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A hidden benefit in the COVID-19 pandemic: Rethinking physical geography pedagogy in higher education using a flipped classroom approach.

Karen J Taylor[*1,2]

[1]Department of Geography, University College Cork, Cork, Ireland
[2]Discipline of Geography, University of Galway, Galway, Ireland

Abstract

A shift in geographical pedagogy has occurred in the last decade with greater integration of active and blended (hybrid) learning techniques in higher education. A 'flipped classroom' approach employs an active classroom and inclusion of pre/post asynchronous course content in replacement of a traditional lecture-based format. This pedagogical research paper investigates the effectiveness of an online flipped classroom approach in the field of physical geography through student evaluation and reflects upon the enforced transition to online learning during the COVID-19 pandemic. An anonymous survey was distributed to final year physical geography students who experienced both on-campus and online education, to evaluate perceived technological skills, broadband access and module delivery preference. Positive qualitative and quantitative results (66 respondents) showed an appreciation for an active classroom, increased student-staff engagement and the use of multimedia resources (i.e. using more than one medium of communication). Sixty-nine per cent of students in this cohort preferred the online flipped classroom to other online lecture-based formats (synchronous or asynchronous). Additionally, 59% of students chose an on-campus flipped classroom approach in replacement of a traditional transmissive lecture or option to remain online in a post-COVID-19 scenario. Overall, this case study provided valuable insight into student experiences of online learning and illuminates a potential pathway to move away from traditional lecture-based methods in undergraduate physical geography. The dynamic, interactive learning environment created by this alternative approach is recommended to enhance learning, accessibility and improve student-staff interaction, particularly for large class sizes where fieldwork may not be feasible.

Keywords: Blended learning; Active learning; Inquiry-based learning; Problem-based learning; Fieldwork; Accessibility; Student evaluation; Large class sizes.

1. Introduction

The subject of physical geography is traditionally considered to be a field-oriented science (Fuller et al. 2000; Petch and Reid 1988) as it concerns the 'processes that shape the Earth's surface, the animals and plants that inhabit it, and the spatial patterns they exhibit' (Welford

[*] Corresponding author karen.jantaylor2@gmail.com

2017). In the 1970s, physical geography was categorised into five main divisions: geomorphology, climatology, biogeography, soil science, and Quaternary environmental change (Welford 2017). The interdisciplinary subject now has an abundance of subdisciplines and specialisms and current undergraduate physical geography modules in higher education typically include a field or research-based component as a form of module assessment (Day 2012).

The dominant pedagogical paradigms in undergraduate physical geography are i) **constructivism**, where learners construct knowledge instead of passively taking in information, which can be traced back to Piaget's (1929) theory of children's cognitive development. And ii) **active learning**, 'any instructional method that engages students in the learning process' (Prince 2004, p.223). Active learning builds upon the constructivist learning theory and posits that students 'learn by doing' (Day 2012). The active learning umbrella also includes other pedagogical approaches such as inquiry and problem-based learning (Day 2012).

In the last decade, greater integration of active and blended (hybrid) learning has been incorporated into undergraduate module design. The goal is to enhance learning and accessibility and improve engagement with students (Day 2012; Godlewska et al. 2019; Graham et al. 2017; Holloway et al. 2021; Moore and Gilmartin 2010; Tasch and Tasch 2016). For example, research-led projects, laboratory and field work tutorials, the use of geographical information systems (GIS), and online multimedia resources are frequently used to develop subject knowledge and understanding of physical geography. Pre-COVID-19, undergraduate physical geography modules incorporated active learning techniques but, in many cases, the traditional transmissive lecture (weekly, in person) remained the main method of knowledge transference between staff and students (Day 2012). Lectures were typically not recorded, and slide handouts and readings were the sole resources provided.

Health and safety regulations associated with the COVID-19 pandemic enforced educators to reassess and redesign teaching strategies and delivery methods. Higher education undergraduate modules and assessments transitioned to online platforms over a short space of time. Educators essentially became content creators and were faced with many associated technological challenges such as software and compatibility issues, access to suitable technology (home laptops or desktops) and recording equipment (microphones, web cameras), and adequate broadband speeds. Furthermore, educators had the difficult task of recreating the 'engagement' or 'social' aspect of a traditional lecture setting online to combat feelings of isolation, lack of support and disadvantage, which many students experienced in the transition to online education during the pandemic.

A flipped classroom approach is a popular alternative teaching method (Abeysekera and Dawson 2015; Bergmann and Sams 2012; Bishop and Verleger 2013; Mason et al. 2013; Roehl et al. 2013; Vereş and Muntean 2021) which can be easily adapted to an online teaching scenario. This approach removes the "traditional transmissive lecture and replaces it with active in-class tasks and pre-/post-class work" (Abeysekera and Dawson 2015, 1) as a form of active and blended learning. The flipped classroom concept supports the cognitive constructivist and social constructivist learning theories (Bruner 1966; Long et al. 2016; Vygotsky 1978), as it promotes student-centred learning under the guidance of professional educators. While traditional teaching pedagogies tend to promote a passive environment that channels 'surface learning' through rote memorization (Ritchhart et al. 2011), the flipped classroom approach utilises 'deep learning' practices such as problem-solving tasks engendering a greater understanding and comprehension of knowledge (Roehl et al. 2013). The alternative approach has multiple benefits for students including the ability to modify class activities to suit students'

learning needs (Graham et al. 2017), promoting student-staff engagement (Roehl et al. 2013), enhancing learning and student motivation (Abeysekera and Dawson 2015; Elmaleh and Shankararaman 2017; Mason et al. 2013), and development of self-directed learning skills (Fernández-Martín et al. 2020). The approach also benefits staff alike, through efficient use of teaching hours (Vereş and Muntean 2021) and providing greater insight into student progress and understanding of course material (Chickering and Gamson 1987; Roehl et al. 2013) (Figure 1). The open structure of the active classroom component allows for multiple pedagogical approaches, including all forms of active learning techniques including inquiry and problem-based learning, as well as the time and freedom to explore topics with students that conventional lecture-based approaches do not.

The concept of a flipped classroom was developed by Jonathan Bergmann and Aaron Sams in 2007 (Bergmann and Sams 2012) and since then has been applied to many subjects areas (Fernández-Martín et al. 2020; Graham et al. 2017; Roehl et al. 2013). Currently, several gaps exist in the flipped classroom literature regarding i) student evaluation (Abeysekera and Dawson 2015), ii) its use as a technique for dealing with large class sizes, and iii) through the subject-specific lens of undergraduate physical geography. Regarding the latter, the literature focuses on geography as a general subject (Azizah et al. 2022; Zeren 2016; Korson 2022) or geographical subfields such as human (Graham et al. 2017), urban (Aguado-Moralejo et al. 2020), or geographical information systems (Castellucci 2016; Rudow and Sounny-Slitine 2015; Tian et al. 2022). Additionally, there are several studies from a secondary school perspective on geography (Ekpoto et al. 2022; Norman et al. 2018) and remote sensing earth and environmental sciences (López Núñez et al. 2020), but again not specifically physical geography. Given physical geography is a field-oriented science, it lends itself towards pedagogical approaches which allow for active learning inside the classroom setting. Review and student evaluation of a flipped classroom approach through a physical geography lens would thus be highly beneficial, particularly in a large class setting.

This case study of an undergraduate physical geography module aims to provide insight into student and staff experiences and share knowledge gained from the emergency online transition of teaching and learning during the COVID-19 pandemic. Findings also seek to enlighten the affordances of the alternative flipped classroom approach through a subject-specific lens of physical geography, bridging the gap in the current literature.

Figure 1 – The educational benefits of a flipped classroom approach

2. Methods

2.1 Project overview

Coastal and Marine Geomorphology (5 ECTs) is a third-year undergraduate course offered as part of a wide range of thematic modules by the Department of Geography at University College Cork. Over 130, national and international students enrolled in semester two of the 2020/2021 academic year from multiple BA and BSc undergraduate degrees. This physical geography module provided an overview of coastal dynamics and introduced students to basic concepts of coastal science, zonation, ecology, geomorphology, and management and planning. The closing section focused on current issues such as marine debris and pollution, climate change, sea level rise, coastal erosion and flooding with a focus on Irish case studies. The module was assessed through continuous assessment (one online research-based assignment, worth 40%) and an online essay-based examination (worth 60%).

Pre-COVID-19, this module was delivered through 24 1-h lectures, two laboratory practicals and an essay-based exam all of which took place on campus over a 12-week period. In compliance with COVID-19 public health measures, the module transitioned to an online platform (Canvas, Learning Management System (LMS) and Microsoft Teams) using a flipped classroom approach (Figure 2). The module was subsequently redesigned and utilised the alternative approach to improve engagement between students and staff as well as promote active, self-directed learning in an online setting. Students were provided with the following asynchronous resources to be reviewed in their own time pre- and post-class:

- Twenty-four pre-recorded theoretical videos (PowerPoint slides with recorded audio in MP4 format), approximately 20-30 minutes in length, were uploaded using the video management system Panopto in Canvas LMS, three days prior to a live class activity. Each video covered a separate topic, with two videos uploaded each week. The material was equivalent to one hour of teaching.
- A pdf printout of the slides and audio transcript.
- Additional resources included academic readings, relevant YouTube videos, links to other educational resources.

In-class activities were conducted synchronously using Microsoft Teams and PowerPoint, utilising the second weekly contact hour. The live in-class activities were developed from the theoretical content (videos) putting the theory into practice and used visuals such as Google Earth imagery, photography, and relevant academic journal figures to generate active learning or problem-solving activities. The live class was typically structured as follows: a summary of the pre-recorded theoretical content was provided at the start of each live class using visual schematics created with the SmartArt PowerPoint feature. This was followed by various types of activities including i) quick answer questions to build confidence and participation, ii) narrative and discussion activities regarding a topical news item or newly published journal article and, iii) guided problem-solving activities related to the course content. Students responded either by audio or text comments. The sessions were not recorded to encourage student participation thus creating an informal learning environment. Students were also given time to ask questions at multiple intervals.

A student feedback survey was created and distributed through an anonymous and confidential survey tool on Canvas LMS at the end of the term, using a mixture of multiple choice, Likert scale and open written questions. Students were informed that the survey findings could be used for research purposes prior to submission of responses – '*The information that you contribute will be* ***anonymous****, you will* ***not*** *be identified*. *Findings may be used for academic research purposes*.' The survey aimed to evaluate student access to broadband, perceived technological proficiency, module delivery preference and provide general feedback for the module. The cohort of students in this study experienced both traditional pre-COVID-19 teaching methods on-campus (i.e. face-to-face lectures, tutorials and written examinations) and fully online education (i.e. online module delivery and assessment) over the course of their degree in equal amounts, providing a unique insight and opportunity for student evaluation. The data is securely stored on a password-protected laptop and hard drive and only permitted staff associated with the module had access to the data through Canvas LMS.

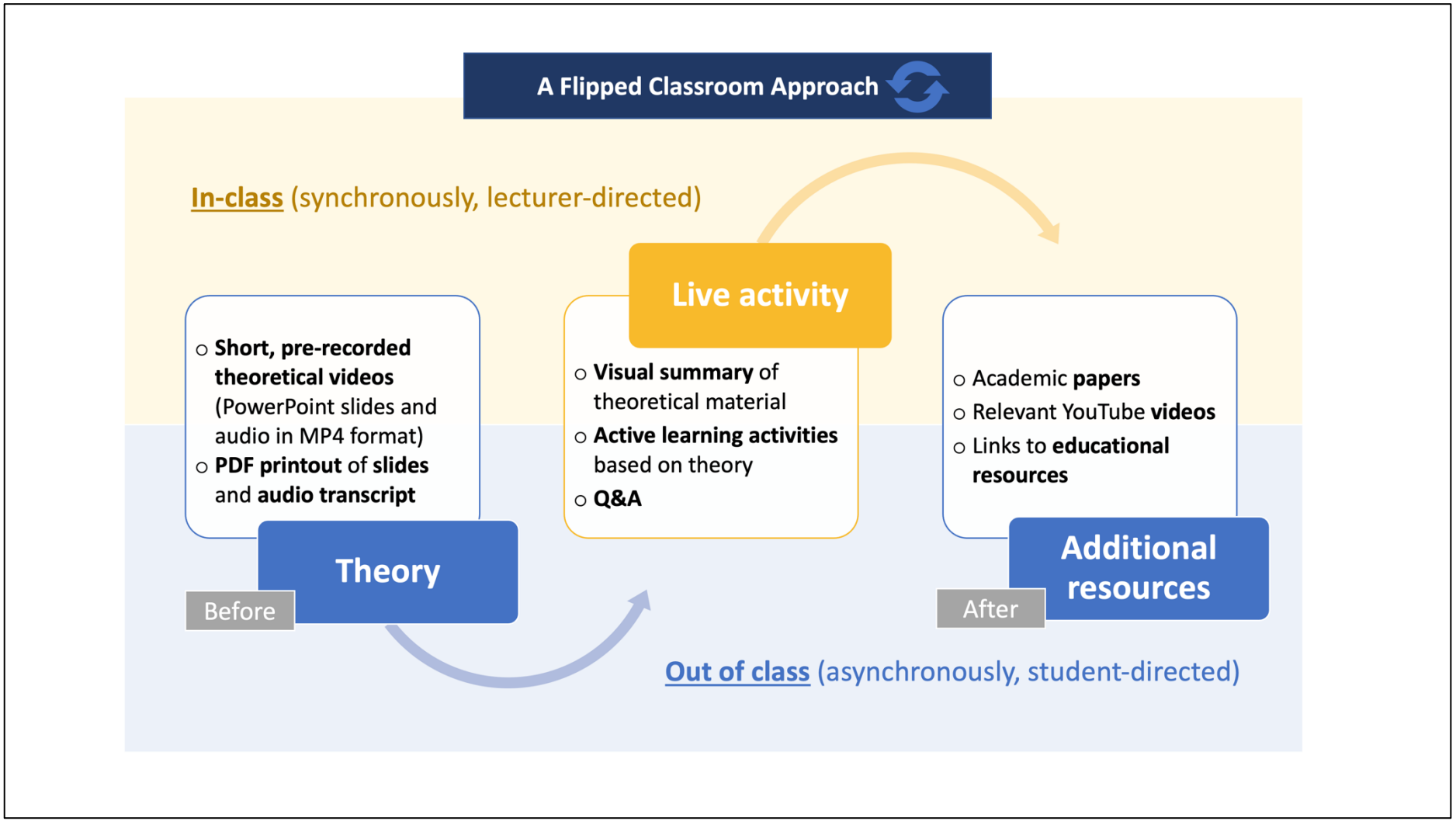

Figure 2 – Illustration of the flipped classroom structure utilised in this study; student evaluation is based on this module design

3. Results

Sixty-six survey responses were completed (class size of 133 students), and the survey took an average of 18 minutes to complete. In general, the students reported the flipped classroom approach to be an effective and accessible method of delivery in an online setting and findings showed a request for an on-campus flipped classroom format in the future. Students showed an appreciation for the active classroom, increased student-staff engagement and the use of multimedia resources (i.e. using more than one medium of communication). The digitised lecture material was particularly beneficial for students with dyslexia, allowing students to review the content at their own pace.

3.1 Technology

Proficient technological skills were required to navigate the Canvas LMS, access course material, complete and upload assignments and exam scripts, and troubleshoot associated issues (advanced knowledge). Despite access to free university information technology (IT) courses, general undergraduate experience, and other free resources (YouTube, Google etc.), most students rated their technological skills as '*basic*' (42%, n=27 students) and '*proficient*' (44%, n=28), and only 11% (n=7) of the cohort identified as '*advanced*' in technological proficiency (Figure 3A). An important and often overlooked variable in e-learning is access to sufficient broadband speeds for streaming and uploading/downloading course material. Fifty-six per cent (n=36) of students had access to '*medium*' broadband speeds (Figure 3B), and 19% (n=12) and 2% (n=1) of students had '*poor*' broadband speeds and '*none*' respectively.

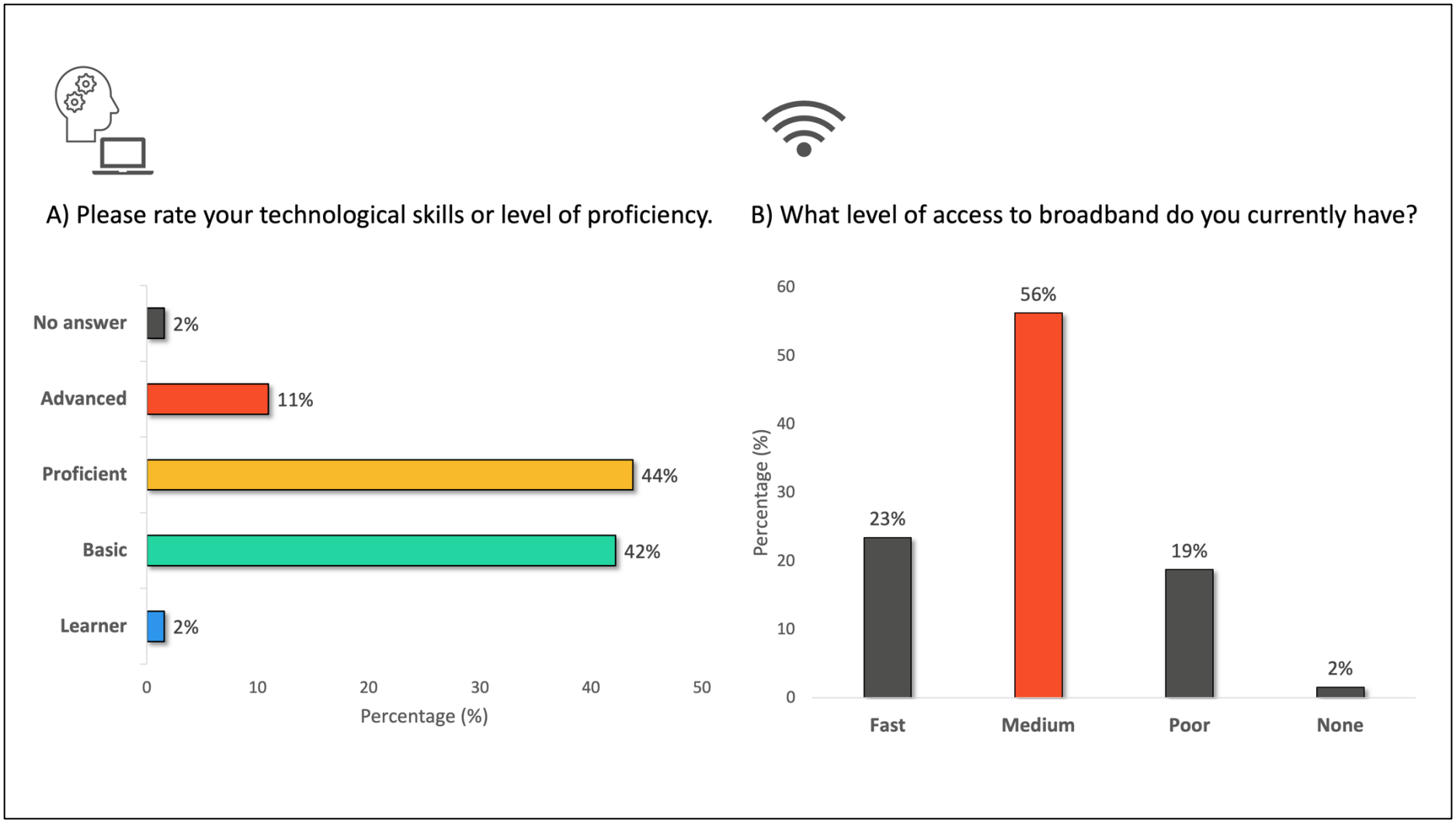

Figure 3 – Bar graphs showing student response to statements relating to technology skills and broadband access; A) level of technological proficiency and B) broadband access

3.2 Module delivery

Final-year students in this case study were exposed to a variety of online lecture delivery methods during the pandemic, dependent upon the lecturer's personal preference i.e. synchronous, asynchronous, or mixed methods of delivery. Student evaluation showed a preference for the online flipped classroom approach utilised in this physical geography module, 68.75% of students (n=44) selected the '*pre-recorded short lectures and a live class activity via Microsoft Teams (mixed)*' as their preferred online method of delivery. Only 18.75% of students (n=12) chose the '*pre-recorded full lecture through Panopto (asynchronous)*' format and the remaining 12.5% (n=8) selected the '*live Microsoft Teams full lecture (synchronous)*' option (Figure 4A). In support of the online flipped classroom approach, 86% of students strongly agreed (42%) and agreed (44%) that the live activity class each week was beneficial (Table 1). Furthermore, 59.4% of students (n=38) chose to move away from the traditional lecture-based delivery (pre-COVID-19 format) and opted for an on-campus flipped classroom approach '*mixture of pre-recorded lectures (theory) and on-campus class activity (practical application)*' in the future. Only 35.9% of students (n=23) selected a '*return to on-campus lectures (pre-COVID-19 format)*' and a mere 4.7% (n=3) chose to '*keep the current online format*' (Figure 4B).

In a subgroup analysis, all categories of the online lecture delivery methods showed a preference for the on-campus flipped classroom in a post-COVID-19 scenario (Table 2A). Fifty-five per cent of the online flipped classroom subgroup (n=44), 75% of the '*pre-recorded full lecture through Panopto (asynchronous)*' subgroup (n=12) and 63% of the '*Live Microsoft Teams full lecture (synchronous)*' subgroup (n=8) chose the on-campus flipped classroom option. Interestingly, of the students who chose the online flipped classroom (n=44), 45% chose to '*return to on-campus lectures (pre-COVID-19 format)*', and none chose to remain online (Table 2).

In the investigation of a student perspective on the most important aspect of a successful physical geography module, 27% of students (n=17) chose a '*multimedia approach to teaching (lectures, videos, readings and activities)*' as the most important aspect, followed by a '*lecturer's communication and presentation skills*' at 23% (n=15) (Figure 4C). The third rated aspect was '*field work or practical application of theory*' at 19% (n=12), followed by '*interesting content*' at 13% (n=8). The aspects of least importance for this cohort were '*face-to-face interaction*' (9%; n=6) and '*continuous assessment covers a significant portion of the overall grade*' (9%; n=6) (Figure 4C).

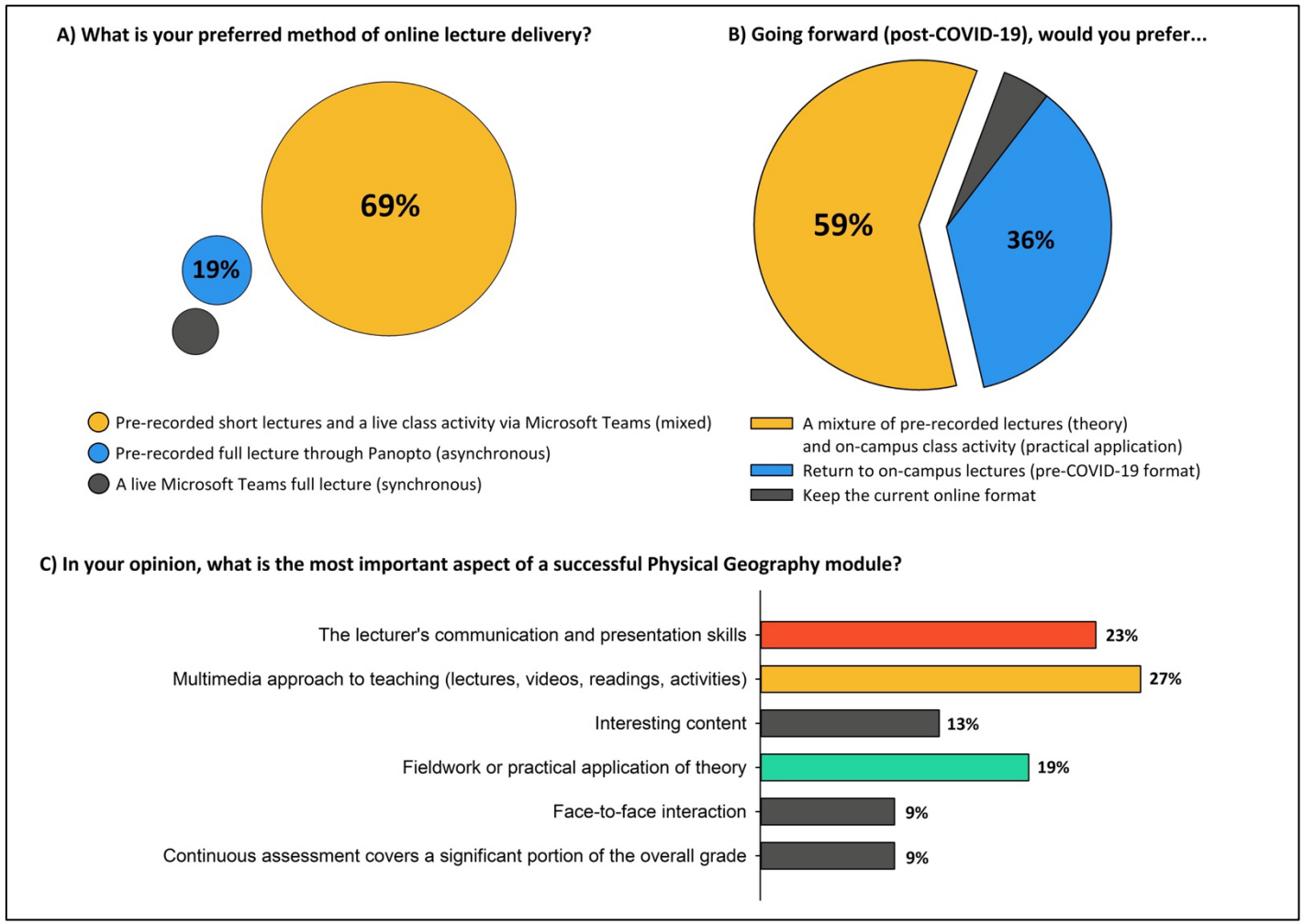

Figure 4 – Graphical representation of student preferences of module delivery A) experienced and B) future predilection. C) Perceived important components of a successful physical geography module

Table 1 – Percentage of student responses to statements related to the delivery of the Coastal and Marine Geomorphology module in the 2020/2021 academic year. Legend: strongly agree (SA), agree (A), neutral (N), disagree (D), strongly disagree (SD) and no answer (NA)

Coastal and Marine Geomorphology Module - Student Evaluation	**SA**	**A**	**N**	**D**	**SD**	**NA**
The pre-recorded lectures were clear and concise	42%	44%	8%	3%	0%	3%
The pre-recorded lectures were audible and understandable	42%	50%	5%	0%	0%	3%
I liked the online format of pre-recorded lectures (PowerPoint slides and audio) + a live class activity	44%	30%	14%	6%	2%	5%
The live activity class on a Wednesday was beneficial	42%	44%	9%	2%	0%	3%
The pace of the course was satisfactory	35%	41%	14%	8%	0%	3%
I liked the content covered in this course	35%	45%	11%	5%	0%	5%
I revised sufficiently to keep up with the classes	15%	42%	26%	14%	0%	3%
The lecturer was easy to approach	61%	32%	3%	0%	0%	5%
Overall, the lecturer's teaching was excellent	50%	33%	14%	0%	0%	3%

Table 2 – A subgroup analysis for three groups in terms of modality preference

Subgroup Analysis				
		Preferred post-COVID-19 lecture delivery method		
A)		On-campus flipped classroom	Keep the current online format	Return to on-campus lectures (pre COVID-19 format)
Online lecture delivery method	Online flipped classroom (n=44)	55%	0%	45%
	Live Microsoft Teams full lecture (synchronous) (n=8)	63%	13%	25%
	Pre-recorded full lecture through Panopto (asynchronous) (n=12)	75%	17%	8%
		Preferred online lecture delivery method		
B)		Online Flipped Classroom	Live Microsoft Teams full lecture (synchronous)	Pre-recorded full lecture through Panopto (asynchronous)
Technological proficiency	Learner (n=1)	0%	0%	100%
	Basic (n=27)	81%	15%	4%
	Proficient (n=28)	61%	11%	29%
	Advanced (n=7)	71%	14%	14%
Broadband access	Fast (n=15)	47%	27%	27%
	Medium (n=36)	75%	8%	17%
	Poor (n=12)	75%	8%	17%
	None (n=1)	100%	0%	0%
		Preferred post-COVID-19 lecture delivery method		
C)		On-campus Flipped Classroom	Keep the current online format	Return to on-campus lectures (pre COVID-19 format)
Technological proficiency	Learner (n=1)	100%	0%	0%
	Basic (n=27)	59%	4%	37%
	Proficient (n=28)	57%	4%	39%
	Advanced (n=7)	57%	14%	29%
Broadband access	Fast (n=15)	60%	13%	27%
	Medium (n=36)	56%	0%	44%
	Poor (n=12)	75%	8%	17%
	None (n=1)	0%	0%	100%

The three groups presented in table two are: A) preferred post-COVID-19 lecture delivery method within the online lecture delivery methods subgroups, B) preferred online lecture delivery methods within the technological proficiency and access to broadband subgroups, and C) preferred post-COVID-19 lecture delivery method within the technological proficiency and

access to broadband subgroups. As subgroup analysis reduces the statistical power of results, the numbers of responses per subgroup have been included for data transparency. **Bold** values highlight relevant insights. Abbreviations: online flipped classroom = '*pre-recorded short lectures and a live class activity via Microsoft Teams (mixed)*' and on-campus flipped classroom = '*a mixture of pre-recorded lectures (theory) and on-campus class activity (practical application)*'.

3.3 Module delivery and technological influence (subgroup analysis)

A subgroup analysis, albeit with reduced statistical power, suggested technological proficiency and access to broadband did not have an influence on student preference for lecture delivery method either online or in a post-COVID-19 scenario (Table 2B, C).

Technological Proficiency

Eighty-one per cent of students with '*basic*' technological proficiency (n=27) chose the online flipped classroom as their preferred method (Table 2B). The online flipped classroom required the most knowledge and technology proficiency of the online options, as students were required to both navigate Canvas LMS to access the pre- and post-class material and utilise Microsoft Teams to participate in the live class activity. Secondly, all categories of technological proficiency chose the on-campus flipped classroom approach as their preferred lecture delivery method in a post-COVID-19 scenario (Table 2C). Fifty-nine per cent of students who identified as holding a '*basic*' level of technological proficiency chose the on-campus flipped classroom which involves a hybrid mixture of online and on-campus learning (Table 2C).

Access to Broadband

All online lecture delivery methods required access to the internet to complete the module. The '*pre-recorded full lecture through Panopto (asynchronous)*' method is the only option that would not require fast broadband download speeds, as Panopto compresses asynchronous video files for streaming purposes. In the subgroup analysis, all categories for access to broadband showed a preference for the online flipped classroom, with 47% of the '*fast*' (n=15) subgroup, 75% of both the '*medium*' (n=36) and the '*poor*' (12) subgroups, and 100% of the '*none*' (n=1) subgroup selecting the online flipped classroom (Table 2A). All categories for broadband access also chose the on-campus flipped classroom, with 60% of the '*fast*' subgroup, 56% of the '*medium*' subgroup, and 75% of the '*poor*' subgroup choosing the on-campus flipped classroom (Table 2C).

3.4 Qualitative responses

In summary, student evaluation showed a demand for change in undergraduate pedagogy with a request to continue the multimedia-focused, flipped classroom approach in a post-COVID-19 scenario. Positive student comments for the following open questions, Q1 '*what did you like most/least about this course?*', Q2 '*what aspect of the lecturer's teaching did you appreciate most*?' and Q3 '*any other comments or suggestions?'* highlight the benefits and success of the module redesign. The following student responses revealed a need for a more engaging and accessible undergraduate education and a preference for use of multimedia resources:

Flipped classroom approach

> "I enjoyed learning more about the themes and topics associated with coastal and marine geomorphology and how engaging the topic was between the readings, videos and live classes each week. It was interesting to be able to engage in each topic without learning about it in detail in face-to-face classes." – Q1
>
> "The live activity! I felt this was a very engaging way to help everyone learn" – Q2
>
> "The **variety**, the pre-recorded with detailed slides and audio and the live class was ideal for questions and simplifying material." – Q2
>
> "Loved the Wednesday live as I was able to **further understand topics by seeing examples** etc." – Q2
>
> "You included **graphs and images** which made the slides easier to digest." – Q2

Post-COVID-19 scenario

> 'The resources and input provided by the lecturer were incredible and made it a positive experience. The combination of pre-recorded lectures and live classes are something I would like to see in a post covid scenario.' – Q2
>
> "If it goes back to face-to-face classes next year I also believe there should be more of a focus on the activities as I often learned more in those 40 minutes than I did in the 2 hours of going through the presentations. I also wish there would have been even more of that type of learning. Putting into practice what we learned." – Q3
>
> "I would put forward a case to allow students to **undertake online over in class** if they wish as some students learn better that way" – Q3

The flipped classroom approach allowed for multiple repetitions of the course material in a variety of formats and perspectives which facilitated deeper learning. Qualitative student responses highlight the benefit of repetition in learning and found comfort in the consistency of posting times on Canvas LMS, particularly in an online setting. Finally, the addition of audio transcripts or captioning provided a helpful study aid for students.

Repetition – key to learning

> "I liked having the recorded lectures first and then the live class with the activities because it nearly acted as a **form of revision** and study when being asked questions. By using the activities I **definitely learned more** than just by looking at examples in a lecture slide." – Q2
>
> "I liked the hybrid mix of both pre-recorded and live lectures, as this made it possible to **clarify and fully understand everything in the PowerPoints**" – Q1
>
> "The live classes were extremely beneficial for revision and for questions" – Q2

Consistency in upload times

> "The consistency of this module was very refreshing. Upload times were constant

which was reassuring." – Q1

PDF print out (slides and audio transcript)

> "I loved how she had the lectures laid out and also print off sheets were **so helpful to be able to follow the lecture clearly**." – Q2

3.5 Other physical geography cohorts

The following year's cohort of Coastal and Marine Geomorphology and a second-year, Quaternary Environments and Geomorphology cohort were additionally asked for their preferred method of course content delivery in an anonymous module feedback survey. Both modules utilised the same online flipped classroom approach as outlined in this case study and were delivered by the same lecturer. Survey findings again showed a preference for an on-campus flipped classroom in a post-COVID-19 scenario. Sixty per cent (n=24) of students from the Coastal and Marine Geomorphology 2021/2022 cohort and 51% (n=20) of the Quaternary Environments and Geomorphology cohort 2021/2022 also selected the on-campus flipped classroom (Table 3).

Table 3 – Table presenting student responses for preferred method of course content delivery in the following year's cohort of Coastal and Marine Geomorphology (2021-2022) and a second-year physical geography module, Quaternary Environments and Geomorphology (2021-2022)

Preferred lecture delivery method for other physical geography cohorts		
Which is your preferred method of course content delivery?	Coastal and Marine Geomorphology (2021-2022)	Quaternary Environments and Geomorphology (2021-2022)
Online flipped classroom	33% (n=13)	23% (n=9)
On-campus flipped classroom	**60%** (n=24)	**51%** (n=20)
Traditional transmissive lecture on campus	5% (n=2)	23% (n=9)
No answer	3% (n=1)	3% (n=1)

4. Discussion

This pedagogical research paper aimed to investigate the effectiveness of a flipped classroom approach in the field of physical geography through student evaluation and reflects upon the enforced transition to online learning in higher education, in response to health and safety regulations associated with the COVID-19 pandemic. As educators, our goal is to engender understanding in the transference of knowledge (Roehl et al. 2013). Romanelli et al., note the best practice most likely involves a teaching method that 'addresses and accommodates multiple dimensions of learning styles that build self-efficacy' (2009, p. 3). Active and blended learning techniques such as the flipped classroom approach are becoming more prevalent in an age of 'digital natives' with a shift towards student-centred teaching (Bishnoi 2020; Roehl et al. 2013). The flipped classroom approach with the inclusion of continuous assessment is also in keeping with Universal Design for Learning (UDL) which aims to improve student's

educational experience through more flexible methods of teaching and assessment by incorporating three core principles into module design and delivery, *engagement* (student-staff engagement through the live activity class), *representation* (including digitally inclusive and accessible multimedia resources) and *action and expression* (through the inclusion of continuous assessment) (Ahead 2017).

This case study provides strong support for a flipped classroom approach, as an effective, student-centred and accessible teaching method for physical geography and other geosciences in higher education. Student evaluation highlights a preference for both an online and on-campus flipped classroom approach and the use of multimedia resources. From an educator's perspective, the active classroom helps to improve engagement with students which is particularly useful in large class scenarios. Both quantitative and qualitative findings provide an important insight into student experiences of online learning during the pandemic and subsequently highlight a potential pedagogical pathway to move away from traditional lecture-based methods in undergraduate physical geography.

4.1 Case study findings

The online flipped classroom approach utilised in this case study proved successful, with students showing a preference for the alternative approach (69%) in comparison to other lecture-based methods of online delivery (synchronously or asynchronously). This method allowed for greater online interaction between students and staff in an informal manner, enhanced learning and supported students' learning differences. By providing students with the theoretical or lecture material in a pre-recorded video format prior to class, students were able to pause, rewind and review the new information at their own pace and in time; this is particularly helpful for students registered for learning support and additionally allows for video captioning. Video captioning or inclusion of an audio transcript is highly beneficial for clarification and comprehension purposes, as well as providing a supplemental study aid (Morris et al. 2016). Captions are also useful for students with hearing impairments, where the course is in a non-native language i.e. for some international students, visual learners or simply for students reviewing the content in a noisy or distracting environment (Morris et al. 2016). According to the Irish Census in 2016, 1 in 7 of the Irish population have a long-term illness, impairment, or disability (National disability authority 2018), highlighting the importance of digital inclusivity and accessibility. From the perspective of creating content, the act of writing a transcript for each slide can be helpful in the recording process for lecturers as it helps to condense and consolidate your narrative.

Finally, the live class activity facilitates deeper learning through active learning techniques such as inquiry or problem-based learning; the active learning tasks act as a form of revision in keeping with constructivist frameworks. The live class activity provides a unique opportunity for students to ask questions and interact with the lecturer in an informal environment. This was highly beneficial for both the students in assimilating the course material and for staff in tracking student progress and understanding, particularly in an online setting. Recording of the live class is not recommended as it significantly inhibits student participation and greatly impacts the informal learning environment. Furthermore, the average exam grade increased by 2% from the previous year, which utilised a traditional lecture-based delivery method; both cohorts were examined using the same method of assessment. Findings from this study have revealed a strong interest in the on-campus flipped classroom over the traditional transmissive lecture on-campus or online flipped classroom in a post-COVID-19 scenario. Technological proficiency and access to broadband did not appear to have an

influence on the lecture delivery preference for this cohort, however, a larger sample size would improve the statistical power of the subgroup analysis findings.

4.2 Reflection of the emergency online teaching and learning experience

The pandemic has altered many aspects of life, forcing society to re-evaluate day-to-day living, including the option to work remotely and the inclusion of digital technological communication. At a governmental level, the Minister for Further and Higher Education, Research, Innovation and Science in Ireland, Mr Simon Harris TD recently launched a project aimed at examining how higher education could learn from the COVID-19 pandemic entitled "Next Steps for Teaching and Learning: Moving Forward Together" (Lowry 2021). Minister Harris stated "there has been a strong spotlight on teaching and learning in higher education since the shift to online and remote education… The involvement of all key stakeholders in this project, which will consider our re-shaped teaching and learning landscape, is very welcome and timely*"* (Lowry 2021). To improve learning and accessibility, a call for greater integration of technology (i.e. hybrid learning) is emerging fuelled by students, staff and at a governmental level.

The transition to online learning proved difficult for both staff and students alike during the pandemic. However, the change encouraged an improvement in technological skills and often a reassessment of module design. Student evaluation of the most important aspect of a successful physical geography module proved interesting. Pre-COVID-19, one might expect the lecturer's communication and presentation skills and continuous assessment weighting to be the most important aspect, however this was not the case. The pandemic has generated new and creative ways to teach; findings from this study show a shift in the teaching and learning landscape, as a '*multimedia approach to teaching (lectures, videos, readings and activities)'* was chosen as the most important aspect, while '*face-to-face interaction*' and '*continuous assessment covers a significant portion of the overall grade'* ranked low in perceived importance.

Physical geography by its very nature is a subject that is best taught in the field, with undergraduate modules typically incorporating a field or laboratory work component. One of the main challenges physical geography lecturers face is facilitating a fieldwork component with large class sizes (+100 students). Where possible, fieldwork and small group tutorials should be prioritised however, this is not always feasible due to social distancing, finance, transportation, staffing and insurance issues. A flipped classroom approach permits virtual expeditions of the landscape and discussion of theory using Google Earth imagery and photography which would ordinarily be too time-consuming in a traditional lecture-based format thus, creating an alternative option for large class sizes. Additionally, research-led data analysis assignments prove beneficial in these situations by providing students with an opportunity to analyse, graph and interpret real data if fieldwork is not possible.

4.3 Limitations

There are several limitations to this small case study. Firstly, the study results were based on students' self-reported data, thus the data should be interpreted with a degree of caution as no assessment of students' learning outcomes was made. Secondly, although the number of participants (n=66) is typical for a student evaluation research paper (Fuller, 2000; Long et al., 2016) a full class response (n=133) over multiple cohorts would be ideal, and preferably include other educators from the field of physical geography. This would significantly improve

the findings' generalisability.

This case study merely seeks to enlighten the potential use of a flipped classroom approach in the field of physical geography. The study findings do not imply that the flipped classroom approach, either online or on-campus, is a universal solution for teaching and learning-related issues within higher education. For example, the student-directed aspects of this approach i.e. the out-of-class proportion, may pose a challenge to some students who favour more traditional lecturer-directed methods. Furthermore, the approach may not be suitable in terms of other module topics or alignment with the educator's teaching style.

5. Conclusion

Is there a hidden benefit in the COVID-19 pandemic for education? It is said that "the most important form of learning is that which enables us to see something in the world in a different way." – John Bowden and Ference Marton (in Hermida 2014). Educators have acquired new e-learning skills and created valuable digitalised lecture content with the enforced online conversion. With higher education transitioning back to on-campus teaching, this paper proposes a rethinking of physical geography pedagogy rather than reverting to our traditional teaching methods. Can we capitalise on our new skills and teaching resources to create a more dynamic, interactive learning environment that is more digitally inclusive and accessible? Findings from this student evaluation of a final year physical geography module have shown an appreciation for the flipped classroom approach and revealed a request for the continuation of this alternative pedagogical approach in the future. Increased integration of technology using multimedia resources is recommended to provide a more inclusive and interactive learning opportunity for all. I personally found the flipped classroom approach to be a more enjoyable and successful way to teach particularly in an online setting. The informal interaction during the live classroom activities was a refreshing change from traditional lecture-based communication of course content. Finally, I would like to encourage educators to share their experiences moving forward – when we share what we learn, we enhance its value.

Additional recommendations for utilising a flipped classroom approach either online or on-campus:

- Educators also should be mindful of student access to broadband and the ability to troubleshoot technological issues. An awareness of download speeds when creating content is key, i.e. suitable file size for download and streaming. Furthermore, the advertisement of free University training courses in writing, data analysis, communication and LMS software is essential, as undergraduate modules become technologically integrated.
- Captioning and/or audio transcript inclusion of course video content is recommended to enable accessibility and provide a valuable supplemental study aid.
- The importance of structure and consistency should not be underestimated when delivering an online course. Students appreciate consistency in the timing and location of posts. Outlining the weekly schedule at the beginning of the module is essential. Arrangement of course material from new to old on LMS is recommended i.e. the newest content is presented first in the availability of order.
- On reflection, it is advised to provide students with the pre-class work approximately five days prior to the live class, as students with part-time jobs required extra time to review the material.

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