Interactive streaming videos for educational use

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Abstract

The rise of accessible technology and the COVID-19 pandemic has led to a significant increase in the popularity and usage of education online. However, online education is still at an early stage. Few companies have received funding similar to that of large technology companies, and research has mainly been restricted to feasibility thus far. This means platforms are not benefitting from the product design, human behaviour and technological research that companies like YouTube, Twitter and Instagram use to ”hook” users.

This project aims to research pedagogy, Active Learning Techniques (ALT), habit-forming techniques, and User Interface and Experience (UI/UX) design principles. These practices will be used to create a prototype education platform to increase student satisfaction and engagement, a crucial precursor to learning and performance.

Interviews will be conducted with three current university students to understand their experiences to better influence design. Usability Tests will then determine the feasibility of proposed features and areas for future work. Results from the Usability Tests show that participants rated the prototype higher than their current solutions and would recommend their university.

This paper recommends further product design efforts and habit-forming experiments in online education platforms, focusing on supporting instructors in specific pedagogical course design choices and more advanced organisation and management of resources.

Research Ethics Approval

This project obtained approval from the Informatics Research Ethics committee.
Ethics application number: 2021/60142
Date when approval was obtained: 2022-04-07
The participants' information sheet and a consent form are included in the appendix.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Jacob Ryan Sieradzki*)

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Thank you to Ash, Sav, Louis, Katie, Daniel, Mum and Dad.

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Chapter 1

Introduction

Online education is experiencing high growth, as COVID-19 has forced educational institutions and students to digitise the physical classroom experience with personalised experiences for students. In 2020 Rajeev Misra, CEO of SoftBank, said that online education is essential for society and can help tackle disparity in wealth. Misra announced that online education was one of the top three focuses for SoftBank's Vision Fund, the world's largest technology-focused investment fund.

I am currently taking an Artificial Intelligence and Computer Science degree at The University of Edinburgh. During my time at the university, I have been exposed to various tools and services to complete tasks for a module, which often have similar functionality and significant overlap between them. I have personally experienced the emergency migration of content into an online environment due to the pandemic.

A module, consisting of lecture videos, lecture slides, and other reading material, is usually split between three platforms for the course. The content of these resources is deeply interconnected in a mental model. Slides of a lecture video should point to a specific time when it is shown during a lecture video, and sections of further readings should be connected to the point where that topic was explained. Fragmentation confuses students and results in distraction and wasted time.

This paper aims to improve the experience of an online education platform by improving student satisfaction and engagement, a crucial precursor to learning and performance. Students will not perform or value an activity they do not want to do. This paper will discover which strategies can be used to improve student satisfaction and engagement by reviewing existing literature on active learning techniques, pedagogical research and course design in both an online and physical environment. This paper will also look at increasing engagement through design, by

Companies like YouTube, Twitter, Instagram and TikTok utilise habit-forming techniques to create unprompted user engagement. The Hook Model is a framework that examines the techniques used by companies that have successfully created products to influence behaviour and bring users back, unprompted. This paper will also explore the Fogg Behavioural Model which theorises how to transform ability and motivation into engagement.

Active Learning Techniques (ALT) are strategies used in the physical and virtual classroom environment to engage students in learning. Benefits include improved critical thinking skills, increased motivation, deeper student understanding and retention, and a range of skills required in real-world job situations, such as personal accountability, interpersonal communication skills and hands-on experience. When COVID has required us to rethink how education is delivered, these skills promote a culture that teaches students to "learn how to learn" rather than allowing complacent students to absorb information from home passively.

This paper will address issues by developing a web-based education prototype application that focuses on learning materials as bite-sized snippets of content and displays a course as a network of these interconnected snippets. Using the techniques mentioned previously, the application will be iteratively improved through user interviews and usability tests. Other features included the aim to increase ability through design and demonstrate the potential of digital product design techniques to encourage participation.

The overall objective is to demonstrate that there has either not been sufficient development in online education, or that the development has been largely focused on the wrong elements. Furthermore, my primary objective is to demonstrate that there is huge potential for using technology in tandem with education to increase student satisfaction and engagement through pedagogic principles to improve skill development and knowledge retention.

Chapter 2

Background Research

2.1 The classroom is moving online

A current trend shows that the classroom is becoming a more digital experience. COVID-19 accelerated this as institutions were forced to shut and the population was required to stay at home. This section will look at the experiences of students and teachers to discuss the potential benefits of an online experience. This section will also look at evidence from the rushed migration to online learning due to the pandemic and discuss how this negatively impacted education.

The COVID-19 pandemic has had an incalculable effect on our society and economy, detrimental to higher education. The UN National, Scientific and Cultural Organisation estimates that 138 countries had school closures, affecting 80% of children worldwide [28]. Furthermore, there is a significant risk that online education may worsen existing inequalities for children living in poverty. In Europe, 5% of children do not have a suitable place to do homework, and 6.9% have no access to the internet [16].

The Office for National Statistics (2020) released a report on the impact of students in higher education due to the pandemic from September to December 2020. Students found themselves in unusual situations compared to the general public but were shown to follow COVID restrictions much like the general public. Students were shown to have lower levels of life satisfaction and happiness and higher levels of anxiety compared with the general population, which was likely exacerbated by unstable plans to migrate to online education by their institution [13].

Watermeyer et al. (2020) reported findings from a survey of 1148 academics in UK universities of their experiences of the emergency migration to online learning due to the pandemic [30]. Many institutions had already invested in digital education before schools' forced closure, and some respondents felt that the emergency change was overdue. As a result, an opportunity arose to question previous assumptions made about transitioning courses online.

Students appreciate the flexibility that online delivery provides, and some faculties felt the online migration brought "academic communities closer together, ironically at a time when they are most physically apart" [30] (p.637).

However, most responses showed that the speed of the transition was an unusual and disorienting experience, with over half of respondents stating that they did not feel prepared to deliver online learning, teaching and assessment. Many respondents felt that the pastoral, administrative and technical roles had become a much more significant part of their job, detracting focus from teaching and research. The reduction in the expertise and personal interaction required has transformed higher education into a much less social and collaborative learning experience.

Instructors often spend much longer than intended responding to students and monitoring discussions, exacerbated when handling multiple time zones. This has led to an erosion of work-life balance, especially for those with child-caring responsibilities. Consequently, instructors cannot spend time on research, with concerns of job loss, career stasis and "a lost generation of academic talent" [30].

Instructors wish to engage in technical training to better support their course but simply do not have time [30]. Instructors said they wanted technical support, reliable infrastructure, and leadership and direction from their department chairs [27].

Google, YouTube and Slack are products that have complex concepts and interactions and have attracted millions of engaged users, despite minimal training. This indicates the low level of focus that has been given to creating easy-to-use education products that help users achieve goals.

Some respondents felt pressure and restrictions from senior management to deliver a course online even when they thought it was inappropriate. This suggests naivety from the institution about the realistic amount of additional workload required and other consequences. Instructors should control course design and have the freedom to trial innovative pedagogies.

Institutions and governments may use the partial success that the emergency transition showed as an opportunity to decrease overhead costs and increase student tuition fees. A report published by the UK Parliament (2021) explores the financial impact on higher education, saying the sector had "responded well" and the overall financial position was "sound". The report shows the government's response to the pandemic with two financial support packages. These had a focus on supporting grants and research projects and supporting lost income from international students [3].

Evidence shows that the classroom is becoming a more digital experience as students seek more flexibility and pressure rises from governments and institutions to decrease overhead costs. Respondents to the Watermeyer et al. survey describe the transition to digital learning as a "weapons race", with success only likely for the largest and most financially stable institutions. However, many assumptions about the transition have been met with concerns by the educators delivering the course during the emergency transition. Furthermore, support packages and lower overhead costs could be used to support disadvantaged students, but they are not. Continuing with the same assumptions made during the transition would prove fatal.

Academics feel overwhelmed and unprepared, and students feel unsupported and uncertain. It seems unusual that there has not been a primary focus on the online platforms that deliver content. We see that not focusing on this poses a risk of impact on a

generation of students, instructors and the future of higher education. Education is in the midst of a digital revolution. This sector must pay close attention to the lessons learnt during the emergency transition to meet the needs of the student and the faculty to deliver a truly practical learning experience.

2.2 Existing literature on education

Checkering and Gamson (1987) state, “Learning is not a spectator sport. Students do not learn as much just sitting in classes listening to teachers, memorising prepackaged assignments and spitting out answers” (p.4) [7]. Edgar Dale’s (1964) influential “Cone of Experience” highlights the importance of direct experiences for effective learning [9]. Therefore, it seems undesirable that a large proportion of online education consists of watching lecture videos and reading resources online.

This section explores techniques and strategies from existing literature showing evidence of improving student engagement in learning. This research will influence the design of this project’s application to improve student engagement and satisfaction and test against participants.

2.2.1 Active Learning Techniques

Camacho and Leagre (2015) provide a survey of literature on strategies to improve higher-order thinking skills through Active Learning Techniques (ALT). These are strategies used in the real and virtual classroom environments that have shown to engage students in learning [4].

Benefits include improved critical thinking skills, increased motivation, deeper student understanding and retention, and a range of skills required in real-world job situations, such as personal accountability, interpersonal communication skills and hands-on experience. Student satisfaction and cooperation also increased due to the regular implementation of ALTs in the classroom.

A review of this paper revealed these main takeaways:

- Students learn effectively through group work and active discussions. This allows students the opportunity ”to gather information and explore peer perspectives” to gain a deeper understanding. (Levy & Petrulis, 2012)
- Students learn effectively when asked to explain ideas in their own words. This develops critical thinking skills and builds knowledge for future problem-solving.
- Asynchronous discussion reinforces learning, such as thought-provoking questions about a lecture. Sharing and explaining ideas to others causes a student to review, analyse and synthesise information. Students essentially teach themselves.
- Problem-based learning fosters critical thinking and problem-solving skills, with a life-long effect. Promoting creativity has a fundamental role in producing engaging problem-solving tasks.

- Scavenger hunts can improve critical thinking and allows students to be in charge of their learning.
- Educational technology that improves digital communication capabilities between students and instructors increases student engagement. Instructors can present ideas visually through interactive media, and students can take a more active role in participation through easy-to-use technologies such as smartphones and QR codes.

2.2.2 Classroom and online education

Tallent-Runnels et al. (2006) reviewed 91 studies to summarise existing research into online education [27]. These studies reveal insights into students' and faculty's experiences with online education and factors that can improve student engagement and satisfaction.

Most studies found little difference in test scores between students who enrolled in an online course and traditional classrooms, implying no significant disadvantage to online experiences. They show that online education benefits students, but elements of the classroom environment must be carefully designed to suit the digital environment appropriately.

McGee and Rice (2012) examine publicly available resources to recommend best practices in blended course design [20]. Whilst this paper focuses on online education; the authors offer insights into factors that influence the suitability of different practices in each environment.

This paper will look at flexibility, usability, asynchronous discussion, pedagogical support, the instructor's role, communication with instructors, and guided participation, as factors that can improve the student experience online.

2.2.2.1 Flexibility

Flexibility and self-pacing was the most crucial feature of online learning for students. Many students choose an online course because of constraints on their schedules and believe online instruction would improve academic performance.

Observing how students spent their time online showed no change in the undesirable habit of cramming before being tested [27]. Self-regulation was also shown to improve the effectiveness of in-person activities when students took responsibility for their learning outside class [20].

This shows that learner control improves student satisfaction and engagement, therefore is not merely a convenience.

2.2.2.2 Usability

Students said their current systems were not transparent and easy to use. Almost 30% said they would like training in using the new system [27]. Ensuring there is adequate

support for online technology which is clear and accessible increases participation and reduces frustration [20].

Technology should be simple enough that students are not confused and remain engaged [20]. Online experiences should be tailored to the intended users' cognitive style and cultural experiences. Furthermore, students' understanding of complex concepts is hindered when the cognitive load is high [27]. On the other hand, using technology that is inessential to learning outcomes is distracting and decreases student motivation [20].

This shows that UI and UX design are fundamental to making online education engaging and not distracting.

2.2.2.3 Asynchronous discussion

Student-to-student discussion encourages users to expand, formalise, and refine their reasoning. Users who shared detailed, thoughtful responses to other users showed enhanced learning and promoted mentoring, critical thinking, and socialisation.

Self-pacing allows for asynchronous discussion, where students can log on to work even if no one else is logged in at the same time. Studies found that delayed responses allowed students to think about responses, resulting in more focused and personally relevant answers with improved depth and quality [27].

Some students found that during in-person (synchronous) group discussions, they had to bid against each other for an opportunity to speak. On the other hand, some students found that an asynchronous method breaks the fluidity of natural conversation [27].

McGee and Rice recommend that online discussions are more successful when they are open-ended rather than completion-oriented. Face-to-face discussions are most successful when used for activities that build on pre-learned knowledge [20].

Many studies from these surveys point to the importance of community, providing students with camaraderie, warmth and "a sense of belonging and place, as well as provide a network of support and collaboration". An atmosphere of respect and safety allows "informed debate and collaborative problem solving to flourish" [20].

Anonymity is another feature identified for online, asynchronous discussion. One study showed that 42% of the females surveyed commented that they value anonymity in a networked learning environment. Another showed that students were more likely to write longer and more focused answers. Community and anonymity may naturally seem like contradicting points, but we will see in Section 3.2.4 how these can be used in tandem.

This shows that asynchronous discussion online allows students to write answers with improved depth and quality. Building community and allowing anonymity increases students' confidence to contribute. Online discussion should be open-ended rather than completion oriented.

2.2.2.4 Pedagogical support

Online courses can increase enrolment but are more time-consuming for faculty than a traditional course [27]. The time to redesign a course suitably requires three to six months in advance of implementation. Poor course translation from classroom to online can cause additional work for students in what is described as the "course-and-a-half" phenomenon. [20]. This may explain why instructors felt unprepared for the emergency migration and unsatisfied students.

Online pedagogy research shows that it is essential to design a course that matches the needs of the learners with the content to ensure success. It indicates that a more sophisticated approach is required to move traditional, text-based courses to the internet.

The correct medium for tasks, activities and discussion must be chosen purposefully to ensure effective learning. Tallent-Runnels found that students in an online environment outperform those in the classroom environment on the conceptual parts of a test. In contrast, students performed better in the classroom on technical knowledge [27].

For example, directly transferring a classroom course (that relies heavily on discussion) to an online setting may lead to unprepared learners, problematic timing of course activities, or lack of instructor support.

Students value timely direct emails, announcements, lecture notes and Q&As but do not value impersonal strategies to encourage discussions, such as creating home pages and unguided discussion groups [27].

This shows that online experiences should be designed around pedagogical practices and that there should be strong integration between components. Applications should support teaching specific features.

2.2.2.5 Instructor's Role

The instructor is responsible for scaffolding the learning process and online interactions that are sufficiently structured to benefit the student's learning. Flexibility does not mean complete student autonomy.

To maintain a level of motivation in students, instruction needs to be high-frequency with weekly pressure to drive motivation and help focus. However, McGee and Rice found that the requirement for high levels of interaction could be met with resistance as instructors may not be willing or capable to provide frequency at this level. Furthermore, this may become ineffective if students are not able to keep up with interactions at this high-frequency [27].

The instructor and instruction should construct online experiences that are high-frequency. Pedagogical features should support course design choices.

2.2.2.6 Communication with instructor

Students value direct discussion with personally relevant instruction relevant to help create a deeper understanding of the material despite desiring autonomy. Interaction

between students and instructors is "the single most important activity in a well-designed distance education experience" (p.122) [21].

Many students found that instructors failed to recognise the importance of the students' feelings, reactions, and responses [27]. McGee and Rice found that shifting from a teacher-directed to a learner-centred paradigm shows improvements in acceptance, success and retention of blended courses [20].

Online experiences should be designed to support direct bi-directional communication and feedback between students and instructors.

2.2.2.7 Guided Participation

Studies found that guided participation yielded a deeper understanding of the material. When learning was conducted without guided participation or immediate feedback, students were more likely to arrive at incorrect misunderstandings, procrastinate or withdraw from discussions. Even a low degree of moderation showed evidence of helping to form a respectful and collaborative community [27].

Online experiences should be designed so that instructors can act as guides in student discussion.

2.2.3 Engagement

Lee et al. reviewed 51 studies to examine influences on user engagement in online professional learning due to low completion rates on existing platforms. Current research on online professional learning has mainly been focused on feasibility rather than optimising user engagement [17].

Engagement is "likely a crucial precursor to learning and performance", which "translates motivation into learning". Technology carries particular promise for engagement in online education due to its potential to individualise learning [17]. Behavioural theories can be used to increase motivation and build habits, as discussed in Section 2.3.3 and explored with interview participants in Section 3.2.5.

The authors found that emotional engagement is high when students find a platform easy to use and can make sense of the course content. Behavioural engagement is high when trustworthy material is used, and interface navigation is intuitive. Applications should be designed not just around a user's ability to learn but to maintain a user's trust and confidence. Cognitive engagement is high when learners receive support from instructors and peers and do not feel alone, pointing to the importance of community [17].

This shows that technology can improve engagement by individualising learning and forming habits. UI and UX design can influence emotions to increase a student's confidence to contribute.

2.3 Habit-forming techniques

Millions of users are addicted to YouTube, Facebook, Twitter, TikTok and other online platforms. The design decisions behind these platforms purposefully intend to manipulate and leverage human emotions and behaviour into addiction.

These techniques can be similarly applied to an online education platform to help encourage healthy habits. Geer (2009) recommends forming habits around technology on first use to promote engagement so that actions are repeated and can meet learning objectives. This section will explore habit-forming techniques and explore how they can be applied to this project's application [14].

2.3.1 Hook model

"Hooked: How to Build Habit-Forming Products" is an international bestselling book by Nir Eyal [11]. Eyal proposes the "Hook" model, a four-step framework that can be embedded into products to encourage habit-forming behaviour in users. The model operates through 'hook cycles' consisting of a trigger, an action, a variable reward, and an investment.

"Companies leverage two primary pulleys of human behaviour to increase the likelihood of an action occurring: the ease of acting and the psychological motivation to do it" (p.8). Strong, negative emotions are powerful internal triggers and greatly influence our daily routines. Avoiding pain is a crucial motivator in all species, and even minor pains and irritations prompt an immediate and often mindless response to relieve an uncomfortable sensation [11].

A habit is a behaviour done with little or no conscious thought. Products designed to create habits change user behaviour and create unprompted user engagement. When a product successfully holds a place in a user's mind, the user will return to this product repeatedly without any explicit trigger [11].

The American Psychological Association defines addiction as a "chronic disorder with biological, psychological, social and environmental factors influencing its development and maintenance" [1]. The desire to re-experience a feeling leads to changes in the brain which affect areas of reward, motivation, memory, impulse control and judgement. Whilst addictions usually refer to a substance; products can have the same effect.

Eyal defines addiction as a habit that has turned into a self-destructive dependency. A user opens Twitter unprompted because of the emotional "itch" to seek excitement during boredom or seek importance, validation, and social connection from feelings of loneliness or inadequacy [11].

Habits do not force people to do things they do not want to do. Habits have short half-lives and revert to original behaviours over time. Products succeed when they solve problems. Therefore understanding a problem and providing high perceived utility is essential to forming habits.

2.3.2 Trigger

Habits require a foundation to be built upon over time. The Trigger in the "Hook" model is the actuator of behaviour and can be external or internal.

External triggers are triggers that a user can see. They increase the likelihood of the desired behaviour by reducing the thought required and are used to drive a user through the "Hook" model initially. External triggers can be advertisements, notifications or word of mouth. An online education platform should provide sufficient utility that relationship triggers entice new users. This way, existing customers can become "brand evangelists" for a product at little or no cost due to institutions' desire to reduce overhead costs.

An internal trigger is formed when a product becomes mentally associated with a thought, emotion, or pre-existing routine. Negative emotions, such as fear, are powerful internal triggers and can trigger reactions unconsciously, even at minute levels. When pain is relieved, positive emotion is formed. Consequently, a habit is developed over time when not acting causes discomfort.

This paper will explore how feelings of being overwhelmed, confused or uncertain can be relieved by feelings of community, progress and support.

2.3.3 Action

In the Hook model, an action is the simplest behaviour in anticipation of a reward. To prompt a user to act, acting must be simpler than thinking. Dr B. J. Fogg (2009), the founder of Stanford University's Behaviour Design Lab, proposes the "Fogg Behaviour Model" for understanding human behaviour [12]. A behaviour will occur when motivation, ability and a prompt (trigger) are sufficient. These elements must be present together at adequate levels to cue an action.

Fogg states that motivation is driven by humans' motivation to seek pleasure and avoid pain; seek hope and avoid fear; and seek social acceptance and avoid rejection. Eyal reports that targeting "ability" holds the greatest return on investment from the Fogg Behaviour Model [11]. The perceived utility of this paper's application should be very high to assist students in all practices and increase ability. Furthermore, promoting features that help to seek social acceptance and avoid fear can drive motivation.

New interfaces can make actions easier and uncover previously unknown truths about user behaviour. This project's application should be natural to use and reflect the mental model of content in a course.

2.3.4 Variable Reward

After an action is performed, a reward satisfies a users' need and causes a desire to re-engage with the product. Rewards must align with the user's internal triggers and motivations to help solve their problem.

Autonomy is an essential feature of rewards. Evidence shows that simply using the phrase "But you are free to accept or refuse" with a request dramatically improves the

likelihood of acceptance. Tasks should be optional and allow students to be wrong and receive constructive feedback safely.

Rewards must also be variable to avoid experiences becoming predictable and less engaging. Content-driven experiences, such as multiplayer games or social media, have infinite variability and become more engaging. Therefore, community-driven features designed to provide constructive feedback through creative, variable rewards can be used to increase engagement.

Gamification is a popular technique to increase engagement, using game mechanics in non-game environments. Stack Overflow, a professional question and answer website for programmers, uses points, badges, and leaderboards when users' add valuable contributions. However, when a solution does not solve the customer's problem, no amount of gamification can prompt engagement. Creative forms of constructive feedback through gamification and reputation points can be used to increase engagement.

Eyal describes three types of rewards that prove effective: the search for social rewards that make us feel socially accepted and significant; the search for physical resources or information; and the search for intrinsic rewards of mastery, competence, and completion.

2.3.5 Investment

To cause a user to create a mental association with an action, the user must undergo a change of attitude about a behaviour.

Eyal reports three tendencies that influence future actions: "The more effort we put into something, the more likely we are to value it; we are more likely to be consistent with our past behaviours; and finally, we change our preferences to avoid cognitive dissonance" (p.140) [11].

Investment causes friction, so it should be valuable enough to increase the likelihood that a user will use it again in the future. For example, by following users on Twitter, the product's algorithms can improve the relevancy of posts delivered to that user. Furthermore, Stack Overflow's points present a public reputation that can inform others of a user's expertise.

Reciprocation is a central trait of human behaviour between people but is surprisingly also relevant between humans and machines. Users are shown to provide more help to computers that helped them than computers that did not. Therefore, investment should be requested after a variable reward to present an opportunity for reciprocation.

Reputation points, contributions, and feedback can be used to build a student profile. These are variable rewards given to other users that incorporate gamification, social rewards and the search for mastery. The investment must be minimal friction and reciprocated to build community-driven rewards and investments.

2.4 Existing Platforms

Online professional learning is growing fast. Notable products include Zoom, Udemy, Open University, Coursera, MasterClass, Kahoot and Khan Academy. However, none of these products consists of the features proposed in this paper's application.

LinkedIn Learning and Duolingo are two market-leading applications in this field, selected for analysis due to similar product aims. This section will look at these applications' information to determine which features make them popular among customers and investors.

2.4.1 LinkedIn Learning

LinkedIn's purchase of Lynda.com (later rebranded to LinkedIn Learning) for $1.5 billion in 2015 is an indicator of the potential seen by investors in this industry. LinkedIn Learning is also encouraged and provided by The University of Edinburgh. Bobby Owinski, a former contributor to Forbes, describes the reasons why he believes Lynda.com is so effective for online learning [24] and is helpful to determine the emotions behind the review.

Owinski believes that the attention to detail in the production and content of each course makes a significant difference in learning. Entertaining production value increases motivation in Fogg's Behaviour Model, as the author says that each course is treated like a "Hollywood production". Furthermore, attention to detail in course content suggests that courses are supported by academic research.

The author says that "intimacy makes courses so effective". This relates to the higher engagement experienced when communities of camaraderie, warmth and support are encouraged. The author describes himself as a "proud user", referencing the professional and creative skills he had picked up and used almost every day. The author's skills and certification are a form of investment and reward. The author's positive experiences have caused him to write an article about the platform, acting as a relationship trigger to his readers.

The author's conscious and unconscious factors influenced his opinion to recommend LinkedIn Learning as an effective tool for learning. Hollywood-level production value is unfeasible for universities but contributes to the belief that higher engagement can improve content.

2.4.2 Duolingo

Duolingo is a market-leading language learning mobile application, having received $75 million in funding since 2019 [8]. The company's mission is to make education personalised, fun, and universally accessible through continuous improvements based on research that is proven to improve retention [10].

Loewen et al. (2019) performed a semester-long study on nine participants using Duolingo to learn Turkish and found a positive, moderate correlation between the

amount of time spent on Duolingo and learning gains. However, claims on the company's promotional materials may be overstated. Whilst activities are built around language learning research; decontextualised exercises have pedagogic shortcomings. The authors believe that these issues are overcomeable with further language-focused research [18].

The basis for Duolingo's habit-forming technology is the streak, a statistic of how many days in a row a user completed a lesson. The streak is a popular gamified statistic designed to help motivate users toward their learning goals. A blog post outlines research that shows that providing users with slack improves motivation rather than forcing rigid rules. Therefore, the company added a feature where a user can "freeze" their streak for a day, a change that resulted in a +0.38% increase in daily active users [19]. This supports the conclusion that learner control improves engagement and is not just a convenience.

The company also added a new animation for streaks, which resulted in a +1.7% increase in daily active users [19]. Another blog post shows that minor improvements to the appearance of skill levels significantly increase learner engagement. By displaying a skill level's visual appearance as cracked, it reduces cognitive load by visually explaining that this skill needs practice and offers empowerment to the user to choose whether to fix it or not. This shows that even minimal user interface changes can improve engagement by leveraging emotions of autonomy, competence and mastery [5].

Duolingo spends considerable time and resources on iteratively improving and personalising its application through usability and A/B Tests. This project discusses and performs usability tests in Section 5. A/B testing is a method where a random sample of product users are shown a slightly different product, and the effect of the change from the original is measured. This project recommends A/B testing as a method to explore in Section 7.3.

Participants from the Loewen et al. study rated the self-pacing, and gamification features positively. The author recommends that Duolingo's gamification is a positive motivator that could be introduced into other learning contexts [18].

This supports previous research on how gamification, flexibility, personalisation and habit-forming techniques can increase engagement. Duolingo demonstrates that this is possible in an online learning environment if not successful in some areas. However, Duolingo is explicitly focused on language learning and is therefore not modular enough to support the complexities of a higher education course.

2.4.3 Emojis

In online communities, there is a trend for students to use emoticons in their online communication to compensate for the missing cues of in-person communication [27].

Emojis are also a popular form of emoticon used widely in social media. In 2016, Facebook introduced Reactions, an alternative way to publicly leave feedback on a post [15]. Reactions included animations conveying "love", "haha", "wow", "sad", and "angry". In 2019, this feature was imitated by LinkedIn, adding similar reactions,

including a “curious” reaction [6]. Both sets of responses are shown in Figure XXX.

One can notice that these reactions were designed to avoid bullying, with obvious choices like “dislike” or “hate” omitted. A more positive and constructive option is added with “curious”, represented by a thinking face emoji.

Vyvyan Evans, a professor of linguistics at Bangor University, states that “nearly 70% of meaning derived from spoken language comes from nonverbal cues like body language and facial expression” [26]. Stark and Crawford (2015) report that emojis “do considerable work to underscore tone, introduce humour, and give individuals a quick and efficient way to bring some colour and personality into otherwise monochrome networked spaces of text”. Furthermore, “emoji can act as an emotional coping strategy and a novel form of creative expression” [25].

The authors also report the “illocutionary force” of emojis with speech “acting as comments of emphasis, de-emphasis or punctuation”. They frequently complement speech to replace common phrases and serve a social role instead of a specific linguistic one [25].

These studies show the potential of emojis to enhance and clarify the discussion, providing a fun and creative medium to students who struggle to communicate effectively using text. They also offer quick and easy response activities that can increase the participation of students online, trigger habits and add gamification to an online platform.

2.5 Summary

This section initially arrived at the following conclusions to explain the reasoning behind the project. There should be a primary focus on the online platforms that deliver content, when not focusing on this poses risks to society and higher education. And, online education should not be primarily composed of watching lecture videos and reading resources online.

This section has researched Active Learning Techniques, existing literature on education, engagement, habit-forming techniques and existing platforms. Key elements of research to focus on in the following sections include learner control and flexibility; good design to make engaging and not distracting through technology; asynchronous discussion; pedagogical support in course design choices; the role of a collaborative community; the instructor’s role in the classroom and high-frequency guided participation by the instructor.

Chapter 3

Interviews

This chapter will show insights from interviews performed with three current university students to inform development. The objective was to identify human behaviour and emotional elements that can increase engagement amongst students.

3.1 Method

Interviews were semi-structured and lasted approximately 40 minutes each. Tests were performed in order of participant number and contained no major differences in methodology.

3.1.1 Questions

Questions used to guide conversation can be found in Appendix B. Apart from these, the interviewer only asked questions to explain or expand on specific responses to avoid influencing answers. Questions were selected from this list to support the natural flow of each conversation.

3.1.2 Repeating Why Five Times

Eyal explains that identifying which emotions to target is not simple. Asking users their feelings often proves unsuccessful, as users' preferences are usually different from how they behave [11]. Taiichi Ohno (1978) proposed "Repeating Why Five Times" as part of the Toyota Production System, which helps uncover the true root of a problem [23]. The following example might be applied to why a user uses online education:

1. Why would a student want to start studying? So they can pass the exam with a good grade.
2. Why would they want to do that? So they can receive a good university degree.
3. Why would they want to do that? So they have a better chance of getting a good job.
4. Why do they need a good job? So they can have a promising career and receive a

good salary.
5. Why do they care about that? They fear being less accomplished than their peers.

During the discussion, this method was used to determine the emotions behind an initial answer. For example, a feeling of panic was shared between participants as a motivator, but their initial answers were deadlines or grades.

3.2 Results and Discussion

Participant 1 (P1) is a final year Applied Sports and Exercise Science student. Participant 2 (P2) is a final year MA Sustainable Development with Geography student. Participant 3 (P3) is a penultimate year MA Fine Art student. Participants were 21-22 years old and took 2-4 modules per semester, 1-3 exams per semester, and 2-4 pieces of coursework per semester.

All participants said that a balance of university experience, social experiences and employment were priorities. All decided to attend university to develop general employable and social skills, with tentative plans for choice of career or industry. This shows that topic content is perhaps less important than the academic skills acquired in higher education. Assumptions made that only video content, and document reading is sufficient or even beneficial for higher learning are disputed here.

3.2.1 Pandemic

All participants said the pandemic had significantly impacted their education. P2 and P3 are international students and had to move countries abruptly. All participants mentioned financial difficulties as another disruptor, and the search for employment alongside studies was challenging to balance. One participant was even required to pay for tools that the university usually provided. Consequently, all participants mentioned struggles with mental health. P3 said their second year was essentially cancelled. They felt very alone transitioning from being constantly in a studio environment (surrounded by a collaborative art community) to one online video call with an instructor per week.

P1's course mainly comprises practical activities performed in person. The pandemic resulted in a continuing drop in the participant's motivation and interest in their course. P2 mentioned that the only practical activities in their course were disrupted and replaced with exercises that felt trivial and the student did not value or engage with. P3 explained that being in the studio was fundamental to their course and that viewing art pieces in an online environment was not nearly as valuable as the practical skills learnt in person.

3.2.2 Learning Experiences

Participants said they had no loyalty to current platforms used in their course and would not recommend it to friends.

When asked about tools used at university, applications for lectures included Learn, Blackboard, Media Hopper, YouTube, Zoom or Teams, and for reading material had

Learn, DiscoverEd, PubMed and Google Scholar. Consequently, all said that the location of materials was unclear and inconsistent for each course. Participants found these tools moderately easy to use, and overall impressions were low. Furthermore, P3 said that Learn worked poorly on an iPad, their primary device used to study.

P1 said that there was a lot of passively watching lecture videos online and that exam preparation included re-watching all videos, as little content was retained during the semester. P1 appreciated a DiscoverEd feature that allowed them to quickly filter through thousands of articles by keywords.

The most time-consuming part of assignments for P2 and P3 was discovering, reading and navigating material. P3 said that assignments often point to a specific artwork or quote and that finding and referencing these were very time-consuming. P2 mentioned that reading articles and writing policy briefs were a time-consuming part of their course. Writing similar pieces of work repeatedly felt useful but unengaging.

3.2.3 Flexibility

Participants said that self-pacing and flexibility were essential to their learning experience.

P1 said that being required to attend a lecture when they were preoccupied or not in the correct frame of mind resulted in little retention of material and, therefore a large waste of time. P2 said that students learn at different speeds and that comparing students at a certain time was unfair and demotivating. P3 mentioned that they required flexibility to balance 20 hours of employment per week and that independence and organisation were one of the skills they hoped to acquire by attending university.

3.2.4 Discussion

Participants said that most attempts to support online discussion by their school were unsuccessful.

P2 mentioned an asynchronous discussion board set up to compensate for the pandemic, but it was largely unused by students or instructors as it felt trivial. They would be more likely to use it if more of their peers used it. This supports evidence that unguided participation reduces engagement.

P3 also mentioned a replacement activity for the pandemic, where they delivered a presentation to a class. Other students did not turn on their cameras or engage, a move that was previously centred around the discussion. This supports evidence that completion-oriented discussion is more effective in the classroom than online.

P1 and P2 said they valued anonymity online. These participants said they felt fear of social anxiety when asked to contribute to a group discussion. By remaining anonymous, the participants thought they had the opportunity to be wrong and were more likely to contribute. On the other hand, P3 did not value anonymity in an educational context as they prefer the personal element of feedback.

This shows that motivated students are more likely to contribute to online group discussions, regardless of anonymity. Less motivated students are more likely to contribute when their contribution is not solely examined in a group. Therefore, features should be designed to minimise the prominence of individual answers relative to others' contributions, to provide students with the confidence to contribute and a safe opportunity to be wrong. This may allow community and anonymity to work in tandem. However, all participants said that one-to-one discussions with the instructor proved the most valuable.

P1 and P3 said that resources were infrequently shared between students, mainly through group chats of friends on social media. All participants noted that sharing resources was rarely encouraged or facilitated by the University. They were unlikely to share resources but found it very useful when others did.

All participants used emojis frequently but seemed confused by the question due to their unprofessional nature compared to academia. They mentioned that they are useful for adding a new dimension to speech, simplifying a reaction, or concluding a conversation. P3 remembered a course from high school in which the teacher asked students to include an emoji in each email, which the participant said felt more personal and less robotic than other interactions.

By mentioning a feature positively, participants recount a past experience and emotional association that previously provided feelings such as joy, relief or satisfaction.

3.2.5 Motivations

Participants found feelings of panic and being overwhelmed to primarily influence their decision to work. Feelings of autonomy, competence, mastery and interaction were identified as critical emotions that created mental associations with the participant of an experience.

P1 and P2 said that their motivation to study was usually close to deadlines. P1 specifically feels motivated to begin working when friends discuss content in group chats and appear more competent than P1. P1 and P3 said that planning assignments provided feelings of satisfaction and progress. P1 noted that breaking large parts of information into bullet-pointed notes provided significant feelings of relief.

P1 fondly remembered Kahoot as a fun, interactive tool used to supplement education in school but could not remember specifics. P3 loved the interface and interactiveness of Duolingo, describing its game-like features. Furthermore, P3 has dyslexia and said that Duolingo's simplicity provided advantages over alternatives. P3 also shared that their mother's Duolingo streak was over 600 days.

Chapter 4

Prototype Development

This section outlines the application built for this project, influenced by previous literature and tested with three current university students in a usability test. Screenshots are displayed in this section, but further screenshots can be found in Appendix A.

4.1 Features

This section will outline the proposed features of the application, referencing previous conclusions to reveal design decisions. In some cases, comparisons will be made about features in popular applications that aided specific visual design decisions.

Some participants mentioned similarities between features they noticed in the Usability Tests and existing products. As mentioned previously, this is a good indication of a positive mental association. This feature has a higher chance of achieving its goals, provided the other application achieved similar goals.

4.1.1 Network of connections between resources

The critical feature identified is to create a network of connected bite-size snippets of content. This is a resource or an excerpt of a resource (a "snippet") that is connected to another resource/excerpt. The platform supports combinations of the following resources (a "link"):

Videos, a specific time marker in a video, a clip range in a video, a PDF document, a page from a PDF document, a highlight of a piece of text or image from a PDF document, an external website or a YouTube video.

Links are shown alongside content. For a video, this is shown relative to subtitles, shown in Figure 4.1. The animation scrolls the current subtitle to the top as the video plays. Two buttons at the top of the right panel to toggle links and show only subtitles. For a PDF document, links are shown relative to pages and text/image highlights, shown in Figure 4.2.

Features and UI is designed around course content. Specifically, videos can be split into

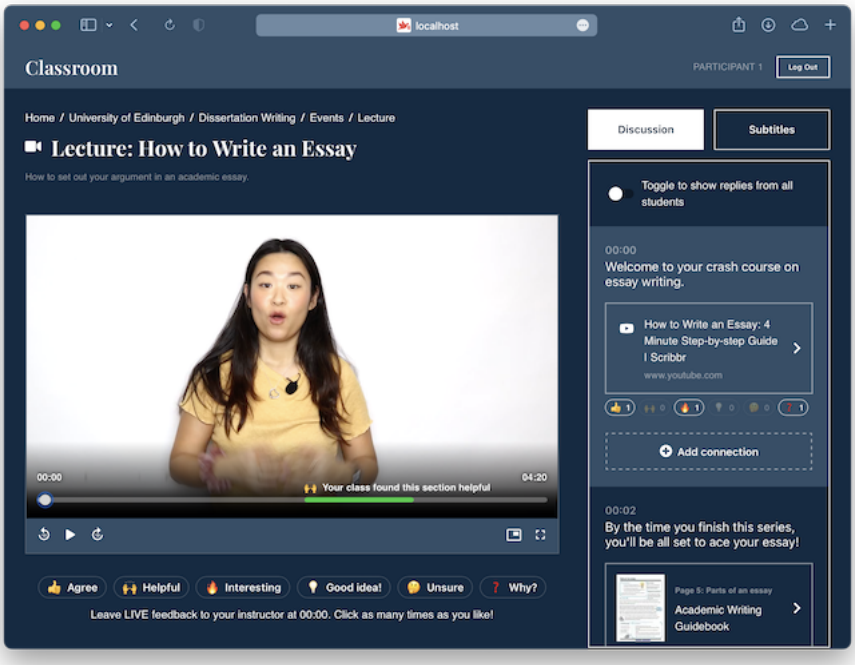

Figure 4.1: Lecture video screen

markers and clips; documents can be divided into pages, sentences, paragraphs, images, diagrams and code excerpts. These offer familiarity to elements in the classroom, addressing usability. This is designed to provide high perceived utility, addressing the utility element of Fogg's Behavioural Model [12].

Students and staff can add links to any other snippet via a popup interface. The left-hand side panel before the popup shows links left by the community. Adding connections can act as a "scavenger hunt". Instructor feedback on links and their links acts as guided participation.

This feature has similarities to Hypothesis, an online discussion board where students comment on elements of web pages. P2 mentioned that this feature reminded them of SoundCloud comments linked to specific moments in a song. This shows a positive indication that this feature could succeed in organising content using more advanced methods.

This paper saw that students learn effectively through group work and active discussions. This feature provides opportunities for students to share ideas quickly and interactively that do not exaggerate social pressures.

Users can choose whether to add connections until they feel comfortable, providing autonomy. This may see low usage amongst unmotivated or unengaged students, but previous literature suggests that providing autonomy and interactivity increases motivation.

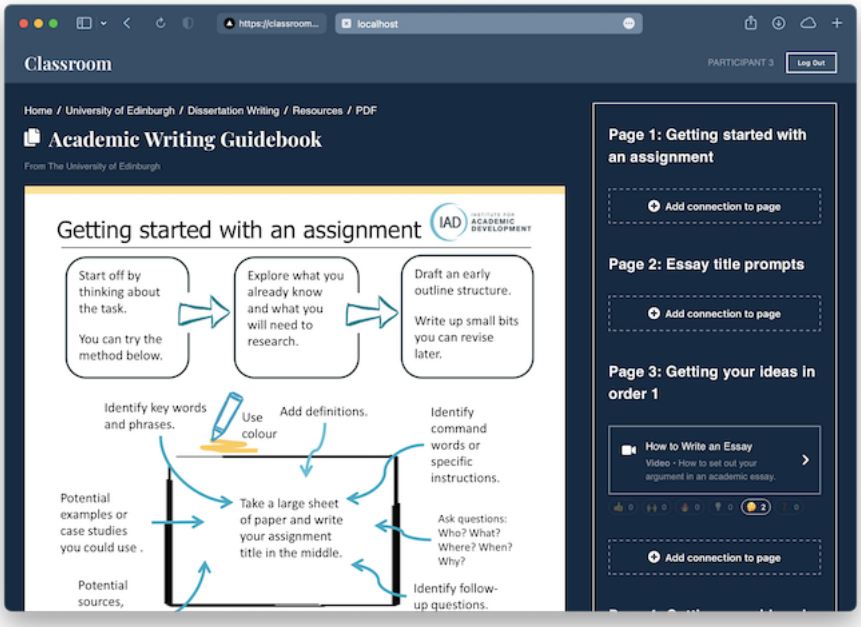

Figure 4.2: PDF document screen

4.1.2 Emoji Feedback

As discussed previously, emojis are a powerful method to enhance speech and ease social anxiety. This section will see how emojis are used in two scenarios to facilitate communication with a lecturer about course content and a student about a contribution.

Facebook and LinkedIn's reactions omitted negative reactions, and LinkedIn chose a more constructive "curious" reply. However, critical negative feedback should be shared, and simple responses may be sufficient. The following emojis were selected to be used in leaving positive feedback (reactions), influenced by Facebook and LinkedIn's reactions: thumbs up to "Agree", hands raised to reply "Helpful", a flame to reply "Interesting!" and a lightbulb to reply "Good idea!".

These provide more dimensions to positive feedback than a simple "Like" and can help users identify quicker what they are looking for in a list of resources with feedback.

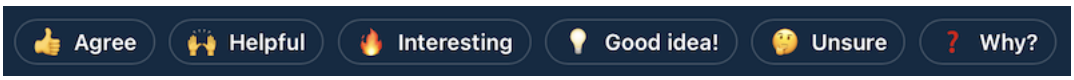

Figure 4.3: Emoji reactions

The following emojis were selected to be used in leaving constructive critical feedback: a thinking face to reply "Unsure" and a question mark to answer "Why?". These provide options to criticise work without being personal or abusive. "Unsure" can be used to signal that a user disagrees with a piece of work without using words like "Disagree" or "Hate". "Why?" is a simple signal to indicate that an answer may be good but needs further development to receive positive feedback.

There is potential for misunderstandings of the meaning behind each emoji. Most emojis are similar in meaning to their visual appearance but may be vague, even though understanding the importance of each is fundamental. A thumbs-up could be misunderstood as a general "good" response, and a flame by no means signals "Interesting" in appearance.

This is by no means a complete solution, as emojis are limited in their use. To provide more profound critical feedback, textual comments should also be used. As many other platforms support public discussion through text and due to time constraints, this paper decided to specifically explore the potential of emoji as a form of communication due to its linguistic advantages, immense popularity in social media, and pedagogic potential.

4.1.2.1 Feedback to students

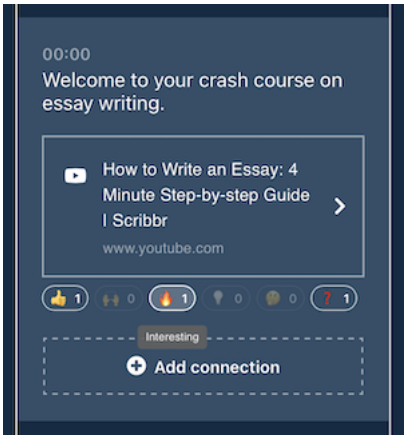

Figure 4.4: Instructors and students can leave reactions to contributions as a simple emoji.

Reaction buttons are shown below each link. Users can quickly click an emoji to leave a reaction and click as many times as possible. Counts of each reaction are shown alongside, as shown in Figure 4.4.

This feature is designed to provide critical discussion in a community through a gamified method.

Slack, an enterprise messenger service, more specifically inspires this feature. Slack shows reactions in almost an identical appearance to Figure 4.4, with any emoji available to choose from.

Centring actions and values around community discussion increase the likelihood of reciprocation to provide feedback to others, as discussed in the Hook model and mentioned by P2 in the Interviews.

4.1.2.2 Feedback to instructor

Below a lecture video appears the same reaction buttons. Clicking one will display an emoji that "floats" across the screen. When enough students mark a section with the same reaction, a clip is generated to be displayed to all other students. In the video, a

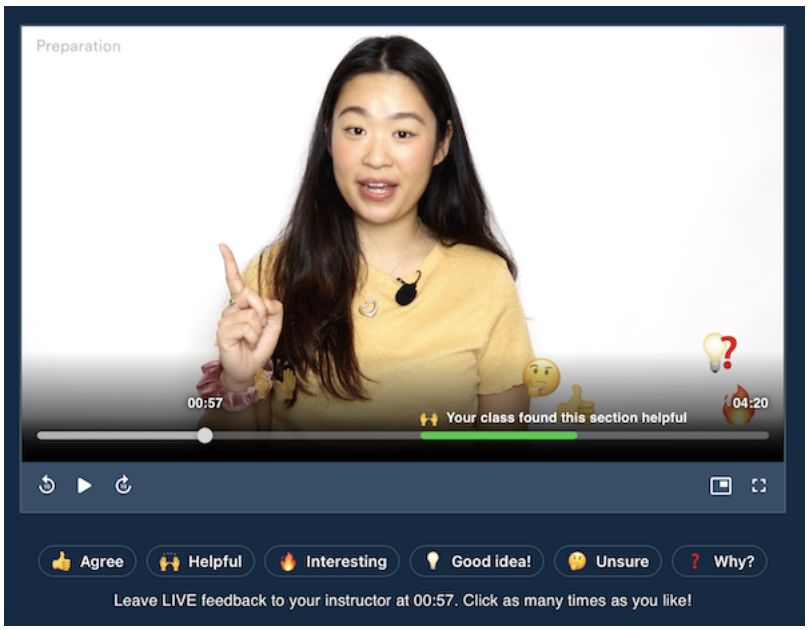

Figure 4.5: Emoji reactions floating across the video to symolise live reactions from viewers. Sections that are popular are highlighted, such as the helpful section here

bar appears that says, “Your class found this section helpful”. When this section of the video plays, reactions left by other students will similarly float across the screen. Both features are shown in Figure 4.5.

This feature adds gamification and also enables communication with the entire community. Reactions are feedback at a specific point in time in this context. Unlike a physical environment, instructors cannot see reactions (such as facial expressions) in response to content.

This feature was inspired by Facebook Live, a product that allows users to publish live videos and receive comments and reactions in real-time. The emojis floating design is directly inspired by a similar feature in Facebook Live. P1 mentioned similarities to a feature that shows sections of a YouTube video.

4.1.3 Completion Screen

The completion screen is shown once a video has reached the end of a lecture video. A friendly message says “Well Done!” and offers the student options to continue. Features on this screen include the progress bar, a nudge to create a link and a collection of past links. This screen is intended to leverage emotions of either panic or mastery dependent on the student’s progress in the course.

The nudge to leave a comment includes messages to encourage creating links, a button to return to the video and a button to navigate to the following lecture. These messages were designed to leverage emotions mentioned previously, mainly focusing on autonomy. This paper saw once that the phrase “But you are free to accept or refuse” increases the likelihood of acceptance. A similar technique was attempted with “This is optional, but will help your class collaborate in discussion”. This feature is designed to place

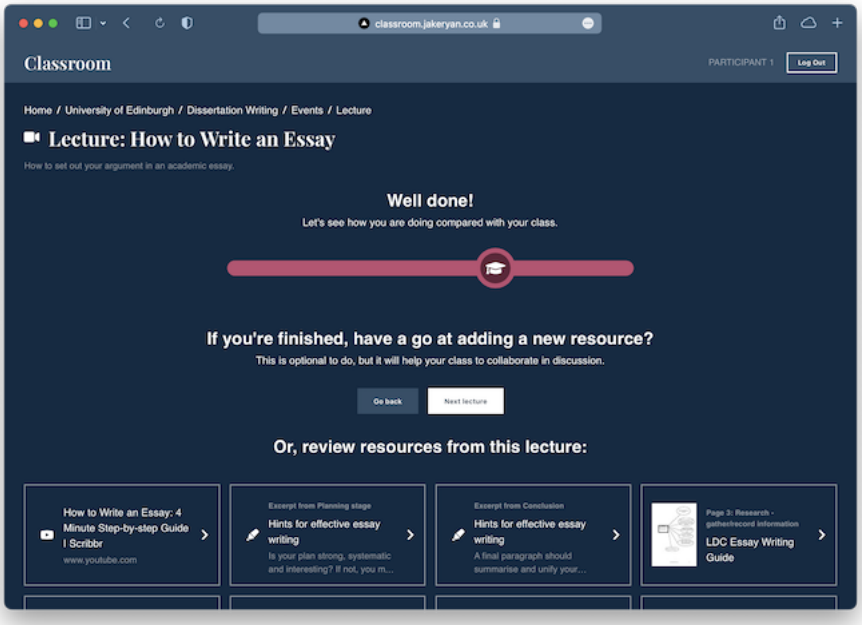

Figure 4.6: Completion screen after a lecture

prominence on recommended actions and load the next trigger for users in the Hook model.

Below this feature is a grid containing links to all of the resources connected in the video, offering an opportunity for the student to review their work and hinting that whilst the video is over, the work required to deepen understanding of this topic is not. This further loads another trigger for users in the Hook model.

4.1.4 Progress Bar

The progress bar is a community indicator of how far along in the course a student is in a course compared with their peers. It is based on an arbitrary metric that is undefined; its meaning was more important. A student at the top of their class feels mastery that they are in control of their learning. Alternatively, a student at the bottom would feel panic and urgency to work more, potentially utilising the actions below.

There were mixed opinions of the progress bar by participants, discussed in the Usability Tests. Two participants originally misunderstood the meaning, thinking it was an indicator of how far along they were in the course individually and indicated this might be a more useful metric.

The design was influenced by the Burn Bar in Apple Fitness+ which was also designed to promote community, especially during the pandemic. The Burn Bar looks very similar but represents the amount of effort (based on calories) a user is putting into a workout compared with all others who did this workout.

4.1.5 Course Screen

This screen acts as the landing page for a course and provides an overview of all learning material. Along the top is course information and tab buttons to view a list of events or resources.

Originally, this screen was an objective for a larger scoped project and was therefore not a focus during usability tests. However, one participant showed surprising interest in this screen and it will be discussed further in Usability Tests.

Two other screens were developed but not mentioned in this section for brevity: a list of institutions (the home page), and a list of institutions per school. Both screens provide no other functionality than this but were used in the Usability Tests.

4.2 User Interface

Significant effort was put into optimising the user experience of the application, including minimal details such as custom styling and animations. Custom appearances of elements that are clickable on hover and click state provide the user indication and feedback. Animations provide interactivity and gamification elements.

Individual features designed to provide utility, interactivity and feedback will not be discussed in this section, as there are too many to list. However, features discovered and commented on by participants (discoverable features) will be explored, in Usability Tests.

4.3 Technical Implementation

The application was built as an interactive website. The web application (“frontend”) was built using React and NextJS, written using Typescript, JSX and CSS and deployed using Vercel. React’s concept of reusable components provided suitability to this project, proving particularly helpful to easily support the complex layout of links alongside subtitles, highlights and reactions.

The server-side software (“backend”) was built using Django, written using Python and deployed using Heroku. Django natively supports PostgreSQL, making it easy to create, edit and deploy new database models automatically. Django also creates a visual administrator tool to organise user accounts and manage database entries. This proved helpful to generate resources and links to be used in the Usability Tests without the need for user interfaces and API endpoints to create these.

A notable design decision of the backend was its database structure. Research revealed that students often experience poor organisation in a course and P1 mentioned that a favoured feature of platforms was advanced filtering. Database models were designed around organisations, providing courses as a combination of events (such as lectures, assignments or labs) and resources divisible by content. This is a basic, high-level representation of learning content, but reveals an opportunity to design databases around

pedagogic features to provide advanced organisation and filtering of content discussed in Future Work.

The backend utilises services from AWS: S3 to provide remote file storage; Transcribe, an automatic speech transcription (ASR) service to automatically generate subtitles for videos; and EventBridge, a service to facilitate the communication between Transcribe and the backend. mp4 video files and vtt subtitles files are saved to an S3 bucket and vtt files are parsed by the backend and saved to the database.

Transcribe performed well, with only one or two minor errors noticed on manual inspection of audio that was difficult to hear or incorrect punctuation. An example of this is that "You'll be all set to ace your essay!" was incorrectly transcribed as "You'll be all set to A. C. say". Another minor issue noticed is that text is split unnaturally sometimes. For example, "In the preparation stage," and "you first need to understand the assignment and choose the topic" were returned separately by Transcribe. These two sentences seem more appropriate merged, as it is unlikely a connection would be added to one and not the other. However, these issues were not noticed by any of the participants and would not be a challenge to fix, given further development.

The software was built with reusability, testability and scalability in consideration. React, Django and AWS are popular services used by companies for their reliability and ability to scale to millions of users. Whilst best practices were not objectives for this project, they were considered important to ensure a smooth testing experience for participants. All services were within student and free trial limits, therefore no costs were incurred.

All software is fully functional, with some minor usability bugs in many areas. Whilst built with best practices in mind, no tests were written or performed on the product's reliability. Furthermore, two major features proved to be more work than time constraints allowed and were partially mocked. Emoji reactions were not saved to the database and random initial reactions from other students were generated to simulate a discussion already in motion. Also, the progress bar indicator was placed at a fixed position, intended to represent moderately high progress against peers.

Whilst the majority of time on this project was spent on the development of the application, the details of implementation are not relevant to the goals of the paper. Therefore, implementation will not be explored further.

The application is available to use at

https://classroom.jakeryan.co.uk

GitHub repositories for the backend and frontend respectively are here:

https://github.com/jacobsieradzki/inf-project-server
https://github.com/jacobsieradzki/infproj-web-app

Chapter 5

Usability Testing

This section will show insights from usability tests performed with the same participants as in Section 3. The objective was to identify whether features achieved their intended goals, and why, and to determine areas for future research.

After each usability test, students were asked to agree with statements on a Likert scale to evaluate the platform's overall success in its aims, discussed in Evaluation.

5.1 Method

Usability testing is a popular method in UX methodology to identify problems in the design of a product, uncover opportunities to improve upon and learn about the intended user's behaviour and preferences [22].

A usability test involves a facilitator and a participant. The facilitator asks the participant to perform a set of tasks for a user which matches the intended demographic. User behaviour and interactions are analysed to determine conclusions about the interface. The facilitator asks the participant to "think out loud" as they navigate, to better understand behaviour.

The facilitator's role is to guide the participant but not to influence the participant's behaviour, which is a difficult balance. In these tests, users are already familiar with multiple online education platforms. Therefore, users were asked to use this platform as they would any other online education platform. Apart from this, a few specific nudges were provided by the facilitator and are discussed individually in Section 5.2.

Some improvements were made between tests based on previous participants' feedback. However, tests were performed consistently in methodology and improvements that were made were largely minor visual and usability changes to highlight or nudge users towards certain features. Due to scheduling conflicts, tests were performed with P2 first, P1 second and P3 third.

5.1.1 Setup

To test with participants, a demo learning environment was created, shown by images in Section 4. Participants were given the context that they would be exploring a dissertation writing course on an online education platform. Users started on the home screen (the list of schools) are were asked to navigate from there.

This course intended to demonstrate links between snippets for a topic that all participants could understand. Free online resources on essay writing were added and a handful of premade connections were created.

5.1.2 Iterations

Between each test, small improvements were made to improve the application for the following tests. These were mainly minor visual changes, but key changes are discussed here.

The first two participants had difficulty noticing the reaction features to a video, mainly the ”helpful” clip and the floating emojis. P1 saw but overlooked the message originally. They said that the colour orange was mentally associated with advertisements, as the psychology of this colour arises feelings of enthusiasm and excitement. Green evokes feelings of peace, motivation and optimism so was a more appropriate colour choice. This change was made before the third test and this feature was the first thing that P3 noticed on the screen.

Visibility of these features was increased and proved no issues with the third participant.

P2 said they would be more likely to use reactions if others had first. Therefore, changes were made before the second test to show randomly generated emoji reactions on first use, simulating an in-progress class discussion.

The specific meanings of emoji in this context were also not realised with P2. The student understood the general meaning from appearance and later realised that they did know what it meant from the reaction labels below the video. A feature was added to show a label when a user hovers their mouse over an emoji. The remaining participants understood what these reactions meant, but reveals that future work is needed to deepen this mental association to an unconscious level.

5.1.3 Script

Test conditions are a major criticism of usability testing. The phrase “user testing” (often used interchangeably with usability testing) implies that the user is being tested, instead of the product. This adds pressure on a student during the test and may cause them to behave unnaturally and feel overwhelmed when they are unable to figure out a task. Ensuring that students do not feel that they can provide wrong answers is fundamental, as even minor suggestions from participants revealed opportunities for future development.

A user testing script is a popular method to introduce context and ease the participant. This allows a researcher to set objectives and receive consistent results. A script was

read to participants before the start of the test, adapted from Playbook UX's template [29]. The script can be found in Appendix B.

5.2 Results and Discussion

All participants performed the tests with minimal usability issues and reported an overall excitement, pleasure and interest in using the application. P1 believed that it would make them do more, as it is easier and significantly more efficient than current solutions. P2 believed that there is "nothing like this currently" and stated that they would like more time to explore and play with features.

However, participants were aware that this was a prototype and mentioned several areas which need significant work to prove effective. Overall, participants enjoyed the experience and were enthusiastic to share thoughts and discuss improvements.

All tests performed relatively smoothly without software errors, except for P2 who encountered multiple errors which required facilitator intervention.

5.2.1 Snippets feature

The snippets feature received very positive feedback. Participants were impressed and excited by its potential and test feedback mainly focused on this. P1 and P3 very quickly started to explore snippet features and created connections and reactions, even before the completion screen. Participants appreciated the autonomy that this feature provided as it felt like more of a collaborative discussion than required tasks.

P3 realised that the feature has the potential to connect citations between documents and appeared visibly delighted by this, a current pain point in their course. P2 appreciated that this system would also be able to support resources outside of the platform, such as websites.

All participants quickly commented on the layout of this screen, saying it was intuitive and simple to understand. All highly valued the automatic transcription scrolling as it made following the video easier. P3 mentioned this was particularly useful due to their dyslexia. All discovered they could click on subtitles to jump to a point in the video, a useful shortcut that they would commonly use. P3 interestingly said that they would sometimes not like to see links as they would like to come to their own conclusions before viewing peer comments. This proposed feature is discussed further in Section 7.3, as part of a larger plan to support purposeful course design.

P2 suggested that returning to resources may be difficult as they would have to remember the list of connections they navigated previously to find it. However, they said that with an improved course screen this would not be an issue.

5.2.2 Emojis feedback feature

P2 highly rated the interactivity and gamification elements, saying that they felt it was "educational without feeling so bland". Participants thought that emoji reactions were

a fun idea, but needed significant work to be actually effective. Text comments were particularly noticed as missing here.

Participants noticed the anonymity that emojis provided and P1 and P2 valued this. P3 reiterated that they did not want anonymous comments because it doesn't feel personal and discussion is less effective.

P2 did not fully understand the meaning behind each emoji. After the improvement mentioned in Section 5.1.2, the following participants understood them when asked. P3 said they did not think the "Unsure" and "Why?" reactions were useful at all, as they said they provided no actionable feedback to improve on a contribution, which was an oversight in research. However, P3 said that without these reactions and with the addition of comments, this platform would be "amazing" for live lectures.

Participants seemed confused by the use of emojis in academia during the interviews but showed positive feedback during the usability tests. This suggests that it is possible to overcome the unprofessional stigma of emoji, providing benefits to a wider audience than younger users who are usually its primary users.

P1 liked the short-form communication and compared the feature to the "Raise a hand" feature in Microsoft Teams. P1 also requested a feature to view all previous links that they had reacted to, so they could revisit them at a later date.

All participants did not understand the "helpful" clip of the video was generated using the live reactions below the video but rated each feature individually.

5.2.3 Completion screen feature

This screen received moderate feedback, albeit some confusion as cognitive load is high here. P1 instantly said there was far too much text on the page. Previously, messages were more verbose than the one discussed in this paper and were improved before the third test. Participants said this screen showed potential but was not close to an ideal solution.

The favourite feature of this screen of all participants was the grid of resources at the bottom, even though they are only partially visible. P3 originally scrolled straight to this feature and ignored everything above. They appreciated the utility of being able to see all resources at a glance that they may have missed.

P1 and P2 both said they would go back to add a connection on this screen but could not provide reasons when asked why. P3 said this screen specifically would not make them go back but said they would be enthusiastic enough to do it of their own accord.

5.2.4 Progress bar feature

The progress bar feature had mixed opinions from participants.

P2 really liked this feature, saying it would motivate them to work harder if they knew their position relative to the class. They even asked for points to be shown to other students to show distribution rather than just a single value.

P1 and P3 initially misunderstood the bar to mean the progress of an individual through a course's content, rather than relative to their peers. Both participants did not like the actual meaning of the feature, but really liked their original understanding, for similar reasons to P2. P1 also said that it was useful to see the bar increment, to see how much each piece of work relative to the entire course.

P3 explained that they did not think a competition against peers was suitable for their course at all. Their course centres around discussion and pieces of coursework, so comparative progress are not relevant. P1 and P3 similarly said it would be a good indicator to view how much.

P1 said they did not like the progress bar because they thought it would demotivate them to study even more if it was confirmed that they are at the bottom of the class. However, Eyal said that users are often unaware of their own emotions [11]. It could be a possibility that this participant's perception of the negative emotion he would feel is the reason that it could work. Previous literature showed that fear is a powerful motivator. Whilst asking the participant is inconclusive, it does reveal useful insights into their perception and can provide background for further research.

5.2.5 Course screen feature

As mentioned previously, the course screen was not developed but a surprising point of interest for P2. This screen was supposed to act as an intermediary screen and was part of unfinished development.

However, P2 spent more time than others exploring this screen as they said it would prove more efficient than their current solution for finding resources. The design of this screen alone proved helpful to this participant to represent tasks such as lectures, assignments and classroom concepts rather than arbitrary video and PDF files.

No further development was performed on this screen as a result, but this observation opened a discussion for advanced course design in Section 7.3.

5.2.6 Usability

All participants experienced the same minor usability issue in that keyboard shortcuts were not supported on the login popup but all were undeterred and recovered immediately. Whilst this issue is minor and not relevant to education, it demonstrates that minor visual changes that provide higher utility can speed a user's flow of interactions.

Two participants noticed a discoverable feature that supported Picture-in-Picture, a widely supported browser feature that displays a separate video window above all other operating system interfaces. P1 noticed that this enabled them to continue watching the video whilst they navigated to other resources and P3 mentioned this would be particularly useful when using their iPad.

Furthermore, P1 noticed and appreciated the attention to detail given to opening links. All links open in a new tab by default, allowing the user to track where they have come from and easily allowing them to return to where they were in each resource. External

links also open in a new tab, without friction about leaving the site which is common on many platforms. The reasons behind the friction are due to keeping users safe on the internet, however, highlights a common usability issue that users notice.

Chapter 6

Evaluation

6.1 Likert Questionnaire

After each usability test was complete, participants were asked to rate how much they agree with eleven statements on a Likert scale, being “Strongly Agree”, “Agree”, “Neutral”, “Disagree”, and “Strongly Disagree”.

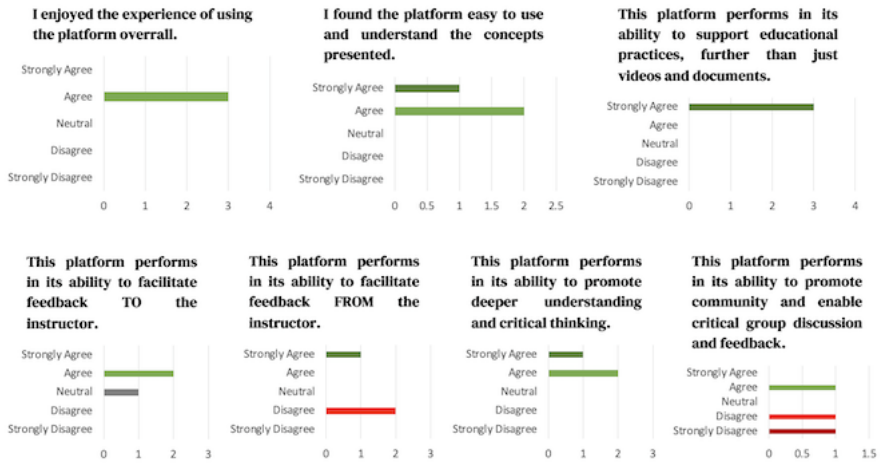

Figure 6.1: Participant’s answers to the success of specific objectives

Firstly, participants were asked to rate the following statements to determine the success of specific objectives in this paper, shown in Figure 6.1

Results show moderately positive results in five out of seven areas discovered. Building community and facilitating feedback from the instructor is an area needing significantly more improvement.

The snippet feature proved very popular amongst participants, saying this is the key feature they would find value in and the reason they rated Statement 6 highly. This strongly reflects views shared in literature and the interviews around issues with poor content organisation and the relief provided by dividing content into manageable pieces.

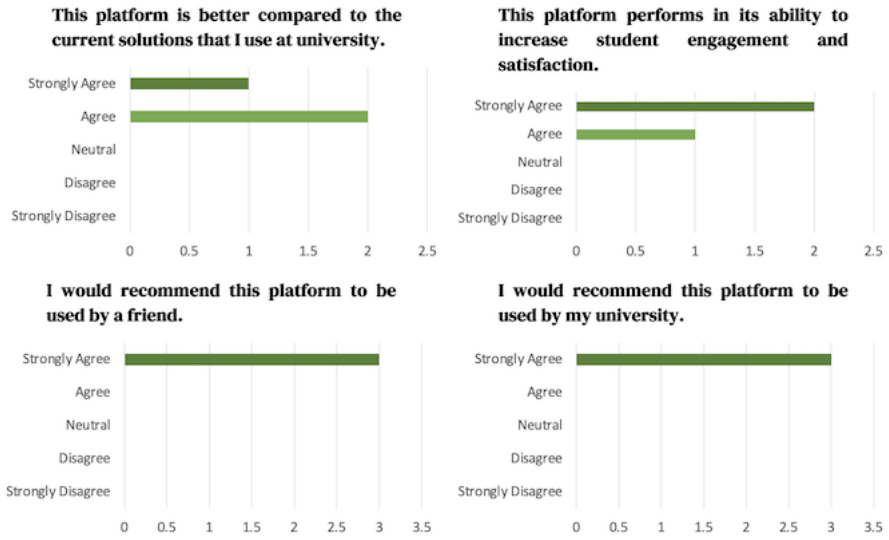

Figure 6.2: Participant's answers to the success of overrall objectives

Participants said that discussion features had signs of potential value, but could be significantly improved with the addition of text comments from students and teachers in combination with emoji reactions. Specifically, critical feedback was not valued as an emoji reaction and P3 suggested this may have no use, as this response contains no actionable information.

Furthermore, the feature to "promote" links to default visibility was largely unnoticed by participants as a key feature to facilitate communication with the instructor. This is understandable as it was only partially developed but revealed a crucial fault. The feature provides positive feedback to exemplar links added by students but provides no actionable feedback for students with poorer contributions. Participants said they would find it useful to place prominence on instructor comments reactions in this section.

Next, students were asked to similarly rate four statements to determine the project's success in its overall objective of improving student satisfaction and engagement online:

- This platform is better compared to the current solutions that I use at university.
- This platform performs in its ability to increase student engagement and satisfaction.
- I would recommend this platform to be used by my university.
- I would recommend this platform to be used by a friend.

Figure 6.2 shows very positive results, with all participants strongly agreeing that they would recommend this platform to a friend and to their university. If test conditions were more ideal, this would prove successful in determining the feasibility of using relationship triggers as a no-cost method of engaging users through the product's high perceived utility.

6.2 Hooked Questions

Eyal describes that the Hook model is a guide for understanding customers better, rather than a how-to guide on creating habits [11]. To build a successful product that holds a place in users' minds, the product must solve a problem.

What do users really want? What pain is your product relieving?

Students want to feel autonomy, competence and mastery when learning the content of a course. This product represents and organises content similar to the classroom providing increased utility and autonomy when dealing with learning material. Features designed to aim to increase the frequency and decrease the length of individual pieces of feedback provide a constant stream of communication in a community, providing warmth.

What brings users to your service? (External trigger)

The high perceived utility of the platform triggers users to act as brand evangelists, recommending the product to their friends and their university. Feelings of panic and uncertainty can bring users back to the platform when they feel they are not in control of their learning.

What is the simplest action users take in anticipation of reward, and how can you simplify your product to make this action easier? (Action)

Communication, in some cases, can be reduced to an emoji reaction through a single click. Emojis provide creativity and efficiency and add an element of gamification to an experience that P2 described as usually "bland".

Are users fulfilled by the reward yet left wanting more? (Variable reward)

Users feel satisfaction and mastery of learning material when they receive positive feedback and further certainty and relief when they are guided with valuable feedback. Centring actions around community and discussion increases the anticipation of this reward as users hope for reciprocated feedback. Furthermore, instructor feedback is more valuable than community feedback and increases the degree of anticipation.

What "bit of work" do users invest in your product? Does it load the next trigger and store value to improve the product with the user? (Investment)

Users add connections between learning material and leave feedback on responses from other users. Creating a connection loads a trigger for other students to react, and therefore creates value for the creator in the form of feedback. As more users interact on the platform, the more valuable it becomes for all users.

Chapter 7

Discussion

7.1 Ethics

This paper discussed habit-forming technologies, a form of manipulation. Ian Bogost, a famed game creator and professor, described these products that shape us as ”the cigarette of this century” [2]. These can be used in positive ways such as Weight Watchers, ”one of the most successful mass-manipulation products in history” [11]. Eyal describes the types of creators who use habit-forming techniques. Facilitators are makers who build products that materially improve users’ lives and who use their own products. Opposite answers to these variables would describe a user as either a peddler, an entertainer or a dealer, a maker who builds products to exploit people.

As this project aims to improve education and would be used by the author, it is safe to label this author as a ”facilitator”. However, this project specifically looked to leverage weaknesses in students’ mental health - such as panic, anxiety and fear. Whilst features like the progress bar were designed to increase engagement, they could have side effects of increasing anxiety and worry. Section 2.1 showed the effects of the pandemic on students’ mental health and product designers should be aware that this could be exacerbated if designed incorrectly.

Facebook’s ”mood-manipulation” experiment in January 2012 is an example of this. The secret test that was completely legal but was highly criticised and described as ”horrifying”. For a period of one week, Facebook delivered posts to users’ news feeds that contained mostly happy words to some users and mostly sad words to other users. After the week, the company found these users were more likely to post especially positive or negative statuses themselves. However, the research objective was to discover how people respond to different types of content. One of the study’s authors said ”our goal was never to upset anyone . . . In hindsight, the research benefits of the paper may not have justified all of this anxiety”.

7.2 Test Considerations

Participants all attend the same university, are of similar ages, spoke the same language and shared other similarities. Participants were chosen based on differences between their course's teaching styles. In this project's aim to increase student satisfaction and engagement, it was a success for these participants. This project's focus on emoji proved successful likely because all participants are frequent users of social media and emoji. However, these participants are not at all representative of the intended demographic and further research should be done on a sample of students with a representative range of demographics, online experience and ideologies of students in higher education.

Furthermore, test conditions were unnatural. A usability test is not a naturally calming environment, especially when it is being recorded. P2 experienced multiple software issues that required facilitator intervention. Interventions were mainly refreshing a page and returning the user to where they were. However, this resulted in a disruption to the participant's flow of thinking and added confusion.

The demo course about dissertation writing proved to be confusing to participants. Whilst participants understood the content, they did not feel any connection towards it. Originally, a demo course would have been set up for each student separately using materials from their actual course. Participants said this would have helped a lot as they would be more likely to create connections and leave reactions. However, due to time constraints, this was not achieved.

Participants would have been asked to use their own devices, especially to see P3's experience on an iPad. However, due to persistent software bugs, participants were asked to use the Google Chrome browser on the facilitator's Macbook Pro to ensure a smoother experience. Fortunately, all participants were familiar with the hardware, operating system and browser experience.

7.3 Future Work

This paper sees that the features that excited users the most were often, educationally, the least significant. Multiple discoverable actions were identified by participants and highly appreciated because of the utility they provided over existing options.

Emoji reactions proved popular among participants and can take much more inspiration from social media. Emojis were the easiest creative form of communication to implement for the scope of this project. Anonymity was discussed but no conclusions were drawn from the usability tests. Therefore, this paper recommends that more forms of discussion be researched, with a particular focus on gamifying the experience.

We see that Duolingo performs usability and A/B tests on users to determine the effectiveness of a new change. Even new animations or minute visual appearances are tested for this app demonstrating how effective these methods are in digital product design and user experience research. Recommended UI and UX design principles were considered and used in the application, but not discussed or evaluated. This paper recommends that these areas be researched more in an online learning environment,

as experiments showed it provided the quickest return on investment, due to the high perceived utility of changes.

Furthermore, habit-forming technologies were discussed but not evaluated. However, tests saw that mental associations could be created, based on the visible positive emotions and feedback that participants showed. This paper recommends improved research and testing into habit-forming technologies, given their potential shown in this project.

This paper's objective was to increase student satisfaction and engagement in an online learning environment, based on academic principles and product design research. However, the pedagogical support mentioned in Section 2.2.2.4 was minimally researched. This paper barely scratched the surface of the work required in this area but determined that choosing the correct environment for the correct activity is fundamental. One small example is the research that suggests online is better for open-ended discussion. Imagine a platform that was equally developed for instructors, backed by proven pedagogical research. Therefore, this paper recommends further pedagogical research to create features that support instructors in course design, and are proven to improve education online.

Finally, this paper mentioned purposeful course design. During usability tests, P3 mentioned two interesting suggestions. Firstly, they wanted to be able to watch a lecture video first without discussion, so they could come to their own conclusions. Secondly, P3 said that the progress bar was unsuitable for their course but P1 said that it would be very useful for theirs. P1 and P3 suggested a different type of the same feature would prove useful. These are examples of factors that are not ideal for all courses and should be provided as an option to instructors designing the course. P2 gave a significant interest to the course screen, which was surprising but was a side effect of designing the database around features of the course. Therefore, this project recommends building products by designing technical implementations around the features of the course, instead of trying to fit the complexities of a classroom course into existing online education platforms. This helps to explain why instructors and students had issues with the emergency transition to online learning.

7.4 Self-reflection

As previously mentioned, the author is a final year university student and personally experienced the pandemic during three of the four years of study.

The author's course experienced the cancellation of in-person activities and group projects. His experiences with the emergency transition and online replacements were a major motivator for this paper. The author's personal interests influenced the direction of the paper toward user experience design and habit-forming technologies as well as personal education experience aided design decisions. Furthermore, the author's passion for building digital products and design influenced the decision to build and test a real application with users.

The majority of the work performed for this project focused on developing and deploying

the web application used in testing. The original objectives for the project were much larger, to also support instructors in a similar fashion. Therefore, portions of code were developed to create, edit and manage content from a staff's user account and were unused due to time constraints.

Chapter 8

Conclusion

This project's primary objective set out to prove that there had not been sufficient development in online education and that increasing student engagement and satisfaction is a crucial precursor to learning and performance.

Overall results from the usability test reveal that all students agreed that the prototype presented was better than the current solutions used. Furthermore, all participants strongly agreed that they would recommend the application to their university and a friend. This holds the potential to act as a relationship trigger to encourage other users to use the platform (an external trigger).

Results from specific features in the usability test find that the most appreciated features were the features that had the least educational research behind them. Dr BJ Fogg's Behavioural Model proved to be the most useful in explaining the intentions and emotions behind actions. These features create mental associations to actions that provide positive emotions through increased usability. Through the applications' progress bar, attempts to leverage fear proved unsuccessful and are one of this paper's recommendations for future work.

Habit-forming techniques, user interface, and user experience design are fields based on scientific research. Still, they are based on too many factors to consider and were too difficult to measure for this project's scope. Iteratively improving applications based on usability tests revealed unexpected results but is valuable in understanding student behaviour.

Furthermore, successful education is similarly dependent on too many factors to consider. Results showed that features were popular with some users but unpopular with others due to their suitability to match their course. Educational practices have not been sufficiently researched in the online environment and are another recommendation for future work.

In conclusion, this paper recommends building technology around educational principles, instead of trying to adapt existing classroom courses directly to the online environment. Furthermore, digital product design research techniques can reveal indications about user behaviour that pedagogy alone cannot. This project focused on a

key feature to divide content into bite-sized snippets. Participants showed excitement toward this feature which is a small indication of this potential.

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Appendix A

Screenshots from this paper's application

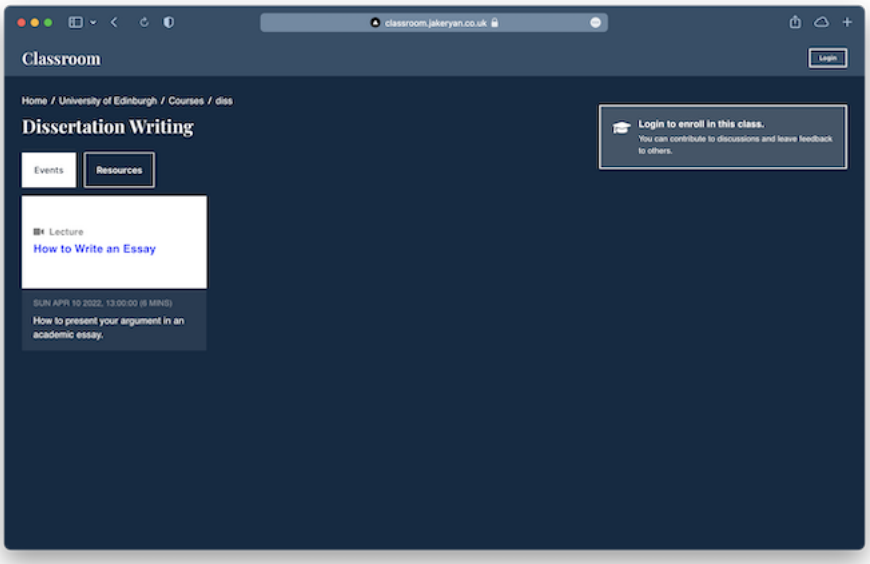

Figure A.1: The course screen, showing a list of events in the course.

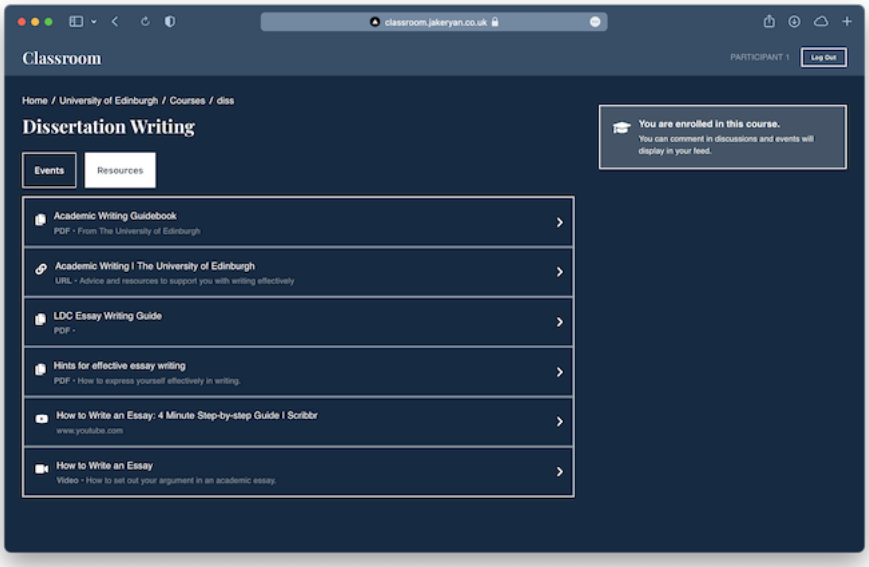

Figure A.2: The course screen, with the resources tab selected. Showing a list of all resources in the course.

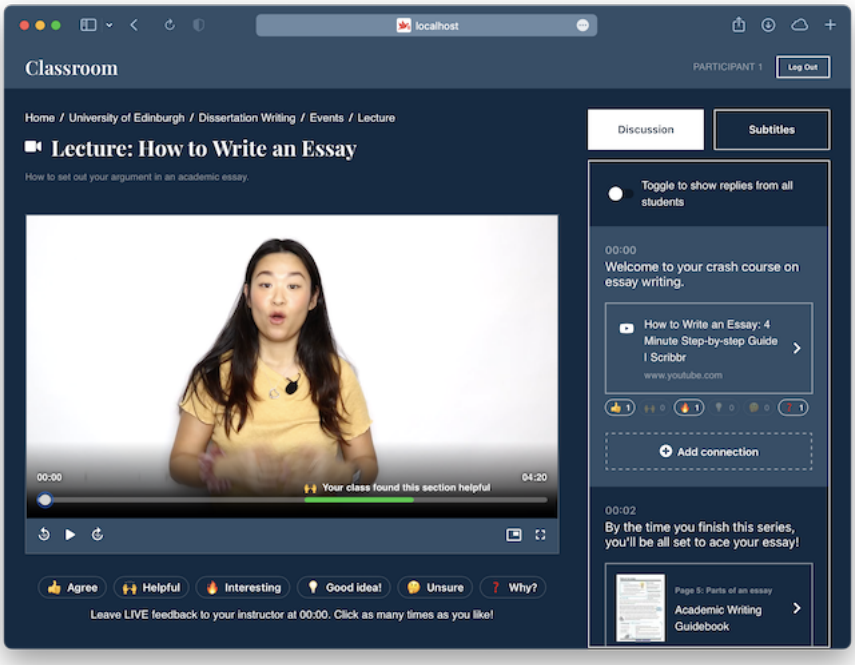

Figure A.3: The lecture screen, for watching videos with subtitles, emoji feedback and links between snippets.

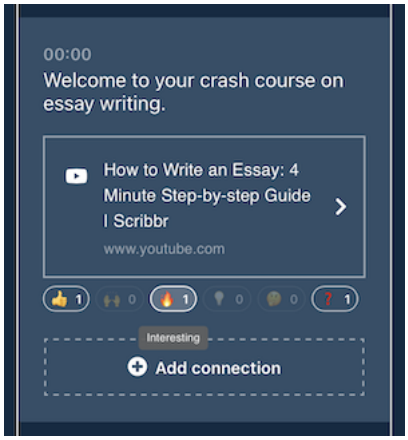

Figure A.4: The lecture screen, zoomed in on interactions with emoji reactions to a link.

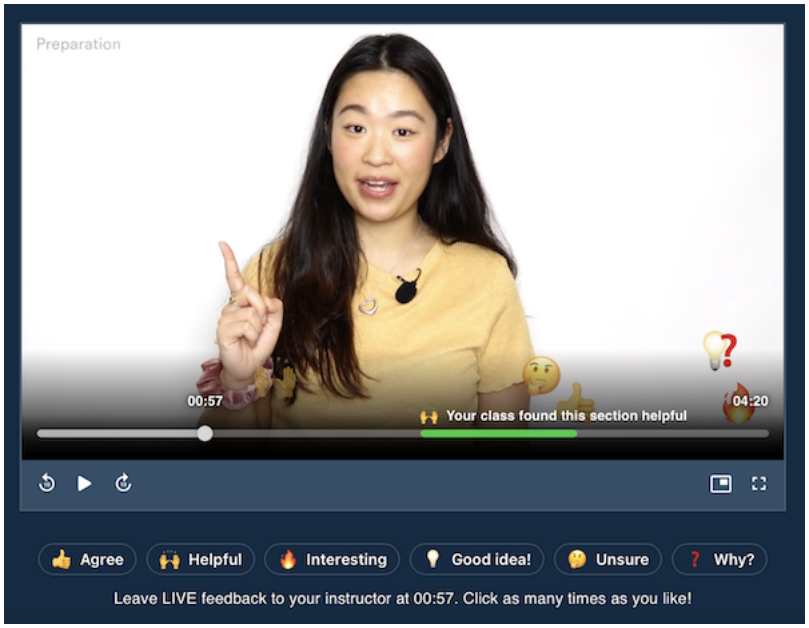

Figure A.5: The lecture screen, zoomed in on interactions with emoji reactions to a lecture video (to the instructor and the entire class). Also shows an automatically generated "helpful" section.

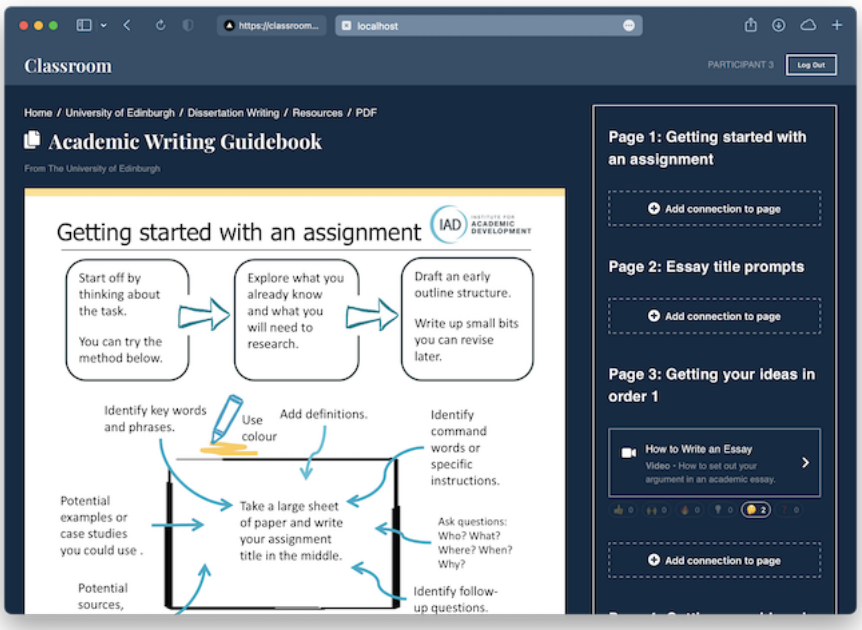

Figure A.6: The document screen, showing PDF pages and highlights with links and emoji reactions.

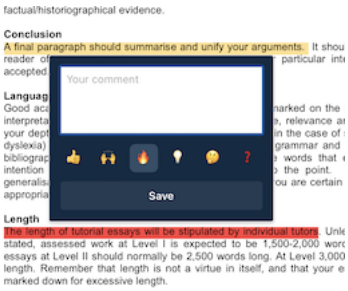

Figure A.7: The document screen, zoomed in on interactions with creating a highlight dialog. Also shows emoji reactions.

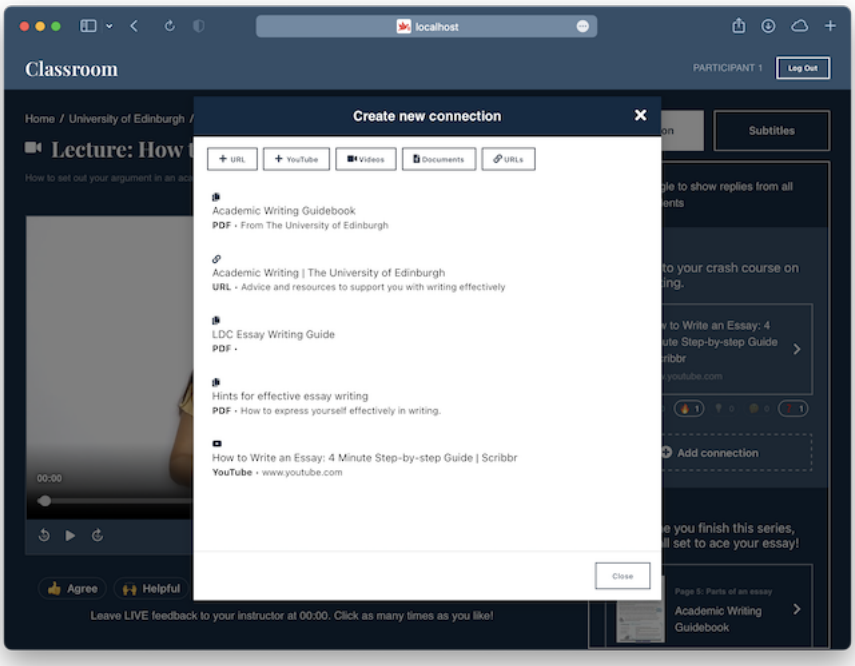

Figure A.8: The dialog which opens when ”Add Connection” is clicked anywhere in the application.

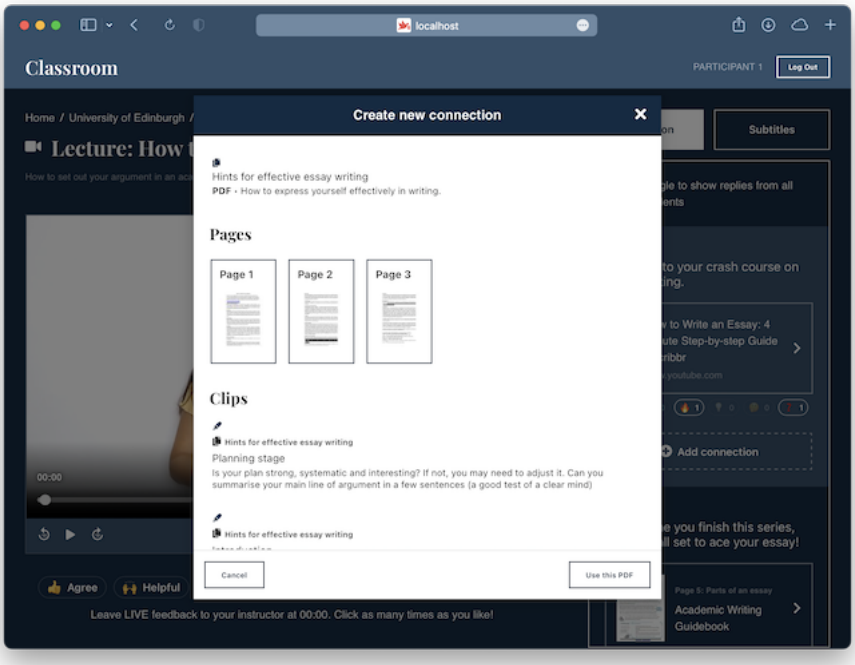

Figure A.9: The ”Add Connection” dialog, once a PDF document was selected. This allows a user to select pages or existing highlights.

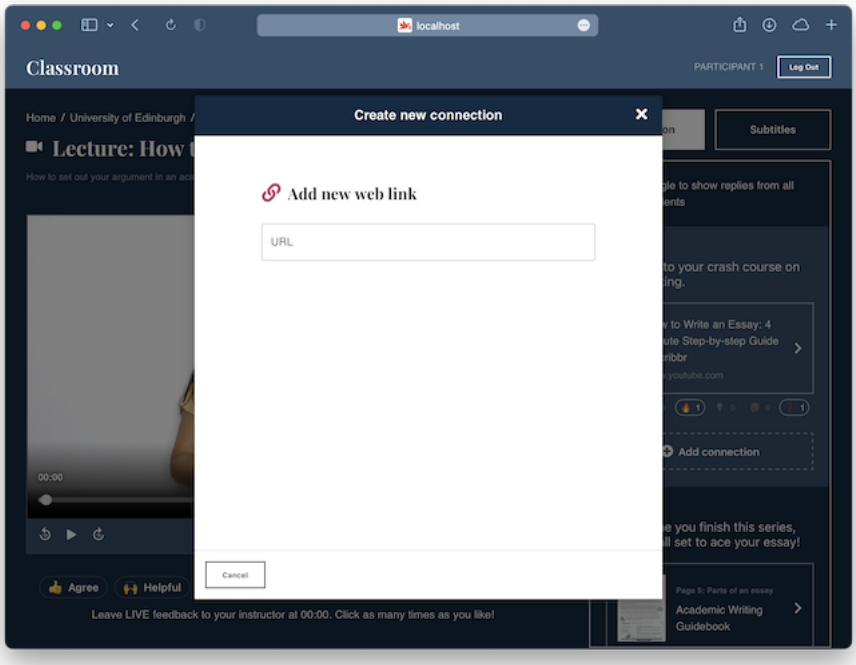

Figure A.10: The "Add Connection" dialog, once the new URL button was clicked. This allows a user to create a link to any URL instantly.

Appendix B

Interview and Usability Test

B.1 Interview Questions

These questions were asked to put the participant at ease and determine the workload of a student:

1. What is your university degree?
2. How many modules do you take per semester on average?
3. How many exams do you have per semester?
4. How many pieces of coursework do you have per semester?

These questions were asked to compare participants' experiences with the COVID-19 pandemic with this paper's research:

1. How have you been impacted personally by the COVID-19 pandemic?
2. How has the COVID-19 pandemic impacted your learning?

These questions were asked to examine participants' motivations and emotions that influence triggers to engage in learning activities:

1. How do you feel about your course at university?
2. What does learning mean to you?
3. How much does your university degree mean to you? Why did you decide to come to university?
4. What is most important to you at university? Education, social life, career development, personal development, general knowledge, life experiences, etc.
5. What career do you plan to go into? What do you plan to do with the knowledge you've learnt at university, and how do you think it will advantage/disadvantage your career?
6. What motivates you to start studying? Why did you decide to study?

7. What are you usually doing right before you start to study?
8. What is the most time-consuming part of studying or preparing for an exam or a piece of work?

These questions were asked to examine previous actions that participants' engaged in which left a mental association in their minds:

1. What does a regular study session look like for you at the moment? What form of resource do you view, and how do you consolidate this knowledge for an exam or an assignment?
2. Can you remember a recent moment, during studying, where you felt a strong positive/negative emotion?
3. Can you remember a recent moment during studying when you felt a strong sense of pride in your work? How was your satisfaction validated/rewarded?
4. Can you think of a time when you felt annoyed by a task you were required to do?

Other questions based on previous research:

1. How much do you value self-pacing for a course at university?
2. Do you prefer to remain anonymous online? Or, in an online learning environment?
3. Which platforms/tools/services do you currently use to watch lectures, read documents, and access learning material at the university? How much loyalty would you say you have to these tools?
4. Have you used any similar or other popular products in the past, such as online courses for your hobbies/interests?
5. How often do you use emojis in texting, social media or other platforms?
6. Do you (or people on your course) often look for external resources to assist with the learning material provided by the University?
7. Do you share external resources (found or made by you) with other students or the staff on your course?

B.2 Usability Test Script

Hello, how are you doing today?

Thank you so much for taking the time today to speak to me. My name is Jake, and I'm developing an interactive streaming platform for educational use. I am investigating features that can be used to improve student engagement and satisfaction during online learning. I'll be chatting with you today, and I will be taking notes during this conversation.

So, please share your honest thoughts as we go along. There are no right or wrong answers! Remember that I am not testing you; I am testing the product. So, it's important to behave as naturally as possible.

Please think aloud as you do this. Please share with me where you're going to click, why you're clicking there, and what you expect to see after you do so. It helps me to understand what is going through your mind and allows me to take good notes.

You will be taking a demo course for dissertation writing provided by The University of Edinburgh. There is one lecture and a variety of resources already added. Your task is to use and explore the application as you normally would use an online education platform whilst studying. The primary feature being assessed allows instructors and students to create links between snippets of content in a public discussion. You have been provided login details and should log in when you feel it is appropriate.

Before we start, I would like to know if you're still okay with this session being recorded?

Do you have any questions before we start?

Perfect! We'll start recording.

B.3 Likert Questionnaire

1. I enjoyed the experience of using the platform overall.
2. I found the platform easy to use and understand the concepts presented.
3. This platform performs in its ability to support educational practices, further than just videos and documents.
4. This platform performs in its ability to facilitate feedback TO the instructor.
5. This platform performs in its ability to facilitate feedback FROM the instructor.
6. This platform performs in its ability to promote deeper understanding and critical thinking.
7. This platform performs in its ability to promote community and enable critical group discussion and feedback.

Appendix C

Participants' information sheet

Participant number:_____

Participant Consent Form

Project title:	Interactive streaming videos for educational use
Principal investigator (PI):	John Lee
Researcher:	Jacob Sieradzki
PI contact details:	John.Lee@ed.ac.uk

By participating in the study you agree that: I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.

- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.

Please tick yes or no for each of these statements.

1.	I agree to being audio recorded.	☐ **Yes**	☐ **No**
2.	I agree to a monitor being screen recorded whilst I perform a set of tasks.	☐ **Yes**	☐ **No**
3.	I allow my data to be used in future ethically approved research.	☐ **Yes**	☐ **No**
4.	I agree to take part in this study.	☐ **Yes**	☐ **No**

Name of person giving consent	Date dd/mm/yy	Signature

Name of person taking consent	Date dd/mm/yy	Signature
Jacob Sieradzki		

THE UNIVERSITY of EDINBURGH informatics

Appendix D

Participants' consent form

Participant Information Sheet

Project title:	Interactive streaming videos for education use
Principal investigator:	John Lee
Researcher collecting data:	Jacob Sieradzki
Funder (if applicable):	

This study was certified according to the Informatics Research Ethics Process, RT number 2021/60142. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

1. Jacob Sieradzki (student, s1823274)
2. John Lee (supervisor, John.Lee@ed.ac.uk)

What is the purpose of the study?

The purpose of the study is to determine what features and factors may improve a student's ability to learn content online, create a new online learning application, and determine its viability to be used in education. I will utilise existing research into education, course development, habit-forming techniques, and user experience design to influence the app's design. I will interview participants for their real views and opinions based on their university experience and perform a usability test on my application.

Why have I been asked to take part?

The research target group is a random selection of students who are currently at the University of Edinburgh and have been impacted by the COVID-19 pandemic.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, up until 7 April 2022 without giving a reason. After this point, personal data will be deleted, and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If

you wish to withdraw, contact the PI. We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

I will first perform a semi-structured interview with each participant individually to ask their views on online learning and education during their time at university, especially in relation to the COVID-19 pandemic. Secondly, for each participant, I will prepare a virtual learning environment using videos and documents that are relevant to that participant's university degree and conduct a user study where each participant is asked to complete a set of tasks inside my application. The tasks will be like those that university students often complete: such as watching lectures and discussing with other students. These tests are designed to determine how a user would respond in a real-world situation; therefore answers, feedback and tasks will not be shared between students.

Data will be collected in the form of an interview and a screen recording session on a computer, roughly 30 minutes in total. Only answers the participant gives during the interview and the screen recording will be used. Your name will be replaced with a numeric identifier and an age range for all participants will be shown.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 4 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a

numeric identifier rather than by your real name. Your data will only be viewed by the researcher/research team (Jacob Sieradzki and John Lee).

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint) and all paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

Jacob Sieradzki is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Jacob Sieradzki, s1823274@ed.ac.uk.

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on http://web.inf.ed.ac.uk/infweb/research/study-updates.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Jacob Sieradzki, s1823274@ed.ac.uk.

General information.

For general information about how we use your data, go to: edin.ac/privacy-research