completion and the subsequent survey feedback encourage the inclusion of similar if not improved versions of the videos to assist students in the learning of the suit of commercial modelling software covered in advanced water engineering at QUT.

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References

Benchicou, S., Aichouni, M., & Nehari, D. (2010). E-learning in engineering education: a theoretical and empirical study of the Algerian higher education institution. *European Journal of Engineering Education, 35*(3), 325-343. doi: 10.1080/03043797.2010.483610

DeVaney, T. A. (2009). Impact of Video Tutorials in an Online Educational Statistics Course. *Journal of Online Learning and Teaching, 5*(4).

Dib, H., & Adamo-Villani, N. (2014). An innovative software appliaction in surveying education. *Computer Applications in Engineering Education, 22*(3), 551-562.

Fernando, A. K., Gebreselasie, B., & Capiral, J. (2010). *Use of hydraulic modelling to aid decision making in the management of Oakley Creek.* Paper presented at the International Environmental Modelling and Software Society (iEMSs) International Congress on Environmental Modelling and Software, Ottawa, Canada.

Katsanos, E. I., Taskari, O. N., & Sextos, A. G. (2014). A matlab-based educational tool for the seismic design of flexibly supported RC buildings. *Computer Applications in Engineering Education, 22*(3), 442-451.

Liu, Y. (2011). Development of instructional courseware in thermodynamics education. *Computer Applications in Engineering Education, 19*(1), 115-124. doi: 10.1002/cae.20297

Lopez-Nicolas, G., Romeo, A., & Guerrero, J. J. (2014). Active learning in robotics based on simulation tools. *Computer Applications in Engineering Education, 22*(3), 509-515.