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NO 81

Enhancing Surveying Education through Blended Learning

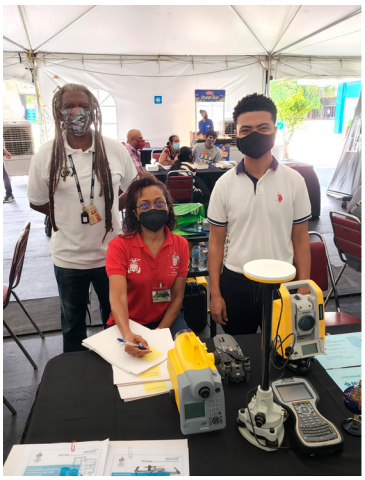

FIG Commission 2 – Professional Education

INTERNATIONAL FEDERATION
OF SURVEYORS (FIG)

Enhancing Surveying Education through Blended Learning

FIG Commission 2

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FOREWORD

Surveying education has a strong tradition of face-to-face lectures supported by practical tutorials and field project activities. 'Learning by doing' or 'active learning' have been fundamental to many surveying programs as well as training and continuing professional development. In 2010, Commission 2 recognised the benefits that online learning (or E-learning) could also have for surveying education, and how it could enhance the traditional face-to-face approaches. The result was FIG Publication 46 "Enhancing Surveying Education through e-Learning" which was a major contribution to the surveying education community globally. This publication builds in Publication 46 and reflects the significant technological and political changes in the surveying education institutions since 2010. The development of ICT and video conferencing, along with the development in Learning Management Systems, has allowed online learning in a way that was not possible previously.

The impact of the COVID pandemic, and the associated lockdowns starting in 2020, resulted in most surveying programs rapidly pivoting to emergency remote teaching mode. This pivot involved an exceptional response by surveying teachers globally and allowed classes to continue in most cases, although fieldwork was heavily impacted. While this emergency remote teaching was not blended learning, it did show that blended learning was possible, and that the essential field activities could be supported by online learning material in very effective ways. Other lessons from the pandemic were that surveying students are diverse with some thriving in face-to-face learning, and others preferring online learning.

This publication aims to assist the FIG community with a summary of lessons learned from the COVID pandemic emergency remote teaching and provides some guidance on good practices in implementing blended learning in surveying education. The content draws on papers presented during FIG events on the lessons, and discussion at online webinars during the FIG Working Weeks and Commission 2 events, as well as discussions on-site at the FIG Working Week in 2019 and the FIG Congress in 2022. We would like to thank the editors: Ir. Liza Groenendijk, Dr. David Mitchell, and Dr. Dimo Todorovski, and all the contributors of this publication as listed in the final pages.

May 2023

Dimo Todorovski
FIG Commission 2 Chair 2023–2026.

David Mitchell
FIG Commission 2 Chair 2019–2022

Diane Dumashie
FIG President

1 INTRODUCTION

Background

Innovative learning and teaching have traditionally received significant attention in FIG Commission 2 with a strong focus on face-to-face approaches. However, the strong potential for e-learning or online learning to enhance face-to-face learning as a blended approach was recognised in the previous terms of Commission 2. E-learning, open learning and knowledge management were major themes, in particular by former Commission 2 chairs Bela Markus and Liza Groenendijk (2005, 2008, and 2010). Their work on e- learning resulted in the 2010 Commission 2 publication: FIG Publication No. 46 '*Enhancing Surveying Education through e-Learning*' and was important for the work of Commission 2 as well as for the broad surveying education and training community. It highlighted the important role that e-learning and online education could play in surveying education and indeed was already being adopted. FIG Publication No. 46 set the framework for understanding effective approaches to online learning in surveying education which were critical to our global response to lockdowns during the COVID-19 pandemic as will be discussed later. Further developments in education, communication technology, and our experiences of emergency remote teaching in response to COVID-19 provided lessons and benefits for delivering a blend of face-to-face and online learning. During the last term the focus of Commission 2 was strongly on blended learning. This report is the outcome of workshops and FIG publications during and after the COVID pandemic. It builds on Publication 46 and aims to discuss the lessons from the pandemic and share some good practices for blended learning in surveying education.

A major global driver for education is the Sustainable Development Goal 4 that aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UN, 2015). There are two main themes in the targets and indicators[1] that are relevant for Commission 2. The first is making surveying education and lifelong learning in surveying accessible for all (targets 4.3 and 4.5), with a focus on inclusiveness and equitable quality. The second main theme in SDG Goal 4 and the targets and indicators is ensuring that all learners acquire the knowledge and skills needed to promote sustainable development (target 4.7). This is a responsibility of all involved in surveying education.

Blended learning is a key strategy in making education more widely available and accessible to all. Surveying academic institutions are supporting the development of blended learning and tremendous progress has been made in the last few years. Blended learning provides students with the opportunity for flexible online access to study resources and with online tutor or peer mentor support. In more advanced courses students are also able to make use of automated support to enhance their learn-

1 Target 4.3: By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.
Indicator 4.3.1: Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex.
Target 4.5: By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.
Target 4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

ing experience. Students who previously lived far away from the education institution or were impacted by disability, financial or cultural disadvantages appear to become more empowered through the use of online services as they now had the flexibility to choose their study location and would not need to come to the University campus to use the facilities and study. The blended approach also appears to have been beneficial for students who worked long hours, or have family caring responsibilities, where students were able to take ownership of their time, priorities and participate in the course using flexible study models that best worked for them.

Also, FIG Commission 2 has a strong focus on supporting regional academic networks to support increased access to surveying education for all. Online learning opportunities through a blended approach appears to remove some of the physical, cultural and time-related barriers by ensuring inclusive and equitable quality education and lifelong learning opportunities for all. FIG will continue to support the Surveying education community to mainstream global citizenship and education for sustainable practice in education policies.

Disruptive technologies are having a major impact on the jobs and roles that surveying students will face when they graduate and are influencing the nature of their professional development and life-long learning. Professional surveying education will need to allow students to fully engage in these disruptive technologies, and increasingly provide learning opportunities anytime and anywhere including remote and self-paced options (Mitchell et al, 2020).

FIG will continue to support the Surveying education community to mainstream global citizenship education and education for sustainable development into education policies. Blended learning is now one of the main themes of Commission 2. One of the key challenges in surveying higher education has been to increase equal participation of women and men. A second challenge has been the traditional and strong emphasis on face-to-face practical learning, where students have been required to travel to major cities to complete their higher education surveying programmes. These challenges appear significant for education institutions with less developed IT infrastructure and with learners with greater challenges. There is a need to develop the capacity of surveying education institutions and leaders to provide quality surveying education opportunities to students who live in remote areas or are unable to travel to cities to participate as effectively. Commission 2 seeks to support advancement in these areas against SDG targets 4.3 and 4.5 through developing the capacity of surveying academic institutions under working group 2.1 (Regional Academic Networks) as discussed below.

Commission 2 aims to promote good practices in professional surveying education by:

- Exploring the needs of society and endorsing universities and other educational organizations: Developing mechanisms and processes that will help to meet those needs.
- Methods and content of education: Supporting and promoting advances in learning and teaching methods and content of curricula with special emphasis on the impact of technology and learning styles on education.
- Knowledge sharing: Promoting sharing of advances in professional education, research in surveying education and training and initiate joint projects (curriculum development, educational material development, joint courses, quality assurance etc.). Improving dissemination of information on educational theory

and practice to the members across the world via existing academic networks.

- Capacity building: Supporting capacity building for surveying education in the developing world, through strengthening knowledge transfer.
- Cooperation with other professions: Reinforcing cooperation with Educational Commissions of International Organisations on the related professions.
- Continuing Professional Development: Encouraging improved surveying practice through the promotion of continuing professional development (CPD) and the practical application of research, helping surveyors continuously to update their academic and professional profiles.

The work of FIG Commission 2 is organised in 4 working groups that implement the Commission 2 workplan:

1. Working Group 2.1 – Developing and strengthening academic networks
2. Working Group 2.2 – Innovation in Curriculum development implementation
3. Working Group 2.3 – Young surveyors in Education – Learning styles in surveying education
4. Working Group 2.4 – Land Administration Education (joint with Commission 7)

What is blended learning?

The competency-related main goals for the education of young surveyors are defined within the learning aims of courses and qualification aims of degree programmes. To achieve these predetermined learning outcomes, course coordinators in undergraduate programmes have to design, apply and continuously refine appropriate teaching and learning outcomes, assessment and methods. Here, lecturers have to take into account framework conditions (e.g., student-related aspects, pre-requisites), infrastructural aspects (e.g., lecture room, equipment, internet availability/bandwidth, software), course-related aspects (e.g., duration, content materials) and current research findings related to teaching). The principal of 'constructive alignment' (Biggs & Tang, 2011) as a reliable basis for achieving learning outcomes, depends on linking course learning outcomes to the teaching/learning setting and assessment.

While a unified definition of 'blended learning' is not available (Torrisi-Steele 2011 and Alammary et al. 2014), describe blended learning as the reasonable educational blend of 'traditional' face-to-face classroom teaching (e.g., lectures, seminars, labs) and media-based online teaching.

The blended learning approach, often synonymously used with the term 'blended mode of study', aims to strengthen the benefits and reduce the drawbacks of both face-to-face and online approaches, and how learning outcomes are assessed. While face-to-face teaching is usually conducted synchronously, media-based/online teaching can be performed both synchronously and asynchronously independent of geographic location of the student and teacher. See the meta-analysis of Alammary et al. (2014) or Christensen et al. (2013) for a classification of blended learning approaches discussing their pros and cons.

In this report we have adopted the definition and description of 'blended learning' as:

> *Blended learning is the thoughtful fusion of face-to-face and online learning experiences. The basic principle is that face-to-face oral communication and online written communication are optimally integrated such that the strengths of each are blended into a unique learning experience congruent with the context and intended educational purpose.* (Garrison and Vaughan, 2011)

In other words, blended learning involves, provides a blend of the most appropriate learning experiences for the surveying course they are studying. This needs a blend of effective online and face-to-face communication including giving and receiving feedback (e.g., Gallagher, 2017). In blended learning settings, there are an increasing number of online communication tools and platforms.

Community of Inquiry and Blended Learning

In this publication we adopt the 'Community of Inquiry' framework used by Garrison and Vaughan (2011) where the emphasis is on students being actively engaged in the process of inquiry in their learning by the presence of teacher, the social setting and their cognitive or abstract knowledge or belief about a phenomenon. The community of inquiry framework involves purposeful, critical communication and debate, and reflection. Social interaction and collaboration help understanding of concepts and allows an individual to deepen their knowledge through sharing and feedback. The community of inquiry framework involves three core elements – 'social presence', 'cognitive presence', and 'teaching presence' (See Figure 1). Teaching presence involves

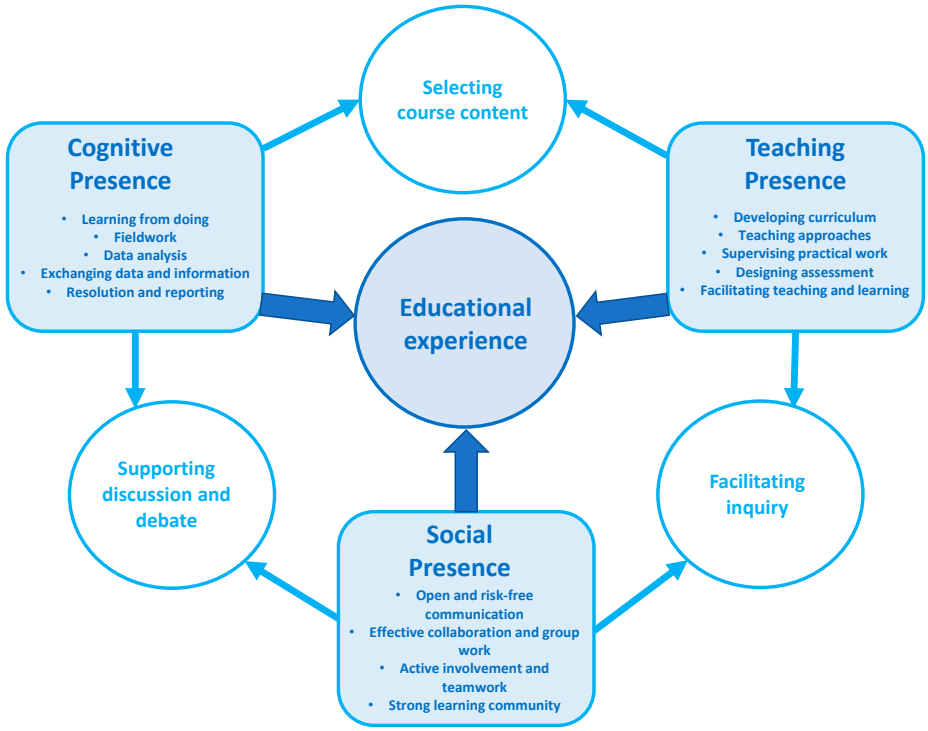

Figure 1: *Community of Inquiry Framework applied to Surveying Education.* (Adapted from Garrison et al, 1999)

the contribution of the teacher to the educational experience and includes developing curriculum, and approaches to teaching and learning and assessment. Cognitive presence is the quality of the learning activities undertaken by the student and includes the cycle of gathering data, integration, analysis, resolution and reporting. Social presence is the quality of the learning community and involves open communication, collaboration and group work. he social, cognitive and teaching presence informs the design of the teaching and learning approaches (Ibid). Teaching presence and social presence together facilitate inquiry. The teaching presence and cognitive presence dictate the quality of the course content. Cognitive presence and social presence determine the quality of the discussion and debate in the learning process.

Social presence through collaboration and a strong learning community

In the community of inquiry framework, students can effectively collaborate by expressing themselves openly and have a sense of belonging to the community. As listed in Table 1 (above), social presence involves peer support that builds on open communication, cohesive groups, and ability to establish strong personal connections (Ibid).

Cognitive presence: learning from experience, reflection, developing actions, assessing

Cognitive presence is needed for inquiry that involves reflecting and interacting with a new concept or idea. There is a circular pattern of learning from experience, then reflecting, followed by developing actions, and further experiences (see Figure 1). It is important that students are provided with active learning and opportunities to explore and reflect and conceptualise (Ibid).

Teaching presence (curriculum, teaching approaches, moderation, assessment)

Teaching presence establishes the curriculum and teaching approaches and methods, as well as moderating and guiding learning and discussion and assessment. Teaching presence brings together effective social and cognitive presence and facilitates discussion and understanding. In a blended learning environment, a strong teaching presence is needed – especially when students connect out of scheduled class time (Ibid).

Blended learning should engage students in the learning process by facilitating both active and interactive learning experiences that address a stated problem (teaching presence). For surveying students, like many other areas of study, it is even better if they are solving a real-world problem. The design of blended learning in surveying education should encourage collaboration (social presence) and the opportunity to explore, reflect, and conceptualise (cognitive presence).

Blended learning for lifelong learning and CPD

Continuous Professional Development (CPD) is an important component of any working professional's career. Through CPD courses, working professionals can extend their education and stay abreast of the latest developments in technology, theory and practice, which promotes lifelong learning. But the challenge for working professionals is to find the time to engage in such courses. A blended or fully online approach helps to facilitate this. Blended learning provides busy professionals with more options to meet their

CPD course commitments if there are options offered online and mostly asynchronously. However, face-to-face continues to be the most desirable way to experience CPD.

Methods

This publication was developed based on consultation within Commission 2 workshops and sessions between 2020 and 2022. As this coincided with the COVID-19 pandemic, with long periods of lockdown, face-to-face workshops were virtually impossible to organise for much of this time. However, the rapid pivot to online teaching by academic institutions also helped facilitate skills in running online workshops. Commission 2 facilitated online workshops and seminars at each of the Working Weeks and also in conjunction with the Commission 7 Annual meetings in 2020 and 2021. These sessions discussions focused on how each academic institution responded to the pandemic and the lessons learned. In 2021 the discussion turned to best practices for blended learning post-pandemic. It is this discussion and the excellent presentations that have informed the design and writing of this report. Writing this publication was undertaken by 16 experienced surveying academics (see acknowledgements) who each contributed to parts of the publication and also provided peer review comments on the final document. The editors would very much like to thank each of the contributors who provided perspectives from the Caribbean, Canada, Africa, Europe, Australia, and the Pacific Islands. Their significant input into this publication made it much richer and informed by diverse country contexts.

Summary

The COVID pandemic accelerated the adoption of online and blended learning in surveying education. This publication is based on the lessons from our response to the pandemic and builds on the contribution of FIG Publication 46 Enhancing Surveying Education through e-Learning. The following chapter presents the results of three surveys of staff and students at education institutions undertaken during the COVID pandemic. These include a global survey by FG Commission 2, a national survey in Germany by the professional association 'German Association of Surveying – Society for Geodesy, Geoinformation and Land Management' (DVW), and a survey by The Technological University of Dublin, Ireland School of Surveying and Construction Management (SSCM). These results of these surveys are presented in Chapter 2. Chapter 2 also provides a description of the lessons learned from the COVID-19 pandemic as further background to good practice recommendations provided later in the report. These lessons learned, along with FIG publications and discussions during this period, informed the good practices in blended learning are described in chapter 3. In chapter 4 good practices in blended learning technology and infrastructure are discussed. Chapter 5 is dedicated to the role and benefits of blended learning in surveying education.

2 LESSONS FROM THE COVID-19 PANDEMIC: STAFF AND STUDENT PERSPECTIVES

Surveying students globally include practitioners, para-professionals and professionals. They may be working in the industry while studying, and their level of study can vary from a certificate to postgraduate studies. Traditionally, the majority of surveying students engaged in education using various forms of learning typically involving face-to-face interactions. Good practice in blended learning has previously taken place in the surveying domain (Mitchell et al., 2020). However, before the pandemic, blended learning was not the standard approach to survey education. It was often an extra component to traditional programmes and Continuous Professional Development (CPD) and/or followed ice-breaker sessions which facilitated a 'getting to know you' phase where initial technical issues could be solved. However, surveying education is often augmented with hands-on, 'learning by doing' activities, with associated calculation and assessment supplemented by remote support and additional content provision.

During the initial months of the COVID-19 pandemic, the global education system experienced a disruptive, externally motivated push for online learning. Official guidelines and national regulations impacted severely on the training of young surveyors around the world as practical training was paused and face-to-face education had to rapidly pivot online. This quick reaction –Emergency Remote Teaching (Hodges et al. 2020) – was one way of dealing with the challenging COVID-19 circumstances, which remains omnipresent and comprehensively impacts future learning and teaching. In contrast to a well-planned digital change processes (e.g., Bond et al. 2018), this forced rapid response was adopted in all regions globally with broad implications for the education of young surveyors.

Many surveying education institutions went through the emergency remote learning, to being able to reintroduce some face-to-face classes, to being able to move to a preferred mode based on the lessons from the pandemic period. For example, the University of Cape Town first moved away from Emergency Remote Teaching (ERT) to Physically Distanced Learning (PDL) before resuming some face-to-face classes, as described in the box below.

Based on the experiences gained throughout the COVID-19 pandemic, the importance of blended learning teaching/learning settings has significantly increased. The transformation of traditional educational activities towards the implementation of a blended learning approach often required upgrading the learning management system, and an accelerated diversification of learning and training activities according to very specific educational objectives. The need for students to interact and communicate in person (face-to-face classes) was one of the main lessons, along with the value of online resources for the acquisition of knowledge (online and remote personal study), and the need to master technical skills (practical exercises in the field). The response by surveying teachers and trainers was outstanding, and the students' rapid adaptation to this new approach to learning and teaching was a key to the continuity of quality education experiences. Ultimately, the pandemic forced the development and implementation of blended learning and decisions about what is the best way to blend face-to-face and online learning. This chapter discusses the perceptions of staff and students about this experience.

Continuing Professional Development at the University of Cape Town during the COVID-19 pandemic

Beginning in 2020, the University of Cape Town's Division of Geomatics offered an online CPD course called *Guidelines for Improved Land Administration*. The original intent was for the course to be delivered face-to-face as a five-day block comprising four hours of interactive lessons in the mornings, followed by an additional four hours of afternoon readings. When the COVID-19 pandemic forced education into predominately online mode, this plan had to be changed.

1. The course was offered fully online with lessons opening every second day. The course thus ran from Monday of the first week to Wednesday of the second week (Monday, Wednesday, Friday, Monday, Wednesday). The plan was still for four hours of 'lessons' followed by four hours of reading per day, but participants could now stretch this over two days. They could thus better manage their work and course commitments.
2. All course material was uploaded to the course site for participants to access in their own time.
3. One exception to the asynchronous course design was a one-hour online meeting for all participants and lecturers at the beginning of each lesson. The purpose of these meetings was to discuss the previous lesson's content and readings, and for lecturers to highlight important topics coming up in the next lesson. They also formed an important social connection for participants to get to know each other and share their ideas.
4. The lesson design included short readings, recorded videos (generally not longer than 15 minutes each), short quizzes to test participants' engagement with the material, and forums for participants to post any insights they had gained during the lesson. Participants were encouraged to comment on each other's forum posts as these were replacing the classroom discussion that would take place in a face-to-face environment.
5. On the final day, instead of the usual readings, participants were invited to complete a three-hour online exam. To accommodate work commitments, a generous time window was allowed within which participants could complete the exam. The exam drew randomly from a pool of questions to ensure each participant's exam was unique and to decrease the chance of cheating.
6. Certificates of attendance were awarded to each participant who attended at least 80% of the live online meetings (four out of five) and completed every lesson (including the quizzes). Certificates of completion were awarded to participants who met the above criteria and completed the exam with an overall result of at least 50%. (Simon Hull, University of Cape Town)

Methods

As discussed in the previous section, the sudden suspension of face-to-face education and implementation of emergency remote teaching from early 2020 accelerated the transformation of traditional educational activities towards the implementation of a blended learning approach. The effectiveness of this approach was assessed in several dedicated student and staff surveys, which are discussed in detail in this section. During 2020 and 2021, a number of surveys assessing the pivot to online learning were undertaken, these include the:

1. **DVW** survey – The professional association 'German Association of Surveying – Society for Geodesy, Geoinformation and Land Management' (DVW) survey, focussed on the effects of the first wave (March–July 2020) of the COVID-19 pandemic on all surveying-related education in Germany. Mayer et al. (2021) present the results of this survey comparing the perceptions of young surveyors and lecturers regarding:
    a. Working from home.
    b. Communication processes
    c. Teaching and learning settings
    d. Completeness of education programmes
    e. Exams
    f. Level of satisfaction (1,500 participants).
2. **FIG Commission 2 survey** focused on surveying students' learning strategies and styles in four main areas:
    a. What is learning?
    b. How the student approaches studying
    c. Student preferences for different types of courses and teaching
    d. How well the student thinks they are doing
    (180 responses from 17 countries across Asia-Pacific, Africa, Europe and North America) Ben, et al., (2021).
3. **TUD** – The Technological University of Dublin, Ireland School of Surveying and Construction Management (SSCM) survey aimed to inform strategies for future programme delivery and focussed on three main areas:
    a. Teaching, learning and assessment
    b. Technology
    c. Students' experience of online learning during COVID-19
    (510 responses from both undergraduate and post-graduate students across all surveying domains) Harrington et al., (2021) and Martin (2021).

The findings of these surveys (DVW, FIG & TUD) are summarised here from the perspective of both the learner and the teacher in three areas: i. Teaching and Learning, ii. Assessment and iii. Technology. Furthermore, a case study from University of Cape Town is presented. The significant challenges faced by staff during the ERT in rapidly

developing new teaching and assessment techniques provide valuable information on improving blended learning approaches for the future of survey education.

Learning and Teaching

It is assumed that the emergency remote teaching implemented during COVID-19 impacted the social presence (see Table 1) by providing fewer opportunities for students to interact with teachers and other students. This has amplified the challenges for students, irrespective of the student background. These challenges are significant and have been identified in the literature (e.g. Raturi et al., 2011; Reddy et al., 2016; Raturi, 2018; Johnson et al., 2021) as including:

1. Student readiness to adapt to the new environment of self and online learning.
2. Socio-economic issues, for example the lack of financial capacity, or family issues and increased social responsibilities, and psychological and emotional trauma due to the outbreak.
3. Lack of motivation and feeling of isolation.

Additionally, under the Community of Inquiry framework (Garrison and Vaughan, 2011), social presence enabling collaboration, expression and a sense of belonging diminishes the rich educational experience afforded by face-to-face learning. It is important to note here that online learning does not work for some students due to lack of access to ICT and computers etc.

During 2020 and 2021, many universities were able to offer much of their theoretical programme material online directly using Learning Management Systems (LMS) and

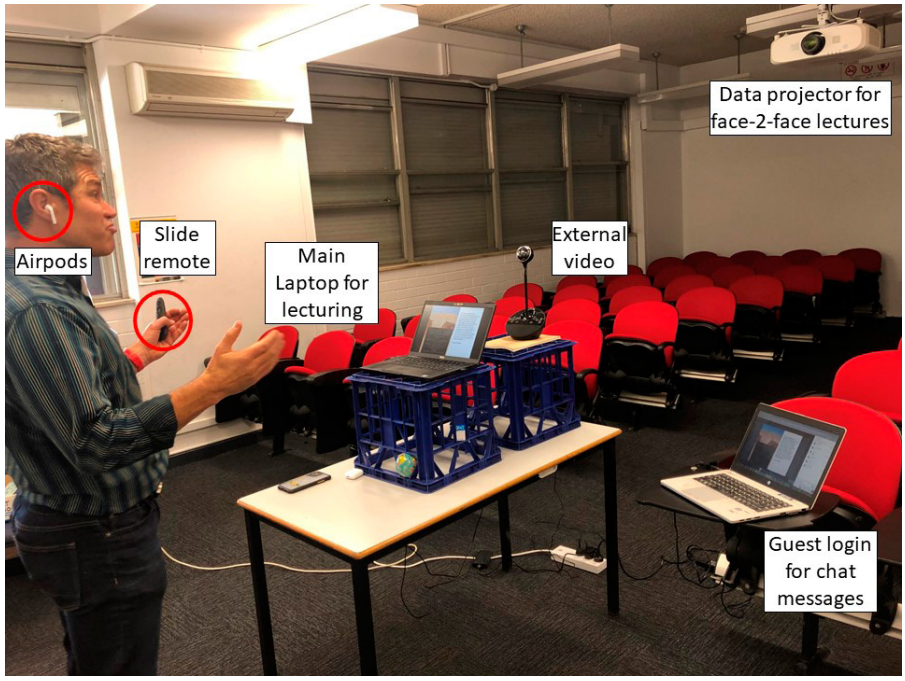

Figure 2: *Teaching online during the COVID pandemic.*
(Source: Craig Roberts)

Virtual Learning Environments such as Blackboard, Canvas, Moodle, etc. In addition, collaboration platforms (e.g., MS Teams), web- and cloud-based tools (e.g., zoom, jitsi, overleaf, google-docs, etherpad, mentimeter, pingo, padlet) were applied in online teaching. Hardware tools (e.g., interactive pen tablets) were also adopted for interactive teaching. Furthermore, increasingly flexible new settings for teaching (e.g., synchronous teaching[2]: additional channels for continuous communication and feedback) as well as for student advice were experienced and developed. To establish research-oriented teaching elements, lecturers could support students in attending to scientific meetings more easily (Mayer et al. 2021). In most places, this structural switch from classroom to online teaching was implemented quickly and Mayer et al. (2021) found that 74% of surveying lecturers in Germany achieved this within two weeks. Roberts (2020b) gives an Australian example of this switch and the time taken at the University of New South Wales.

During the pandemic over 90% of all TUD 'Chalk & Talk[3]' surveying classes took place as per the scheduled timetable using synchronous teaching and learning. However, the benefits of asynchronous online learning [4] are evidenced from the significant percentage (80% of TUD and 77% of FIG) students who used recorded content to review and revise course materials. 73% of the (FIG) respondents found short videos (2–8 minutes) useful to help them familiarise with the topic or complete assessments. In addition, over 90% of TUD students found the range of additional online materials supportive of their learning and going forward 40% of students (TUD) would like to retain some element of online learning. Interestingly, the FIG survey found that online games or game theory in education were not a very effective measure for learning.

Results of the TUD survey strongly indicate that as expected student preferences are for onsite face-to-face education. This result aligned with the FIG survey where 76% responded that they learn better if they are doing an activity in class. 86% of FIG respondents indicated they prefer 'blended learning' which combines face-to-face and online study and 73% prefer to learn through traditional 'face-to-face study'. In the FIG survey, only 30% of respondents strongly agree or agree that they "prefer to learn through online study". Where the learning mode is online there is a strong preference (in the FIG survey) for having the option to have asynchronous learning. Measures of the overall student experience from the TUD study indicate a positive teaching and learning environment. This implies that students found the teaching materials developed were appropriate for online learning and they could follow the curriculum. Thus, programmes were successfully delivered online with positive engagement with the materials from students. However, wellbeing and mental health were negatively impacted as a result of the shift to the Virtual Learning Environment. TUD students found the learning environment and lack of physical contact with their peers very isolating. This supports the thesis that the physical and social environment of higher/tertiary education is a significant factor in students' flourishing (Garrison and Vaughan, 2011).

With respect to online teaching, this was an incredibly challenging time for academic staff. They needed a lot of support in developing appropriate online learning materials. Many universities have dedicated pedagogical and technical staff who support online programme development and delivery, and this support was vital in harmonis-

2 Synchronous teaching – although learning from a distance, virtual attendance at classes each week, at the same time as the instructor and classmates. https://online.osu.edu/.
3 Chalk & Talk – theoretical classes in a typical classroom situation
4 Asynchronous online learning – a general term used to describe forms of education, instruction, and learning that do not occur in the same place or at the same time. https://www.edglossary.org/.

ing blended learning approaches during COVID-19. Going forward, blended learning is very time consuming and challenging to deliver in a way that includes quality face-to-face and active learning, and staff will need to be supported. Mayer et al. (2021) found in the DVW study that the skills of sessional lecturers (e.g., public service, private companies) must be treated cautiously regarding online teaching to ensure quality. Ideally, further pedagogical qualifications and/or guidelines, which address the adequate didactical qualification of lecturers for online learning (e.g., feedback, online interaction, monitoring of self-regulated online-learning), need to be developed.

Assessment

Assessment of learning outcomes achieved is a fundamental requirement of education systems to demonstrate the knowledge and skills attained by the learner. Tertiary education assessments include closed book invigilated written examinations, in person oral examinations and presentations and practical tests. All of the above methods had to be reconsidered and redesigned for online delivery during the COVID-19 pandemic. Alternative modes of assessments adopted by TUD included time limited online open book examinations, online multiple-choice questionnaires (MCQs), online presentations and oral examinations amongst other things. Figure 3 identifies the usage of online assessment methods across all surveying disciplines accessed by surveying students.

Mayer et al (2021) found that in Germany (DVW) the transition from in-person to online oral examinations was successful, thereby guaranteeing a more inclusive setting for exams. The TUD students' experience of online assessment methods was surveyed and found that such assessment methods were effective in demonstrating their knowledge (76% of the total respondents). In addition, 70% of TUD respondents found online assessment to be less stressful than traditional in-person assessment methods. This is interesting as it indicates that the majority of students today are very comfortable in an online assessment environment.

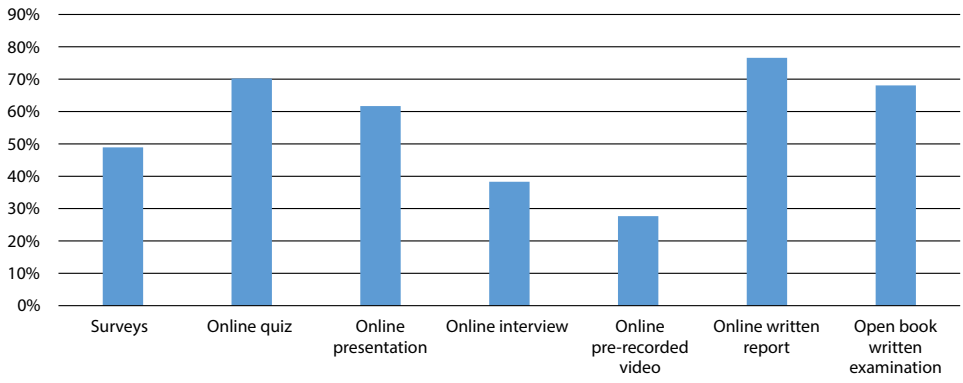

Figure 3: *Online assessment modes used by TUD Surveying students during the COVID-19 pandemic in 2021.* (Martin 2021)

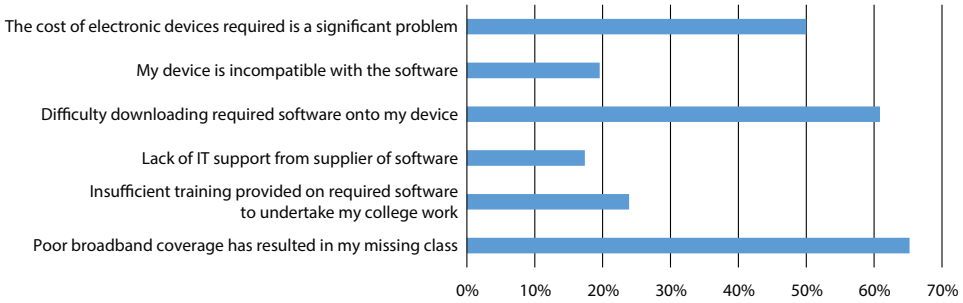

Figure 4: *Technological issues identified by TUD student s during COVID-19 .* (Martin, 2021)

Technology

The availability of Information Technology (IT), IT infrastructure and internet connectivity is a major driving force behind successful blended learning programmes. Of concern for students in many countries is the cost – personal and institutional – and access to infrastructure. This is even more of a challenge for remote students in education institutions with less developed IT infrastructure and learners with greater challenges. The University of the South Pacific, as an example, is owned by 12 member countries and has 14 campuses across the region. The geographic and spatial disparity of the islands makes poor connectivity and unstable internet connection conspicuous. The TUD study assessed ICT issues for students and found that the most significant (>60%) issue was broadband availability when accessing synchronous online classes. TUD Geospatial students also noted that the cost of electronic devices was a substantial issue (50%). Although these students typically purchase their own laptop, one of the main technological issues highlighted was the software requirements for geospatial data manipulation and visualisation, which exceeded their PC capacity. This is a particular issue for Geospatial surveyors who typically deal with extremely large data sets. Figure 4 outlines the issues highlighted by Geospatial TUD students.

The pivot to online ERT also meant that teaching staff had to upskill extremely quickly in the use of technology. Staff did find that software was more user friendly than anticipated and limiting programme material dissemination and communication platforms to a couple of platforms (Moodle, MS Teams etc.) was beneficial. However, the availability of hardware (e.g. additional screens, headsets, video, cameras) was reported by lecturers as an inhibitor to successfully delivering programmes online.

The following box summarises the experience at the University of Cape Town during the emergency remote teaching period and how it evolved during the years 2020 and 2021.

Summary

Based on lessons learned during the COVID-19 pandemic, a greater understanding of individuality and diversity of both national and international students in their home countries was experienced and may be used to improve the online CoP in the future. Outcomes from the surveys (DVW, FIG & TUD) and the University of Cape Town case study presented here are a good basis for development, integration and acceptance of

University of Cape Town Case Study

When the pandemic first hit in March 2020, all students were sent home and South Africa went into 'lockdown level 5'. Initially this meant that we could only leave our homes to get food and supplies or to see a doctor. Gradually the lockdown restrictions were eased, but students were not permitted to return to the University of Cape Town (UCT) campus for the rest of the year. All lectures were conducted online and asynchronously. This posed a challenge because Geomatics is a 'hands-on' degree and we needed our students to return to campus for practical surveying tasks and to access software and hardware for advanced geoinformatics assignments.

At UCT, Geomatics falls under the School of Architecture, Planning and Geomatics (APG). A concession was given for disciplines in the performing and creative arts (PACA) for their students to return to campus in September of 2020 – disciplines such as dance, music and drama were unable to proceed remotely. The School of APG took hold of this opportunity: the architects wanted students on campus for their studio-based, creative teaching, and Geomatics wanted students on campus for 'hands-on' learning and teaching in surveying and geoinformatics. Particularly non-negotiable was the need for first- and second-year undergraduate students to be on campus for their basic surveying practical tasks, such as levelling, trigonometrical heighting, traversing, detail surveys (contouring), triangulation and trilateration. The third year surveying students were engaged in a cadastral survey project for which an online simulation was equally not ideal. Thus we applied for and were awarded PACA status by the University with the opportunity to welcome students back to campus in September.

However, the pandemic worsened and showed no signs of abating. For largely economic reasons the lockdown restrictions were eased further, and staff debated the wisdom of inviting students back to Cape Town and onto campus in the midst of a pandemic. We eventually took the difficult decision to continue the suspension of all practical, on-campus activities for the remainder of the year, and to pick up the pieces in 2021. Instead, we offered students simulated activities online with a focus on data processing and analysis instead of data capture.

During 2021, all lectures remained online and asynchronous, with students required to be in Cape Town and to attend practicals and tutorials on campus. The University of Cape Town was well prepared and equipped to manage the pandemic. Air conditioners were upgraded, masks were worn at all times (indoors and outdoors), equipment and surfaces were sanitised after use, students and staff were required to vacate an indoor venue for 15 minutes every hour, numbers of students permitted in a venue were carefully controlled, and no personnel were permitted on campus without first passing a health screening questionnaire. These practices allowed the non-negotiable land surveying practicals as well as on-campus tests and exams to resume (lockdown levels permitting). On-campus geoinformatics tutorials resumed where the benefits of peer learning and tutor support are evident. The gaps in students' practical skills and conceptual knowledge due to the suspension of practical activities in 2020 are clearly evident, especially for the third year cadastral project (students who were in second year in 2020). Additional support has been needed for these students and a change in the usual scope of the project.

Flexibility and resilience have become essential for staff and students alike in managing the ever-changing COVID-induced landscape of blended learning.

Simon Hull, University of Cape Town

blended teaching settings in the future, supporting a more holistic, diverse and digital education. Whilst the continuing education of young surveyors during the COVID-19 pandemic was difficult, an overall satisfaction rate in programme delivery and assessment of about 50% was found by Mayer et al. (2021). This result indicates that improvement from the ERT is required to ensure blended learning meets student needs. Improvements in blended teaching should include the development of new and interactive course materials and a redesign of assessment strategies suited to the current environment where information is almost always available online. In addition, access to course materials in an online educational platform is essential. Such programme portals offer various learning and assessment options and enable remote collaborative working. It should be noted however, that considerable time, effort and skills are required by teachers in developing appropriate online programme material and maintaining learner engagement. The effort and voluntary contributions of teachers and trainers, and the students' rapid adaptation must also be considered as conditions of success. Online learning does not work for every student for various reasons including access to ICT (broadband availability) and the cost of electronic devices. The learning by doing elements of survey education are very difficult to achieve by online learning approaches alone. Therefore, much of survey education will continue to require face-to-face interaction, supported by online resources under a blended learning model.

Lessons from these three studies – DVW, FIG and TUD – apply to Learning and Teaching, Assessment and Technology. These include clever timetabling solutions, which facilitate simultaneous on and off-site programme delivery. The importance of the practical '*learning by doing'* elements of the surveying curriculum cannot be underestimated and cannot be delivered in an online environment. The pivot to online assessment, which maintained the integrity of the survey qualification, required a significant effort by educators in a very short time frame. This appears to have been successful and effective and provides a good basis for such assessment methods in the future.

3 GOOD PRACTICES IN BLENDED LEARNING

Previous chapters have shown the potentially transformative benefits of blended learning for surveying educators and students. This chapter provides guidance about how to organise learning programmes around a blended learning model. This includes good practice guidance for designing and delivering blended learning geospatial education and will be useful for teachers, trainers, lecturers, programme leads, accreditation bodies and students themselves.

However, despite the benefits of blended learning, it is a difficult and time-consuming process to implement in a comprehensive way. Blended learning is not simply the merging of remote learning and traditional face-to-face teaching on the same programme (Jones and Sharma, 2021, Allan et al., 2019) there are institutional requirements and design considerations for each element to improve the other (FIG 2010, Garrison and Vaughen 2011). Good practice in blended learning encompasses creating good learning environments for face-to-face, online, and remote learning as well as effective design in how these are blended. Standard learning design assessments (e.g. appropriate learning outcomes and constructive alignment of assessments to these), should be authentic and encourage a 'deep approaches to learning' (Biggs, 2011) and 'life-long learning' (Kelly, 2019).

Implementing the good practice suggestions in this chapter requires considerable institutional buy-in, supportive community practice, institutional resources and IT infrastructure (Bonk and Graham 2005; Allan et al. 2019; Jones and Sharma 2021) which may not always be available. Therefore institutions, academics and training providers should focus on the guidance on what is possible for their context. Practical examples of topics, skills and competencies that should be developed in person, face-to-face and those that can be developed remotely, are given. New technology allows new ways of learning and teaching but must be used in a scholarly and thoughtful manner (Allan et al., 2019) – some aspects are highlighted in the section below and are discussed in detail in the next chapter. Consideration of how to assess learning, and ensure its validity, and quality, is considered though readers will know that learning and teaching scholarship is constantly being updated. This chapter ends by describing the challenges for implementation and suggestions for good practice. If blended learning consists of in-person and remote learning, then guidance is required on both aspects.

Creating a Community of Inquiry using blended learning

Blended learning is an entirely new mode of learning where 'both online and physical learning are made better by the presence of the other' (Garrison and Vaughan, 2011, p. 5). Critical to this is the Community of Inquiry model as described in Chapter 1, with elements of teaching, social or cognitive presence required (Vaughan et al., 2013).

There is no strict requirement for a specific amount of the time to be provided for either face-to-face or online components of blended learning. Instead, consideration should be given for the 'educational needs of the course' (Ibid, p. 9) to determine what is most appropriate for each context. Course design, considered later in this Chapter, should assign content to the appropriate delivery mode (Ibid 2013). A blended learning approach could, for example, ensure that the time spent on face-to-face learning prioritised the following:

- The use and cost of physical resources such as surveying instruments
- Establishing relationships and peer learning between students
- The use of high-specification computer labs
- Invigilated exams

The three main elements of Teaching, Social and Cognitive presence can overlap, in particular where Social and Cognitive issues impact the ability to establish and maintain an appropriate Teaching presence (Ibid, 2013). A case-study in Blended Learning design with specific examples is provided later in this Chapter.

Social presence (collaboration and a strong learning community)

A fundamental requirement of a community of inquiry is a strong social presence. Students must learn in a cohesive group within a trusted environment that has open communication, where they are free to express themselves, collaborate and socialise together (Ibid). Building social presence through activities like in-class introductions, and the careful use of group work supports the development of open communications and critical reflection (i.e. Teaching Presence). A practical way to do this is to start classes with initial introductions and in-person familiarisation. This is better if it can be done on campus so that these identities and relationships can be carried over into the online or remote element of the course.

With regards to critical reflection and discourse, integrating on-campus and online activities requires awareness of the relative strengths of 'spontaneous verbal and reflective written communication' (Ibid, p. 37). Synchronous on-campus communication is more spontaneous and influenced by peers while asynchronous allows for more reflection, reason and rigor (Ibid). Note however that with the recent increased use of technologies such as Microsoft Teams and Zoom, synchronous communication is now common for online and remote learning activities for those with the necessary resources (bandwidth, data and hardware). In a synchronous verbal environment e.g. computer lab, tutorial room – building the social presence can improve motivation and help with class discussion and brain storming sessions.

Cognitive presence (learning from experience, reflecting, developing actions, assessing)

Cognitive presence is the ability for students to 'construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry'. (Ibid, p. 11). There is a strong overlap with social and teaching presence in the community of inquiry model. The way in which something is learned is just as important as what is learned and so 'purposeful and collaborative activities that support discourse and reflection' (Ibid, p. 21) are needed. For surveying education this means active learning that is practical and hands-on. Some of this will be group work and it may be necessary to deliver practical modules in discrete blocks instead of on a weekly basis.

Cognitive presence is enhanced when students are aware of the learning choices and design within the teaching presence, and are given some measure of control in their own learning such as the co-design of assessments, choice of submission format (Nicol and Macfarlane-Dick, 2006). They also have a 'shared responsibility' for maintaining an open and respectful learning environment and achievement of learning outcomes

through enabling information exchange and applying new ideas or theories (Vaughan, et. al., 2013).

As discussed in Chapter 2, blended learning needs clever timetabling to facilitate simultaneous on and off-site programme delivery, with dedicated teaching rooms with the technology to record lectures and tutorials. A single learning portal (LMS or Virtual Learning Environment) with the possibility of remote login facilities students' access to required software and data storage facilities and enables easy learner engagement with all aspects of the programme. For example, the University of New South Wales (UNSW) now offers hybrid learning, with some students in the room and some online. Lectures are delivered live, and lecturers can receive questions from students either in the room or online via chat messages or sometimes by unmuting. While there are some coordination challenges for lecturers, these are manageable and when it is set up correctly there are benefits for staff and students. All lectures are recorded. In one class in 2021 there were 30 students in the room and 10 online – with one in China, one in Malaysia and some from regional and remote areas of Australia. UNSW builds enthusiasm and motivation by drawing parallels between theory and real-world examples, live demonstrations of equipment or techniques in class with student participation (if possible), and collaborative activities involving the whole class. These include a map reading exercise for grid convergence etc, logistics planning for a static GNSS practical project, and velocity vectors for the Australian plate (Roberts 2020a, 2020b).

Teaching presence (curriculum, teaching approaches, moderation, assessment)

There are three general areas of teaching presence in a Community of Inquiry: (i) design, (ii) facilitation and (iii) direction (Garrison and Vaughan, 2011; Vaughan et al., 2013). These bring together the Social and Cognitive elements (Chapter 1) to achieve appropriate learning outcomes. Examples include setting the curriculum and assessment, shaping constructive engagement, and focusing and resolving issues (Vaughan et al., 2013).

In the '*design*' phase it is good practice to design for open communication and trust, and also for critical reflection and discourse. Clear communication to students is very important and includes outlining what is expected of them e.g. that they are taking ownership of their own learning; sign posting of online activities and due dates (Garrison and Vaughan 2008, Adekola et al., 2017). There should be a mechanism for communication regardless of the mode of learning e.g. on campus, remote, synchronous, asynchronous. The instructor should be 'predictably present' (Vaughan et al., 2013) but not constantly present. In the '*facilitation*' phase it is good practice to establish a community of students, cohesion and a purposeful approach to inquiry. In the '*direction*' phase it is good practice to ensure that (i) there is respect and responsibility, (ii) the inquiry moves to resolution, and (iii) assessment is aligned to learning outcomes (Vaughan et al., 2013).

Online learning aspects of blended learning

FIG Publication 46 (FIG, 2010) described good practices for e-learning that still apply today. This section builds on these good practices and describes how they fit into a blended learning approach. As outlined, online learning is only one element of Blend-

ed Learning and 'activities must be congruent with anticipated goals in the subsequent face-to-face class' (Ibid, p. 37).

Students may lack confidence and experience of blended learning, so it is important to explain clearly to students what it is – though this will change over time (Jowsey et al., 2020). Course leaders should be aware that in one study only 54% of students enjoyed trying out new and innovative technologies (JISC, 2020a) so clear instruction and scaffolding is critical.

Developing social, cognitive and teaching presence

Creating a safe, open environment that allows for critical discourse is an important part of both social and cognitive aspects of the design of teaching presence. Whilst synchronous, in-person communication and collaboration may offer excitement and motivation, asynchronous dialogue can improve critical discourse as the delay while they visit online forums gives time for reflection. It can also enable students that 'do not feel comfortable participating in spontaneous face-to-face dialogue'. Continuing discussions that begin on campus, in-person and carry on into the online learning environment is a good way to ensure the learning experience is blended (i.e. moving from one mode to the other) with the subsequent move to asynchronous online discourse allowing 'further reflection and discussion' (Vaughan et al., 2013, pp. 40–41)

Facilitating blended learning during the pandemic: lessons from South Africa and Australia

Surveying education evolved during the pandemic where teaching staff had to find innovative ways to adapt to remote and online learning while maintaining the quality of learning experiences for the students. In this section there are two examples presented in different institutional and student contexts. The first is from the University of Cape Town in South Africa, and the second from the University of New South Wales in Australia.

University of Cape Town

Although the University of Cape Town (UCT) has long had an online, Sakai-based learning platform called Vula[5], it was mostly used for communicating with students, sharing resources, and setting assignments. That changed considerably when the pandemic hit. After several weeks of training and preparation, conversion from face-to-face teaching to online lessons was achieved. Two important recommendations were made upfront:

1. Lessons should be conducted **asynchronously**. For many students, devices (laptops or phones) and home spaces were shared with more than one member of the family. Some students needed to travel to areas with better internet connectivity to access lessons. And with all family members being at home at the same time, there was no guarantee that students would be available for lessons according to a university-set timetable. Thus, lessons were prepared and made available for students to access in their own time.
2. Online lesson content should be **low-impact**. Many students do not have access to high-end, or even medium-end, devices. Although some local internet service providers allowed students access to educational sites without incurring

5 *Vula* is an isiXhosa / isiZulu word meaning 'open'.

any data costs, many students live in areas with low or no internet connectivity. It was therefore important to design lessons that did not require students to download large files, such as video. Where video lessons were recorded, students (many of whom are not first-language English speakers) were provided with transcripts and screenshots of the recording as substitutes.

There are obvious drawbacks to these recommendations, the first being that asynchronous learning leaves students isolated from their peers and lecturers. This was somewhat allayed by using WhatsApp groups including staff, tutors and students to discuss lessons and assignments. Also using low-impact lesson content obviously constrains the lecturer, restricting opportunities to expose students to wider online content. Although educational sites did not have data costs, other sites (such as YouTube) did, and online lessons needed to be designed with this in mind. UCT provided students with a monthly data allocation to assist them to remain connected and access lesson materials that might incur a data cost. They were also provided with entry-level laptops on loan to ensure they could remain connected and complete their tasks. Some tasks require higher-end computing and proprietary software. Under 'normal' conditions, students would access these devices and programmes in dedicated computer labs. Under COVID-constrained conditions, allowance needed to be made for remote access to these devices. This was no small task and required careful management of computer labs to set up sufficient dedicated remote access devices alongside devices that could be used by students on campus (once access to campus was permitted). Yet this was an essential component for successful online learning, especially in the geoinformatics courses that required high-end processing capabilities.

University of New South Wales

During the initial change to ERT at the UNSW in 2020, field practical projects for the 1st year surveying students in levelling, handheld GPS/GNSS and building set out were replaced with online activities as follows:

- **Levelling:** A video of the lecturer performing a levelling survey was filmed in small vignettes in a local park including deliberate mistakes. Multiple choice Moodle quizzes were embedded between these short videos asking students questions about the field practice and asking them to identify examples of poor practice (what not to do). Students could only advance to the next step after completing each separate quiz. New videos commenced with a narration reviewing the previous task. This suite of video/quizzes took students through the process of levelling and included some calculations. A second part to the exercise then requested students to go to their local park and design a levelling practical project and draft a locality sketch. While they didn't physically do the levelling, they were required to do all the thinking behind designing their own level run. Constraints were given including at least 3 setups, a closed level run, to a selected benchmark. Students were then assessed on the quality of their design as well as their skill at drawing a useful locality sketch containing all the required mapping information.
- **Handheld GPS/GNSS:** Students were directed to download some free apps onto their phones (Apple or Android). Due to the Open data policy in NSW/ Australia, government Apps have been developed and can be used to find local survey marks. Students are asked to find 3 local survey marks (most 1st years never

do this), then measure with GNSS in the national datum (experience with coordinate systems), and then use the GNSS View App to capture current constellation of satellites at the time of measurement (experience with accuracy and GNSS constellations). Students prepare a report with photos and screen captures.

- **Building set out:** This project has traditionally been a group exercise on campus using a total station. This revised version is effectively the same exercise except students do it at home or in the local park, using a tape measure only, and try to achieve a 5mm level of accuracy. In the assessment the student reports must show all the checks used and include with photos or diagrams and explanatory comments.

At the University of New South Wales modern geodesy taught online was quickly adapted to COVID conditions. Two collaborative whole-of-class face-to-face practical exercises (namely (i) a map reading exercise, and (ii) logistics planning for static GNSS) were emulated live online using an external video camera/microphone and a whiteboard. Students were required to unmute while the lecturer directs the class live on the whiteboard (which all students can see) and develops the idea live on the video using coloured whiteboard markers. Students were asked to decide what is required to do the activity and are encouraged to contribute to the discussion. This promotes a team spirit Roberts (2020a).

In this same 3rd year geodesy course (subject), students were asked to select a research topic from a list and prepare a 4-minute, pre-recorded video presentation at the end of term. It was compulsory to attend the online conference in the final week. The topics were curated into themes and an additional MS Forms link for students was prepared to enable individual peer review of their colleagues. The lecturer moderated the event and introduced each video providing some context. Pre-recording guards against the myriad problems that will likely be encountered if live delivery is attempted. It also becomes a video resource that can be used in the wider industry for CPD events. Indeed, students were informed that this is exactly like a CPD event required to maintain professional qualifications in their future careers (Roberts 2020a).

Assessment

Assessments are usually classed as either summative or formative. Summative assessments are used to measure student achievement of Intended Learning Outcomes, i.e. to 'certify learning achievements' (Nicol, 2009, p. 13). Formative assessment, which does not contribute (immediately) to a student's grade, should be used to improve learning i.e. 'assessment for learning' (Ibid, p. 13). Either can be used for both on- and off-campus elements of Blended Learning, though programmes should include opportunity for formative feedback prior to summative assessments (Nicol and Macfarlane-Dick, 2006) with feedback returned in time to allow the student to reflect and act on any feedback that can be used for the next assessment. Ideally, the weighting and intensity of assessments should start small and increase as the academic session progresses. Submission dates of assessments across the degree programme should be mapped to minimise conflicts and academic load of students and staff – although some clashes may always occur.

Where possible Geospatial Surveying assessments should be authentic with 'tasks that mirror the skills needed in the workplace' (Nicol, 2009, p. 40). For example, to assess a

student's ability to centre and level a Total Station an authentic assessment would be an examined practical demonstration, not an essay. It is important for assessments to include reflection on the learning such as asking the student to discuss other options or additional steps that might be undertaken to improve the outcome – such as asking for an 'Educational Reflection' section at the end of a traverse report.

In line with the principle of 'constructive alignment', assessment tasks should be explicitly tied to the Intended Learning Outcomes (Biggs, 2011) and the same ILO should not be assessed multiple times although this may depend on the number of ILOs and the amount of detail they contain. For example, an ILO regarding Survey Control could be used for assessments linked to Level loop networks, GNSS and Traversing assessments. In some instances, repetition or practice is desirable; for instance, installing a traverse network can occur when using instruments for the first time but also during an extended residential field class/camp that occurs much later in the degree programme.

The number of summative assessments should be enough to adequately show attainment of the ILOs but not so much that they overwhelm and increase anxiety (Nicol, 2009). This can result in students developing strategic learning practices (Biggs, 2011) which can result in them avoiding deeper engagement with material and 'assessment as learning' comes to replace 'assessment of learning' in a context of tightly specified criteria, as the achievement of grades may be at the expense of a more complex understanding (Jessop and Tomas, 2017, p. 995). This can result in superficial engagement with material e.g. simple memorisation, no reflection etc.

Practical examples of assessment strategies can be found in Nicol and Macfarlane-Dick (2006) and Nicol (2009). Group projects 'encourage students to study and learn together, which leads to the natural development of friendships and supportive groupings' (Ibid, p. 37). However, care should be employed to not overuse group work and submissions. Group projects can lead to student resentment and inability for individuals to be assessed as an individual, with some group members taking total control and others not participating much to the group submission. Methods of peer assessment of individual contributions of group members are available (Spatar et al., 2015), and require care in setting the expectations and explaining how the responses will be anonymous and helpful to all students (Nicol and Macfarlane-Dick 2006; Nicol 2009; Kelly 2019; Falchikov and Goldfinch 2000).

Online Exams and quizzes

Blended learning offers the opportunity (and in some cases, the necessity) of new assessment types e.g. online, open book exams (Nicol and Macfarlane-Dick, 2006) and appropriate steps should be taken to minimise the opportunity for plagiarism and collaboration. For example, exam questions can be adjusted so that they are not simply requiring core knowledge and definitions (that can be found via Google), but application of these into a given scenario e.g. proposing a GIS workflow to determine possible locations of a new building development with conditions A and B in country C.

The available time for the exam can also be minimised to reduce the ability for students to collaborate (Stadler et al., 2021) though some allowance should be made for download and upload times, taking scans of hand-written diagrams, etc. Another approach is to compare the grades the student receives for non-test type assessments with the grades they receive for tests and exams, looking for an obvious difference.

An observation is made by total station (in face left) from point A to a prism target at Point B.

A vertical zenith angle of 048^ 12′ 27″ is recorded. Which of the following statements is true?

Select one:

a. The vertical angle relative to the horizon is +221^ 47′ 33″
b. The vertical angle relative to the horizon is +041^ 47′ 33″
c. The vertical angle relative to the horizon is -041^ 47′ 33″
d. The vertical angle relative to the horizon is -221^ 47′ 33″

Figure 5: *An online class test using Multiple Choice Questions on Moodle.* (Kelly, University of Glasgow).

For online tests, quizzes and exams, it is good practice to create a library of questions from which the online learning platform can randomly draw. This is onerous for the academic to set up because it requires the creation of multiple questions of different kinds at different levels of cognition. Randomisation is essential, however, to avoid students contacting each other during the test and sharing answers. Taking connectivity constraints into account, students should be given a window of time within which to complete the assessment. Thus, it is possible for one student to have finished the assessment before another student begins. The increased use of a Virtual Learning Environment such as Moodle can be exploited for use as a platform for online quizzes, where large question banks can be created for various quiz types including multiple choice assessments (Roberts 2020a) – e.g. see Figure 5.

Whilst creating large question banks in the required format on the Virtual Learning Environment can take a significant amount of time, it does provide benefits for standardisation and efficiency over the longer term. Grading and issuance of both general and question-specific feedback can be automated, allowing educators to spend time on other aspects of the course such as increased face-to-face time during surveying practical sessions. These quizzes can also be used for formative feedback and act as a progression check to confirm online video lectures have been watched and understood. For example, the University of New South Wales found that embedding short, low-risk quizzes into online lessons was an effective way of ensuring that students remain engaged with the content. In an online environment, it is tempting for students to watch a lecture video or read lesson content and move on to the next item without pausing to consider what they have just learnt. Embedding short quizzes into the lesson and making completion of the quiz a pre-requisite for opening the next item in the lesson, is an effective way of creating this pause and reflect moment. Students can also gauge for themselves whether they have understood the content before moving on. Quizzes should be able to be completed more than once to allow students to go back and address any questions they did not answer correctly. Students reported that they found these short quizzes highly valuable in helping them to remain engaged and check their progress through the course.

For theory-heavy courses such as geodesy, quizzes with lots of short answer responses were used at the University of New South Wales. Roberts (2020a) gives an example of

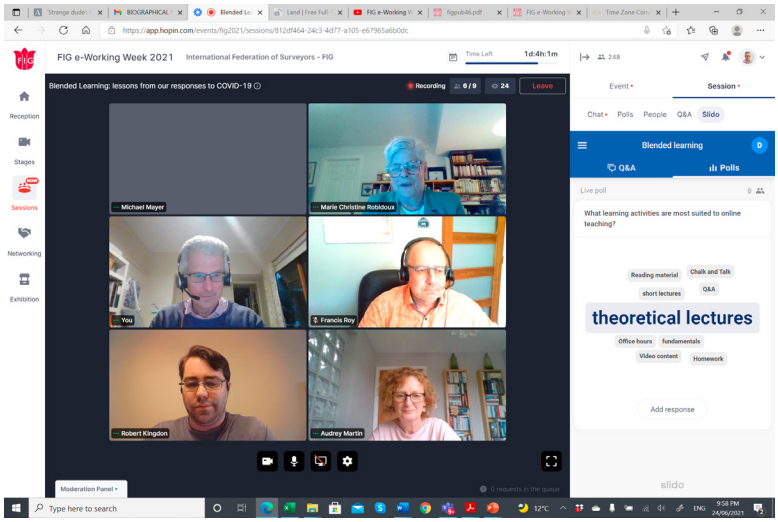

Figure 6: *Using a poll in a Commission 2 webinar during the 2021 FIG e-Working Week.* (Source: David Mitchell)

teaching modern geodesy which employs over 230 True/False questions testing small items of theory. The first quiz covered one-third of the material with a question bank of about 70 questions, students are allocated 20 chosen at random. The focus is on revision and not gaining marks with the assessment worth only 2%. The second quiz covers two-thirds of the subject material with a question bank of 140 questions from which 20 chosen are chosen at random, and the assessment is worth a further 2% of the total assessment. The third quiz covers all the subject material and features all 230+ questions again with only 20 chosen at random for a 2% assessment. Once the final assessment is closed, answers to all questions are released for revision.

Online proctoring

Remote exams can also be proctored by specialist software that monitors the students' activities and computer browsing ability, however there are serious privacy and access considerations with these approaches (Paredes et al., 2021). Geospatial students should be reminded of and abide by their Institution's Code of Conduct, Student Regulations etc. as well as any ethical criteria from their professional institution (such as the Royal Institution of Chartered Surveyors).

At the University of Cape Town, the sudden lockdowns brought about by COVID-19 precluded on-campus exams. The services of an online proctoring agency were employed and allowed the students to complete the same exam at home. The exam was shared online, and students wrote at their desks on their own paper while an invigilator watched them through their webcams. A recording of the exam was made, and the invigilator flagged any suspicious activity for the academic to review. Students scanned and uploaded their completed exams within 20 minutes after the time was up. For most students, this was a stressful experience initially, but once they got going it was as stressful as a 'normal' exam and no issues were reported. For some students, however, there were multiple and critical problems resulting in the exam having to be aborted. These students then applied for a deferred examination citing all available evidence of their inability to complete the exam online. Issues were mostly related to connectivity.

A few students were unable to meet the requirements for writing the exam in this manner and applied upfront to write on campus under 'normal' conditions. This was possible because the country had once again reverted to a more relaxed lockdown level.

An approach used at the University of New South Wales was to run exams by emailing students the complete paper and providing a return email. Some exams use the open book approach and questions are designed for this type of exam. Some questions are provided from industry practitioners. The open book approach is used to give students a chance to demonstrate their knowledge. The class sizes are not large (max 50) and timing of the exam had to consider international students in different time zones and this creates challenges. In the school the approach taken is 10 mins reading time + 2 hrs exam time + 20 minutes allowance for submitting online to account for IT issues. Where the exam has computational questions, more than one question is prepared and randomly distributed to the students. While this can be a lot of work, some academics use questions which can be tailored to have different numbers for the same style of question. Another way is to use student ID numbers to develop questions which are individualised. These approaches are better for large classes and once done can be adapted (Roberts 2020b).

Implementing blended learning

Successful blended learning experiences require significant input from academics, their peers, management, learning technologists and often the institution itself (Porter et al. 2014, Allan et al. 2019). Various forms for blended learning exist from: Enabling (e.g. improving access), Enhancing (incremental improvements to course or learning) or Transforming (fundamental shift in learning dynamic) blends of learning (Bonk and Graham, 2005). An overview of these, with examples can be found in Figure 7.

The sudden and short-term pivot to online teaching during the COVID-19 pandemic is unlikely to be sustainable or optimal for teachers or students (Hodges et al. 2020,

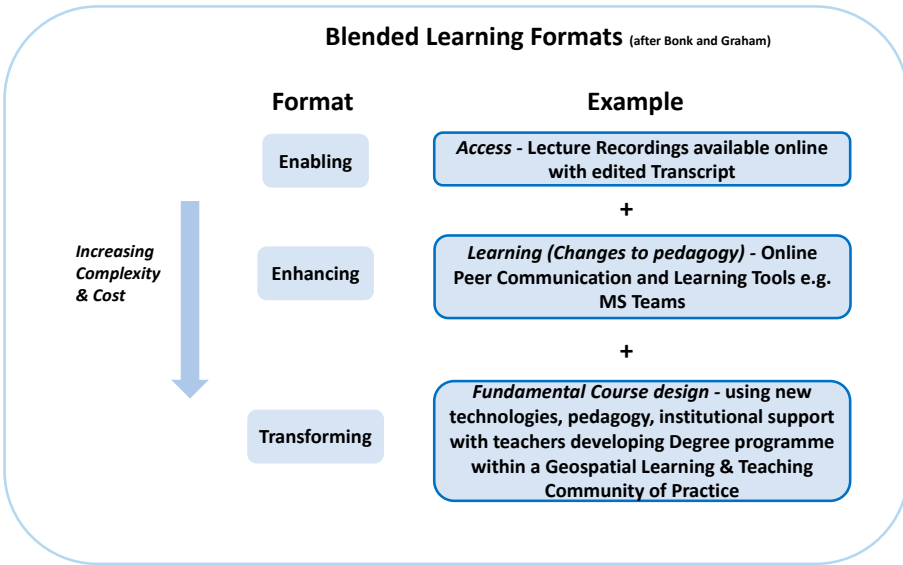

Figure 7: *Blended Learning modes with example – adapted from Bonk & Graham 2005.* (Kelly 2022)

Martin 2021) with more substantial moves towards the goal of transformative Blended Learning formats to be the norm in the future. It should be noted that small changes or adaptions can result in the layering of additional material and cognitive load onto an existing course and can 'lead to frustration, dissatisfaction and diminished learning outcomes' (Vaughan et al., 2013, p. 23).

More substantial, transformational blended learning requires significant internal learning and development and support from peers and institution, including formalising research and dissemination strategies (Allan et al., 2019) – products such as journal articles but also informal experiences e.g. blogs, should be disseminated so as to become 'community property' (Glassick, 1997, p. 4) for the benefit of other educators.

Research in pedagogy can be challenging for academic staff who have traditionally studied in the technical fields of surveying as it involves new epistemologies, methodology and methods, so study of this discipline is required (Trigwell and Shale 2004, Cousin, 2008). It may also require working with academics from different disciplines as well as instructional designers and learning technologists (Dale et al., 2021) as well as estate planning for technology-enabled teaching rooms.

Academics engaged in geospatial learning and teaching are recommended to adopt dissemination strategies such as the 'D-cubed strategy' that explicitly outlines the need to 'assess the climate of readiness for change' (Hinton et al., 2011, p. 14) as an important element of any scholarship intervention, particularly one as significant as blended learning. Good practice generally includes considerations for the following areas: Design Process, Pedagogical Strategies, Technology & Digital Literacy and Communication (McGee and Reis 2012; Adekola et al. 2017, Allan et al. 2019). While the syllabus of Surveying programmes should be influenced by the priorities of professional accreditation bodies, they should also engage with the scholarship of learning and teaching principles such as constructive alignment.

Design Process

Undergraduate and postgraduate programme aims and objectives and accreditation requirements should follow the principles of constructive alignment (Biggs, 2011). As illustrated in Figure 8, the process of constructive alignment in courses or modules starts with understanding the course aims and objectives. Within these courses, 'learning outcomes' (LO) should be written based on what the student should be able to do by the end of the course and be consistent with the course aims. An appropriate assessment should be identified to evidence attainment of each 'intended learning outcome' (ILO). The blended learning design then follows by identifying the elements that could be best achieved in a synchronous face-to-face environment and those that can be online/remote and perhaps asynchronous– se Figure 8.

Note that online activities do not need to just be asynchronous in nature. If the technical infrastructure capacity of the institution and the students allows it, then live lectures (with integrated Q&A) and group collaboration work (e.g. through MS Teams channels) can be performed. When writing the ILO's the revised version of Bloom's Taxonomy (Krathwohl, 2002) should be used to indicate the required skills such as using higher order verbs to promote learning beyond the simple memorization of facts towards a deeper learning approach to understanding the underlying meaning (Marton and Säljö, 1976). Development of more generic, transferrable skills or Graduate Attributes should also be explicitly planned for through the design phase (Nicol, 2010; Smith, 2016).

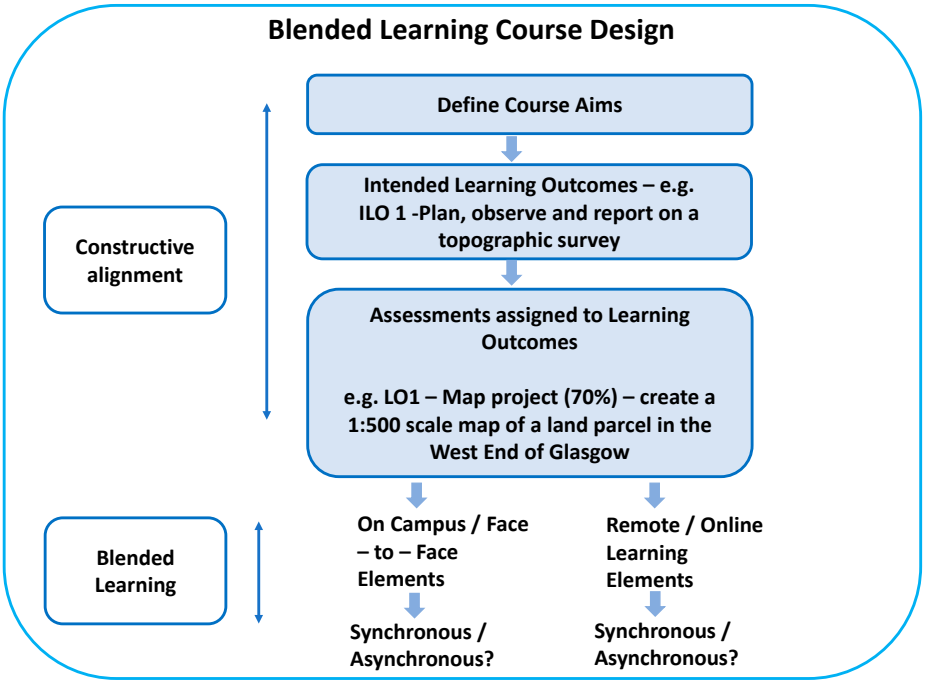

Figure 8: *Constructive Alignment with Blended Learning.* (Kelly, 2022)

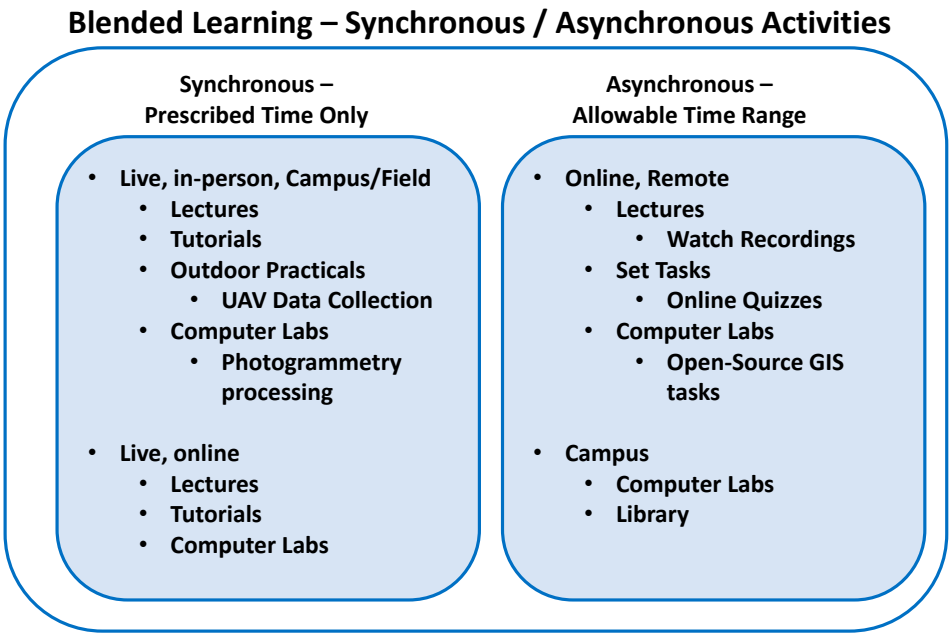

Figure 9: *Example activities split by nature of time completion – Synchronous, Asynchronous.* (Kelly,2022)

Figure 9 provides examples of typical learning activities and which are best suited to asynchronous or synchronous approaches. It is good practice to split computationally demanding tasks to campus facilities, where possible, and have other elements with more flexibility e.g. ensure that lecture has been watched with accompanying quiz answered during a 7 day period – this is important for access e.g. students working at home who may be informal carers, have working commitments etc.

The 'standard' lecture has received a lot of critique over the years and the COVID-19 pandemic has meant that institutions were forced to adopt online approaches. Whilst in-person lectures are valuable due to their social interaction and dynamism between parties (Charlton, 2006), online recordings increase access by allowing recordings to be watched anywhere and at any time, importantly increasing access for students with English as a second language (Adekola et al., 2017). Also, students can pause and rewatch sections to enhance deep learning. Accompanying transcripts add clarity for all users as well as accessibility for e.g. deaf students (Lynn et al., 2020).

Pedagogical Strategies

FIG Publication 46 described the growth in pedagogy in e-learning classifying learning experiences in terms of how much control the student has over the learning activity content and nature. Traditionally, teaching content was transmitted to the student through a lecture, lecture notes, or other means. A recent focus on active learning has allowed the student to have more control over how and what they learn. Another approach that is common in surveying education is collaborative or interactive learning where the learners interact with each other and a teacher, allowing the learning content to emerge. Group work is one example where this can happen.

In a blended learning approach, these student-centred activities and collaborative learning approaches involve both online learning as well as face-to-face learning. Blended learning can complement "hands-on" practical experiences with online audiovisual materials, documents, and software.

When using a blended learning approach, it is recognised that that online learning on its own is not appropriate for the more practical "hands on" aspects of surveying education such as field practical projects. These practical aspects need to be predominantly taught using face-to-face methods. However, online resources can make the face-to-face tuition more effective (FIG 2011). For certain elements of a Blended Learning approach, asynchronous activities will allow students to progress at their own pace (Nordmann et al., 2020).

In choosing when to use online or face-to-face approaches in a blended learning model, it is important to use activities and assessment types that encourage deeper learning. For example reflective diaries allow students the time and space to reflect on their own learning (Plack et al., 2005). The use of continuous learning journals, reflective diaries etc to allow critical reflection (Butler et al., 2010) by analysing experiences to improve future performance, and allows opportunities for students to work and learn together (Allan et al., 2019). One online approach to reflection is to ask for a 'reflection video' where students are asked to reflect on their understanding of the key theory through video and submit through the LMS. This approach allows students who cannot easily access the campus to communicate about their experiences. Collaboration in reflection can be achieved through an online ePorfolio space for students to reflect on their experiences as a project develops with the teacher structuring the learning using templates/examples and rules for use of the site.

Open book exams are authentic in other professions and vocations (Finch, 2016) and can develop higher order learning processes (Gibbs, 1988) and can work well in surveying courses. For example, RMIT University in Australia has used an open book approach for the final exams in its cadastral law subjects. Traditionally these open book exams were undertaken at a designated exam venue and students were allowed to bring in whatever subject notes they needed. The exam was designed in such a way that if student need to look up every answer they will run out of time. The aim is for students to develop a set of notes from which they can quickly find the answers to questions that arise. This approach can also be replicated in online exams, but plagiarism and the use of incorrect information sources is a challenge.

Teaching staff should scaffold the student through the process of blended learning to address learning issues that may arise. It is good practice to ensure integration between online, remote and in-person, campus-based activities. With the increase in number of communication platforms, and learning technologies, care should be taken to manage the cognitive load of the student (Allan et al., 2019). As illustrated in Figure 8, when using Blended Learning, it is likely that face-to-face and online learning will be designed based on the course aims, and with learning outcomes designed using Blooms Taxonomy, or the revised Blooms Taxonomy (Krathwohl, 2002). General guiding principles include:

- Core, theoretical knowledge e.g. lectures, slide packs, should be available online for asynchronous delivery.
- Careful design of the online learning environment is necessary.
- Using face-to-face time to maximise practical experience of using surveying instruments, use of campus computer labs for computationally intensive data processing especially if licenced, collaborative group project work, residential field classes etc.

See Figure 10 for examples of how typical educational goals and learning approaches may be classified in a Blended Learning environment.

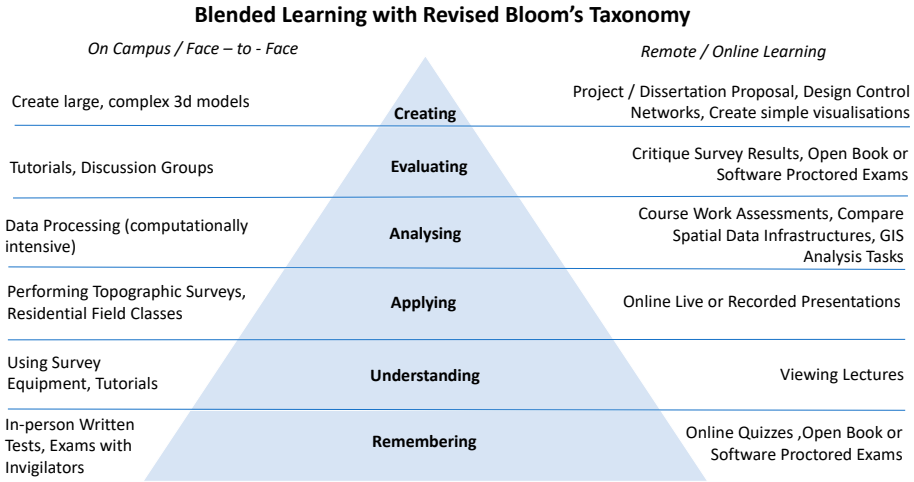

Figure 10: *Examples of activities and assessments on Blended Learning Geospatial Surveying degree, organised around the Revised Bloom's Taxonomy.* (Kelly, 2022)

Creating a community of practice among teachers and students

The implementation of blended learning can benefit from creating 'communities of practice' for both teachers and students. Communities of practice can emerge through purposeful, open, disciplined strategies (Garrison and Vaughan, 2011) which can enable and encourage change and scholarly inquiry into blended learning. A community of practice can also include students both through their learning and assessments (Ibid) but also as collaborators in e.g. assessment design (Nicol 2009, Deeley and Bovill 2017). It is often assumed that students will naturally be able to use technology but they will not necessarily know how to use online communication tools in a learning environment (Nordmann et al., 2020) and may not be the technological 'Residents' (White and Cornu, 2011) or have the 'Autonomy' (Adekola et al., 2017) to be independent learners. Both the University of Glasgow and The University of the South Pacific has a published Netiquette guide[6] which outlines guidance on online communications. Students sometimes do not view the online space as a 'safe place' to talk (JISC, 2020b). To assist, a feeling of community can be developed through encouraging peer activities on platforms outside of the course management system such as MS Teams (JISC, 2020b).

Example of applying a blended learning approach to achieve a single learning outcome.

This example involves a simple traversing practical project and the blended learning approach to a learning outcome regarding Survey Control is shown in Figure 11. In this example the project is performed within the virtual learning environment and is available for both synchronous and asynchronous communication between the teach and the students. The process can start with the students watching an online lecture recording on the theory of traversing in their own time.

The second stage is on-campus and involves a tutorial on the project and includes traverse calculation example and a question-and-answer session. Students therefore can take questions that arose from the online lecture introduction into this practical tutorial to seek answers.

The next stage is online and involves the project requirements and assessment task being issued to the students through the learning management system and allows them to start the desktop reconnaissance and project planning. During this phase the survey network plans can be acquired and developed remotely (using existing topographic maps, satellite imagery, Google Street View etc). These are ready to be taken into the field and adjusted for on-site conditions.

The students are now able to do face-to-face learning in the field using the data acquired in the last step. The project plan developed can be amended based on site reconnaissance and surveying observations undertaken in the field. The face-to-face learning continues on campus with the data processing and analysis using licensed software.

The final stage is the online submission of the assessment task through reporting and analysis of the results.

6 https://www.gla.ac.uk/schools/healthwellbeing/guidelines/remotestudy/.

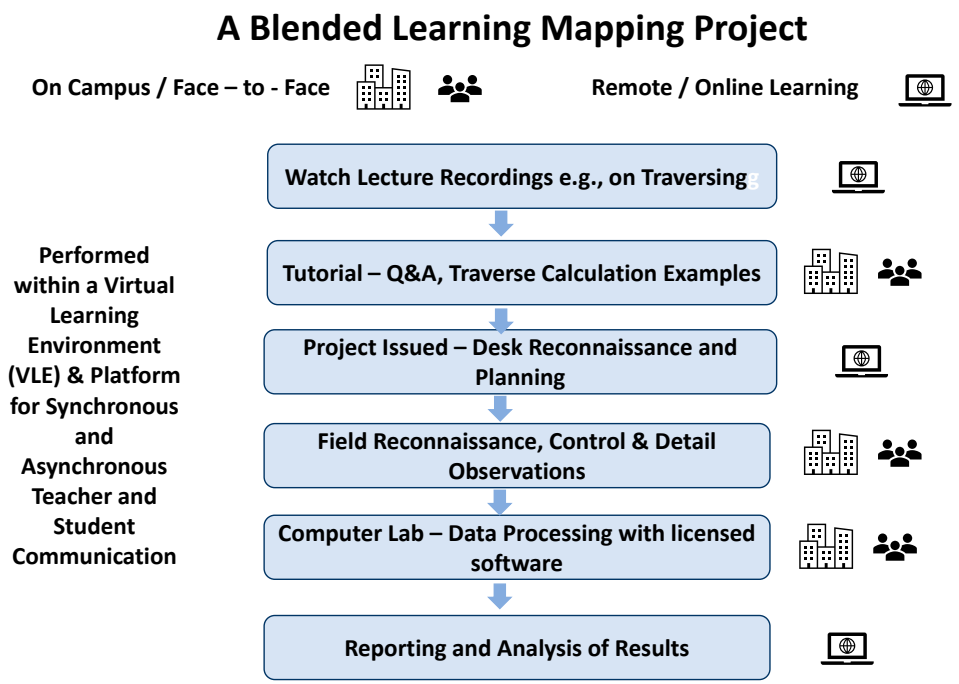

Figure 11: *Blend of in-person and remote learning to achieve a single Learning Outcome.* (Kelly, 2022)

This example shows how activities can be carried over from online, remote to on campus / face-to-face delivery, ensuring that the learning experience carries through the modes (Vaughan et al., 2013).

Summary

The University of Laval case study highlights the way that blended learning evolved out of previous experience with online and remote learning. The experiences during the pandemic show us that blended Learning has the potential to offer a transformative learning experience for students. However, the design and implementation of true blended learning experiences has many considerations. Educators following good practice will have to consider the overlapping and interdependent teaching, social and cognitive presence that exists in their programme of study. Practical examples of how degree programmes and individual course modules can be designed have been outlined and serve as examples to be considered in the context of the resources available in at their institution.

Case Study Université Laval Québec, Canada

Université Laval (Quebec, Canada) has been recognised for many years for the quality and diversity of its on-line programmes on offer. Distance learning was already well established with some academic programmes being offered completely remotely. Most relied on a static teaching method, mainly based on the online provision of documents to read or view, the individualization of student learning (detrimental to group activities) and few contacts with teachers and trainers.

However, the sudden cessation of face-to-face training activities due to the COVID-19 pandemic has forced the transformation of traditional distance learning approaches. The pandemic has shown that this "traditional" approach of distance learning needed to be reviewed and replaced. Thus, the training methods are no longer simply binary, being either face-to-face or at a distance. In geomatics, these modes are now combined into a hybrid set of activities (that might be called Blended Learning), according to the different educational objectives to be achieved.

The transition to hybrid training (and blended learning) has been greatly facilitated by the use for nearly ten years of a high-performance technological platform (the University Portal), supporting the offer of both face-to-face and distance courses. The Portal is the centerpiece of an improved blended learning offer. The successful implementation of blended learning strategies is also based on the voluntary participation of teachers and trainers, which is necessary to change their teaching practices and to develop new class material. Finally, the students must have the capacity to adapt and to familiarise themselves with a new learning environment (such as the virtual classroom). To be successful, students must adopt strict discipline, be autonomous and create with their colleagues a new learning community and network.

Face-to-face teaching should no longer be considered the default mode. Its selection must be justified according to specific training objectives. Several questions then arise: Is there an added value to the presence of students in class? Will they perform any tasks? Could they learn as well if they were remote? Basic knowledge acquisition can be achieved by other means than sitting in a classroom and listening to a lecturer, like attending virtual classes (synchronous and asynchronous), watching video clips, reading hypertexts, and answering online quizzes. For developing skills and competencies (know-how), physical presence is normally required. The objective is then to master the use and handling of instruments (measurement, imaging and point capture, mapping, calculation and drawing software, etc.). These face-to-face activities contribute also to the development of skills relating to teamwork, oral communication, leadership, etc. These activities can be carried out individually or in groups. In addition, the qualities relating to behavior and ethical decision-making, affecting interpersonal relations, professionalism, empathy, etc., can be developed using case studies and simulations, with remotely accessible material and locally available mentors, and followed with individual or team meetings (face-to-face or virtual).

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4 BLENDED LEARNING TECHNOLOGY AND INFRASTRUCTURE

Technology is ever evolving, and there is a risk that technology and infrastructure drive the education experience and dictate the educational outcomes. In this chapter the community of inquiry framework (Garrison and Vaughan, 2011), introduced in Chapter 1, is used to set the theoretical foundation for blended learning technology and infrastructure.

As described in Chapter 1, in the community of inquiry framework the quality of the educational experience depends on the depth of the community of inquiry which has three aspects:

1. **Social Presence**: The ability of students to fully participate in the learning experiences and tasks, and in communication with staff and other students.
2. **Cognitive Presence**: The extent to which students can create meaning through their practices of learning and discussion and reflection.
3. **Teaching Presence**: The way that the teacher designs the learning experiences in the context of the social and cognitive presence of students to create meaningful learning outcomes (See Figure 1).

The framework provides a structure by which we can preserve the integrity of a blended learning approach regardless of technology and infrastructure choice. Consistent with all three elements of the theoretical framework, a critical prerequisite for success in blended learning is connectivity that enables learners and educators. Connectivity is a function of access to infrastructure and technology. Connectivity is broadly classified into three categories: (i) infrastructure available at the tertiary educations, (ii) public infrastructure, and (iii) access to technology at the individual learner level.

In the following sub-sections, the technology for teaching and learning in a blended learning setting is discussed. In particular, the learning management system (LMS) and its requirements for blended learning is investigated and examples of the connectivity challenges identified due to remote learning requirements forced by the pandemic are given. The current learner's technology choices and their preferences are also presented. The section highlights how fundamental education requirements such as equity, diversity and inclusion can be hampered by the lack of connectivity in blended learning settings.

Technology for teaching and learning

As discussed in Chapter 2, remote students in education institutions with less developed IT infrastructure and learners with greater challenges are the most affected by poor infrastructure or lack of devices. The examples provided at the University of South Pacific and the University of Cape Town highlighted some of the challenges related to infrastructure. Also in Chapter 2, the Technical University of Dublin study found that the most significant IT issues were (i) broadband availability when accessing synchronous online classes, (ii) the cost of electronic devices, and (iii) the difficulty in downloading the required software onto their device.

Technology should enhance learning and achieve learning outcomes and not just be used for its own sake (Kirkwood and Price, 2014). It is good practice to issue guidance on expectations regarding communication etiquette of online environments. The digital literacies of staff and learners vary, e.g. the digital resident and visitors model (White and Cornu, 2011) and 'attributes (skills)' (Adekola et al., 2017). For equity, diversity and inclusion, it is critical to minimise the need for fast internet connections (e.g. large 3d point cloud downloads) and intensive computational capacity. Students' often do not have capable devices. One national survey in the UK found that laptop ownership was high (93%) (JISC, 2020a), but there is no guarantee that a student's device may meet demanding specifications from geospatial processing software. Device ownership is likely to be lower in other regions.

It is essential that not all 'computer work' is scheduled to be performed away from campus as high-powered PC activities are a cost barrier to blended learning. Another issue is software licences. Suppliers were very flexible during the COVID-19 pandemic but are unlikely to continue their generosity over the longer term. Blended Learning materials and data must comply with General Data Protection Regulations (GDPR) or regional equivalents. Digital accessibility is now covered by law in the UK (Uni. of Glasgow, 2020). Access can be problematic for all learners, however, additional challenges and support are required for international learners who may be transitioning to a different educational system and Blended Learning (Adekola et al., 2017). Therefore, good practice recognises that some cohorts may need additional support.

The Learning Management System, a fundamental for blended learning

Learning Management Systems (LMS) are a basic software infrastructure needed to implement blended learning and training. These online platforms can be used within institutions (eg university, company) and enable the:

- management of learners,
- creation and management of teaching/learning materials and resources,
- accessibility of learning materials
- possibility for online lectures and groupwork
- communication in teaching and learning contexts,
- planning and monitoring of teaching/learning processes and
- assessment of learning objectives.

Good practices in eLearning were discussed by Groenendijk and Lemmen (2008) and FIG (2010), who describe the LMS as a cornerstone. The focus of the LMS is on informational, person-related, communication, didactic and assessment aspects of education and training in blended learning. LMS are ubiquitously available, provide course structures (e.g. classes, working groups) and are usually browser-based. Access to LMS can be explicitly managed; for example, closed groups can be created in compliance with data protection regulations. Tools for rights and role management (e.g. administrator, tutor, learner) are integrated.

As discussed in Chapter 2 the ERT response by many universities was to place their theoretical programme material onto their Learning Management Systems (LMS) and Virtual Learning Environments supported by collaboration platforms, and web- and

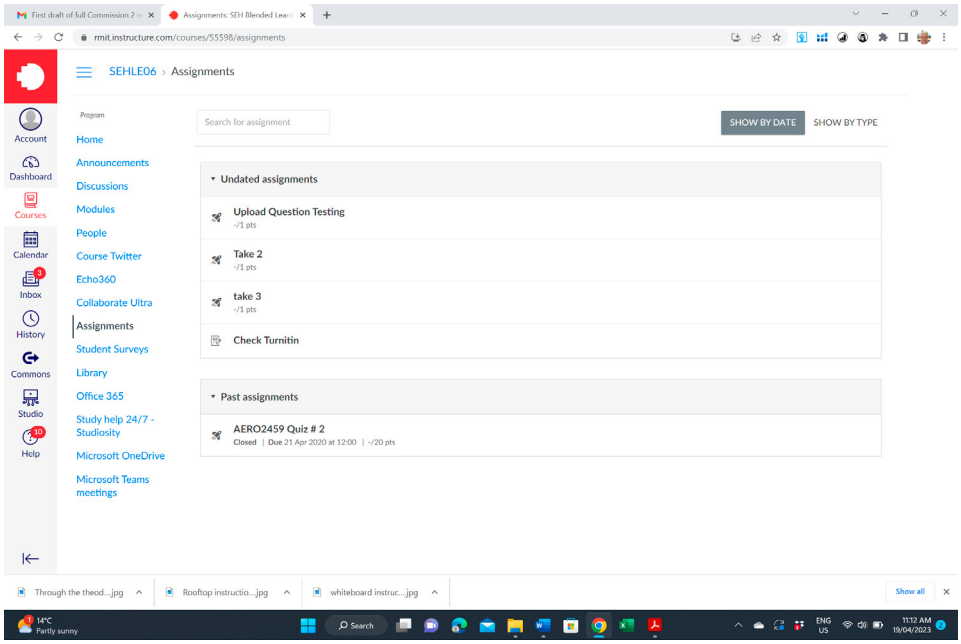

Figure 12: *Example from a Learning Management System.* (Source: David Mitchell)

cloud-based tools, and hardware tools and devices. Surveys by DVW and TUD found that this approach was successfully delivered online with positive engagement by students with the materials. However, there was a big negative impact of the shift to the Virtual Learning Environment wellbeing and mental health for some students. TUD students found the learning environment and lack of physical contact with their peers very isolating. The design of the physical and social environment is a big factor in the students' learning experience (Garrison and Vaughan, 2011).

LMS can contain static teaching/learning content (e.g. books, scripts, weblinks, program code, audio/video files) that can be up- and downloaded efficiently (e.g. drag & drop, zip download). At the same time, comment and rating features enable interaction between learners and educators and between student peers. Collaborative tools (e.g., wikis, configurable database structures, whiteboard, discussion boards) increase learner-centeredness and competency orientation in LMS. In addition, LMSs also offer tools for self-organisation (e.g. notebook, calendar).

Since teaching/learning content is managed in a LMS, there is a close relationship with Content Management Systems (CMS), which efficiently manage any content, and Learning Content Management Systems (LCMS), which focus on managing teaching/learning content (e.g., creation, archiving, distribution, reuse) (Barreto et al., 2020). LMS can be interpreted as (L)CMS but focus primarily on learners and teaching/learning processes (Foreman, 2017). Often, LMS have authoring tools that enable content production without programming skills.

Since communication is crucial for teaching and learning processes, LMS include synchronous and asynchronous communication tools (e.g., mail, chat, forum). These communication tools also allow for the learner and educator relationships to be modelled within the LMS (Bassendowski & Petrucka, 2013). At the end of teaching and learning

units, learning objectives can also be monitored to support constructive alignment. In this context, the LMS has configurable assessment functionalities, including different types of assessment tasks and feedback options.

The installation and the operation of LMS usually requires extensive hardware resources and information technology skills, not to mention a dedicated support team. For more information on this topic see Cavus & Zabadi (2014) who compared different open-source community-driven LMS (e.g., ILIAS: https://www.ilias.de/en/ ; Moodle: https://moodle.org/?lang=en). Also, Wright et al. (2014) provide a good basis for deciding on the most suitable LMS. Commonly used options include Blackboard, Canvas, and Moodle.

Learning technology during the COVID-19 pandemic

A global perspective

In the FIG Commission 2 survey of learners, they were also asked questions about their online learning approaches during the COVID-19 pandemic (Ben et. al., 2021) and the results are illustrated in Figure 13. Learners had to transition from often traditional learning settings to fully online environments. There were opportunities to use blended learning approaches at some stages during the pandemic.

The students surveyed responded that LMS are relied upon by most of the learners and as mentioned earlier, are fundamental for blended learning as they help significantly

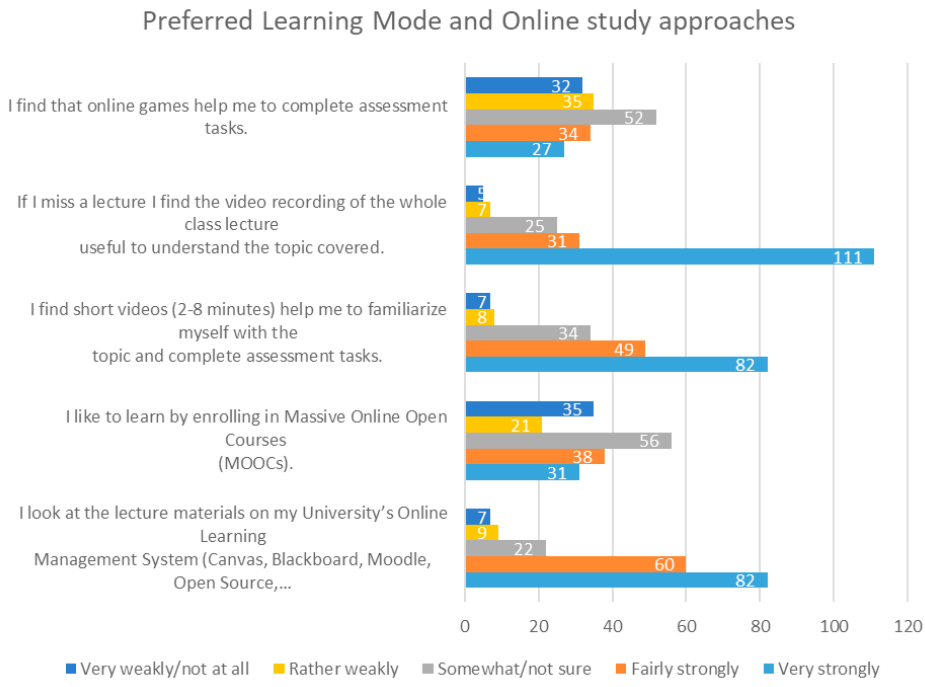

Figure 13: *Online study approaches, results of FIG Commission 2 survey.*

improve teaching presence. The survey also indicates a strong preference for blended learning instead of online education; MOOCs have not been identified as a preferred learning model. There is relatively a high demand for traditional learning by the learners suggesting the teaching presence of the framework may still be better performed in conventional settings. Deferred online classes such as recordings are preferred over real-time online courses, offering a more robust teaching, social and cognitive presence. In particular, short video materials designed and aligned with the learning assessment are highly favoured by the learners. Short videos are often purposefully designed for blended learning and have more substantial teaching presence attributes.

The University of Melbourne: An Australian perspective

The University of Melbourne has a long-standing online infrastructure for teaching and learning. This includes LMS, video recording and variety of tools for online teaching and learning. However, this infrastructure was not utilised to its full potential before the pandemic. LMS is often used as a place to make the teaching material accessible to students, for discussion and communication and to some extent for assessments. The extent of the utilisation was at the educators' discretion.

The pandemic, however, changed this dynamic and educators had to replace the teaching and learning mechanisms that rely on in-person attendance with online activities. Synchronous online teaching was the dominant replacement for the lectures. Some educators chose to record their lectures and use the lecture time for questions and answers. Virtual computer labs replaced the physical computer labs, where students were given the software tools to be installed on their personal computers. Fieldwork components were stopped during the lockdown and run in an intensive mode where the restrictions were lifted. Offshore students were given an option of organising internships with local surveying companies instead of fieldwork. Virtual computer labs were often scheduled, so the offshore students from different countries had appropriate opportunities. Examinations were conducted online, including multiple-choice questions, extended answer questions or oral exams. In the second year of the pandemic, when the restrictions were eased, some teaching and learning activities were offered in a synchronous blended mode. However, the subjects requiring fieldwork continue the conventional teaching approach.

The students' experience indicates that teaching activities such as lectures are well received during the pandemic. Synchronous or recorded courses mainly satisfy the learning requirements. However, face-to-face practical work, even for computer-based assessments, are preferred by students. The educators also found it challenging to protect the integrity of online exams of all sorts and forms. Blended synchronous learning also appeared to be challenging. Online students in this teaching mode often expressed a lack of attention by the teaching team.
Mohsen Kalantari – University of Melbourne / University of NSW

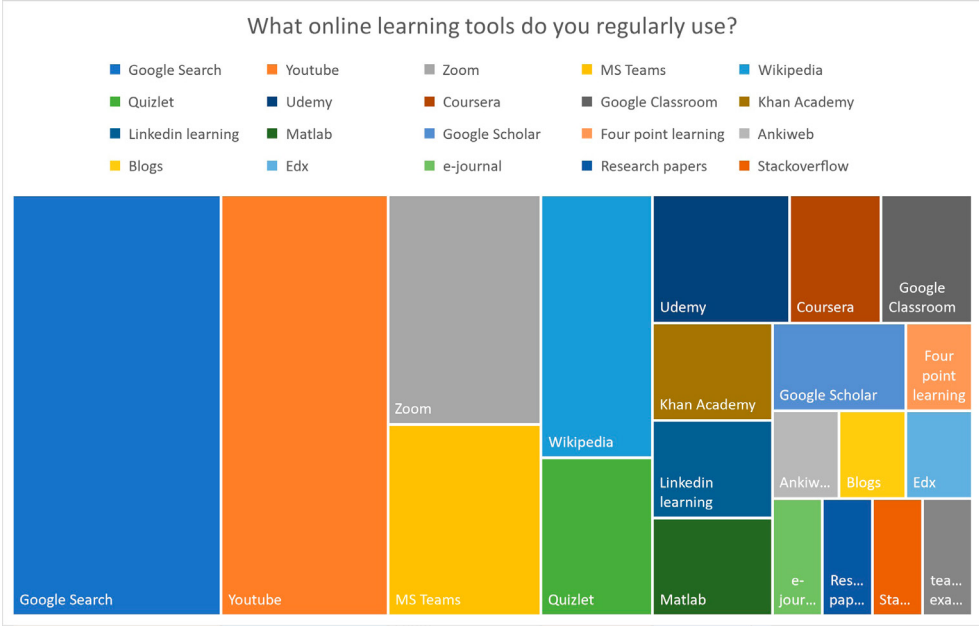

Figure 14: *Tools that the respondents of the FIG survey regularly use.*

Informal online learning tools used by students

As discussed in Chapter 2, the survey created, distributed and analyzed by FIG Commission 2 identified the breadth of tools available and used by students for learning and these are listed in Figure 14. This list shows the range of online learning tools that surveying students are currently using. Although online lectures can be provided by the LMS, often use is made of additional tools such as MS Teams or Zoom. The Covid-19 pandemic has forced teachers to search for tools to make their online session more interactive. However, teachers may not know which tools the students are using. Some of these tools are used within their LMS, but many are not. For example, the use by students of youtube videos is very high which is a concern.

Teachers need to communicate with students about the online learning tools that add value, and those that the students should not use. For these informal tools (those not on the LMS or recommended by the teacher), the critical question for educators is – how effective are they in delivering the expected educational outcomes?

Lessons from the Caribbean

Surveying education at undergraduate and postgraduate levels in the Caribbean region is primarily delivered at The Department of Geomatics Engineering and Land Management at the St. Augustine Campus of the University of the West Indies (UWI). Other smaller individual institutions provide surveying training to a certificate, technician, and associate degree level on some of the islands, such as the Barbados Community College and the Sir Arthur Lewis Community College in Saint Lucia.

The UWI, as a regional university, was familiar with challenges to collaboration and communication before the pandemic as administrative meetings sometimes necessitated quick flights between countries of the region, especially to the Headquarters

at Mona in Jamaica, even though the use of expensive video-conferencing hardware and software was nascent and burgeoning. The St. Augustine Campus shut its doors due to the pandemic as mandated by the national government in Trinidad and Tobago, where the campus is located, in March of 2020. All the surveying and lab work involving mapping and software were immediately suspended. Remote teaching was swiftly instituted via the Moodle-based learning management system already in place and a hastily included video conferencing software, Blackboard Collaborate, so content delivery was not severely affected. However, interaction, engagement, and connectivity suffered, leading to some measure of dissatisfaction from learners and educators.

Even though there was already available and financed communication platforms in Blackboard Collaborate and Microsoft Teams, many persons regionally, as occurred globally, became more familiar with Zoom software for interaction and collaboration. Additional licences for Zoom had to be purchased to accommodate large meetings. Planned conferences and seminars pivoted to the many newly developed and developing online conference management platforms such as Hubilo. These were also quite expensive.

The Department and the rest of the Faculty of Engineering perhaps found it easier to segue to remote teaching than other faculties such as Social Sciences and Humanities, for example, where being IT proficient had previously not been such a necessity. In consequence, there were almost daily capacity-building workshops for educators to demonstrate the functional aspects of the Blackboard Collaborate software to allow for remote teaching and provide tips and tricks to account for the human communication differences of remote teaching and learning.

Many months after classrooms at the UWI were forced to go remote, both learners and educators were still managing the advantages and disadvantages of online collaboration. A significant percentage of learners either had low connectivity or inadequate devices and were disadvantaged in accessing classes at home. In a few instances, arrangements had to be made to allow learners to access UWI's satellite offices in other islands and borrow the use of devices to connect for classes. Learners had already developed WhatsApp groups for connection, and now the use of this software has grown to more of a necessity than an addition. Despite the attempts to restore the learning experience to previous practice, some learners could not cope with the feelings of disconnect that persisted and opted to take a leave of absence from their programmes until a greater semblance of normalcy was available.

Defending the integrity of online examinations to programme accreditation bodies became problematic in the absence of sufficient funding or willingness to institute costly proctoring by external agencies. In depth analyses were done on examination results, which showed early seemingly inflated improvement in grades. To counter this, a move was made to create more authentic assessment that mirrored practical applications of the theory. This is, however, difficult to attain in a very practical course such as surveying. Instead, stricter rules for quizzes such as random selection of questions from large question banks and scrambling of responses were used to deter cheating. Greater use of similarity testing software to deter plagiarism and collaboration was affected.

The University has now returned to face-to-face teaching and is distilling the more advantageous outcomes of the remote teaching and learning into a push for converting more courses or programmes into well-structured blended or online delivered offerings. Hybrid flexible modalities are also being considered but may require reconfigur-

ing classrooms with expensive technology that may not be possible in the current post pandemic economy.

Summary

This section reviews and reports the technology aspects of blended learning in infrastructure requirements and the community of inquiry framework. From an infrastructure perspective, moving to blended learning assumes that learners have the necessary bandwidth, available data, suitable devices, and learning spaces to access online content. These assumptions are not necessarily easily met. Hence, it is of paramount importance to design online lesson content that is low impact and provide alternatives for learners who may not be able to connect online. It is also essential to consider what happens if/when a learner's device no longer works. The studies identified cases where a learner spilled a soft drink on his laptop, possessed no insurance and could not afford repairs. Or a learner's laptop charger became damaged. Living far from any urban area meant waiting several weeks before making a trip to the city to buy another charger. In both cases, the learner could not access online lessons until the problem could be resolved. Besides the infrastructure requirements, there are some critical lessons from the framework perspective. Mental well-being must be accommodated (social presence), also hardware (teaching presence), connectivity and other issues outside of the learner's control such as using low-bandwidth materials, non-synchronous teaching (teaching presence) and flexible options in accessing materials (teaching presence) must be considered. The study did not reveal much on the cognitive presence as infrastructure, social and teaching challenges were dominant in the findings and likely mask the consequential cognitive challenges.

5 THE BENEFITS OF BLENDED LEARNING FOR SURVEYING EDUCATION

On many occasions, the potential of online training and education as well as e-Learning has been proven as an appropriate methodology for knowledge sharing and providing online education (e.g. FIG Publication 46: Enhancing Surveying Education through e-Learning). With the outbreak of the COVID-19 pandemic, almost all activities of work and education were transformed in a short time online using different platforms for small/medium/large meetings, workshops, classes, practical projects and exams. In parallel with fully online work and education, a blended learning approach became a necessity. In the times of relaxation after the COVID-19 measures, elements of the blended method remain. Like all education methods, there are pros and cons related to aspects of both the face-to-face and online teaching aspects.

Examples of pros are: education accessibility from all parts of the globe with internet connections; scalability of student numbers; lecture recordings for convenience; digestible micro-lectures are all advantageous in pandemic lockdowns.

Examples of cons are: performing practical projects (like we do in field surveying) is a challenge, examination has some limitations, student engagement online suffers, ICT requirements, ICT expertise of students, shyness of students to engage online (especially with the prospect of recordings) (Todorovski, 2020).

The blended approach has the potential, if designed carefully, to overcome some of the Cons: for example, running practical projects and examinations face-to-face, supported by online materials. The following sections further describe the benefits of blended learning to surveying education.

Policy considerations

FIG Publication 46 noted that, as of 2011, e-learning had become popular because of its potential for providing more flexible access to content and instruction at any time, from any place (Means et al, 2009), noting it:

(i) increases the availability of learning experiences for learners who cannot attend traditional face-to-face offerings,

(ii) assembles and disseminates instructional content more cost-efficiently, and

(iii) enables instructors to handle more students while maintaining learning outcome quality equivalent to comparable face-to-face instruction.

These benefits are still relevant today and apply even more so to blended learning. What is important is that student learning outcomes are of the same quality whether online or face-to-face methods are used. This means choosing the most suitable approach for the learning objectives and designing the instruction to have the most appropriate blend of face-to-face and online learning to meet the specific needs. The benefits of blended learning include providing access for more students through more online learning options. A larger suite/ selection of academic staff and industry expertise in delivering the learning materials, and an off-campus de-concentration of training.

Regional Academic Networks, capacity building and knowledge sharing

Networks of academic, educational and training institutions are proven platforms for knowledge sharing and exchanging experiences in education and capacity development. Blended learning has great benefits for these regional academic networks as it allows sharing of digital learning materials, and where IT and infrastructure allows, more than one institution connected to the same online session. Examples of such networks are UN-HABITAT Global Land Tool Network[7], the Eastern Africa Land Administration Network[8], and the Latin America Land Administration Network (LALAN). The objective of these networks are to: perform activities that can support capacity development, exchange experiences and increase knowledge in the areas of geodesy, surveying, geo-information sciences and earth observation, geo-information management and land administration.

Through adopting blended learning approaches, regional and local academic networks could benefit from lessons learned in education. For example, meetings/workshops for knowledge sharing and experiences in latest curriculum developments and exchange of latest publications and research (MSc, PhD, etc.) could be organised using a blended learning approach and made available to students at several institutions. In the same manner, capacity development activities could be organised for more entities/members from the network with support of available technology and online platforms. However, when planning and implementing such activities it is important to have in mind the abovementioned pros and cons.

FIG Africa Regional Network Experience

During COVID-19 pandemic lockdowns, social media has played an important role in communicating resources for continuing professional development. Many African learners face challenges that demand a different response to course delivery than the solutions appropriate for the developed world. The fundamental challenge to remote learning is the lack of an internet connection. This is due to a lack of hardware (computer or smart mobile) to connect to the internet and the inability to purchase data to facilitate contact. Even when learners have an internet connection, home working environments can be impoverished and not conducive to study. Many dwellings are overcrowded, noisy, and lack essential resources such as electricity and water. Home environments can also be places where a learner faces threats to health and safety. Learners work late at night while the rest of the family is asleep. Devices may be shared between family members; each with legitimate needs to use the device. The internet infrastructure may not allow for streaming lessons live, and it may not be easy to download videos or other large files. Data can also be costly.

Educators in Africa needed to respond by delivering non-synchronous content with very low data requirements while being extremely flexible and accommodating of learner hardships. At the University of Cape Town, learners were provided with laptops, hard copy notes, and essential stationery supplies. These were delivered to learner homes, even in remote rural areas. Data bundles were also provided, while high-level negotiations with the leading cell phone data providers ensured that learners could access the learning platform using cell phone internet links. In rural areas, cell phone

7 GLTN (https://gltn.net/)
8 EALAN (https://ealan-network.org/)

data links can also be poor. Synchronous online lectures and tutorials were reduced to a minimum or, better still, avoided altogether. Learners often have no access to resources used routinely in more affluent settings such as Youtube videos and existing online tutorials commonly available on the sites of software and instrument suppliers. This meant that new materials needed to be created by educators to be shared via the free-to-access teaching platform.

The Africa Regional Network response was to establish a set of themed Facebook Groups to facilitate sharing resources for remote tertiary education in Africa (e.g. groups on teaching land law, GIS, plane surveying, GNSS). The Facebook @FIGARN Group platform is not a repository for teaching materials – the intention is to share materials directly between participants. Educators indicate resources that they have developed and can share, and also where good, free, flexible (low bandwidth, variable access) resources already exist on the internet. An example is the materials on the responsible governance of tenure by the FAO. Although set up for African educators, these themed Facebook Groups are open.

The Africa Regional Network (ARN) Facebook platform @FIGARN shares links to online resources such as MOOCs and training sessions, especially those hosted by organisations with relationships with FIG such as FIG Corporate members and FIG partners. Many corporates refocussed their way of communicating with clients by embracing these technologies. The increased online and free offerings have helped surveyors in Africa to obtain world-class training and exposure to new technologies. Embracing new ways of continuing professional development will serve to reduce the digital divide – it is an exciting new world and one in which African practitioners in remote locations need not be left behind.

Lifelong learning, CPD and alternative career pathways

Continuing Professional Development (CPD) is a requirement for all professional surveyors. FIG Publication 46 described the potential role of e-learning in CPD and argued that e-learning was a perfect fit for the concept of life-long-learning and CPD as it is a flexible mode of learning for professionals. E-learning for CPD provides surveyors with flexibility in completing their CPD commitments making life-long learning more achievable. However, blended approaches are crucial for CPD courses and events as they provide the flexibility of online learning with the option of face-to-face instruction where appropriate. In the face-to-face model, the working professional who wants to stay abreast of new technologies, theories and practices is constrained by the need to either take leave or find time outside of normal working hours. Where possible blended approaches are to be favoured, but they have to allow for on the spot practice and supervision and professional networking and personal interaction. Conferences and other in-person or online, synchronous events provide the networking opportunities that are difficult to emulate online. Using blended learning in a CPD event allows the working professional to gain knowledge and skills relevant to their work in their own time. When designing CPD courses, it is important to take the circumstances of the working professional into consideration. Flexibility is important.

A recent example from the University of Cape Town's Division of Geomatics illustrates the point. Under 'normal' conditions, a CPD course would run from Monday to Friday on campus. Participants may attend lectures and discussion groups from 09h00 – 13h00,

followed by lunch and three to four hours' worth of reading materials to prepare them for the next day. The course would conclude with an exam. Participants would need to take a week's leave to attend such an event but would gain immensely from the interaction with other participants and the lecturers or tutors. Such a design can, however, be very draining, especially if the participant is checking their emails and responding to work queries during tea / lunch breaks or even in lectures. The constraints imposed by the COVID pandemic forced a rethink of this standard practice and the inclusion of online approaches. The course under question still ran for five days, but instead of these being consecutive, it ran every second day (Monday, Wednesday, Friday, Monday, Wednesday). Each day started with a live, online meeting to facilitate discussion and sharing of ideas. The previous lesson was discussed, and participants were introduced to the topics for the current lesson. Participants enjoyed participating in live polls using tools such as Mentimeter. Online meetings were limited to one hour to avoid online-fatigue and to accommodate participants' potentially busy work-day schedules. Lessons were designed to be completed within three to four hours and comprised of short readings, videos, forums and online quizzes. The forums and quizzes are important for maintaining participant engagement with the content. After completing the lesson, participants had one and a half days to complete the assigned readings. An online, randomised exam completed the course. Feedback from participants was favourable. They enjoyed the extra time to work on their lessons and the flexibility that this approach allowed. In a blended learning approach this online CPD could be complemented by a face-to-face session to allow discussion or networking.

Blended learning also allows for CPD activities to count as micro-credentials that can be recognised in surveying education at different levels.

Summary

Blended learning is a key strategy in making education more widely available and accessible to all – especially in countries where access to major cities to study is difficult for many people. Surveying academic institutions are supporting the development of blended learning and tremendous progress has been made since the COVID-19 pandemic started.

Since the COVID-19 pandemic and continuing uncertainties related to delivering face-to-face education, Blended Learning has become the norm in current education practices. It is to be expected that in the future Blended Learning will continue to be common practice in surveying education, training and continuing professional development.

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DEFINITIONS AND ABBREVIATIONS

Asynchronous learning – students access instructional materials at any time they choose and these materials do not include live video lectures or tutorials. https://online.osu.edu/resources/learn/whats-difference-between-asynchronous-and-synchronous-learning.

Blended Learning – Blended learning is the thoughtful fusion of face-to-face and online learning experiences (Garrison and Vaughan, 2011) where instructors combine in-person instruction and online learning activities allowing students to complete some components in person and some online. https://www.leadinglearning.com/hybrid-vs-blended-learning/.

Chalk & Talk – Theoretical classes in a traditional face-to-face classroom situation.

Community of Practice (CoP) A community of practice (CoP) is a group of people who share a common concern, a set of problems, or an interest in a topic and who come together to fulfil both individual and group goals. https://www.communityofpractice.ca/.

Emergency Remote Teaching (ERT) – During the initial months of the COVID-19 pandemic, practical training was paused, and face-to-face education had to rapidly pivot online. This forced rapid response was adopted in all regions globally with broad implications for the education of young surveyors.

Face-to-face teaching – According to IOWA State University "Traditional (Face-to-Face) teaching (also known as in-person, F2F) focuses on several elements, including lectures, capstones, team projects, labs, studios, and so forth. Teaching is conducted synchronously in a physical learning environment (utilizing appropriate safety measures), meaning that "traditionally," the students are in the same place simultaneously. The traditional classroom has the significant advantage of face-to-face interaction between the student and educator and the students themselves. Students derive motivation from the teacher as well as from the other students. https://www.celt.iastate.edu/instructional-strategies/teaching-format/traditional-face-to-face/.

Formative Assessment – are assessment tasks that identify misconceptions and learning gaps during the semester and assess how to close the gaps. The results help to shape learning, and can encourage students to take ownership of their learning. https://poorvucenter.yale.edu/Formative-Summative-Assessments.

Hybrid Learning – Simultaneous teaching to a class F2F and online and usually including recording of the lecture. Hybrid courses combine face-to-face and online course delivery into one integrated experience (synchronous and asynchronous). The mix of delivery modes will depend on an instructor's teaching strategies and course learning objectives.

Intended Learning Outcomes (ILO) – describe what a student should learn and be able to do when they complete their studies. http://www.bristol.ac.uk/academic-quality/approve/approvalguidance/intendedlearningoutcomes/#:~:text=Intended%20Learning%20Outcomes%20(ILOs)%20define,are%20measurable%2C%20achievable%20and%20assessable.

Learning Management Systems (LMS) – is a web-based software application on which you can store customised online instructional materials. An LMS provides an interactive learning environment. https://link.springer.com/referenceworkentry/10.1007/978-1-4419-1428-6_187.

Online learning – Online learning refers to instruction delivered electronically through multimedia and Internet platforms, with no face-to-face components or activities. It is also sometimes called web-based learning, e-learning, computer-assisted instruction, and Internet-based learning. https://www.sciencedirect.com/science/article/pii/B9780081005989000027.

Summative Assessment – evaluate student learning, knowledge, and proficiency, at the conclusion of a subject, course, or program.
https://poorvucenter.yale.edu/Formative-Summative-Assessments

Synchronous learning – students access instructional materials at scheduled times through virtual attendance at classes each week, at the same time as the instructor and classmates. https://online.osu.edu/resources/learn/whats-difference-between-asynchronous-and-synchronous-learning.

Virtual Learning Environment (VLE) – is a program that organises learning material for subjects using the Internet. This includes information such as lecture and tutorial material, assessment details, discussion fora and facilities that enable students to keep notes about what they have learnt.
https://www.oxfordreference.com/display/10.1093/oi/authority.20110803120011791;jsessionid=678D0AD297340376EFAFD13463A7EDD9.

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FIG PUBLICATIONS

The FIG publications are divided into four categories. This should assist members and other users to identify the profile and purpose of the various publications.

FIG Policy Statements

FIG Policy Statements include political declarations and recommendations endorsed by the FIG General Assembly. They are prepared to explain FIG policies on important topics to politicians, government agencies and other decision makers, as well as surveyors and other professionals.

FIG Guides

FIG Guides are technical or managerial guidelines endorsed by the Council and recorded by the General Assembly. They are prepared to deal with topical professional issues and provide guidance for the surveying profession and relevant partners.

FIG Reports

FIG Reports are technical reports representing the outcomes from scientific meetings and Commission working groups. The reports are approved by the Council and include valuable information on specific topics of relevance to the profession, members and individual surveyors.

FIG Regulations

FIG Regulations include statutes, internal rules and work plans adopted by the FIG organisation.

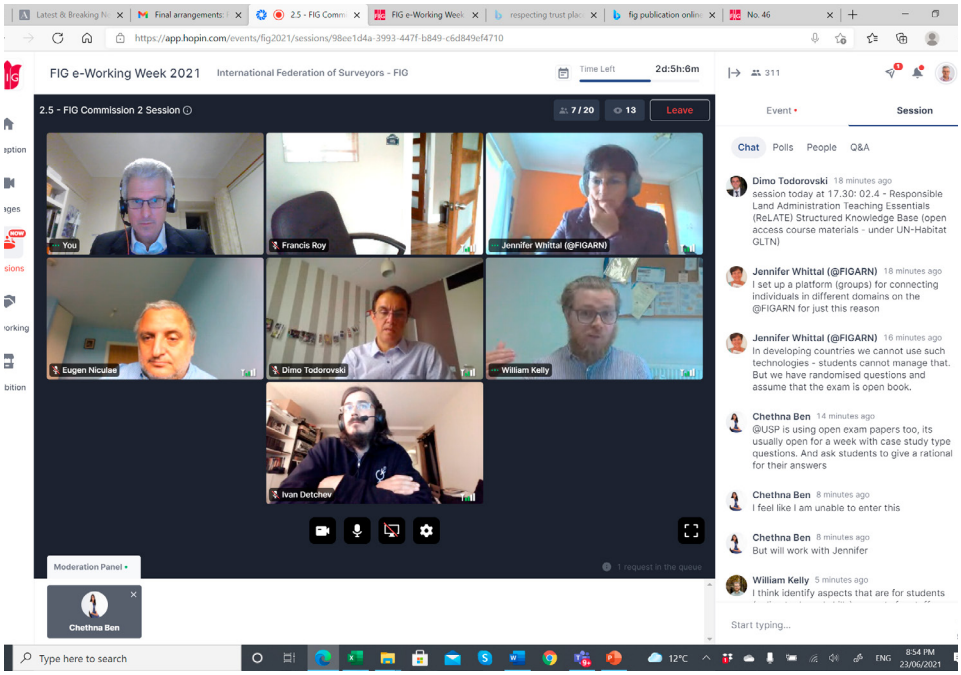
List of FIG publications

For an up-to-date list of publications, please visit
www.fig.net/pub/figpub

ABOUT FIG

International Federation of Surveyors is the premier international organization representing the interests of surveyors worldwide. It is a federation of the national member associations and covers the whole range of professional fields within the global surveying community. It provides an international forum for discussion and development aiming to promote professional practice and standards.

FIG was founded in 1878 in Paris and was first known as the Fédération Internationale des Géomètres (FIG). This has become anglicized to the International Federation of Surveyors (FIG). It is a United Nations and World Bank Group recognized non-government organization (NGO), representing a membership from 120 plus countries throughout the world, and its aim is to ensure that the disciplines of surveying and all who practise them meet the needs of the markets and communities that they serve.



Commission 2 blended learning webinar held during the FIG e-Working Week 2021.

Surveying education has a strong tradition of face-to-face lectures supported by practical tutorials and field project activities. 'Learning by doing' has been fundamental to many surveying programs as well as training and continuing professional development. In 2010, the benefits that online learning (or E-learning) could also have for surveying education was recognised in FIG Publication 46 "Enhancing Surveying Education through e-Learning". Since then, the development of ICT and video conferencing, along with the development in Learning Management Systems, has allowed online learning in a way that was not possible previously. The impact of the COVID pandemic, and the associated lockdowns starting in 2020, resulted in most surveying programs rapidly pivoting to emergency remote teaching mode allowing lectures and tutorials to continue. This pivot to online did show the potential of blending online and face-to-face learning, and that the essential face-to-face activities could be supported by online learning material in very effective ways. This publication aims to assist the FIG community with a summary of lessons learned from the COVID pandemic emergency remote teaching and provides some guidance on good practices in implementing blended learning in surveying education. The content draws on papers presented during FIG events on the lessons, and discussion at online webinars during the FIG Working Weeks and Commission 2 events, as well as discussions on-site at the FIG Working Week in 2019 and the FIG Congress in 2022.

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