# Challenges of Teaching Engineering Analysis Software to Distance Education Students

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## CONTEXT
Engineering analysis software packages are regularly used in industry for solving problems. Therefore, it has become a necessity for the engineering academics to teach the students how to use software for solving problems. Academics face considerable challenges while teaching distance education students. The challenge arises not only from teaching the students we cannot see but also how the students access and use the software from home. In fact, providing proper software access to off-campus students (up to the students' satisfaction) is not an easy task. The access process involves multiple technical issues. Diverse and dispersed student cohorts working in another part of the world at a different time zone, make the situation even trickier. The complexity increases further depending on how easy it is to learn the software and how technically involved the software is.

## PURPOSE
In this paper, we present an example of how we are teaching the Strand7 software to our off-campus students at the University of Southern Queensland (USQ). The challenges we had faced over the years and the performances of various technologies that we have implemented, the learning and teaching activities we have designed, are discussed in detail. This paper can serve as a guide for options to teach software online.

## APPROACH
We have implemented various technologies for providing remote access, and have designed learning and teaching activities for online teaching. In addition, we have provided recordings of live video tutorials as learning resources showing how to use the software Strand7. The performance of each technology was judged based on students' satisfaction and whether the intended learning outcomes were achieved or not.

## RESULTS
Progressively, we have implemented various technologies including Virtual Desktops, Remote Access Laboratories (RALs) and Virtual Private Networks (VPNs) for providing remote access. We have found that multiple technical factors, some of them beyond our control, affected the system performance badly. These technologies failed to provide viable long-term options for the online teaching of engineering analysis software. Therefore, we have explored other avenues. The current option in which the Strand7 Company provides the service to the students for a nominal charge is perhaps one of the best. Other options including the software CD provided by the Company for a limited period or the Student Version/Open Source software packages are also good**.**

## CONCLUSIONS
Teaching online students how to use engineering analysis software packages comes with an additional challenge of providing remote access. We have trialled various technologies for providing this service with limited success. We found that other options including the service provided by the Company or Student Versions/Open Source software packages are perhaps better alternatives. We found that our designed learning and teaching activities along with the video tutorials helped the distance education students to achieve similar learning outcomes as the face-to-face students.

## KEYWORDS
Web-based teaching, online, engineering analysis software, remote access, digital technologies.

# Introduction

Engineering analysis software packages have become part and parcel of solving problems in the industry. As a result, along with theoretical approaches, engineering educators now teach the students the art of computer programming and how to use computer software for solving problems. Teaching students face-to-face about how to use various software packages is relatively straightforward. Students use the software packages in the computer labs of the university. Direct help from the tutors (one-to-one interaction) and peers facilitate student learning.

However, teaching distance education students how to use software packages poses a formidable challenge for the academics. The challenge is two-fold. The first one arises from teaching the students we cannot see and the second one comes from how the students access and use the software from home. The aim is to provide a learning environment in which the online students can achieve similar learning outcomes as the students studying on campus.

This paper focuses on the academic practice of teaching engineering analysis software packages to the external cohort. It depicts our journey as the engineering academics towards the successful teaching of engineering analysis software packages to the off campus students at the University of Southern Queensland. As USQ has about 70% of students studying online, it is very important to provide them learning experience similar to face-to-face students.

An example of the teaching of Strand7 software for the Structural Analysis CIV3505 course is presented in this paper. It explains the challenges we have faced over the years while teaching and how we have implemented various changes for providing better learning outcomes for students. The performances of various alternatives have been compared from different perspectives. Thus this paper can serve as a guide of possible options for the online teaching of engineering software packages and recommends a good teaching practice that can be applied elsewhere.

# Background

It is difficult to provide distance education students with opportunities to actively learn transferable skills as these cannot be learned passively (Brodie, 2010). Similar challenges apply in providing students with opportunities to learn complex engineering software for problem solving tasks. Learning these tools usually is done during tutorials that heavily rely on peer-to-peer and tutor interactions.

Barak (2006) has developed four principles for supporting computer-based learning activities, namely, learning is contextual, learning is an active process, learning is a social process and reflective practice plays a central role in learning. While these can guide the approach to provide learning opportunities for student, challenges remain: providing access to commercial software and teaching the software remotely. In the end, beyond student satisfaction, the measure of success is whether the activity delivers its objectives as “the pedagogical effectiveness of any educational activity is judged by whether or not the intended learning outcomes are achieved” (Arango, Chang, Esche and Chassapis, 2007).

## Access Issues

On of the major hurdles of teaching distance education students is to provide remote access to commercial software packages. Proper access to software is essential for students as they need to learn how to use software for solving problems. Because the off-campus students miss out the one-to-one interactions with the tutors/peers in the tutorial sessions, they need to spend more time in learning when they are stuck. This necessitates their accessibility for a longer period of time. Furthermore, they need to have the flexibility of logging at any time and use the software. Therefore, supplying proper access to software remotely becomes an

integral part of quality teaching. In fact, it becomes such a significant component of teaching that it affects the student learning experience if the proper service is not provided. This gets reflected in the student evaluation of the course.

The access process involves multiple technical issues including Internet connectivity, speed, security, licensing, firewall configuration of the user and operating systems. The student community is diverse. It includes individuals from industry, mature-age students and people from various ethnic backgrounds. Therefore, their need of support vary from person to person. Furthermore, the community is dispersed; some of them are working in other parts of the world in different time zones. Apart from these, the complexity increases further depending on how easy it is to learn the software and how much technically involved the software is. Increasing complexity needs more live interaction.

### Teaching Challenges

Teaching engineering analysis software to distance education students comes with the challenge that the software packages are highly mathematical. Therefore, they are difficult to learn. The complexity of usage and the capability varies from one software to another. This makes teaching harder. We will now explain briefly why teaching of these software packages is so involved. These software packages are used for modelling various systems such as manmade structures, machines, natural biological systems; and for studying their behaviour under various actions for example, earthquake, impact, temperature. Modelling such systems correctly using software itself is complicated. Once this is done, its behaviour under the action is studied at the next step.

This is often an iterative process. Models often do not work out of the box and require a more complex process then word processing software, for example. Debugging is required to overcome modelling errors, for example. If the model runs well, a solution of the problem is obtained. The problem does not end here, as one needs to understand/analyse the results in order to find out whether the solution may be correct or not because of incorrect modelling. This step is crucial. Students can get stuck at any of the above-mentioned steps and need to spend considerable time in solving it. Thus the problem solving using engineering analysis software packages is much more complex and needs more time and effort to teach as well.

## Approach

Over the last six years we have used various methods for providing external students with access to software. In this paper, we are evaluating different approaches in regards to providing access to software packages and how they have affected the learning outcomes of the distance education students.

In order to provide software access from home, we have implemented various technologies at USQ. These are: a) Virtual Desktops, b) Remote Access Laboratory (RAL) and c) Virtual Private Network (VPN). These are state-of–the-art technologies used for various online services. In each case, the students were given step-by-step instructions both in the StudyBook and StudyDesk of how to access the software packages using the process. It is worth mentioning here that the university has the necessary infrastructure that is required for providing and maintaining this service for the students. It also has the necessary number of licenses required as it allows a number of students to access the software simultaneously.

This becomes critical at the time of assignment submissions. The IT department also plays a significant role in solving the technical issues on a day-to-day basis. There was a designated online forum for reporting the access issues for Strand7 so that the IT department can solve them. After trialling one option, students' satisfaction was considered as the *benchmark* for the performance evaluation of the system. Student evaluation of the course reflected how the system performed and whether it did improve the learning outcomes or not. Trialling of new options were primarily driven by the lack of students' satisfaction regarding remote access.

## Virtual Desktops

Firstly, we implemented the Virtual Desktop system for providing software access. In this process, the students access the software through the StudyDesk Moodle environment of the university. They log into the Sun Secure Global Desktop (SGD) interface. This interface allows the students to connect to a remote computer. This executes a Java client locally in a browser on student's device. The actual software runs on a server and students control the software remotely.

## Remote Laboratory

Distance education students have the opportunities for performing experiments through remote labs (e.g. White, 1996, Kist, Maxwell and Gibbings, 2012, Kist and Basnet, 2013). Based on the same principles, RAL was used for providing the software access to the students. Through RAL, the students were able to book a session at their convenience. During the booked time, they remotely login to the university server. After login and accepting certificates, the students login to the Sun Secure Global Desktop (SGD). The SGD interface creates a full remote desktop on the student's computer. Then the students can run the software. The connection provided through this system was secure.

## Software Licence Access via Virtual Private Network (VPN)

In order to provide better service, we attempted to implement the Virtual Private Network (VPN) option next. Here students run the software locally and a VPN connection allows the software to connect to the licence server on campus. Thus the students can access the software while they are off campus. The student experience is very similar to using it in the on-campus mode as only software licences were managed via the VPN**.** Because of the requirements of the software vendor, we could not use this approach for the teaching of Strand7. However, this can be used for teaching of other software packages.

## Other Options

We have explored other possible options that can eliminate the above-mentioned difficulties of remote access. In the case of Strand7, the software company itself provides access to the students for a nominal charge. Another software provider has supplied CDs for a fixed period, say, for one semester. Student versions of software packages that the students can purchase at a minimum cost is another option. Student versions are good for learning with a limitation in the modelling/solving capability. Attempts have also been made to use Open Source software packages for teaching that the students can freely download and use. Open Source software packages may not be as powerful as the commercial ones, but they serve the purpose of learning the basics well.

## Learning and Teaching Activities

The learning activities we developed for the online teaching of software were comprised of four distinct steps: a) remote access b) running the software c) solving the tutorial problems (solution provided), d) solving the assignment questions correctly. The assignment questions were the same irrespective of the study mode and they carry significant weightage of the total marks. Therefore, in order to obtain a good grade, the students had to learn well how to use the software for solving problems.

The software 'Help' file provides a description of how to solve problems using the software. In order to faciliate learning, we have moved one step ahead and recorded live video tutorial sessions in which we have shown step-by-step how to solve engineering problems using Strand7. These demonstration videos became new learning resources for the students. Furthermore, online discussion forums were available for the students to pose queries and discuss with the teachers/peers.

# Results

This section summarieses our findings for the various options.

## Virtual Desktops

This simple procedure depends on the Internet connectivity, speed and therefore, can be seriously affected if the user/student has not enough bandwidth connection. Because the students login to a system that is running on Windows, whoever is using different operating systems also has issues. In this process, due to the technical issues beyond control, the students had failed to access the system properly on many occasions. If all the licenses were used up, there was no way another student would know when he/she can login. This problem was eliminated through the booking system provided in RALs.

## Remote Access Laboratories

However, similar to the Virtual Desktop, its performance depends on the Internet connectivity and speed of the user. The firewall configuration and the version of Java in the student's computer also affect the access. In this case, when the system was running, it was fine; however, getting proper access to the system was an issue many a times. The technical problems were solved on a case-by-case basis, still many students were not satisfied with this service. Furthermore, the system goes into the 'Deep Freeze' mode if somebody makes any change in the system. No access is possible during the 'Deep Freeze' period when the system is returned to its default configuration. This was frustrating to students as well.

## Learning and Teaching Activities

The studydesk analytics shows 170 views (total enrolment 100) for one such a tutorial in 2015 and 198 in 2016 (total enrolment 104). These numbers exclude the on campus students (about 30) who attended the sessions. This and good students' comments in the evaluation shows increased student engagement and in turn, demonstrates the effectiveness and impact of this innovation in learning and teaching. Both the face-to-face and the distance education students appreciated this.

The designed online learning activities addressed all four learning principles as identified by Barak (2006). The students were learning the background theories at the first step, followed by using the software. This gave them the context for learning the software and made their learning more effective. While learning, the students actively used the designated online forums, and posted their queries on the forums. The teaching staff provided them active support by responding to their queries. Fellow students were encouraged to respond to these queries and shared their experiences. These social interactions and reflective experiences enhanced the student learning during the study. In fact, we observed that the students who were active on the forums learnt better because of their reflective practices.

Because the students were in isolated environment, they needed to spend more time in learning and this perhaps made them more independent learners. The assignment feedback helped them to reflect on whether they have understood the problems and were able to solve them correctly. We found that the students studying online did their assessment equally well as their on campus counterparts. This indicated that the distance education students were able to achieve similar learning outcomes as the face-to-face students.

## Summary

Our observations while teaching distance education students at USQ show that apart from the challenges associated with the web-based teaching, providing access to software packages remotely plays an important role. It is quite hard to provide a service up to the students' satisfaction. We had implemented three types of state-of-the-art technologies for supplying the service to the students. All these technologies were capable of providing

similar learning environments for the students studying online. However, technical factors of multiple dimensions with some of them beyond our control, affected the system performance badly. As a result, some students were never happy and it was reflected in the student evaluation of the course. High expectations and lack of patience were also responsible for negative feedback. We feel that these technologies failed to provide a viable long-term option for the online teaching of engineering analysis software.

The current option in which the Strand7 Company provides the service to the students at home is perhaps one of the best. The company charges the students a nominal fee for providing the service. This mostly eliminated the technical issues related to the software access/licensing/security as the company directly deals with it. This saved the time of the academics and IT staff in dealing with the access issues. There were no complaints and certainly it improved the learning experiences of the students. Another variant of this type of service in which the company Ansys provides a CD for a limited period is also a good option. Furthermore, we have found that the Student Version of the software packages and the Open Source software packages are also good tools for learning, although they may not have the full capability as the industrial ones. Comparisons of all these options considering various features are presented in Table 1. Irrespective of the approaches, the same learning and teaching activities were used for teaching.

The learning and teaching activities that we have designed addressed the four learning principles. The recorded live video tutorial sessions in which we have shown them step-by-step how to solve engineering problems, became effective learning resources for the students, both oncampus and off-campus alike, and increased student engagement. These, in turn, enhanced the learning outcomes of the students studying online.

**Table 1: Comparisons of Various Options from Different Perspectives**

| | **Remote access using Virtual desktops, RAL and VPN** | **Company/Student Versions** | **Open Source software** |
|---|---|---|---|
| **Educational Opportunities** | Full capabilities with good learning opportunities. | Limited capabilities, though it may not affect learning. | Limited capabilities though it may not affect learning. |
| **Student experience** | Good experience if it works fine.<br>Generally not satisfied because of the access issues. | Generally satisfied.<br>Fewer technical issues. | Limited data available. |
| **Technical challenges** | Severe involving multiple technical issues as it depends on the Internet.<br>Needs IT infrastructure and IT support staff as well.<br>Needs maintenance of the components.<br>Any technical problem or if debugging is required, it can be fixed very quickly. | None for the academics.<br>If any it is dealt by the company. | None for the academics.<br>No infrastructure or maintenance required.<br>Any technical problem or if debugging is required, it takes much longer to get it fixed. |
| **Teacher perception** | Involvement required apart from teaching.<br>Needs time and effort for designing the course.<br>Access issues affect learning and student evaluation.<br>No extra expense for the student. | Extra expense for the student studying online only for the service. | No extra expenses. |

# CONCLUSIONS

Teaching students online how to use the engineering analysis software packages comes with an additional challenge of providing the remote access. We have trialled three technologies for providing this service with limited success. We recommend that other options including the service provided by the Company or Student Version/Open Source software packages are perhaps better choices for teaching the off campus students. The designed learning and teaching activities along with the video tutorials helped the distance education students to achieve similar learning outcomes as the face-to-face students.

# References


Arango, F., Chang, C., Esche, S., & Chassapis, C. (2007). *A scenario for collaborative learning in virtual engineering laboratories.* Paper presented at the 37th ASEE/ISEE Frontiers in Education Conference, Milwaukee, Wisconsin.

Barak, M. (2006). Instructional principles for fostering learning with ICT: teachers' perspectives as learners and instructors. *Education and Information Technologies*, 11, 121-135.

Brodie, L. (2010). Problem based learning for teams working in virtual space. Doctor of Engineering (EngD). Retrieved from http://eprints.usq.edu.au/8374/

Kist, A.A., Maxwell, A., & Gibbings, P. (2012). *Expanding the concept of remote access laboratories.* Paper presented at the 119th ASEE Annual Conference and Exposition, San Antonio, Texas.

Kist, A.A., & Basnet, B. (2013). Providing equivalent learning activities with software-based remote access laboratories. *International Journal of Online Engineering*, 9(3), 14-19.

White, R.T. (1996). The link between the laboratory and learning. *International Journal of Science Education*, 18, 761-774.