Tools and Techniques for Exploring Engagement in a Flipped Classroom

Thesis by

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Declaration

I declare that this thesis is my own work unless otherwise stated. No part of this thesis has previously been submitted for a degree or any other qualification at Newcastle University or any other institution.

Haneen Ahmed Khudhur Qarabash

I confirm that, to the best of my knowledge, this thesis is from the student's own work and has been submitted with my approval.

Supervisor
Dr Marie Devlin

Abstract

Student engagement has been linked to satisfaction, retention, and better student performance. It is considered a factor and a goal for enhancing the students experience in higher education. However, engagement is a complex construct that includes multiple aspects that is influenced by learning environment, teaching staff, and the students' background and expectations. There are many studies investigating different learning environments and exploring various aspects of engagement like behaviour and emotion. One area that has not been sufficiently researched is the flipped classroom, which is a blended learning model publicized as an approach to improve engagement. Thus, this thesis offers an in-depth exploration of student engagement in Higher Education flipped classroom and identify indicators and measures that can be used to understand as well as improve engagement in this context. In addition, this study investigates the role of technology-enhanced reflection in improving engagement in class and introduces a new tool designed to support reflection in small group activities.

The study was conducted in a third-year module on Ubiquitous Computing in the School of Computing Science. The module was a fully flipped course where students prepared before class by going through the provided material on the website. In class, students engaged in small group activities to expand on what they learned online. Data was collected from the website, class observations (forms and video), and interviews with students and the module leader. In addition, a web app called Group Tagging was developed as a tool to support reflection using video tagging was tested to investigate whether this type of reflection can improve student engagement in class.

Across the two case studies conducted as a part of this research on a flipped classroom, I identified a range of measures and methods that can be used to increase students' engagement. The study showed that engagement in the flipped classroom could change depending on the structure of the course, clear communications with the students, the teaching staff's continued engagement and giving the students an incentive and motivation to keep doing the work required. The findings also showed that video supported-reflection helped the students stay on task and participate more in class. It also worked as an incentive for them to be better prepared before coming to class.

To my beloved family

For their love, endless support, encouragement & sacrifices

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Chapter1.

Introduction

1.1 Overview

Student engagement is an important aspect of modern teaching in higher education. Universities and lecturers recognize the importance of having the students motivated and engaged in their learning for a better learning experience and more efficient outcomes (Fry et al. 2008). This can be seen clearly through the multiple surveys and inquiries universities conduct to understand how students are engaging in their courses and to obtain feedback from the students on their learning experience (Krause & Armitage 2014; van der Velden 2013).

In research, engagement has been a topic of interest for decades and there is a wealth of literature on many aspects of students' experience in higher education and their engagement (Trowler 2010). Researchers have considered what engagement looks like and how it can be measured and there are many studies breaking down engagement to identifiable aspects such as behaviour and emotion. There were studies conducted both inside and outside the classroom to understand engagement and the student experience (Fredricks & Mccolskey 2012; Handelsman et al. 2005).

Student engagement is a complex construct that includes different aspects such as behaviour and emotion. It is also influenced by different factors such as the learning environment and teaching style (Fredricks & Mccolskey 2012). There have been many attempts to define what student engagement is (discussed in chapter 2) but there has not been a consensus between researchers. However, there is an agreement that engagement is very important in enhancing the students' experience and outcomes.

The interest in student engagement in higher education stems from its perceived benefits to the students' learning and development. Engagement has been shown to improve performance and is closely linked to higher quality learning outcomes (Coates 2005; Graham et al. 2007; Kuh, Kinzie, et al. 2007). It is also linked to improved retention (George D. Kuh et al. 2008) and has a positive impact on improving the experience and outcomes of disadvantaged students, students with disabilities and mature students who may need to work or have family responsibility (Krause 2005). In addition, engaging in academic activities has been shown to benefit the collective body of students and not just the individuals. Engaged students can create an active and collaborative work environment with their peers (Kuh 2009). Moreover, students being engaged in non-academic activities, such as taking part in committees and being involved

in the university's policy making would help give students a stronger voice and influence on their learning (Magolda 2005).

It is also shown that students are not the only group benefiting from engagement, Educational institutes are concerned with providing the best learning experience which will in turn translate to less dropouts and better satisfaction rates (Krause 2005) and research shows that engaged students are more likely to put effort, persist in their studies and not give up. Previous studies show that first year students who reported being engaged were more likely to continue to the second year and not drop out of college (Kuh 2009). Collecting data on students' engagement can help universities provide high quality teaching and make adjustments to courses and the learning environment to engage more students, especially student groups more likely to disengage like international students who may encounter different teaching practices they are not familiar with or have problems communicating using another language. This could make their engagement, especially socially, more challenging (Yorke 2006).

Moreover, any information on how and why students engage with their studies can be useful to lecturers in designing and delivering engaging learning activities that will in turn produce better learning outcomes. Data on students' engagement can also help teachers and staff identify students that are at risk of failing or dropping out, which would be useful in making early interventions to help those struggling students (Umbach & Wawrzynski 2005; Macfadyen & Dawson 2010).

Research on engagement has been more often focused on traditional teaching methods (such as lectures and face to face leaning and teaching), with the interest in engagement in online learning environments increasing lately due to the rising popularity of distance learning and open online courses (Fredricks & Mccolskey 2012). These two environments traditional and online are the focus of most research on student engagement due to it being the main teaching approach most universities employ. However, there are other learning environments that are neither a traditional classroom nor an online course and these environments are gaining popularity as well.

One such environment is the '*Flipped classroom'*, which is a form of blended learning that includes aspects of both a traditional classroom and an online course. A flipped classroom can take many shapes but the main concept is to provide the students with the material they need to learn before class and engage them in activities that help further their understanding of the material in class (Bergmann & Sams 2012). Many lecturers are using the Internet as a means to communicate with the students outside class and deliver the material the students need to prepare. The material can be articles, videos, or even existing online courses. So, we can say

that a flipped classroom has both an online part similar to online courses and an offline part similar to traditional classes. This makes a flipped classroom an interesting study of engagement as well as a challenge with all the different aspects of the course that have to be balanced for the best learning experience. However, published literature on engagement in this context does not study the topic in depth. Research on the flipped classroom focus mainly on the reported experience of students and teachers and infers engagement based on how positive the experience was. Although there are studies investigating behaviours (mostly online) that show engagement, little is known about how students engage in a flipped classroom and what are the indicators that can be used to measure engagement in this context.

Thus, this research focuses on investigating how students engage in a flipped classroom environment. In this work I explore the different aspects of engagement in a flipped class that offers the students opportunities to interact with the material, lecturer and each other both online and offline. The work aims to understand and describe engagement in this particular setting and contribute knowledge on how to measure engagement as well as what indicates engagement. It also introduces a new tool that can be used to promote engagement in class as well as assist in collecting information on students' participation.

1.2 The Challenge of Collecting Data on Student Engagement

The first challenge when studying engagement is collecting data that can be used to understand students' engagement in any educational setting. Each class is different in its design and delivery and each lecturer has their own style of teaching, which creates a unique teaching environment. The topic and tools used are also a factor in how students engage in class. In addition, engagement has different aspects; some can be observed (for example certain behaviours such as asking questions, attending class), and others are harder to discern (for example emotions) (Rienties & Rivers 2014). Thus, it is important to choose the data that can best represent or indicate engagement. The methods also should serve the purpose of measuring engagement whether it is for research or for a lecturer wishing to understand their students' experience and enhance their engagement in the course. It is important that collecting the data can be done easily and that it does not add too much work to the lecturer or interfere with students' learning, while providing a "good enough" indicator of engagement for the students in class.

Asking students for feedback is a method that is commonly used in universities to obtain a measure of students perception and experience (Fredricks & Mccolskey 2012). However, there are a several issues with this method when trying to understand and design for engagement.

The first issue is the frequency of enquiry. How many times should the students be asked to provide feedback to have enough data about engagement in a course and when should this feedback be provided for it to be useful to the lecturer in improving the learning experience? (Matthews & Ross 2010).

Another issue is whether students are willing to give feedback regularly and if they will be truthful about their experience. Students can easily get overworked during the semester and asking them to fill surveys regularly adds more to their workload (Fredricks & Mccolskey 2012). In addition, power relations between the lecturer and students may cause them to give answers they think the lecturer or module leader wants to hear due to concerns about their grades if they give bad or very critical feedback (Fredricks & Mccolskey 2012).

This problem is related to the first issue about the frequency and time of feedback. It brings up the question of whether the students should be asked for feedback during the run of the course, which risks work overload and less truthful answers, or should the feedback be given after the end of a module, which may result in less information about how the students engaged over time and also means it may be too late for the lecturer to change things in the module if it failed to engage the students. One more issue with collecting data on engagement by asking students is the risk of distracting them when they should be focusing on their learning.

There are other methods that have been experimented with in literature when studying engagement such as observations in class and learning analytics. Observations in class are frequently used by teachers to monitor the students and they could be a useful tool to highlight behaviour that could indicate engagement (or disengagement). However, collecting useful data on students' engagement is dependent on the skill level and objectivity of the observer, class size (easier to observe small number of students), and teaching method (lecturing or group activities) (Matthews & Ross 2010). Learning analytics and observing the students' interactions online is another useful source of data on student engagement in online learning (Larusson & White 2014). In addition, some researchers are attempting to use bio-sensing and other physiological measures to examine student emotional and cognitive engagement and explore the suitability of these methods for measuring engagement (Rienties & Rivers 2014).

In this thesis, I describe how some of these methods were tested in a flipped classroom to see how well they served the purpose of understanding engagement in this setting. The focus is on finding the methods that provide good indicators of engagement while causing the least possible distraction for the students. In addition, I explain how this work on finding a suitable method of collecting data on engagement in a flipped classroom environment affected the design of Group Tagging. Group Tagging is a tool designed based on the framework of systematic

reflection (Ellis 1995) to enhance engagement in group activities. It allowed students to record short video clips during group activities and tag them to identify the content of the clip. The clips are later made available to the students to review and share. The main purpose of Group Tagging was to encourage reflection on participation in class as well as engagement in group activities. However, the problems faced when collecting information on students' engagement in class made me consider using it as a tool for collecting data to help both the lecturer and the researcher understand engagement.

1.3 Research Aims

This research aim is to explore student engagement in a course based on the flipped classroom model. Data was collected using different methods such as logging traffic to the course's website, observations in class and interviews with the students. The main goal was to create an understanding of what engagement in this setting may look like and how the lecturer can identify parts of the module that failed to engage the students.

One important aspect of the study was finding a balance between not disturbing the students learning and collecting enough data on engagement. Thus, I worked on trying to find methods to collect data without having to ask the students for feedback continuously. The research questions that guided this study are:

1. ***What are the indicators of engagement in a university course built as a flipped classroom? and what are the methods that can be used to measure or increase engagement in this context?***
2. ***What data and methods can be used by a lecturer teaching a flipped course understand engagement in their classes?***
3. ***What is the effect of video-supported reflection on students' engagement in group activities in class? And what are the requirement for creating such technology and deploying it in class*****?**

   The third question was added after conducting the first case study and finding an issue with the students' participation in class. The question was to explore a possible solution to the problem and introduce the Group Tagging app, which was the intervention tested in the second case study.

1.4 Thesis Structure

This section describes the outline of the thesis and gives a brief overview of each chapter

Chapter 2 focuses on the literature on student engagement. It explores how researchers define engagement and describes the different aspects of engagement identified in literature. In addition, I explain the different learning environments and the challenges they pose when studying engagement. The chapter also includes an overview of the methods used in various studies to measure engagement and explore their findings and the settings those studies were conducted in.

Chapter 3 focuses on the first case study "The Ubiquitous Computing Module (Ubicomp1)". In this chapter I explain the context of the study, the design of the course and the data collection methods I used during the run of the module. The chapter also includes the analysis of the data and the findings from this first exploratory study.

Chapter 4 introduces Group Tagging, the application that was developed to support students' reflection and improve engagement in small group activities as well as provide data on student engagement in class. The chapter includes an explanation of the problems with small group activities and the challenge of collecting data in class during Ubicomp1, which informed the design of the app. The chapter also details the design and development process of Group Tagging. In addition, the chapter explores the literature on reflection on learning activities and using video for reflection.

Chapter 5 focuses on the second run of the Ubiquitous Computing module (Ubicomp2). This study explores the same engagement issues with a different cohort of students and examines the new methods for measuring engagement and outlines the results of deploying Group Tagging in class.

Chapter 6 includes the discussion of the findings from both studies and relates it back to the research questions and the literature. It also includes a detailed evaluation of the Group Tagging app based on the finding from the second case study.

Chapter 7 the conclusion summarizes the main contributions of this work, describes the limitations, and outlines the future work that can be done to further the results.

Chapter 2.

Literature review

2.1 Introduction

The issue of engagement is increasingly at the forefront of educational research. There is a wealth of research connecting students' engagement to retention (Berger & Milem 1999; Fredricks et al. 2004; George D. Kuh et al. 2008), student satisfaction (Carini et al. 2006), academic success, and social engagement (Astin 1984; Chickering & Gamson 1987; Kuh 1995; Berger & Milem 1999). However, to be able to measure and improve student engagement it is essential to understand what engagement is and what factors influence it.

This chapter reviews the literature on students' engagement and how it has been defined and understood by previous research. It also describes different learning environments and the challenges and benefits each of them offers when considering student engagement. In addition, the chapter also explains what a flipped classroom is and why is it of interest for research on engagement.

Finally, the chapter outlines the commonly used methods for measuring engagement in literature and examines their suitability for different learning environments and the advantages and disadvantages they each offer for collecting data on student engagement.

2.2 What is Student Engagement?

Student engagement has many definitions in literature due to the variety of methods researchers used to study learning and teaching. Earlier research on engagement was more focused on the students' involvement (Astin 1984), participation (Kuh, Cruce, et al. 2007), and experience. The term student engagement was not used in these studies (Trowler 2010). But this changed in the 1990's when interest in student engagement surged due to many studies linking positive students outcomes with participation and involvement in educational activities as well as improvement in satisfaction, persistence, academic and social engagement (Kuh 1995; Zhao et al. 2005; Berger & Milem 1999).

Several researchers attempted to define engagement depending on whose responsibility it is to engage students. Some scholars placed that responsibility solely on the students and defined engagement as the time and effort the students put into educational activities in and outside class (Krause & Coates 2008; Hu & Kuh 2002; Kuh, Cruce, et al. 2007). Others focused more

on the educational institutions and described engagement as the practices used by the educational institutes to involve and empower students. As Little et al. (2009) defined it "*'The process whereby Institutions and sector bodies make deliberate attempts to involve and empower students in the process of shaping the learning experience* ". Thus, they conclude that it is the educational institute's responsibility to design the learning experience to engage students. Kuh (2009) presented his new idea of student engagement as "*The time and effort students devote to activities that are empirically linked to desired outcomes of college and what institutions do to induce students to participate in these activities*". This definition combines the ideas from the two previous definitions. It defines engagement as a joint responsibility of both students and institutes where students are required to put the time and effort into their work, and the institute is required to provide students with the best learning experience. This can be achieved by carefully designing courses, providing resources, and creating a supportive environment for all students (Kuh 2001). Kuh's definition and his work on student engagement are of a particular interest since it was the basis for the development of the widely used National Survey of Student Engagement (NSSE). NSSE was developed in Indiana University in 1998, and its aim was to assess the quality of learning for undergraduates in the US. The design of the questionnaire is based on the research on engagement that show links between characteristics of engagement and students' satisfaction and achievement (Indiana University 2001). NSSE is currently used in the US, Canada, Australia, New Zealand, South Africa, UK and Ireland (Price & Baker 2012). The wide adoption of NSSE and the many research studies published discussing the findings and the survey itself makes Kuh's definition of students engagement the most commonly used definition in literature (Price & Baker 2012; Fang 2016; Robinson & Hullinger 2008).

However, there is another aspect of studying engagement that Kuh's definition does not sufficiently cover, which is the non-academic engagement that could affect the students' experience and outcomes. While Kuh focused on the educational activities and how the students engaged with them, researchers like Coates (2007) discussed other aspects such as active learning, collaboration, communication with academic staff, and the feeling of belonging to a learning community. Coates believed that those aspects, as well as the educational activities, impact the students' learning experience and should be taken into consideration when examining engagement. This position on engagement has been supported by research on student emotional and cognitive engagement and its impact on performance and learning, especially the effect on motivation and self-regulation (Rienties & Rivers 2014).

Additionally, Coates' (2007) attempt at classifying students engagement styles is also worth noting when trying to understand engagement. Coates believed that understanding students' preferred engagement styles is key in designing the educational experience in universities. Coates surveyed 1051 undergraduate students enrolled in 17 different courses offered by 4 educational institutions in Australia. The courses selected all used online management systems to obtain information about the students' experience both online and offline. Based on the findings Coates suggested a typology to describe four styles of engagement: collaborative, intense, passive, and independent. In addition, he also made a distinction between academic and social engagement. Coates explains each of the four styles as follows:

- *Intense:*

Students with the intense style of engagement are highly involved in academic activities. They use provided online and offline resources (e.g. library services, extra-curricular activities) more than others. They have better communication and interactions with peers and teaching staff (face to face or online), and think of themselves as active, motivated and imaginative students (Coates 2007).

- *Independent:*

Students with this style have a more academic than social approach to studying. These students think of themselves as participants in the learning community and have a good relationship with peers and staff but they are not likely to collaborate with others in or outside class, or participate in other social activities around campus (Coates 2007).

- *Collaborative:*

Students with a collaborative engagement style prefer the social aspect of university life to the academic and especially to individual work. They tend to value the feeling of belonging to the university community and it usually shows in their involvement in activities out of class, and in their interactions with peers and staff. Being more social, they prefer group work and group activities and are more likely to collaborate and work with other students in and out of class (Coates 2007).

- *Passive:*

Students who report a passive style rarely involve themselves in any activities online or in class, and they do not engage with peers or staff (Coates 2007).

Coates (2007) also emphasised the importance of understanding that these styles are not traits or types of students. These styles are states that a student can move to and from depending on the situation and the environment. So, they should not be used to categorize students, but they

may be useful in understanding engagement and what can affect it. Also, understanding these styles can help when designing activities that could aid students' transition from one state to another to achieve the learning outcome of the activity.

However, Axelson & Flick (2010) argued that while NSSE as well as Kuh and Coates's work on engagement have value, it is very simplistic and relies on trying to predict performance based on student behaviour, which minimizes the effect of the students' feelings and cognitive engagement with their learning. Axelson & Flick stress the importance of addressing the 'messy reality' of the learning experience and understanding all aspects of engagemnet without elevating one above the others, especially in the absence of evidence in literature.

What Axelson & Flick, along with other scholars, stress upon is the idea that engagement is not a simple measure but a combination of aspects or constructs, which need to be considered together to understand engagement and to be able to measure it (Fredricks & Mccolskey 2012). However, there has been a variation in the number of constructs that are included in different studies and definitions. Earlier research proposed a two-aspects model that consisted of *behaviour* (e.g. participation, lack of disruptive behaviour) and *emotion* (e.g. feeling of belonging, interest) (Finn, J. D., Pannozzo, G. M., & Voelkl 1995; Marks 2000; Skinner et al. 2009). More recently researchers proposed a three dimensional model that includes *behaviour, emotion* and a *cognitive* aspect (Jimerson et al. 2003; Fredricks et al. 2004; Wigfield et al. 2008). In addition, Appleton et al. (2006), proposed a four-aspects model that split what was referred to as behavioural engagement in the previous model into two constructs; behaviour and academic. The model considers behaviour as the students' participation and attendance as well as extracurricular activities, while academic engagement includes elements such as time spent on task, completing homework and credits obtained. Each one of the proposed aspects of engagement has a wealth of research examining it and studying the impact it had on students' experience and learning. However, when discussing student engagement as a topic these aspects are commonly considered together to reach a better understanding of engagement and most methods proposed to measure engagement rely on aspect models to explain their approach (Trowler 2010; Fredricks & Mccolskey 2012).

Generally, the three aspects model is the most widely used model. There is not enough research to differentiate between the behavioural and academic aspects in the four-constructs model proposed by Appleton et al. and no other researchers have adopted it in their studies yet (Fredricks & Mccolskey 2012). Thus, I will be using the three-construct model for this study to discuss the aspects of engagement. Next, is a brief definition of each construct:

Behaviour

The behavioural aspect of engagement is generally used to describe the student's involvement and participation in educational activities both inside and outside class as well as the absence of disruptive or undesirable behaviour (Trowler 2010). Behavioural engagement usually refers to the observable actions of students that can be considered either positive (e.g. following rules and being on time) or negative behaviour (e.g. skipping class) (Fredricks et al. 2004). Other definitions for behavioural engagement consider the student involvement in learning tasks and actions such as effort, perseverance, concentration, asking questions, and participating in discussions (Finn, J. D., Pannozzo, G. M., & Voelkl 1995; Skinner et al. 1990). A third definition includes non-academic behaviour such as involvement in extra-curricular activities and sports in the range of behaviours that demonstrate engagement.

Most studies focus on one or more specific behaviours that could have an impact on student learning to identify a particular behaviour that can be a clear indicator of engagement and performance. For example, Dazo et al. (2016) examined students' video-viewing behaviour in a flipped classroom to understand how they engaged with the videos before class, and Macfadyen & Dawson (2010) analysed students' interactions in an online learning management system (LMS) to identify behaviours that were the best predictors of achievement.

Affect

Affect or emotional engagement refers to the students' feelings about their learning experience and includes emotions such as interest, belonging, confidence, boredom, and frustration (Henrie et al. 2015a). Hence, researchers suggest that emotion has an important role in students' learning due to its impact on motivation and self-regulation (Kim et al. 2014; Mega et al. 2014). According to Finn (1989) and Voelkl (1997), emotionally-engaged students experience more positive reactions to learning and the teaching staff and they are more likely to put effort into their work. The link between the different kinds of emotions (positive and negative) has been examined extensively by researchers in the past. White (2013) conducted a study to examine the impact of emotions on students' satisfaction and identified 14 emotions students reported experiencing that explained the variance in satisfaction with their learning experience. These emotions were both positive (e.g. joy, excitement, hope, interest) and negative (e.g. stress, pressure, worry and fear). Also, Pekrun et al. (2009) proposed a model that linked students' emotion with academic performance. They examined the goals students wanted to achieve (such as attaining mastery, performing better, or avoiding work) and achievement-related emotions (such as hope, enjoyment, pride, anger, anxiety and shame). They found that these emotions when examined along with the goal of achievement are very good predictors of

performance. Rienties & Rivers' (2014) review of literature on measuring learning emotions included 100 studies examining different kinds of emotions (positive, negative, and neutral) that have been studied in relation to student learning and performance.

Cognitive Engagement

Cognitive engagement is usually defined as a student's level of investment in learning. This includes strategies students use when studying, the willingness to take challenges and putting more time and effort into learning new and difficult skills (Henrie et al. 2015a). Research on cognitive engagement frequently refers to self-regulation and the desire to go beyond what is required to learn and is sometimes linked to motivation. Cognitively-engaged students are said to be less afraid of challenge and are more persistent in pursuing their goal (Fredricks et al. 2005; Meece et al. 1988). In addition, learning literature shows that cognitively engaged students use learning strategies to plan, monitor and assess their learning and accomplish tasks (Pintrich et al. 1993). However, measuring cognitive engagement can be difficult due to its internal nature and can only really be inferred by observing behaviour and corroborating it with the student's own reports (Fredricks & Mccolskey 2012).

Generally, we can see that student engagement does not have a clear definition in literature, and that there is no consensus between scholars as to what engagement looks like or how to describe it. What they generally agree on is that engagement is not one simple measure but a multidimensional construct that includes different aspects, some are observable, like behaviour, while others are harder to detect, like emotions. Each one of these constructs impacts the student's learning experience and must be considered when studying engagement.

In addition to the above, it is worth noting Trowler's (2010) assertion that engagement can be positive or negative and that it is possible for a student to be positively engaged in one aspect (behaviour, affect, or cognitive) while being negatively engaged in another. Trowler argues that negative engagement is not disengagement but another form of engagemnt that results in the opposite of the desired result. For example, when considering behavioural engagement, a positively engaged student would attend lectures and participate voluntarily, a disengaged student would skip class without giving an excuse, while a negatively engaged student would attend and deliberately cause disruption. So it is important when studying engagement to understand the reason behind behaviours or emotions and why the students react in a certain way to an educational setting or actvity. Focusing on one aspect of engagement or on the desired effect only would not provide a full understanding of student engagement.

2.3 Student's Engagement and Educational Context

In the previous section, I discussed the different definitions of student engagement and its aspects as well as what needs to be considered when studying it. However, most definitions and arguments presented were focused on the student and did not consider the external factors that could impact engagement, mainly the learning environment. In current educational practice, we can identify three main teaching approaches in formal education in universities; face-to-face learning, online learning (E-Learning), and blended learning (technology-supported learning). Each model of teaching offers its own unique challenges when considering engagement, and there have been many studies examining students' engagement in each one of these environments, which I cover in the next sections.

2.3.1 Student engagement in class (traditional or face-to-face learning)

Understanding and measuring student engagement in the classroom can be challenging due to the different variables that each particular context presents. A class can consist of a few students or more than a hundred. It can be a traditional lecture model of teaching where students are mainly passive listeners, or seminar-based class where students are required to work together. The mode of teaching, materials and tools used, activities planned, assessment, students' background etc. are all factors that could affect how and why the students may engage or disengage in a class.

As mentioned earlier, many studies on engagement did not look into engagement itself but were either focused on a single aspect or attempted to find indicators of engagement by examining the students' interactions in and outside class. One of the actions that is usually mentioned in research into class engagement is attendance. Researchers commonly notice students' attendance rates and connect it to their engagement or satisfaction in a course (Hospel et al. 2016; Krause & Coates 2008). Studies using this connection as proof of engagement usually refer to studies such as Romer (1993), who noted the lack of evidence for this claim and conducted a study to examine the effect of missing lectures on students' performance. The study was carried out in three courses in Economics offered by three different universities in the US that were known for low attendance rates. Romer compared the results of students who were regularly in class to those who attended infrequently and found that there was a strong correlation between attending lectures and performing better in the course. Those results were later confirmed by Durden & Ellis (1995), who checked the validity of this result in their Principles of Economics course and found that attendance does indeed impact academic performance but that the relationship is not linear. According to their findings, absence does affect performance if the student missed four or more lectures, but is not an indicator of

performance when absence is less than that. Credé et al. (2010), also analysed the relationship between attendance and grades and reported a strong connection between the two. Their study showed that attendance was a better predictor of college performance than standard tests on admission.

Attendance can be considered as a form of positive behavioural engagement, so it is important to understand why students miss lectures and what could be the reason for frequent absences. Massingham & Herrington (2006) asked that specific question in their study into why absence was a growing trend for university students. Their findings showed that the students' lifestyle and their perception of the topic and teaching staff were the main factors for missing class. Students who have a busy lifestyle (social engagements or the need to work), and students who disliked the lecturer or the topic (found it boring) were more likely to skip lectures if they had the option to. They concluded that the teaching methods and the lecturer's personality were the most significant factors in motivating students' attendance and that attendance does have an impact on performance. Thus it is important to identify the reason why students are disengaging and missing class if we want to improve their performance and learning.

Another factor that could impact attendance in a course is the use of video capture and tools such as Recap (Kong et al. 2007) to record lectures and make them available online for students after class. Recap is a tool that automates the process for capturing and creating a video presentation from syncronizing the audio and powerpoint presentation. The use of video capture has been increasing in higher education to provide the studnets with a replacement or supplement for attending lectures. However, this method is often cited as a reason for decreesing lecture attendance while not improving the studnets attainment of the material (Williams et al 2016). This issue with video capture have been invistigated by studies such as Edwards & Clinton (2018), who examined the effect of introducing video capture into their second year research methods module. The study showed that using video capture caused a substantial drop in attendance to the lectures. It also showed that the studnets attainemnt of the material taught was impacted negativly by the over reliance on this method instead of attending lectures.

However, this result is contested by other research such as McLean & Suchman (2016), who conducted a simliar study in their own Microbiology course and found that there was no impact on attendance when video capture was avaiable to the studnets. This difference in results between studies is what makes the effect of using video capture and recap a controversial topic between instructors and researchers. Thus, while it is important to consider the impact of video capture on attendance, the real impact of it is not yet proven to be negative or positive.

Participation is another measure that has been used in literature to study engagement and improve performance. Participation is commonly presented as the students' active behaviour in class. Actions like asking or answering questions and being actively involved in activities are considered positive engagement and a desirable behaviour in class (Rocca 2010). However, research shows that participation can be influenced by many factors such as confidence, gender, language-fluency, the cultural background of the student and the learning environment (Vandrick 2000; Dancer & Kamvounias 2005). Dallimore et al. (2004) noted these issues that can limit participation and worked with their students to find a way to address them. They surveyed students enrolled in a course that required active participation and asked them to identify what they thought enhanced the quality of participation in class. The students' answers suggested the following factors, which they thought affected the quality of participation in class i) grading participation, ii) active facilitation by the lecturer, iii) good questions to provoke conversation, iv) constructive feedback, v) a supportive environment, vi) the instructor expanding on ideas already mentioned and adding clarity to discussions.

Other researchers also attempted to address the issue of quality participation. For example, Lord & Melvin (1994) experimented with assessing participation by having both teachers and students evaluate it in class. The teachers assessed the students and they in turn were asked to rate their peers' participation in what they called the "prof/peer method". They found that in general the students thought the method was fair and the professor's grades for participation were consistent with the students' own ratings. This result can be linked to the findings of Dallimore et al. (2004) on using grades for better quality participation and we can conclude that a fair assessment of participation can be a method to increase quality participation.

However, findings from other similar studies to Lord & Melvin found that students usually rated their participation and that of their peers higher than what the professor gave, which can lead to dissatisfaction when the students get their grades (Gopinath 1999; Dancer & Kamvounias 2005). In addition, Fritschner (2000) conducted a study to understand the students' and instructors' perceptions of particpation using class observations and interviews (both students and instructors). The findings showed that students appreciated the particpation aspect of the class but did not normally engage with it unless prompted. Most students were comfortable with letting the "talkers" take care of it and they would just listen. Fritschner also found that lecturers' expectations of particpation can be as low as "they are still awake by the end of the lecture" or as high as "everyone contributed at least once". Instructors unkowningly conveyed these expectations to the students with their speech patterns and attitude. As a result, students fell into patterns of particpation in accordance with these unspoken expectations. This

work shows that for many students particpation does not happen naturally in class and that students need to be encouraged to be more active. It also highlights the importance of clearly communicating expectations of participation to students.

The introduction of technology into the classroom may be a viable option for measuring and improving engagement in class. Audience response systems (ARS) have shown good results in engaging students and increasing participation (Hunsu et al. 2016). Clickers are being increasingly used in universities to allow students to answer questions quickly and get immediate feedback and they can be used anonymously or the student's answers can be linked to their name. Clickers offer the advantage of quick and easy feedback for both instructors and students, improve participation, and help in facilitating discussion as well as being an entertaining activity for both teacher and students (Blasco-Arcas et al. 2013; Martyn 2007). Graham et al. (2007) examined the impact of using clickers in class on student engagement and their effect on encouraging participation of reluctant students. The study surveyed students and faculty in 12 courses covering topics in Biology, Physics, Psychology, Chemistry, Education, and Statistics (11 faculty members and 688 students). The aim of the study was to identify students with low participation and examine the impact of introducing clickers on their engagement in class compared to other students. They found that students perceived clickers as a valuable tool for getting formative feedback but did not like it being used as an assessment to or to force participation. Students' complaints in the study were mostly due to experiencing technical difficulties when using the tool, which resulted in negative feelings being associated with it, especially when it was used for grading.

However, including clickers can be costly and difficult to implement for many institutes, and some teachers can be reluctant to add new technology to class due to aforementioned cost and fear of technical issues that can be distracting and frustrating to both staff and students (Blasco-Arcas et al. 2013).

Other technologies that have been experimented with include live blogging (or tweeting). Worth (2017) used Twitter (Twitter 2018i) as a replacement for taking notes in his photography class. The students were asked to tweet their notes, questions, and comments and those tweets were displayed on a monitor to the whole class. Worth found that this method helped students who were too shy or lacked confidence to speak and be more active in class. It also provided a record for all the students' comments that was shared publicly with people outside class who were interested in the subject and wanted to engage in discussion as well. Thus, we can see that technology can offer tools for improving and measuring engagement in class.

Though it is important to note that introducing certain technologies to the classroom (mainly Internet-related technologies) can shift the learning environment from a traditional classroom to blended-learning environment, which has its own challenges when it comes to student engagement.

2.3.2 Student engagement in online learning environments

With the increased use of the Internet, students now have the ability to take full educational and training courses completely online using their own devices without having to be physically in class or attending any lectures. Many universities offer courses (credited or not) using the Internet and these courses are sometimes open to people from outside the university and around the world (Thomson 2010; Croxton 2014). However, this model of teaching raises a different challenge when it comes to understanding and improving students' engagement. The distant nature of online learning and the lack of face-to-face interactions affect the instructor's ability to observe the students closely and interact with them directly to address any issues. Thus, it is important to understand how the different learning environment affects engagement and what the instructor could do to offset the lack of direct interactions (Thomson 2010; Dixson 2010).

The first thing to consider is the appeal of online courses and why they have become so popular. Online learning provides the opportunity for students who are physically unable to be in class to expand their learning and offers them access to more advanced education opportunities. It also offers flexibility in time and the ability to customise and personalise the learning experience of individual students. For educational institutions, online learning offers the ability to expand their reach and enrol more students at lower costs without the need for new buildings and facilities (Meyer 2014).

Due to these benefits, many studies on student engagement in online environments were conducted to ensure that online students get a similar learning experience as students who are on site. Interestingly, a number of these studies that set out to either understand engagement, improve it, address the issue of students dropping out, or to improve satisfaction all reached similar conclusions; the role of the instructor and the design of the interactivity in the course were the most significant factors in improving students' engagement and performance. Dixson (2010) surveyed 186 students in different online courses and talked to instructors teaching the courses to determine what the students found engaging in them. The results couldn't identify a specific activity that the students found particularly engaging but did find a link between the availability of communication channels with instructors and peers and students' engagement.

Similarly, Croxton (2014) conducted a literature review on student satisfaction in an online learning environment and found that one of the best predictors of student satisfaction is the

student to instructor interactions. The ability to interact with peers and work in groups was also highlighted as a component of satisfaction but the quality of communication with the instructor rated significantly higher than any other aspect. This relates back to the challenges in engaging students mentioned earlier due to the lack of face-to-face interactions that affects the social aspect of learning and may impact the students' motivation. Thus, it is important that the students are provided with clear instructions and quality communications with the instructors to offset this issue.

However, this can be very difficult to implement in large courses, and especially massive courses with thousands of students taking the course at the same time. For example, Massive Open Online Courses (MOOCs), have gained a lot of popularity recently due to being free (or low cost), open to a large number of students and easy to access to anyone with an Internet connection (Zutshi et al. 2013). The interest in MOOCs stems from the huge number of students enrolling in these courses, which can reach a 100 thousand simultaneous students on the popular platforms such as Coursera ((Coursera 2018d) and Udacity (Udacity 2018j). These platforms were largely responsible for the massive growth of MOOCs as they offer Universities with a platform, easy to use tools, and the potential of reaching millions of users who are registered to those sites (Pang, Yanxia, Tong Wang 2014).

However, the main issue with MOOCs stems from the high dropout rates in these courses. Thousands of students may register on a course but only a few of them complete it. Research showed that, in most MOOCs, only 5-15% of the enrolled students actually finish all assignments and get a certificate at the end (Daradoumis et al. 2013). Understanding the reason for this dropout rate can be useful in understanding engagement in this learning environment. The students register for these MOOCs because they are interested in the knowledge they offer so why would they not continue till the end of the course? And what happens that causes them to disengage?

Rivard (2013) argues that the open nature of MOOCs is the main reason for the large number of students dropping out. Most MOOCs are free and thus the students who enrolled don't lose anything by dropping out from the course, unlike paying students who would incur monetary loss. Rivard also criticised the research on MOOCs that compares the number of students who registered to the course to those who completed it to calculate the dropout rate. This approach does not take into consideration that many students would register when the course is first advertised because it is free and easy but not show up later when the course starts for a variety of reasons (e.g. lack of time or losing interest).

Accoring to Yang & Sinha (2013), MOOCs greatest strength is in the freedom they offer students to pick and choose what, where and when to learn since everything is freely available. However, this is also MOOCs' biggest problem, that students lose motivation due to other distractions in their lives and the absence of accountability. A student can choose to only do some of the assignments or drop the course altogether without losing anything. There have been arguments that the students would be more engaged if given an incentive such as credits toward a degree were offered, but what incentive would work best is still unclear as evident by Colorado State University (among other institutes) offering credits for completing its MOOC. The university offered a MOOC for a very low price that students could take for college credits but no one took it (Kolowich 2013).

Thus, we can see that online learning still has many challenges to overcome as a learning model concerning engagement, and that many of these challenges stem from the social aspects (or lack of) in this environment. Building a learning community and good connection with the instructor that promotes continued engagement as well as providing the right incentive could be essential in the success of online courses.

2.3.3 Student engagement in blended learning environments

The general definition of blended learning is *"The use of multiple modes or methods of instruction to deliver education"* (Singh & Reed 2001; Driscoll 2002; Singh 2003). However, as it is very likely that any educational system will use more than one method or model of instruction, a more specific definition is required to better understand what blended learning means in literature. One definition that can be more reflective of the history of blended learning is "*the use of online technology in delivering education alongside traditional face to face instruction*" (Singh 2003; Garrison & Kanuka 2004). Technology in this definition refers to Internet and online technologies such as Learning Management Systems (LMS) e.g. Blackboard and Moodle, social media platforms like Facebook and YouTube, online clickers and online quizzes.

The use of technology in blended learning can range from only providing students with extra material they can access online, to completely redesigning courses and the learning experience of the students to include online technologies that facilitate communication and replacing parts of traditional teaching (e.g. podcasts or videos instead of traditional lectures) (Sharpe et al. 2006). Research shows that students' reception of the use of technology in education is mixed depending on the technology in question and how well it is integrated into a course. Most students find the extra resources and flexibility of access to online material to be very valuable to their learning. However, their reaction to the courses redesigned to include technology was

not always positive due to technical difficulties as well as the students' lack of understanding of the role of technology in the course. In addition, students were not always ready to make the needed changes to their study strategy that would help them adapt to new methods of teaching and learning (Sharpe et al. 2006).

When considering student engagement, blended learning's main advantage is in combining traditional face-to-face teaching with online learning and offering possible solutions to some of the problems both have. The traditional teaching aspect of blended learning addresses the issue of lack of (or poor) social interactions that online learning suffers from, while the online aspect has the potential of being the solution to the issue of students' lack of participation due to shyness or missing class because of other life commitments (Nielsen 2008; Worth 2017). However, blended learning is not without its own issues. As mentioned previously, students have mixed reactions to educational technology and the way blended courses are designed and delivered is essential to their success in engaging students.

One form of blended learning that has been gaining popularity and is publicised as an approach to improve student engagement is the Flipped (or Inverted) Classroom (Roehl et al. 2013; Gilboy et al. 2015). In a flipped classroom the traditional format of lecturing in class, then having students do extra work (homework) later at home to enforce what they learned is flipped. In this model, students are given the lecture material *before* class to prepare, preparation material could be a recorded video of the lecture, a number of short clips covering the important pieces of the topic or a text for students to read like an article or a book chapter. It could also include quizzes or exercises to be completed before class (Bergmann & Sams 2010; Bishop et al. 2013).

In class, the lecture is replaced with active learning activities (group or individual) designed to engage the students and expand on what they learned about the topic from the preparation material. These activities can be problem solving exercises, design tasks, case studies, etc. and the teacher's role is to facilitate the discussions and help students during the session. The teacher may also give short lectures if they feel that the students are struggling with a particular concept or need more information on a topic to be able to get through the activity (Miller 2012; Jacqueline E. McLaughlin et al. 2014a; Chen et al. 2015).

Research on the flipped classroom model focuses more on the process of flipping the class and providing advice to instructors. For example, Miller (2012) published an article with five things teachers need to consider before flipping their classroom. The list included 1) The preparation material: the students must understand why they need to watch the videos or read the text provided 2) Activities in class: choosing relevant activities to the topic of the course 3)

Technology: what tools are available and how to overcome technical difficulties 4) Reflection: adding ways to support student learning and assessing their understanding of online material 5) Time and place: ensuring the students have the time and means to go through the provided material.

To evaluate the flipped classsroom model, Fulton (2012), conducted a study surveying students, instructors and parents in a school in the US about their experience with the flipped classroom and identified certain advantages to the approach. First, the students liked that they could move at their own pace and are not tied to the time and duration of the lecture. Second, the activities in class helped teachers identify problems and learn more about the students' learning styles and study strategies. Third, classroom time could be used more effectively and the teachers could change their approach easily if they felt that what they were doing was not working. Fourth, teachers reported more interest and engagement in the flipped classroom and they also thought that using the internet and technology in teaching added flexbility and customization options.

Other researchers also reported better performance in courses that used the model, but there is little evidence in literature identifying the exact reasons for this improved performance (Bishop et al. 2013). What is clear though is that the flipped classroom success depends on the student enagement before and in class (online and offline). Students will have to watch the videos or read the text beforehand to be able to participate in class and not fall behind. Sometimes there are also online quizzes or discussions that the students need to take part in. In addition, the students must participate in the class activities that are designed to build on the knowledge they already acquired (from online material) and address any issues they had with it (Bergmann & Sams 2012).

Research on student engagement in a flipped classroom relies mostly on students' experience and satisfaction with the course and teaching. Most studies conducted on the topic used self-report measures and directly asked students whether they found the class engaging, and sometime asked them to compare it to other traditional courses (Bishop et al. 2013). For example, Gilboy et al. (2015) reported on a study of flipping two undergraduate modules as an experiment to explore the possibilities of enhancing performance by moving to the flipped classroom model. The study evaluated the new approach by surveying the students about their experience after the course ended. The findings showed that the majority of the students preferred watching the recorded video lectures and doing the activities in class rather than having the professor lecturing. However, they had concerns about not having the professor available to answer questions when they were watching the recorded lectures. Gilboy et al. used

these findings to infer engagement and stated that the students were more engaged in these flipped courses than the tradtional lectures.

The biggest reported issue in implementing the flipped classroom model and one that could prevent its success, is the students' lack of understanding of what a flipped classroom is and what they needed to do in order to succeed in it. In addition, researchers and instructors have noticed a resistance to change that made some students' experience in the flipped classroom unsatisfactory (Roehl et al. 2013).

The lack of defined measures and indicators of engagement in the flipped classroom environment was one of the factors that prompted this current work. The flipped classroom is advertised as a model for increasing engagement yet there is not enough research on why there is increase in engagement. How can engagement be measured? What are the indicators of engagement in this environment? And what are the factors that affect engagement in a flipped classroom? These questions are some of the issues this study tries to address.

2.4 Measuring Student Engagement

This study focuses on engagement in a flipped classroom context. In the previous section the importance of students' engagement was discussed and the definition as well as constructs of engagement in literature were established. In this section I focus on how researchers have approached measuring students' engagement, and what the most frequently used methods are.

There are many sources in literature that address measuring certain aspects of engagement. These studies vary in what aspects they are examining and in their definition of engagement. Their methods could factor one or more of the three constructs of behaviour, emotion, and cognitive engagement. This variance in definitions resulted in studies that used different instruments and approaches to measure engagement within a range of contexts and environments. Generally, the most frequently used methods were self-report methods (questionnaires, interviews and focus groups). Other methods such as observations and bio sensing were also used in literature usually accompanied by self-report for better results.

2.4.1 Surveys and questionnaires

Questionnaires are a popular method to collect data from participants in research. They are especially useful when working with a large number of students and in online learning environments due to their scalability (Matthews & Ross 2010). In research on engagement, questionnaires are answered mostly by students (DeBourgh 2003; Graham et al. 2007; Filak & Sheldon 2008), and sometimes by teachers (Gallini & Barron 2001; Kay 2011), or parents (Institute for Research and Reform in Education 1998).

Questionnaires are widely used to measure different aspects of engagement, as well as to understand the students' views on new or existing teaching and learning models. For example, Gallini & Barron (2001) constructed a survey to examine students and faculty perception of engagement in courses that used the Internet as part of teaching practice. The survey did not include detailed questions about behaviour, emotion, or cognitive engagement, but asked the students directly to rate their level of engagement and pick aspects of the course they found engaging. Chen et al. (2010) on the other hand, used the results from NSSE to explore the relationship between using web tools and students' performance and engagement.

Both of the previous examples were examining the same learning environment (blended learning), and both used a survey as the method to measure engagement. However, their goals were different with Gallini & Barron focusing on how engaging the course generally was while Chen et al were more interested in the relationship between technology and engagement. Also, Gallini & Barron constructed a new survey for the study while Chen et al. chose to use NSSE which was already being used by the university. The similarities of the two studies as well as the different approaches they used highlight the main issue in studying engagement, primarily that there are no agreed upon tests or indicators of engagement that can be used in research on the topic. Even well-known surveys like NSSE are contested by researchers who think it emphasises the behavioural aspect of engagement while minimizing other constructs (Axelson & Flick 2010). Thus, it is up to the researcher to either chose a previously proposed method or design their own.

Nevertheless, there have been a number of attempts by researchers to create questionnaires to be used as a measure of student engagement. These questionnaires were striving to provide researchers, teachers, and faculty with an easy to use measure of student engagement, and they tried to include indicators from one or more of the three constructs of engagement (behaviour, affect, and cognitive). These tools tended to be more focused on data collection when created for research, and on reflection when developed with the teachers and faculty in mind.

As mentioned earlier, the most generally known survey on student engagement is the National Survey of Students Engagement (NSSE), which is a survey designed to assess students' learning experience on an institutional level (Kuh 2009). It is used or referenced frequently in literature about engagement in higher education. The questionnaire was formally launched in 2000, and since then more than 1600 colleges and universities in the US and Canada have administered the survey to their undergraduate students. NSSE was updated in 2013 with new customization options to fit the specific learning objectives for each institute administering the survey. (NSSE 2016)

Faculty and administration used NSSE data to evaluate quality of learning and work on improvement of student experience. Researchers also used data collected through the survey in their own studies. Those studies ranged from evaluating new approaches and instructional models (Chen et al. 2008; Rabe-Hemp & Woollen 2009; Chen et al. 2010), examining the connection between engagement and retention in first year students (Fang 2016), and comparing engagement of students of different genders as well as educational and cultural backgrounds. (Kuh, Kinzie, et al. 2007)

Another well-known survey (though not on the same scale) is the Motivated Strategies for learning questionnaire (MSLQ), developed by Pintrich et al. (1993). This questionnaire was designed to measure the cognitive engagement of college students in a single course. It consists of two sections; first is the "Motivation" section, which evaluates the student's goals, belief in their skills and anxiety caused by tests. Second is the "Learning Strategies" section that assesses the student's use of cognitive and metacognitive strategies when studying, and their management of different resources. MSQL consists of 81 questions in total. It is formatted in sections that can be removed or rearranged, depending on the intended use of the questionnaire. For example, it is possible to use the section about learning strategies separate from the motivation section.

Some scholars consider the MSLQ an acceptable method for measuring cognitive engagement (Fredricks & Mccolskey 2012), and it has also been the base for the questionnaire designed by (Tuan et al. 2005), which was developed to measure students' motivation toward learning Science in school. Additionally, it was adapted for both a Chinese and Turkish context, where some parts of the questionnaire were changed or removed to fit better to the studied population (Rao & Sachs 1999; Karadeniz et al. 2008).

Another example is the Online Student Engagement Scale (OSE) created by Dixson (2010) to measure engagement in online courses. The scale focuses on the student's behaviour but also includes an assessment of emotions, skills and participation. The validity of the scale was proven by comparing the student's self- report (by answering the questionnaire) with their observable behaviour from the data collected about their interactions online.

Additional questionnaires on engagement include Fredricks et al.'s (2005) "Engagement Scales", which includes three parts, one for the teachers, one for the students and the final part is for the parents. It was designed to give schools a tool for testing new teaching approaches and reforms by measuring student engagement and was completed by the school's children. Another examples include Roblyer & Wiencke's (2004) rubric that assesses engagement and interactions in distant learning courses, the Classroom Survey of Student Engagement

(CLASSE), which asks the students about their behavior inside and outside class in relation to a specific course.

What we can see from the previous examples is that while these questionnaires were developed to provide a method of measuring engagement that can be used by other researchers (or teachers), they were all focused on engagement in a specific environment or measuring a certain aspect of engagement. NSSE was the only survey asking questions about all aspects of the students' experience in university, but it has been criticized for focusing too much on behaviour.

There are researchers who also examined the teachers' perspective and designed surveys and rating systems for them specifically. Fredricks et al. (2005) in their "Engagement Scale" included a teacher questionnaire on students' behaviour in class along with the student questionnaire. The two surveys (the students' and teachers') were designed so that the data collected from both could be analysed together to get a better understanding of the students' engagement. Thus, questions asked were usually about the same behaviour but from a different perspective. For example, the teacher would get a question asking if the student participates in class, and the student would get a question about whether they were really participating or just acting as if they were. According to Fredricks et al. this method produced a much richer data set that helped inform their study.

Similarly, Kay (2011) included a teachers' survey in his study on evaluating engagement in web-based learning tools. The survey was part of an evaluation scale developed specifically for assessing learning, design of, and engagement with web-based learning tools. Both students and teachers had to complete an evaluation survey that included questions concerning engagement.

In general, surveys and questionnaires offer many advantages and have been commonly used in research. The main advantage of using them is their scalability and low cost; they can be administered to any determined number of participants without a need to change them. They produce well-structured data that is already coded which makes performing analysis easier (Matthews & Ross 2010). In engagement research, questionnaires and surveys provide the ability to obtain the students' subjective opinions and emotions, which is something that can only be guessed at from data about their behaviour or from teachers' observations. They are also the easiest method of collecting data in a classroom setting (Appleton et al. 2006).

However, there are downsides to using surveys. For one, the researcher will not be able to follow up with the participants for additional data if the survey is anonymous. Also, the usually rigid format of answering the questions does not allow the participants to answer in their own

way. In addition, low response rates may result in a biased sample that does not truly represent the researched population (Matthews & Ross 2010).

Also, there are issues that are specifically concerning when working with students. For example, it is possible that the students may not answer honestly (which is a concern in all self-report methods) especially if they think that it may affect their grades (Fredricks & Mccolskey 2012). There is also the matter of when to administer the questionnaire and how many times. Measuring engagement only once may not give a true depiction of the changing engagement during the run of a course or school year, and asking the students to fill questionnaires many times may be distracting from their learning and adding to their workload (Henrie et al. 2015b).

2.4.2 Interviews and focus groups

Other self-report methods that have been used in the literature on engagement include interviews and focus groups, though they are usually used in addition to other methods like questionnaires and observations. Interviews and focus groups allow the researcher to explore what people think about, as well as provide the participants with the opportunity to express their ideas, opinions, and experiences in their own individual way (Matthews & Ross 2010).

What can be seen in the literature is that interviews and focus groups are not used as a measure of engagement but as way to get more information around engagement. For example, The Higher Education Funding Council for England (HEFCE) conducted a study that aimed to explore student engagement in England as well as recognise educational institutes' practices and policies when it comes to engagement. 172 semi-structured interviews were conducted as a part of the study with faculty members, administration staff, student union representatives and students. However, the topic of discussion in these interviews was more focused on how engagement was perceived by the different stakeholders as well as the policies and practices that were in place to measure and improve engagement (Little et al. 2009).

Another example is the research conducted by Vaughan (2010), which investigated the process of shifting the teaching approach from traditional lecture-based learning to active blended learning. One of the main aims of this study was to examine the link between the new learning approach and students' engagement in the courses that were redesigned to include technology. In order to do that, the author interviewed the faculty involved and administered a questionnaire for the students. The questionnaire used was based on NSSE. The interviews with the faculty were focused on the process and challenges of the course redesign and interacting with the students. Results from both methods were then used to make the conclusion that there was an improvement in engagement with the new design.

Another example of using interviews as a data collection method together with a questionnaire is Fredricks et al. (2005) who interviewed some of the students that completed their "Engagement Scales" questionnaire. The students they interviewed were the ones who scored highest and lowest on the engagement scales. The aim of the interviews was to obtain additional information from those students about their attitude toward their school, classroom, teachers and work, and whether that attitude reflected the difference in scores in the survey.

Strayer (2012) also used interviews, focus groups and a survey to study engagement in a flipped classroom. The focus of the study was to compare a flipped statistics class with another traditionally taught class. The interviews and focus groups were used to give the students an opportunity to talk about their experience and highlight what they thought worked and what they struggled with. The participants of the study were different in the two courses and the findings showed that students in the flipped class became more open to collaborative learning with each other and more accepting of innovative teaching methods.

Generally speaking, interviews and focus groups allow the researcher to follow up or expand on a topic that may be raised during conversation that was not originally in the plan. Data collected is qualitative and is particularly useful for exploratory studies (Matthews & Ross 2010).

However, interviews and focus groups do have their own issues. The interviewer's skills and bias can impact the quality of the data collected (Matthews & Ross 2010). The data collection is often very difficult to scale, and analysis is usually time consuming which may limit the amount of data the researcher is willing to work with (Henrie et al. 2015b). An important issue that also must be taken into consideration with interviews and focus groups is the different personalities, social standing, backgrounds and cultural issues of both the interviewer and interviewees. These things can be detrimental in how the participants will react to the researcher when interviewed and to each other in the focus group (Matthews & Ross 2010).

2.4.3 Observations

Observations can be quantitative or qualitative depending on how they are applied. They also differ depending on the role the researcher takes in the process. The observer can be an outsider witnessing the events and recording what they see, which is considered as a simple form of observation, or they can be a part of the observed group with more intimate knowledge of the participants (Matthews & Ross 2010). Teachers in class use simple observations frequently as they usually keep track of attendance, assignments submissions and participation. It is sometimes the only method available for teachers to assess student engagement.

Simple and complex observations have been used in literature to study students' engagement. These studies usually focus on a single behaviour or a range of behaviours as indicators of engagement. The method used can be as simple as monitoring attendance like Gatherer & Manning (1998) did in their study, which found a correlation between the attendance of first year students in biological sciences with their exam performance at the end of the course. Gatherer & Manning applied statistical methods (correlation and regression) to the data from attendance records already available to all teachers to predict the students' performance in the final exam. They found a weak but positive correlation between lecture attendance and exam performance especially in female students. Dazo et al. (2016) on the other hand used the more complex data from the log files from TrACE, an asynchronous media platform, to observe and analyse the video viewing behaviour of the students in a Computing Sciences flipped class. They concluded that the number of times a student viewed the video as well as the time they did it had a significant correlation with their course performance. Also, the students who voluntarily watch the videos without a prompt from the teacher or the platform frequently performed better.

There are a number of observation forms and codes that researcher can use to record different behaviours inside and outside class. An example of a simple method that has been proposed for observing engagement in class is the Student Engagement Walkthrough Checklist (Jones 2009). The checklist is a simple Likert scale measured on five-point scale (very low to very high), for five characteristics (Positive body language, consistent focus, verbal participation, confidence, fun and excitement). These characteristics are proposed as behaviour that can be used to examine the level of students' engagement at any given time. The data obtained from the observations can be used by the teachers as a reflective tool on their teaching methods, as well as by the administrators and teaching coaches or peers as a tool to examine a specific teaching practice (D. Jones 2009)

Volpe et al. (2005), in a review of coding schemes that are used in observing students in class in elementary schools, found that while there are many coding schemes available for researchers, they are mostly validated with a single study and there is a shortage of evidence of their validity. This limitation makes it important that researchers be careful when choosing an existing observation code.

It is worth noting that observations have an important role in studying engagement in online learning environments. Observations are being used to analyse students' behaviour in Learning Management Systems (LMS) and Virtual Learning Environments (VLE) that are adopted by Universities and used in online courses. These observations are providing a huge amount of

data on how students access and use these systems and the material available to them. The analysis of this data led to the emergence of the Learning Analytics field of research that focuses on predicting performance based on analysis of students' online behaviour. (Pardo 2014)

Learning Analytics is a fairly new field and there is on-going research on the methods, analytics approach, and interpretation of the data used within it (Larusson & White 2014). There are few researchers who used learning analytics to study aspects of engagement in online courses and virtual classrooms. However, most of the published research is more focused on designing systems for analysing, reporting and visualizing the raw data collected. For example, M. Liu et al. (2015) designed a learning analytics system called Tracer that visualizes the students behavioural patterns when writing in cloud environment. The observed behaviour that was used as an indication on engagement with the task is the time they spent typing and how many pauses they took during the activity. D. Y. Liu et al. (2015) also used learning analytics to design a plugin for Moodle (Moodle 2018g), an open source learning management system. The proposed plugin uses grades, assignment submissions, logins and forum interactions as indicators of student engagement.

Generally, observations offer the advantage of providing a rich account of what is happening in the real world and can be collected without disturbing the participants' activities. The disadvantages of using observations are the time and commitment it requires from the researcher. Observing people for a long time while trying to decide what to record and what is important can be difficult and could lead to the observer losing motivation and objectivity. Also, there are the ethical issues that come with observing people without their knowledge, and the opposite problem of having the participants being aware of the observer and thus affecting their behaviour. (Matthews & Ross 2010)

Another issue that can arise when using observations is the observer's level of skill especially when it comes to describing and interpreting a situation or behaviour. An observer must be careful to be objective and not let their own views and biases affect how they record and analyse what they see (Turner & Meyer 2000).

2.4.4 Other methods

Some researchers have used psychological or biophysical sensors and similar technologies to study students' engagement. These sensors are used to collect data about the student's physical responses when learning. Miller (2015), used eye tracking and reading times to measure cognitive engagement in reading tasks. The study was based on a number of assumptions about reading behaviour that would indicate engagement such as the reading pace, how long are the eyes focused on a single word or sentence, and the idea that how long the student looks at a

word may indicate an emotional connection. While the technology itself worked as expected in the study, Miller points out a couple of limitations, mainly the fact that it is based on assumptions that may not be always true, for example looking at a word for too long may indicate emotional engagement or that the participant could be looking at the word but thinking of something else. In addition, some age groups like young children may exhibit different behaviour when observed that can affect the results.

Kushnir (2013) used EEG-brainwave patterns alongside a survey to evaluate the effects of using clickers and peer instruction in class. Kushnir looked at the student's brain waves while doing different activities in class and established patterns that emerged in classes that used peer instructions and others that appeared in traditional lectures. The brain waves were used as an indicator of engagement by looking at things like attention, arousal and anxiety based on the neural activity observed. The paper however does not mention how many of the students surveyed wore the EEG headsets that were used to collect the data. It also did not discuss any limitation to the use of this methods or the reliability of the analysis used. Thus, the consistency of the results may be in question.

Shen et al. (2009) investigated using bio sensing to detect emotional engagement when learning in real time by using sensors to record brain wave patterns, blood pressure, and sweat gland activity on the hand. While their study yielded good results in identifying emotions, they had a few issues when collecting and analysing the data that need to be considered when using these methods for measuring engagement. One of the challenges came from the equipment used in the study. The reliability of the sensors' reading can be affected by a variety of things, for example how the electrodes were placed on the skin and how much gel was used under them, even humidity in the air could affect the readings. Another issue was that there was only one participant in the study and his emotions were measured using the sensors only, which makes the reliability of the findings questionable.

The use of these bio sensing and physiological methods can be effective in collecting data about students' emotional and cognitive engagement. However, there is insufficient research about interpreting the data collected, and the results can be speculative. This issue can be addressed by using bio-sensing alongside other methods such as self-report to confirm the findings and correlate what the students report with the readings from the sensors. To add to that, an important challenge these methods face is the reliability of the equipment as well as their cost, which may not be a problem in the future when better, more cost effective sensing technologies are developed. (Henrie et al. 2015b)

The different methods and approaches researchers and teachers used to measure engagement demonstrate how complex engagement is and how the changes in teaching methods, learning environment, recourses available, students background and motivation in addition to many other factors can impact students' engagement at any given time. Thus, choosing the best methods for measuring student engagement in any particular class is a challenge that this work will attempt to address in the case of the flipped classroom.

2.5 Summary

This literature review demonstrated the complexity of studying student engagement and understanding how and why students engage or disengage. Many scholars have attempted to formulate a clear definition of engagement and some of them have more popular definitions than others, like Kuh (2001). However, most definitions are criticised for focusing on specific aspects of engagement while minimizing others or for being too simplistic. What most scholars agree upon on when it comes to understanding engagement is that it is a complex multidimensional construct that is influenced by internal and external factors such as motivation, emotion, learning environment, etc. It is also demonstrated in different ways depending on the context. For example, the students voluntarily asking questions or giving an opinion could demonstrate participation and engagement in a traditional lecture–based class. While posting in a forum or using chatting platforms could be how participation is demonstrated in an online learning environment.

This literature review included examples of the various methods used in research to measure aspects of engagement, which ranged from self-report methods (e.g. surveys, interviews), observations of behaviour both online and offline (using simple observations in class or learning analytics for online environment), and other more complicated methods like bio sensing. The variety of methods proposed and the researchers' continued work to examine new measures shows how complex the problem of measuring engagement is, especially when considering the limitation of attempting not to distract the students while doing research (as it could be a reason for disengagement). This reason was the motivation behind including the second research question in this work. The complexity of the problem and variety of methods makes it especially difficult for a lecturer to apply them while also teaching. Thus, I examined the methods I used as a researcher to collect data on engagement as well as improve it from the perspective of the lecturer to offer suggestions on what methods are most suitable for the task. The main goal of this was to provide lecturers and teachers who wish to understand and monitor engagement with options to do so.

In addition, this review demonstrated the gap in literature concerning the flipped classroom model, which is a form of blended learning that has been advertised as an approach to improve engagement. Unlike traditional and online learning environments, the flipped classroom does not have the same depth of research to understand student engagement or to test methods to measure it. Thus, this study attempts to address this issue and fill the gap by examining the different aspects of engagement within a flipped course offered by the School of Computing Science at Newcastle University.

The next chapter introduces the Ubiquitous Computing module (Ubicomp), a flipped module where this study was conducted to work closely with students and teaching staff on identifying indicators of engagement as well as to test different methods and technologies for measuring and improving engagement.

Chapter 3.
Methodology

3.1 Introduction

This chapter details the sources of data used during this research to collect information on student engagement in flipped classroom. It outlines how the data was collected in the two case studies conducted during the run of the Ubiquitous Computing module in the two academic years 2015/2016 and 2016/2017, the tools used to gather the data, and steps taken to clean and structure the information before analysis. The chapter also describes the quantitative and qualitative methods used to analyse the data as well as the methods employed to validate the results of the analysis.

3.2 Data Sources

In both case studies conducted as a part of this research, data was collected from a variety of sources to cover as much of student engagement in class and online. The data that was found most relevant to answer the research questions as well as the tools used to collect it is described in this section

3.2.1 The student's online activity:

Data on the students' online activity was collected from multiple sources to cover any activity the students engaged in. The main sources of data were

- *Visits logs from WordPress:* WordPress was the chosen platform to deliver the online material to the students in the Ubiquitous Computing module. A plugin named SlimStats was used to track the students' behaviour on the website. SlimStats Analytics (Crouse 2016) is a free WordPress plugin that records user activity on a website by tracking clicks. The plugin creates a record every time the user clicks on a link and stores the information in a database. Each record contains the user name and ID, a timestamp, type of link clicked (internal, external, or download), the name and URL of resource requested when a link is clicked, browser details, and the device's operating system and specifications. The plugin also attempts to calculate the time the user spent on a specific page by calculating the difference between two clicks.

Before the analysis of the log files from WordPress, the logs were cleaned by removing all activity by the teaching team or students who dropped the module in the first two weeks (a number of students either attended the first seminar or created an account on the website but did not show up for the rest of the module). In addition, a couple of students' records were

dropped from the analysis because their browser blocked the tracker so there wasn't enough data collected about their activities on the website.

In the second case study, data was also collected from the plugin myCRED - Version 1.7.9.3 (Merovingi 2016) that was added to the module's website to award the students points based on their activities online.

- *YouTube analytics:*

All videos created for the Ubicomp module were hosted on a private channel on YouTube. Information about the number of times a video was viewed, and access time was obtained using the analytics feature on YouTube, which could be used alongside the data from the website traffic to examine the students' behaviour online.

- *Comments and Tweets:*

The total number of comments that the students made on the website as well as the number of Tweets posted using the module's hash tag were counted manually each week to obtain information on the students' participation online.

This was changed for the second case study and a discussion forum was introduces instead. The data on student's participation online was collected from the students' use of this forum in the second Ubicomp instead of Twitter and the comment section.

- *Quiz results:*

A WordPress plugin called WP-PRO-Quiz (Fisher 2018) was used on the website to conduct online quizzes. The plugin allowed embedding quizzes into the pages of the website and automatically calculated points after the quiz was submitted. WP-PRO-Quiz stored the students' answers, time they took to complete a quiz and total number of points obtained. The plugin did not offer any analytics, so the data was collected and organized for each student manually. Quizzes were used to test the students' preparation before class and the results were used as an indicator of the students' engagement with the course's material.

- *Group Tagging logs and edits:*

Group Tagging was introduced in the second case study and used to collect data on students' activities in class. Group Tagging records the use of the application during sessions and when creating edits. Every clip created is recorded with metadata about who created it, when was it created, the session it belongs to and what the tag used. Edits also have meta data attached to them such as creation time, the user name, the session it was created for, the tags included, length of the video, the title and description, as well as feedback if given.

The students submitted edits created by putting together multiple clips to showcase their participation in activities in class. The lecturer used these edits to mark the student's

participation in class. 18 students consented to the use of their videos (edits and clips) for the study. Additional details on Group Tagging will be discussed in Chapters 5,6 and 7.

3.2.2 Data from class

- *Attendance:*

In the first Ubicomp, the teacher monitored the students' attendance, and a register was taken every week in class. For the second Ubicomp the videos produced by the students using Group Tagging where the source used to monitor attendance.

- *In-class observations:*

Data on students participation in class was collected using an observation form provided by the "Teachers handbook on student engagement" (D. Jones 2009). It was used to note overall class behaviour in the seminars. The form is designed to obtain information on the student's level of engagement in class by observing their behaviour without disturbing them. The observations are carried out by an observer who uses the check list (Appendex A) to rate the level of engagement at any time in five categories; positive body language, consistent focus, verbal participation, student confidence, fun and excitement. The observations were carried out in all seminar classes by the researcher, and sometimes by another PhD student who also attended the classes.

The form was dropped in the second case study and the videos submitted by the students using Group Tagging were used instead as a data source for measuring engagement in class.

In addition, throughout the module, I kept a notebook with observations on interesting things that happened in class and a record of remarks or ideas discussed with the module leader and the students.

3.2.3 Data on student's experience

- *Semi-Structured Interviews*:

For the first study eight students were interviewed after the end of the module to get more in depth understanding of their experience during the course. The students were asked about what they liked or disliked in the course, how they prepared before class, how they handled work load, assessment, course work and group work, and what they thought about the tools and technology used in the module (Bootlegger and the website). Each student completed a short survey created by the researcher (Appendix F) after the interview. They were asked to rate their experience in the course (from poor to excellent), the feedback they received, and study material used. Additionally, they were asked to choose the assignment they found most useful to their learning from a list.

For the second case study, five students (1 female and 4 males) were interviewed after the end of the module for more information on their experience during the module and with Group Tagging. The interview questions were prepared based on the preliminary analysis of the data obtained from the website and Group Tagging logs as well as the observations made during class.

For both case studies, the interviews were each 30-minutes on average, and were audio recorded. The recordings were later transcribed and analysed using thematic analysis. A copy of the interview schedule and questions can be found in the appendix E and J.

Participation in the interviews for both case studies was voluntary. The students were contacted by email and offered an Amazon voucher for participating in the interviews.

- *Interview with the Lecturer:*

The module leader (lecturer) was interviewed after the end of the module in the first case study to talk about creating and delivering the module (interview was conducted and transcribed by a colleague). The transcripts were analyses using inductive thematic analysis. A copy of the interview schedule and questions can be found in the appendix G.

Furthermore, the researcher had weekly meetings with the module leader and guest lecturers in the module. Class activities and assignments were discussed in the meetings as well as students' performance and reaction to past activities. Meetings were informal and not recorded.

However, due to time constraints and the module's leader circumstances, it was not possible to conduct an interview after the second run of Ubicomp

3.3 Data collection and Analysis Methods

3.3.1 Statistical Methods

Several statistical methods were used in both case studies to analysis the data or test for results reliability. This section covers those methods and why they where chosen for this research.

Frequency Distribution analysis:

Quantitative data obtained from The WordPress website, YouTube, and Group Tagging logs were analysed using Frequency Distribution analysis in SPSS. Distribution analysis is often used to summarise large amounts of quantitative data to make it easier to spot trends and interesting features in a data set. Frequency Distribution Analysis creates a table that shows the frequency of occurrence for certain values in the data set. These frequencies are often displayed as graphs to present the data in a manner that is easier to understand and interpret (Pagano 2013).

Cohen Kappa coefficient

The Cohen Kappa coefficient (k) (Laerd Statistics, 2018) is a method to test agreement and reliability between two (or more) raters. Cohen kappa has been used in research as measure of the agreement between two coders in content analysis. It is preferred for this type of analysis since it takes the possibility of chance-agreement into account. In the case studies, Cohen kappa was used to evaluate the level of agreement between two coders who worked on the interviews coding. For each study, a second academic (not the researcher), Cohen Kappa coefficient and SPSS was used to calculate the level of agreement between the two coders.

There are five assumptions that needs to be met to use the Cohen Kappa coefficient (Cohen 1968):

1. The responses made by the two raters must be measured on a nominal scale and the categories are mutually exclusive.

   For this study, the second coder (rater) went through a sample of the interviews transcripts and coded them using the codes that emerged from the thematic analysis conducted by the researcher. The resulting quotes from both coders (researcher and second coder) where checked against each other to examine whether the two coders chose the same quotes for the different codes. Each match was denoted with a "Yes" or 1 and each mismatch with a "No" or 0. These values are nominal and the categories are mutually exclusive. Thus the study design meets the first assumption.
2. The observed data are paired observations of the same phenomenon (both raters assess the same observations.

   Both coders in the study used the interview transcripts and the same codes. So the second assumption is met.
3. Each response variable must have the same number od categories and the cross tabulation must be symmetric (square)

   As mentioned in the first assumption, the coders' responses were translated into two columns with "yes" and "no" which denoted a match in the use od the code. Those columns then translated to "Matched" and "Didn't match" respectively. Thus the third assumption is met.
4. The raters are independent

   The second coder in each case study was an academic who did not take part in the interviews and worked with the anonymised transcripts in a different location. The second coder did not have any prior knowledge about the first coding process and only

worked with the transcripts and codes provided. This ensured the study meets the forth assumption.

5. The two raters were the same for all observations.
   As there were two case studies and two sets of interviews, a second coder was selected for each case study. So the first coder was always the researcher but a second person did the coding to check reliability. Due to workload and the availability of the second person, it was not possible to have the same second coder for both case studies. However, since those studies are independent and the Cohen Kappa was run on both, the study still meets the fifth assumption

For the first case studies, the interrater reliability agreement for the two coders was found to be Kappa= 0.74 ($p<0.001$), and for the second it was found to be Kappa= 0.79 ($p<0.001$). Both show strong agreement.

Correlation:

Correlation is a statistical method used to determine whether two quantitative data items or data sets are related (Pagano 2013). Determining correlation between two items can be useful in predicting future behaviour. There are two important values that need to be considered when conducting correlation analysis, the correlation coefficient and the p-value. The correlation coefficient is the value that represents correlation and it is always in the range between +1 (perfectly positive correlation) to -1 (perfectly negative correlation). If the value of the coefficient is 0 it means there is no correlation and the results are probably random. The most commonly used type of correlation coefficient is the Pearson Correlation Coefficient. It is used to test linear relationships between data sets. The p-value is the probability that the results would be the same if the correlation coefficient was equal to 0 (random relationship or null hypothesis). If the p-value is less than the conventionally accepted 5% ($p < 0.05$) then the correlation can be considered as statistically significant (Pagano 2013).
For the second case study, SPSS and Pearson correlation was used to determine whether there was any correlation between the results from the Motivated Strategies for Learning Questionnaire and the final grades of the students.

3.3.2 Qualitative Methods

This section describes the qualitative methods used to collect and analyse data on the students' experience in Ubicomp

Interviews and Thematic Analysis

Interviews are a common method of collecting data from participants typically conducted using face-to-face communication. It is one of the main methods used by social scientists. It allows for direct interaction between the researcher and the participants and is usually used to learn more about people's feelings and experiences. Semi- structured interviews are a type of interview that have a pre-determined schedule and questions that are open to be expanded on if the conversation warrants it. The researcher can deviate from the prepared schedule to follow up on something the participant said or to probe for more information (Matthews & Ross 2010). Semi-structured interviews were used to collect data concerning students' experiences and feelings during the Ubicomp module as well as the lecturer's experience in creating and delivering the module. Thematic Analysis, which is a widely used method to analyse qualitative data and identify themes (Braun & Clarke 2006), was used to analyse the transcripts of the interviews. In the first case study I used an inductive approach to thematic analysis where the transcripts were first coded and then grouped by themes. For the second case study. A more deductive approach was used. The codes and themes identified in the first case study as well as the preliminary results of the quantitative analysis of data from online activity were used to inform and guide the thematic analysis.

The Motivated Strategies for Learning Questionnaire (MSLQ):

The questionnaire was developed in 1991 by Pintrich et al. as an instrument to evaluate and assess the students learning strategies in higher education setting. Its design was based on general cognitive theoretical framework on motivation and learning strategies. MSLQ consists of two sections; the motivation scale, which includes 31 questions based on the social-cognitive model of motivation (Pintrich et al. 1993) and focuses on three aspects 1) Expectancy, which refers to students beliefs about learning and their perception of self-efficacy 2) Value, which refer to the perceived value of academic work and why students would engage in it 3) Affect, which focuses on test anxiety and students' apprehensions about exams as a way to examine the student's concerns and worries.

The second section is focused on learning strategies; it includes 31 questions concerning the students' cognitive and meta-cognitive learning strategies and 19 questions about how they manage different resources.

Overall the MSLQ consists of 15 different scales; 5 of them fall under motivation and 9 under the learning strategies scale. The different sub scales of MSLQ can be used together or individually depending on the need of the researcher (Pintrich et al. 1991). MSLQ was used in the second case study as a method for measuring cognitive engagement as well as to examine

whether there is any correlation between the students' motivation and study strategy with the performance in the course. Appendix K includes a sample of the MSLQ questions.

3.4 Summary

In this chapter I outlined the data sources that was used in this research to collect data on student engagement. The data was collected from two case studies that took place in the Ubiquitous Computing module that was run in the first semester of the academic years 2014/2016 and 2016/2017. The chapter also included a description of the methods used in collecting and analysing the data in those case studies and the rational behind choosing those specific methods for this research. The advantages and limitations of the chosen methods are discussed in chapters 4 and 6 using the results and finding of each individual case study.

The next chapter introduces the Ubiquitous Computing module (Ubicomp), the flipped module where this study was conducted to work closely with students and teaching staff on identifying indicators of engagement as well as to test different methods and technologies for measuring and improving engagement.

Chapter 4.
The First Ubiquitous Computing Module

4.1 Introduction

This chapter introduces the Ubiquitous Computing Module (Ubicomp), a course designed based on the flipped classroom model and offered to third year students in the School of Computing Science at Newcastle University. It describes the design of the course and the choices made when developing it as well as the delivery of the module during the first semester of the academic year 2015-2016. The aim of this case study was to help understand engagement in a flipped course in Higher Education as well as identify indicators of engagement that can be used as measures of student engagement or as methods to improve it.

The chapter includes a detailed explanation of the data collected to measure engagement during and after the module as well as the methods used to analyse the data and presents the results from each of these analysis methods. Finally, a discussion of the findings on how the students engaged in the module and an evaluation of the methods used is provided.

4.2 Study Context

The focus of this case study was to understand the patterns and trends of engagement in a flipped classroom in natural settings. The aim was to collect as much data as possible to create an understanding of students' engagement and participation inside the classroom and online. Creating the Ubiquitous Computing module was the first step to understanding the context of a flipped classroom and how students interacted within this environment. To do that, the researcher worked closely with the module leader and teaching staff to create a fully flipped module that that was offered to third year students in the School of Computing Science as a part of their degree. The students' interactions and activities online and offline throughout the module were monitored and analysed to identify the patterns and indicators of engagement in this context.

4.3 Design of Ubicomp 1

The first iteration of the course was delivered in the first semester of the academic year 2015-2016. The module serves as an introduction to the concept of ubiquitous computing and provides students with theoretical and practical knowledge on ubiquitous computing as well as its technologies and concepts. The module covers subjects such as context awareness, activity recognition, wearable technology, and the Internet of Things. The course was 10 weeks long

and consisted of 2 hours of seminars plus 2 hours of practicals weekly with one-week break in the middle of the semester.

In preparation for the module, a study of what constitutes a flipped classroom and how it is implemented was conducted. The study included literature on what a flipped classroom is as well as papers and articles written by teachers and lecturers who tried flipping their classes and shared their experience. The work of Bergmann and Sams (who are considered pioneers in the flipped classroom movement) and their own personal experience in teaching a flipped course was the base for the design of the Ubicomp module. Bergmann & Sams 2012 taught high school students and used video lectures as preparation material before class. The students were encouraged to come to class with questions after viewing the videos. In class, the students' questions were answered before they were given the assignment for the day. The assignment could be a problem-solving activity, inquiry activity, or a test. Other work that informed the design was the study conducted by Xin et al. (2013). The study examined the experience of instructors trying the flipped classroom approach for the first time and collected both qualitative and quantitative data to understand the impact of the change on the instructor's preparation, time, and interactions with the students as well as the students' perception of their experience in the course. Other studies that examined the practical application of a flipped classroom are Kim et al. (2014), that details the experience of instructors and students' in three separate undergraduate modules. McLaughlin et al. (2014)'s work on redesigning a course in a health institute also provided useful guidelines on the process. In addition, (Freeman Herreid & Schiller 2012) offered the experience and account of several teachers who tried the flipped classroom model and examined the advantages and disadvantages of the approach based on these experiences.

From the previous literature, we see that the common practice when flipping a classroom is to provide the students with audio podcasts or video lectures (usually accessed online) to be viewed before class. The students are then asked to either answer or come up with questions in preparation for class. In the seminar, the students' questions are discussed and then they are given an assignment to work on in class either individually or in groups.

Two issues when flipping a classroom need be addressed for a successful flip. First: students' resistance to the flip. The students may be unprepared for the change and that may lead to them neglecting the preparation before class. Second, the preparation material whether it is video, audio, or reading, must be created or selected carefully to ensure the quality of instruction as well as engaging students with the topic. The students are asked to do the preparation outside class and away from the instructor's supervision and thus it is important that the material is

interesting and informative to help them prepare for class. The students being prepared and having gone through the material beforehand is essential for the success of a flipped module.

The Ubiquitous Computing module's design took into considerations these issues and the best practices from the accounts of other instructors and combined it with the practical experience of the team of staff members from the School of Computing in Newcastle University. The team consisted of seven people, the module leader (a lecturer), five experts, and one person as the technical support (role assumed by the researcher). The module leader was responsible for making the decisions on the material to be used and how it was presented, delivering the module, and assessment as well as being an expert for two weeks of the course. An expert in Ubicomp was a researcher whose work was within the topic taught in that week, so they had more in-depth knowledge and could answer the students' questions from their own experience. The other experts were lecturers and teaching assistants from Open Lab who helped create the material for the course and deliver it to students. They also answered questions and helped design activities in class. The technical support was responsible for creating and updating the website for the course, shooting, editing and uploading the videos, and assisting the students in any issue with the website or the tools used in the module. In addition to the role of technical support I also worked as a part of the teaching staff designing the course, creating the online material, designing activities, working with students in class (seminars and practicals), and marking at the end of the module.

Ubicomp was designed as a fully flipped classroom, in which the students were given preparation material before class and engaged in group activities in class to further explore the topic they were learning about that week. At the beginning of each week the new material for that week was published on the course's website for the students to go through before coming to class on Friday. In the seminars held on Fridays, the lecturer and the expert answered any questions the students had about the material, and then they worked in small groups throughout the session to discuss and solve problems the instructors' team had prepared beforehand. These activities were chosen by the teaching staff to further expand on what the students had learned from the online preparation material.

The material online was published on a WordPress site designed specifically for the module. The choice of using WordPress rather than Blackboard, which is the learning management system used in Newcastle University, was due to many reasons. First, the ease of navigation, the blog format of WordPress made it easy for the students to find the latest published material, which is usually at the top of the page. Second, the ability to embed videos into the pages (which Blackboard does not support) was an important aspect, as we did not want the students to go back and forth between platforms for the videos and the other material. Third, a dedicated

WordPress website created for one module only would load faster and is easier to access than Blackboard, which is a big platform that contains material for all modules in the the university. Lastly, to make the website more accessible to anyone whether they are students or not since Blackboard can only be accessed by students and staff of Newcastle University.

Each week a new blog post was published containing 3 to 4 videos about 5 minutes long on average. Each video showed the expert answering one question or explaining a concept. Other materials provided in addition to the videos were, a transcript of the videos (for students who preferred reading text to watching videos), two or more academic papers available for download (a required reading), links to articles and videos from external sources related to that week's topic, and a multiple-choice quiz. Figure 1 shows an example of the weekly blog posts.

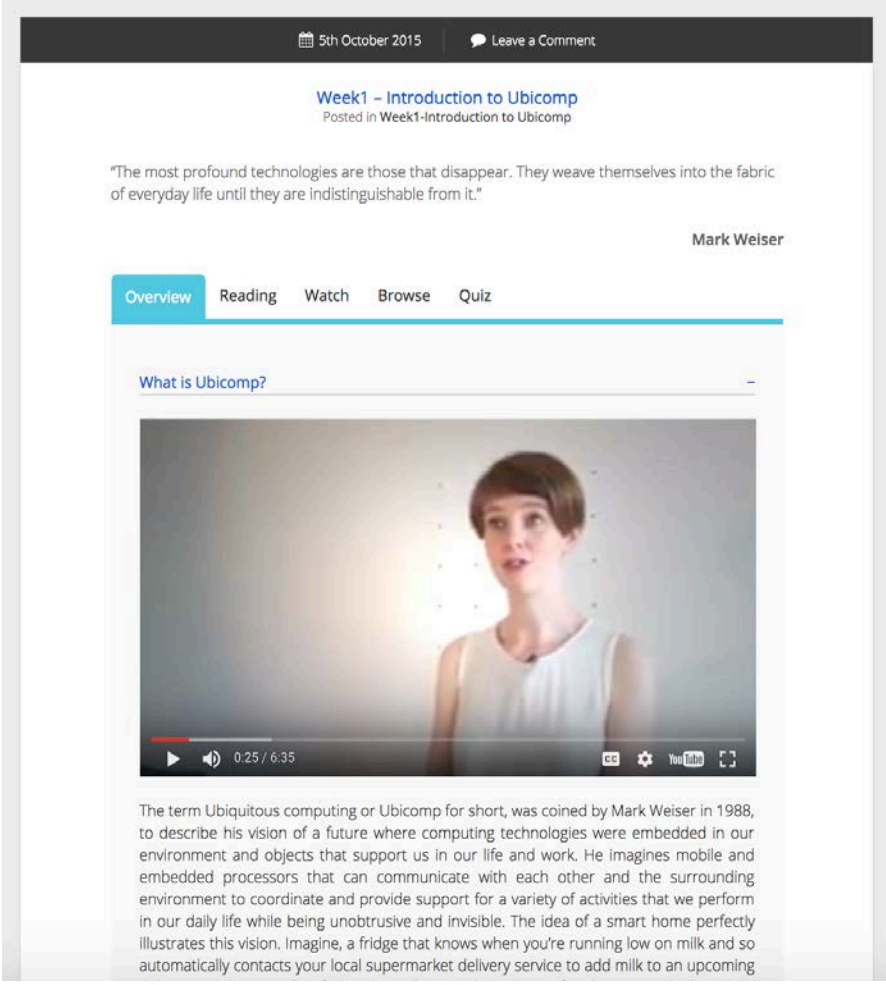


Figure 1 Blog post for week 1 -introduction to Ubiquitous Computing on the module's website

For the two-hour seminar classes each week, the module leader and expert of the week put together two or three group activities for the students. The class started with 10 minutes for questions to address any issues the students had with the material online, and then moved on to the activities for the class. The activities were mostly discussion-based, where the students were given a problem, a situation, or a technology to discuss and then present to the class. They also

did some design activities where they made artefacts (such as fiducial markers or wearable technology) using low-fidelity prototyping materials. The activities were all designed to further explore an idea, a concept, or a technology that was explained in the online material. The students worked in small groups of 4 or 5 and were free to use their electronic devices to search for information online during class.

Moreover, the students had two hours of practical sessions each week. In those sessions the students worked with Raspberry Pi(s) to implement and test some of the concepts they were learning in the course. Also, the last two sessions were dedicated to a project, where the students worked in groups to develop a system for helping isolated older people. They used the Raspberry Pi and what they learned in the practical session to make a prototype.

Assessment in the module was 100% based on course work. The assignments were as follows

- Project report: Each student was required to submit a report explaining the design process, development and rationale of their group's project. This report constituted 40% of their final grade for the module.
- Tutorial videos: The students used a mobile app called Bootlegger (Bootlegger 2018b) to shoot short video clips of their practical session. Then they individually used these clips to create tutorial videos on how to use the Raspberry Pi. Each student was required to create three videos (3 minutes each). This assignment constituted 30% of the final grade.
- Online quizzes: the students were required to take a quiz on the website each week. The quizzes consisted of five multiple-choice questions, which were meant to test the students' understanding of the week's material. The quiz provides immediate feedback to the students and give them the correct answers to the questions as they work through it. They can be taken only once but there is no time limit to how long they would spend answering it. The quizzes were added to the module to address the issue of ensuring the students' preparation before class. The quizzes constituted 10% of the final grade.
- Online participation: Students were required to discuss the weekly material using the comments section on the website or Twitter using the course's hash tag (#UbicompNCL). The assignment was introduced to encourage the students to be thorough in their preparation and engage with the material more. Activity online constituted 10% of the final grade.
- Participation in class: The students' attendance and participation in the seminar classes was required and assessed. This participation made up 10% of the final grade.

Preparation for the module started at the beginning of 2015 and the creation of the website and most of the videos occurred between June and September of the same year. The amount of work required and the time the teaching staff and technical support had to put into it was more than was initially planned, and it was not possible to finish creating all the material for the course before it started in October. Thus, work continued on the videos and other content throughout the first half of the semester which added to the workload of the teaching team but did not affect the students (who were unaware of this).

4.4 Delivery of Ubicomp1

Ubicomp ran for eleven weeks; 10 weeks of teaching with 1-week break in the middle. The module started its first session on the afternoon of Friday the 9th of October 2015. The first session was an introduction to Ubicomp, where the module leader explained the structure of the module, assessment, and work required. The module leader also introduced the concept of Ubiquitous Computing and explained what the course covered and presented the website.

During practical sessions, the students used the Raspberry Pi(s) to test and implement some of the Ubicomp concepts and technologies they were learning about. The module included nine practicals in total; two of the sessions were dedicated to the project at the end of the course. The students were asked to use Bootlegger to document their work in the practical sessions, and then use the video clips they shot to create their tutorial videos. Bootlegger is an Android application for video commissioning that allows several users to join a single shoot and share videos recorded using the app (Schofield et al. 2015). Bootlegger was chosen for the video tutorials assignment because it allowed the students to collaborate on the video creation process. The students were taught how to use the app in the first seminar.

4.5 Methods

4.5.1 Participants

The participants in this study consisted of all the students who completed the Ubiquitous Computing module in the first semester of 2015/2016. All students were third year undergraduates from the School of Computing Science except for one student from civil engineering. The number of students who completed the module was 34; it consisted of 29 males and 5 females. The students were informed of the study on the first day and were given information sheets explaining what the study was about, what information was being collected, the measures put in place to protect the privacy of their data, and the intended use of the data. Information sheets and interview consent forms are included in Appendix B.

4.5.2 Data Collected

Data was collected from a variety of sources to cover as much of student engagement in class and online. Methods chosen were self-report, observations, and learning analytics. Those methods (discussed in chapter 2) were the most suitable for collecting data in Ubicomp as they provided data on the students' interactions online (learning analytics), offline (observations in class), and the students' and module leader's experience (interviews). In addition, these methods offered a lot of data without disturbing the students during the module.

- *Visits logs from WordPress*
- *YouTube analytics*
- *Comments and Tweets*
- *Quiz results*
- *Attendance*
- *In-class observations provided by the "Teachers handbook on student engagement" (D. Jones 2009)*
- *Interview with the module leader*
- *Semi-Structured Interviews*: For this study eight students were interviewed after the end of the module to get more in depth understanding of their experience during the course. The students were asked about what they liked or disliked in the course, how they prepared before class, how they handled work load, assessment, course work and group work, and what they thought about the tools and technology used in the module (Bootlegger and the website). Each student completed a short survey created by the researcher (Appendix F) after the interview. They were asked to rate their experience in the course (from poor to excellent), the feedback they received, and study material used. Additionally, they were asked to choose the assignment they found most useful to their learning from a list.

4.5.3 Data Analysis

This analysis methods used for this case study include:

- *Frequency Distribution Analysis*: data obtained from The WordPress website, and YouTube was analysed using Frequency Distribution analysis in SPSS to make it easier to spot trends and interesting features in a data set
- *Interviews and Thematic Analysis*: Semi- structured interviews were used in this case study to collect the data on the student's experience in the module. Inductive thematic analysis were conducted to identify themes in the students' responses
- *Cohen Kappa coefficient*: The method was used to test the reliability of the coding in the analysis of the students' interviews.

4.6 Findings

As mentioned in the previous section, data was collected from different sources throughout and after the module's end to cover all the students' interactions in the module (online and offline) as well as their feelings and opinions about the module. The students were required to be active and engaged both online and offline and the nature of these interactions varied according to the locations they took place in (in class or online), and the means used (for example talking vs. typing). The findings are split into three parts: online activity, offline activity and the third section contains the data that does not strictly fit into either of those two contexts.

4.6.1 Online data

To keep the terminology clear when I refer to the information recorded by the plugin, I am using the term *visit* or *page visit* to refer to the user clicking on a link to a page within the website. I will be using the term *download* for a click on a download link, *unique download* to refer to the number of times each individual student downloaded a specific resource and *external links* for clicks on links to external web pages.

Traffic and students' activity on the WordPress website

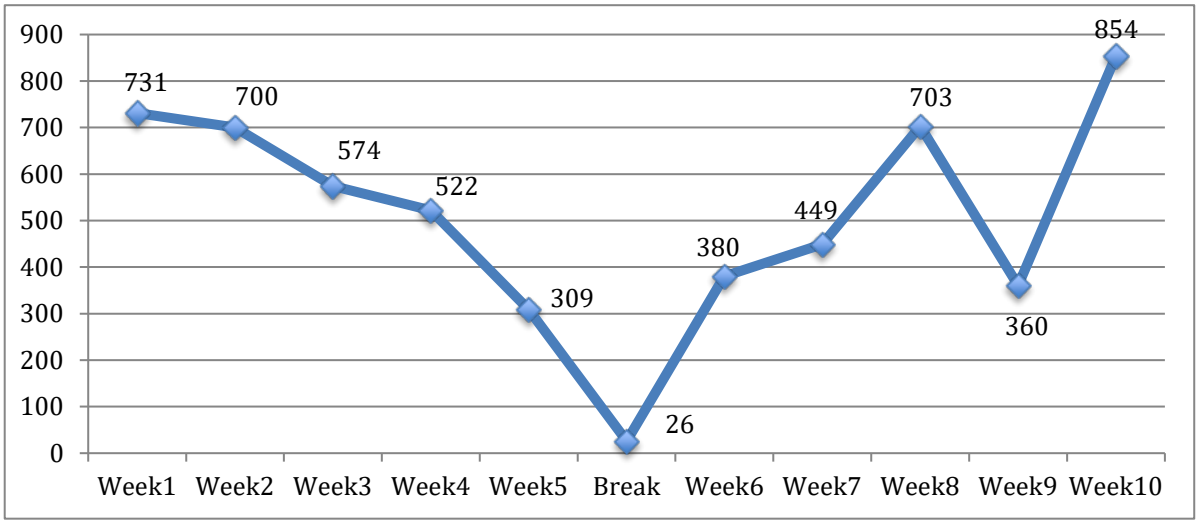


Figure 2 Total number of website visits each week

Figure (2) shows the traffic on the website during the semester. The highest number of visits happened in the beginning of the module when the students were first registering on and exploring the site. It is interesting to note that the weeks 8 and 10, which covered wearable technology and accessibility, had a surge in number of visits that did not happen with the other topics. This would suggest that those topics were perhaps popular or interesting for the students. However, if we compare the numbers to the total number of visits the topic posts for those two

weeks received (Table 1) we can see that the opposite is true. Those topics were the least popular and had less visits than the rest of the weeks' topics. This contradiction can be explained if we add the assignment deadlines, which were at the end of those weeks. The extra traffic was happening because the students were visiting the site to access information for their assignments and to visit that week's topic.

Table 1 also shows that the home page was, as expected, the most visited part due to it being the landing page and the page the user is directed to when they first login. The Course Topics page was also popular as it was a shortcut to reach any topic's post.

Topic	Visit Frequency
Privacy Policy	2
Feedback	11
Contact us	18
FAQ	47
Register	52
Course Work	80
About	94
Download	521
Course Topics	770
Home	1226
User Profile	179
Week1-Introduction to Ubicomp	444
Week2-Context Awareness	409
Week3-Location in Ubicomp	344
Week4-Activity Recognition	332
Week5-Surfaces and Tangible Interactions	223
Week6-Natural User Interfaces	250
Week7-Internet of Things	190
Week8-Wearable Technology	163
Week9-Privacy and Security	204
Week10-Accessibility	176
Total	**5748**

Table 1 frequency of visits to each part of the Ubicomp course's website

The average number of visits per student was 169.9 across the whole 10 weeks. The standard deviation was 84.18, which demonstrates the big difference between the number of visits for the most and least active students with the highest number of visits for a single student being 350 and lowest 44.

Figure (3) shows the number of times the papers were downloaded each week. The quizzes were based on those papers (the required reading) so it is useful to know whether the students did the reading before taking the quiz. The average number of downloads for the module was 52 downloads per week. The average number of unique downloads was 23 downloads per week.

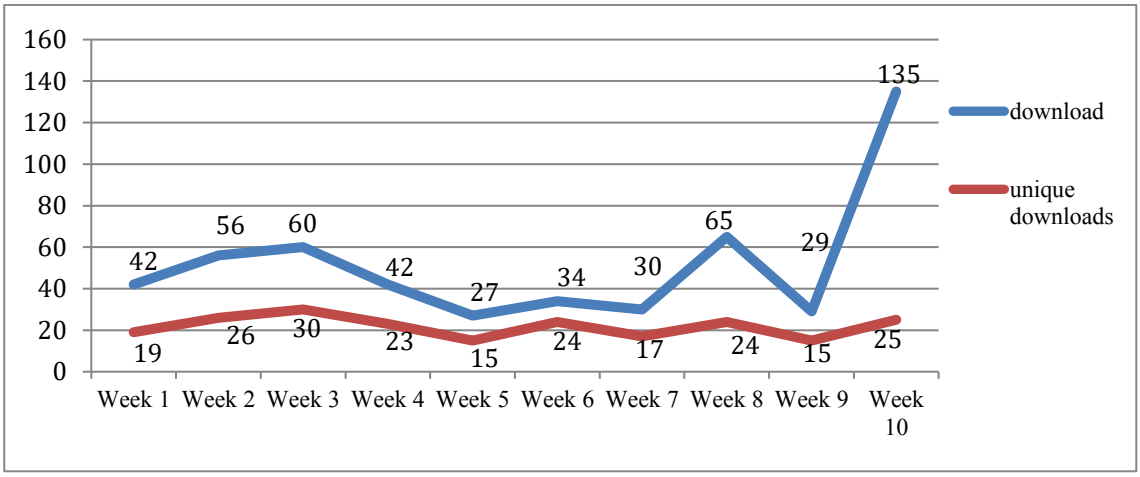


Figure 3 number of downloads and unique downloads per week

Videos watching trends

Table (2) shows information about the short videos included in the topic's posts every week. These videos were recorded by the experts and offered to the students as a quick introduction to the topic before they read the required paper. The following analysis will only consider the video watching trends and not consider whether the students have chosen to read the transcripts of the videos (also provided on the website) rather than watch them, as these choices were difficult to track.

Week	Number of videos	Videos total length (min)	Total number of views	Total time of watched (min)
1	5	21	214	492
2	5	13	147	280
3	6	14	219	351
4	6	29	181	520
5	5	10	123	185
6	5	10	109	164
7	6	23	79	186
8	4	19	45	131
9	5	17	54	110
10	4	23	42	128
Total	**53**	**179**	**1213**	**2547**

Table 2 Videos information

Figure (4) demonstrates a noticeable drop in the number of video views as the module progressed with the last three weeks having the least number of views.

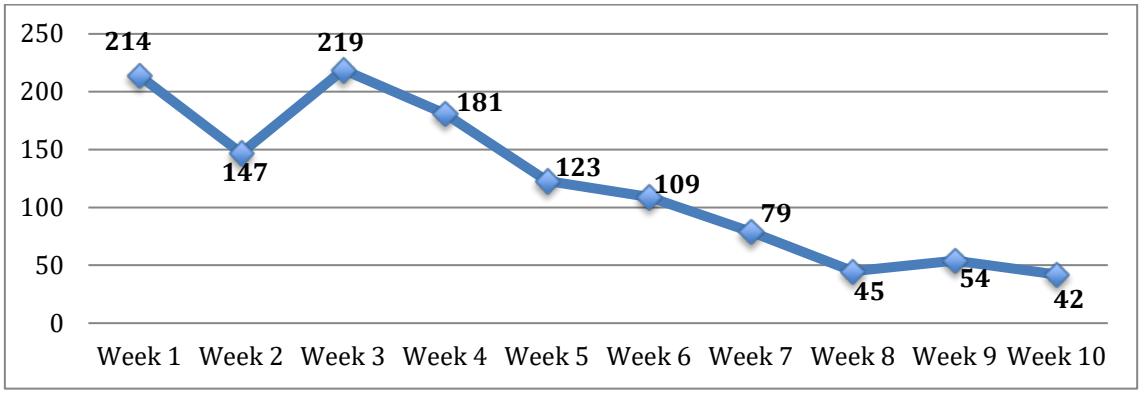


Figure 4 number of video views and watch percentage per week

It is worth noting that two of the most viewed videos on the website were videos shared by the module leader demonstrating how to create a video using Bootlegger. The videos were made to help the students in their video tutorial assignment.

Comments and tweets

The students were required to leave a comment on the topic post each week or Tweet about it using the module's hash tag as part of their mark for online participation. The numbers show that the students were not very active in this assignment and that only a few students regularly commented or Tweeted. The average number of comments per week was 10.3, for Tweets it was 9.4. Tweets were also more likely to be a picture or a remark from the practical sessions rather than a comment on the week's topic or the material discussed in class.

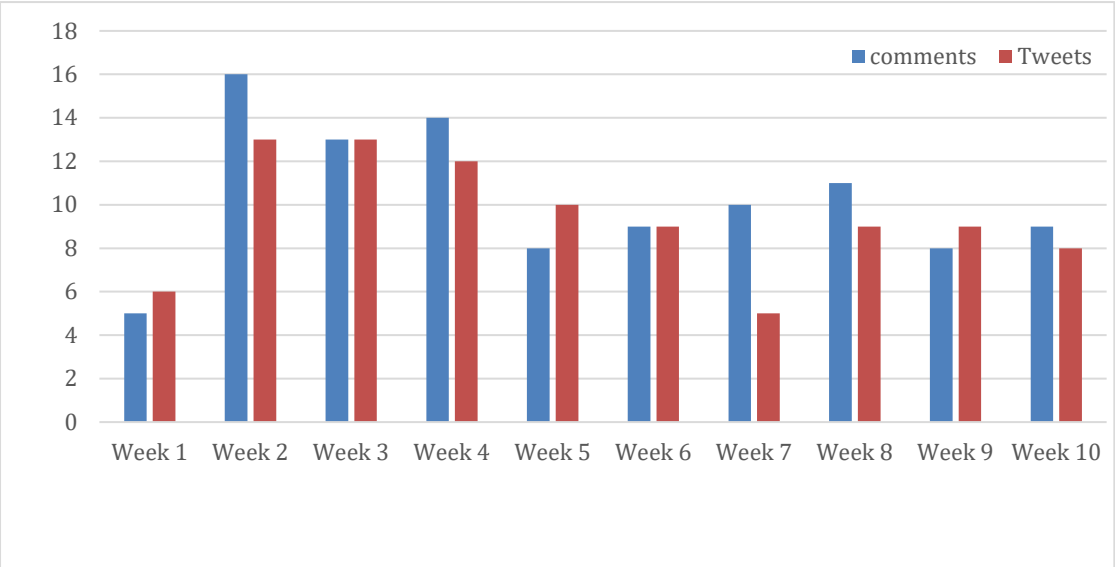


Figure 5 Number of comments and tweets per week

An example of some of the Tweets posted by the students:

"First e-learning tasks completed for #ubicompNCL - bring on Friday class!"

"And the winner from the IoT idea pitching is Team6 with Smart Jack Rack! #ubicompncl"

"It's always fun to explore the potential/limits of wearable tech and AR through Sci-Fi like Continuum and Ghost in the Shell #UbiCompNCL"

85% of the students wrote at least one comment, and 68% Tweeted at least once. Only five students commented or tweeted every week and two students did not do either. Figure (5) illustrates the number of comments and tweets posted every week.

Time spent online

SilmStats, the tracker used to record activity on the website, stores the time the user stayed on a single page without clicking on anything. However, the plugin does that by constantly pinging the browser to check whether the website's page is still open or not. This results in inaccurate numbers since WordPress does not automatically logout users if they were inactive for a long period of time. This means that the user can leave the page window (or tab) open for hours without engaging with it and the tracker would record it as time spent on page. This problem showed clearly in the logs as one of the student's time on page exceeded 24 hours in one visit, which was not plausible. For this reason, this information was dropped from the analysis.

Online Quizzes

The students were required to complete an online quiz each week. The quizzes consisted of five multiple-choice questions for a total of 10 points. The number of students completing the quiz each week was high (average 32 students out of 34) and the results were also good (average 7.77 out 10). Figure (6) shows the number of students who completed the quiz each week, and figure (7), shows the average number of points obtained in the quizzes.

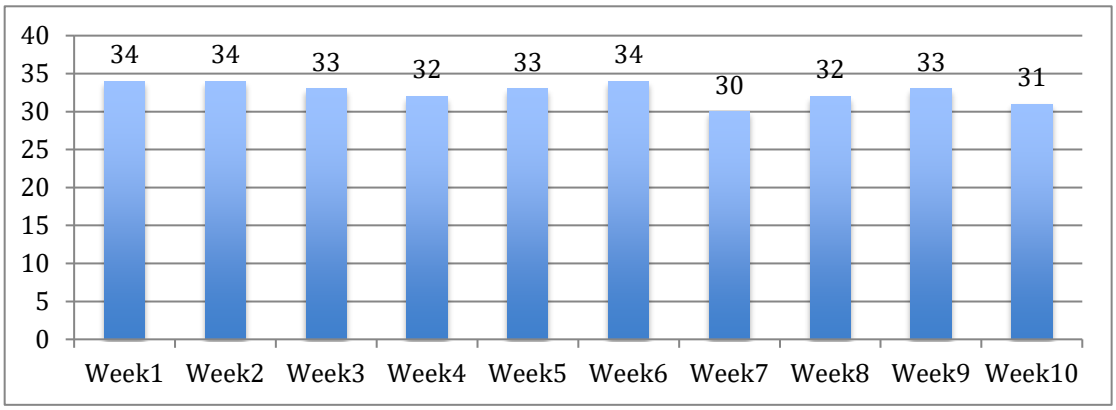


Figure 6 numbers of students who completed the quiz each week

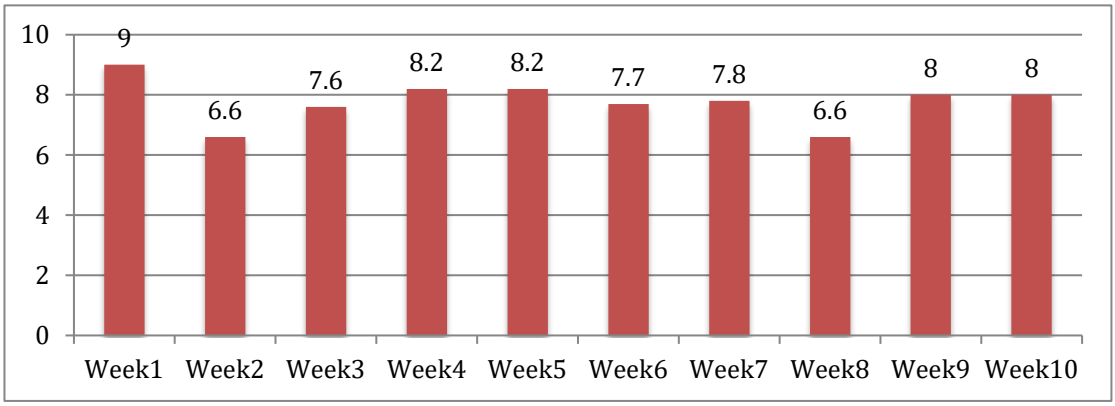


Figure 7 Average quiz scores each week

4.6.2 Offline (class) data

Attendance

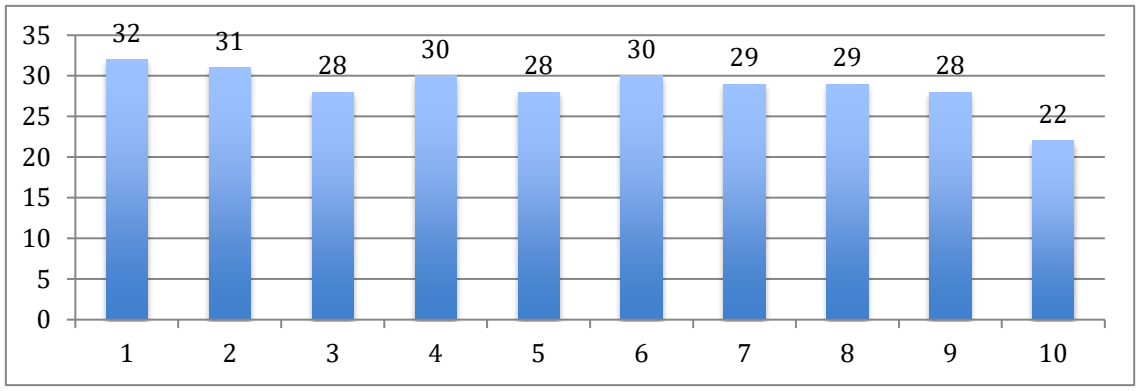


Figure 8 Number of students attending each seminar

The lecturer monitored attendance during the module every week. The average number of students attending the seminars was consistently between 80% - 90% every week with the exception of the last week where it dropped to 60% (figure 8)

Observation on student engagement in class

As mentioned earlier, observation forms (Appendix D) were used to rate the students' levels of engagement during seminars. One or two observers were responsible for completing the form every ten minutes to cover the entire class time and record the level of engagement as class progressed and students worked through the activities. However, due to the main observer (the researcher) having to help in teaching and assisting the students with their work, it was not possible to adhere to the fixed schedule of observations. In addition, the second observer was only able to help occasionally and not in all classes, which resulted in incomplete data about engagement levels throughout the entirety of class time. This issue, which was also mentioned in the lecturer and students' interviews (discussed in the next sections), made the data insufficient to fully understand the students' engagement in class.

Nevertheless, there are few interesting things to note from the data regarding how the students engaged with the different activities in class. Ubicomp included different activities depending on the topic of the week and the concept being taught. The activities can be grouped in to five categories depending on what was required of the students to do.

1- Q&A: the first 10 minutes of every seminar started with the students and the lecturers asking and answering questions about the online material and the quiz.

2- Design: the students worked in their groups to design a new technology or a study. For example, they were asked to design an interactive experience for the visitors of a gallery using proximity sensors. There were a total 3 design activities in Ubicomp (example, design a system to allow "safe walking" for people with dementia).

3- Debate: the students engaged in several debates throughout the module. The activity was about controversial topics such as privacy or the advantages and disadvantage of some of the technologies and concepts of Ubiquitous computing. Each group would adopt a position to argue for with another group or in front of the entire class. The activities were structured so that during the first half the students would work within their group to prepare their arguments, then the second half would be the actual debate. There were 3 debates in Ubicomp (Example for debate topic "Are tangibles useful?")

4- Making and prototyping: there were a number of activities where the students had to create something using low fidelity materials to either show a design or illustrate a concept. For

example, they used play-dough to design and create a tangible interface for a music player. There were a total of 5 making and prototyping activities in Ubicomp.

5- Problem solving: the students were given an issue to discuss and to solve. For example, they were asked to try figuring out what touch technology was used in the ticketing machines in metro stations. Then they were asked to suggest the best technology to be used in those machines based on what they learned about touch surfaces and the working conditions of the machines. There were a total of 3 problem-solving activities in Ubicomp

Table (3) shows the average rating for each type of activity in all five categories. These numbers were obtained from the activities that had at least two forms completed during the activity (two or more points of observations). All activities rated reasonably high for positive body language, with problem solving being the highest (4.7). The same can be noted for constant focus, which had the same score. The other three categories have noticeably lower ratings, especially fun and excitement, with making and prototyping scoring the highest (3.8). Q&A has the lowest rating of all categories (1.9) due to it being mostly the teacher talking and the students only listening. It is also worth highlighting that verbal participation does not have high scores in any of the activities observed even though the activities were designed to promote discussion.

Activity	Positive body language	Consistent focus	Verbal participation	Student confidence	Fun and excitement
Q&A	**3.7**	**3.7**	**2.6**	**2.3**	**1.9**
Design	**3.8**	**3.8**	**3.5**	**3.3**	**2.8**
Debate	**4.4**	**4.2**	**3**	**3.5**	**2.9**
Making and prototyping	**4.5**	**4.4**	**3.1**	**3.3**	**3.8**
Problem solving	**4.7**	**4.7**	**3.7**	**3.9**	**3.4**

Table 3 Average rating for each engagement indicator for activities in Ubicomp

4.6.3 Data on students' experience

This section includes the findings from 9 semi-structured interviews (8 students and the module leader) conducted after the end of the Ubicomp module. The interviews were between 30-40 minutes each and the questions asked were about the students experience in the module and their study strategy. The module leader's interview focused on the workload and on their experience creating and teaching the module. (Interviews questions can be found in Appendix G).

Key themes from students' interviews

Experiencing the flipped classroom

This theme emerged from the answers to questions about how the students would describe the module and the things they liked or disliked. All eight students described the module as 'different' and 'enjoyable'. They cited the unpredictability of activities in class as well as the variety of topics and assignments each week as the reason why they found it different to their normal teaching experience.

Student 3*: "There was course work then there was also the whole participation, there was doing quizzes, it was so diverse compared to other courses and that was really what made it my favourite I guess".*

The students particularly liked the discussion aspect of the course and topics covered by those discussions. They found working with real world problems and technologies that they interact with in their daily lives to be interesting. They also thought that discussing those things among themselves and with the lecturer and experts gave the module a more lively and human feeling because they were people talking about real issues.

Only one student said that they preferred a lecture-based module even though they enjoyed and learned from discussions in class.

When asked about things they thought really worked in the module most of them picked the discussion in class and the practical sessions. The discussions made the course different from their normal learning experience and they enjoyed the atmosphere created in class through friendly interactions and relaxed conversations.

Student 3:" *it's so kind of ...human in a way. Its friendly, everyone is a lot more ... kind of open about, it's a more open environment that I felt comfortable in compared to one it's just like a lecture"*

The practical sessions and working with the Raspberry Pi(s) was also a highlight for most of the students. They liked the link between what they learned from the class and the work they did with the Pi(s), which was always an implementation of one or more of the concepts they learned about that week. However, some of them mentioned they sometimes struggled with the task and didn't finish in time but they still picked it as one of the things they liked the most.

Student 7: *"I liked the linking of the practicals on weekly basis, to what we were talking about... Say for one week we were talking about context awareness and then the next week we go into the practical with the Raspberry Pi(s), and then create a context aware system, so I thought that lent itself really well, like there is a really clear transition from content"*

When asked about what didn't work well in the module, most complaints were about the tools used in the course and sometimes the assessment. Concerning their experience in the flipped classroom, the issues they had were mostly about the connection between the online material

and the activities in class. They all admitted to enjoying the activities but not always understanding the link between what they watched and read online and the problem they were working on in the seminar.

***Student 8**:" like some of the activities [...] just seemed a bit... kind of irrelevant... but... I don't know, I thought [there] was a lot of time spent of stuff like that, whereas there could've been more teaching inside the flipped class"*

Assessment in the module

Assessment was naturally important to the students and the subject came up a lot in the interviews. Although there was a direct question about assessment in the interview schedule the students brought it up unprompted and related it to their overall experience in the module. Generally, the students liked the variety of assessment methods in the module and each picked one or two of the assignments as things they liked in the course, but none of them were happy with all assignments. There were different reasons as to why they liked or disliked an assessment method. The most prominent complaint was about the video tutorials they had to create using the Bootlegger app. The problem however was not the task but the tool they had to use. Technical issues with the app near the deadline caused a lot of stress for the students and they complained about it a lot on Twitter, through email to the module leader, as well as in the interviews. It is interesting to note that they liked the assignment and the idea of creating tutorial videos. 7 out of 8 interviewed said that they preferred it to writing reports or essays and thought the idea creative and valuable.

***Student 4:** "The videos, they were different than you know... and it was a bit weird at first recording the videos but after your first couple, I actually, I actually quite enjoyed it so,.. I definitely prefer that personally to writing reports"*

In addition, they all thought the concept behind Bootlegger was very good and it would be a perfect choice for the assignment if not for the technical issues.

***Student 1:**" It is really a good idea, but it seems like it's in early stages of development, it's not 100% functional yet... it was so stressful especially in third year when you've got a lot of course work, and you are trying obviously to do very well, and it just doesn't work its quite frustrating"*

The quizzes were more divisive for the students. Some of them thought they were a very good method for testing their understanding of the material online as well as an incentive to do the preparation before class. Others thought the quizzes were either too easy and could be answered without reading the paper, or too confusing and hard to answer. They did all agree that the idea of having a quiz either online or at the beginning of each seminar was a good way to assess their preparation and encourage them to be more focused when reading the paper.

Student 2: *"the quizzes is a good idea when the reading is there because it does mean that you're going to read it all to just grab the points."*

Student 5*: "The quizzes that you can do online... I mean I did as well and I know a lot of people did, 'cause there was no sort of time limit or pressure on the quizzes. You could have the document open on one screen and you can just run Ctrl+Find what you are doing, so I know a lot of people did that."*

The assessment for online participation using comments and Tweets was not received favourably in general. None of the students could see the point of the assignment and some of them had a strong negative reaction. They were mostly confused as to what was needed and how they are supposed to learn from Tweeting or writing a comment on the website. Twitter in particular was pointed out as a fun thing to do but not a good way to assess participation. The students who did use it said that it was an easy way to get marks but that they weren't learning anything because their tweets were rarely about the topic.

Student 3: *"I got marks from that, [I tweeted every week] ... but [..]it feels like all you had to do is say that I've done the reading about this week or say I have a Ubicomp lecture and basically get the mark, and it felt like , you can end up with 10% without ... learning anything"*

For the comments section, there were few who liked it and either posted themselves or just went through what everyone else wrote. Others ignored it completely because they were unsure what to write or just weren't comfortable posting things online.

Student 2: *"Sometimes you could tell people were just tweeting like you know to get a mark like it wasn't really useful content, but [often whenever] people commented on the Ubicomp WordPress site like on the blog, it was more meaningful"*

The other two assessments for participation in class and the report weren't mentioned much and even when asked the students didn't have a great deal to say about them.

Experience online

Ubicomp used a WordPress website as opposed to using Blackboard, which is the learning management system that Newcastle University adopts. Thus, the online experience for students taking the module was different from what they experienced in other modules. Generally, the students were open to trying new technology and reported liking that the module used different tools and technology in teaching including the website. The students interviewed were all quite satisfied with the website and preferred WordPress to Blackboard which they described as 'slow' and 'complicated'. They also liked the structure of the website and the weekly blog because it was easy to navigate, and they could find what they needed quickly.

Student 1*: "It was useful 'cause all resources were kept in one place so if you ever wanted to go back and look at anything you had the reading, the quiz, extra materials and the videos and stuff and it was all in one place rather than just scattered about on Blackboard everywhere"*

One issue was highlighted by the students as a problem with the WordPress website, was the fact that it is separate from the University's system. The students had to create a new user account and some of them did not like having many usernames and passwords. In addition, they still had to use Blackboard and NESS for their other modules, which they found to be slightly confusing. However, none of them wanted Ubicomp to drop the website or move to Blackboard.

Student 6: *"like in general it is kind of... A little bit confusing sometimes [...]... This not just for this class but [about] all our classes [..] we have NESS and Blackboard, and [..] some lecturers post the assignment specs on NESS and some puts them on Blackboard and then some over here so... Sometimes it is just confusing having these different systems,"*

Study strategy and workload

Preparation before class is essential in Ubicomp, so the students were asked about how they prepared and the time they needed to finish their work. In addition, how much of the material online they went through weekly was discussed to understand what they found useful and engaging and what they thought they could skip. The students used different strategies when preparing before class. Some of them tried to go through all the materials (videos, papers, external articles, quiz) every week, although they could not always do this because of other coursework taking priority sometimes. Others reported only reading the required paper, so they could complete the quiz and secure the mark. All of them said that they were more engaged at the beginning of the semester and tried to at least check all the resources provided but as the course progressed and the coursework increased for other modules, they started prioritizing and some of the time they allocated for Ubicomp was given to other assignments and modules. Mostly, they reported spending between 1-3 hours per week on Ubicomp related stuff.

Student 1: *" I didn't always watch the videos, [..] I would just do the bare minimum and go for the required reading, do the quiz [and] turn up"*

Student 7: *" I had a lot more modules last year [in] this semester, so I had a lot to do in a week. So, it was a bit of [sort of crammed in the end], I made sure that I got [] basic knowledge"*

The students also had different preferences when it came to the videos. Some of them liked the videos and watched them before reading the paper as an introduction to the topic. Others preferred to read the transcript of the videos because it was faster, and they could skim through it to get a general idea of the week's topic.

Student 5*: "you obviously had that required reading to do, so I would do that first, and then go through [..] the transcripts of the videos rather than watching the videos. I felt like, I thought I found it easier to focus on reading the words... I [felt like zoning out] if I put the little clip on I might be thinking about something else whatever, and it's like background noise, if I am reading something its easier for me"*

One important thing that was mentioned by a student was the effect deadlines had on their preparation and attendance. He revealed that if the deadlines were too close to the seminar time

or the practical session, many of the students would drop class to focus on the assignment. He specifically mentioned the last seminar as an example, which was two hours before the report's deadline. He suggested that many students didn't attend so they could focus on the assignment. As noted earlier (figure 8) that seminar (week 10) did have the lowest attendance during the module.

Working in groups

Ubicomp relied heavily on small group activities in class. The discussions and working in groups was mentioned repeatedly by the students when talking about the module. The students were also asked specifically about how they felt working in groups and if it caused them any discomfort.

Group work and discussions in class was also chosen by all the interviewed students as one of the things they liked about Ubicomp. The students reported enjoying sharing their opinions and listening to others' ideas as well as working together to solve a problem or create something.

***Student 3**: "I really like group activities in class, the ones where we get into groups and write on the poster. I thought that was great because it really brought out everyone's ideas and things, and particularly seeing all the groups, what they've done"*

None of the students interviewed professed any discomfort at doing group work and one student even said that he usually does not like working in groups but in Ubicomp he thought that the activities, topics discussed and the atmosphere in the class in general made it easier for him to engage and talk to his group. However, some of the students thought that others may have been uncomfortable with being a group and were maybe too shy to participate.

***Student 5:** "I got a lot of friends who are more introverted and stuff [..] They totally didn't agree with the discussion getting marked [..]. They might not feel comfortable speaking."*

In addition, the students had questions about accountability in group work. Some of them mentioned people who did not contribute to discussions or groups that had only two or three people doing all the work while the rest just watched. They all thought that for the best outcome from this sort of activity it is important for everyone to participate and since participation is assessed it is also essential to know who did the work and who was relying on others.

***Student 1**: "I observed a couple of teams in a couple of weeks were there is just two people doing the work and the other three were just f** about doing whatever they wanted"*

4.6.4 The module's leader expectations and experience

The interview with the module leader was transcribed and analysed using thematic analysis. The themes that were the focus of the analysis were (i) the module leader's expectation when developing and delivering the module and (ii) her experience during the run of the module.

From the beginning it was obvious that she was very concerned about the reception of the module by the students. In her experience, the different format and activities, which required participation, were not always popular with the students.

"I taught to the computing science students here for 4 or 5 years and I know them to be in general quite anti the use of non-traditional methods in teaching. They normally don't respond to it very well, they find it patronising, they are thinking it's primary school stuff"

However, she believed that this teaching approach could provide the students with a better learning experience and help keep them engaged.

She also had concerns about the material that was given to the students, and whether it was enough, too much, or too little. In addition, she was unsure about allocating time for creating material which could be unimportant nor useful to the students instead of putting that time and effort into something else more beneficial to their learning.

"So, finding the right amount of content to give the students, sort of, the information I think this is still a little bit of unknown for us"

She was especially concerned about the videos, which required the most time and effort to make but the students did not seem to engage with. Moreover, the reason behind that behaviour is hard to determine from the data available to the lecturer. Thus, she was left wondering whether it was a good time investment or not and if the videos should possibly be made differently in the future.

"Data seem to suggest that they stopped watching the videos quite quickly. So it's not really clear to me if that's just 'cause they didn't like the way the videos were made or they didn't think they were good enough quality, or if actually it's quicker for them to read the blog post than to watch the video, or easier for them somehow to maintain attention"

As for the students' reception of the module, the module leader found the mixed evaluation they gave the course a bit discouraging. She thought that some of them really liked it and gave it a high rating while others did not and gave it a low rating which resulted in an average 3 out of 5 overall rating for the course (in the survey conducted by the school at the end of the semester). She thought that their reception of the course could be be related to their learning style and preferred teaching methods.

"I think some of them… either felt like flipped classes in particular were really good 'value for money' or they were completely meaningless. I think that probably would tie back to the kind of student that they are, what kind of learner that they are"

Her experience in the classroom was also mixed. She enjoyed teaching the class and liked the different activities. She also thought that the students' participation was good and enjoyed it as well.

"I enjoyed teaching those, you know, students participated well, there was quite a good turn up, I mean, we were giving marks for turning up, but still there was much better turn up on that than it was in my HCI class"

However, in their feedback some students complained that the classes were too easy, and the teaching was patronizing. The module leader was unsure about this and thought that the friendly environment she tried to create in the class, to help them be more comfortable participating, may have been the reason why they thought that.

"I think at times I was trying to strike the balance of making the learning and the environment in the flipped class feel safe and comfortable, and supportive, and, I think, the students mistook that for being soft and patronising. Where what I was really trying to do was encourage them to participate"

In addition, the module leader highlighted the issue of engagement with some of the activities done in the flipped class. She had noticed that the students would spend a few minutes on the activity, and if they were confused or did not know what to do they would stop working and talk about something else. She specifically mentioned design activities as activities that the students did not engage with much.

"Those activities allowed them to go really off topic, waste time and then think that the course is just a joke 'cause they just sitting there and messing about for 45 minutes."

It is also worth noting that the module leader had concerns during the run of the module about whether the students where learning enough from the flipped class. These concerns where expressed repeatedly in the chats we had during the module and when designing the activities. She was wondering if the group discussions were really helping the students learn from each other or if the fact that some of them are not doing the preparation work before class affected the level of discussion. Another issue that was brought up in those chats was the fact that some students did not participate much in the discussions while others were very active, and she wanted to know what could be done to encourage the passive students to engage more.

4.7 Discussion

The aim of this case study was to investigate student engagement in the context of a flipped classroom to answer the first two research questions of this work. In this case study I started identifying indicators and measures of engagement as well as possible methods to improve it. I also test various methods a lecturer can employ to obtain information on how the students are engaging with the different parts of the module. The previous section of the chapter outlined the results of the analysis of data collected from several sources during and after the Ubiquitous Computing module, and this section focuses on how those results relate to the research questions and aims of this research.

4.7.1 Indicators of engagement in a flipped classroom

Online engagement

Engagement online is an important aspect for determining success in a flipped classroom like Ubicomp. The module was built to provide the students with all the preparation material online, so the students being active on the website and engaging with the material means they were coming to class better prepared, which is an essential part of the success of a flipped class (Bergmann & Sams 2012). Thus, to understand how the students engaged online in Ubicomp, information was collected from the website and YouTube to examine the students' interactions online and how they did their preparations during the module. The students were also asked to talk about their engagement with the online material during the interviews after the course ended to get an insight into their own experience and thoughts.

From the data in figures 2 and 3, we can see that the traffic to the website was higher in the beginning of the module and decreased as the semester progressed. The same can also be seen in the number of video views each week. This indicates that the students were engaging with the material posted online more at the beginning, which was confirmed by the interviews where the students said that they were doing less work due to the increase of coursework from other modules. This is a known issue that was touched upon by (Dazo et al. 2016b) who investigated the video viewing behaviour of students in an flipped classroom and found that the students often do not watch the videos without being prompted and encouraged to do so continuously throughout the course. As this was an issue the teaching staff for Ubicomp was aware of, the online quizzes were added to the preparation as a motivation for the students to read the paper and watch the videos in order to get the marks. In addition, the lecturer would remind the students of what they needed to do for the next class at the end of each seminar and in the introduction video of the week's topic. However, the numbers show that this was ineffective and the students still lost motivation when the workload increased. This prompted an inspection of why the quizzes failed when research such as (Dazo et al. 2016b; Gehringer & Peddycord III 2013) has shown that using quizzes and reminders before class encouraged the students to prepare and improved their performance. To understand the issue; the results of the quizzes as well as the number of times papers (that the quizzes were based on) were downloaded was examined together again. As the findings previously showed, the number of times the papers were downloaded averaged at 52 (42.78 without adding the last week's downloads which was a big increase that happened due to the students needing the papers for their reports) with an average of 23 unique downloads. This indicates that an average of 23 out of 34 students were downloading the papers every week with some of them downloading them multiple times or downloading the extra reading as well. Comparing downloads to the number of students

completing the quizzes, (average of 32 out of 34) and their scores (average 7.7 out of 10) showed a discrepancy. The number of students downloading the papers is lower (figure 3) than the number of students completing the quiz and scoring high (figures 6 and 7). Moreover, if we examine the weekly number of downloads compared to the quiz results of that week rather than averages, we can clearly see the weeks with low number of downloads have similar results for the quiz to the weeks with higher number of downloads. For example, week 5 which had the lowest number of unique downloads (15), has 33 students completing the quiz with an average score of 8.2 points, which is the second highest score in the module. The above inconsistency in what the data show can only be explained by the students themselves and they talked about it during the interviews. As mentioned earlier, the students have confirmed doing less because of the increased workload as the semester progressed. They also talked about how the quizzes were easy to answer without doing the reading. While some of them found the quizzes a good motivation to prepare before class, others thought that the answers to the questions in the quiz were sometimes easy to guess or to search in the .pdf of the paper or on Google. Thus, it was possible for many students to pass the quizzes with high marks without doing any of the preparation. This clearly proves that the quizzes by themselves were not enough motivation because they were not challenging enough and that the students when pressed for time will look for any shortcut available to complete the work.

What the previous results show is that the traffic to the website and the video views were a better indicator of what the students were really doing online and that the quizzes have failed as an incentive and an indicator of engagement.

Another aspect of engagement that needed to be inspected is the comments and tweets the students posted. This was a marked assignment and was introduced to increase student's engagement online by encouraging discussion. The findings indicate moderate participation on both the comment section and Twitter. Some students were posting frequently on either or both websites but the majority either did not post at all or did it once or twice only. The task did not produce the intended discussion as the students found the idea confusing and did not know what to post. Thus, most of the posts were isolated opinions that other students rarely responded to. The tweets were even less useful, as the students did not see it as a learning tool and used it to post pictures from the seminar and practicals or just put a comment about what the week's topic was. Therefore, the results from analysing the students' posts and tweets did not produce useful information on engagement. Nonetheless, it was valuable in understanding the students' perception and experience with posting comments online and using Twitter.

Offline engagement

The previous section focused on the students' engagement online which is the preparation part of a flipped classroom model. This section will examine what was learned about the students' engagement offline or more specifically engagement in class. The data used to explore this part of the module comes from the attendance records, observations and the students and module's leader interviews.

The first thing to consider is attendance as the flipped classroom model requires the students to be in class and engage in supervised activities designed to further what they learned from the preparation material (Bergmann & Sams 2012; Xin et al. 2013). Thus, the attendance of the seminars in Ubicomp was important to provide the students with the best learning experience. In addition to that, there is a large amount of research in higher education that shows a positive, though weak, correlation between attendance and academic performance (Durden & Ellis 1995; Gatherer & Manning 1998; Credé et al. 2010). Therefore, attendance can be a good starting point when studying engagement in class.

For Ubicomp, attendance was high and at least 80% of the class were present every week except for the last week which had only 60% of the class attending the seminar. This was explained by a student later as being caused by the deadline for the report falling only two hours after the seminar. Consequently, some of the students chose to work on the report rather than attend class. These numbers are quite good and were maintained throughout the module, and it shows that the students were engaged and motivated by the activities in class enough to show up every week and not skip the seminars.

Observation data collected during the seminars was insufficient to draw conclusions about engagement in class. As mentioned in the findings, the observer was unable to keep a fixed observation schedule and the colleague who assisted was not always available. The information gleaned from the data available shows the students being highly engaged verbally and having a positive attitude albeit not much fun. However, talking to the module leader revealed that her observations did not match what was on the observation forms. She mentioned noticing the students losing interest halfway through the activity and going off topic, which would look like a highly positive verbal engagement to an observer watching the whole class but was not a reality. This demonstrates that the instructor, who is working closely with the student groups is in a better position to observe engagement, but they don't have the time to fill the forms while assisting the students in their work, which is their main concern. Therefore, I can conclude that observation of the students' interactions in their groups can provide good information about their engagement in class, but the method used to record the information must be chosen carefully so as not to disturb the students and burden the instructor.

That leaves the interviews with both the module leader and the students as the main source of in depth information on engagement in class. The interviewed students indicated liking the seminars and enjoying the activities. They found group work to be fun and engaging but were not all satisfied with the perceived learning outcomes from those activities. The module leader also had concerns about learning from the activities and thought the students did not take them seriously because they thought it was 'what you do in school rather than university'. The students themselves also confirmed the module leader's observations above about them losing interest and going off topic. In addition, the issue of balanced contribution in group work was also mentioned. The students thought it was not fair to assess participation in class based on group work because not everyone was participating equally. The module leader had the same concern about encouraging quiet students to participate and engage more, not just for assessment but also for a better learning experience to all students.

From all the above we can see that the students found the seminars interesting and thus their attendance was high but they did not always understand or engage with the activities in class. They thought it was a fun experience that was different from the traditional teaching they were used to but did not feel that they were learning much in the seminars. This suggests that the seminars can be very engaging if the right activities were included, especially activities that can motivate the students to participate more.

4.7.2 Evaluation of methods used to study engagement in Ubicomp

One of the goals of this research is to provide suggestions on methods an instructor can use during their courses to understand how the students are engaging with the class and the material. Accordingly, this section focuses on critiquing the methods used to collect data on engagement to examine how suitable they are for a lecturer teaching the module.

Learning analytics

As the previous discussion on online engagement showed, data on website visits, number of downloads, and video views can be a good indication of the students' engagement. Hence, having this data available to the lecturer throughout the semester can help him/her identify specific points in the module that may require change to be more engaging as well as providing information on how individual students are faring. However, the method of collecting the data and how it is presented is very important in this case. The lecturer, unlike the researcher in this study, does not have the time to clean the data and run the analysis multiple times. This means an automated way of collecting, cleaning, analysing, and presenting the data is needed to provide the lecturer teaching a module with up to date information on engagement.

For Ubicomp, the choice of Wordpress as the platform for delivering the material meant that the data collection had to be done using existing traffic trackers that are developed to show the blog owner the most popular posts for placing advertisements or to provide more content like it. The resulting data, while being comprehensive, required a lot of work to clean before analysis. It also needed knowledge of how the data is stored in the database and how to use statistical packages and software such as Microsoft Excel and SPSS to run analysis and produce graphs. That makes following the same method used in this study by a lecturer, without assistance, very difficult. However, using a learning management system (LMS) such as Blackboard and Moodle can solve this problem since these platforms offer analytics tools that track the students while on the website and present the data in a way that is easy to understand (D. Y. Liu et al. 2015; Macfadyen & Dawson 2010). The issue then would be to choose the platform that offers what the lecturer and the students need, considering accessibility, ease of use, and extra functionality, while at the same time having good analytics tools to provide the lecturer with enough data to assess engagement.

Observation forms from the Student Engagement, Teacher Handbook

Observation of the students' interaction in class can be a very useful tool to measure engagement. The method that was chosen for this case study was a simple form (Appendix D) that was converted to an electronic format and published online for easy access. The electronic form was designed to be mobile friendly, so a lecturer can quickly and easily fill the form on their phone while doing other tasks in class. However, that did not work as intended due to the need of fixed schedule of observations. The form needed to be filled frequently (every 5 to 10 minutes) to produce enough data on the level of engagement throughout the seminar and during the different activities. The observer in this study was not the main lecturer but still had to help with the activities sometimes and that interrupted the observation schedule and resulted in insufficient data. This means that in order for the observation form to be useful, the observer must be completely focused on the observations and not be involved in anything else in class. That naturally excludes the lecturer and requires an additional person to take the role of the observer.

Another issue that was revealed with the forms when analyzing the data was the validity of whole class observation for small group activities. The observations do not show how individual students were engaging in their groups and could not tell the difference between the students working on the activity or discussing something else unrelated. This problem can be solved by having multiple observers each observing one or two groups at a time or have the one observer watch different groups each class (Matthews & Ross 2010). Clearly, these solutions will either require more people in class as observers, which may not be possible and can also

be distracting for the students, or produce a small amount of data per group, which would not be enough to understand their overall engagement.
Therefore, while the forms can be a useful tool to measure the levels of engagement a couple of times during the module (provided there is an observer available), it is not a suitable method for collecting information on engagement in every class, especially in the classes that involve small group activities.

Semi-structured interviews with the students

The literature review on measuring engagement in chapter 2 detailed self-report methods, such as interviews and surveys, and how they are the most commonly used method for measuring student engagement. The interviews conducted for this case study provided very useful information about how the students themselves thought about engagement and the module as a whole. The interview with the module leader was also very helpful in understanding their perception of the students' engagement and highlighted problems with other methods used in the case study. However, the main issue with interviews is that they cannot be conducted frequently during the module and that the transcription and analysis is time consuming (Henrie et al. 2015a). The interviews in this study were conducted to obtain in-depth information from the students to help explain the findings from the other data sources but they are not a suitable method for a lecturer to get feedback from the students during the course. Other than the time it takes to conduct the interviews, there is also the issue of the students being honest in their feedback because of the power relationship between lecturer and student, which makes informal chats an unreliable source of information as well (Fredricks & Mccolskey 2012).
It is important that the lecturer talks to the students and ask for feedback, but interviews are not the best method for a lecturer who wants to obtain data on student engagement.

4.8 Summary

This chapter focused on exploring engagement in a flipped classroom and testing some of the methods normally used to measure students' engagement. It introduced the Ubiquitous Computing module that was created for the study and discussed the design decisions that shaped the module as well as the creation and delivery of the material. The chapter also details the data collected for the study and the analysis methods and tools used to understand and measure engagement both online and offline. The findings show that the flipped classroom model can engage students if the right tools and incentives are employed. It demonstrates that the students can easily be overwhelmed with coursework and neglect preparing before class, which is an integral factor in the success of a flipped class. In addition, the results suggest that observations

of the students' behaviour both online and offline can be a good indicator of engagement. The chapter also outlined the advantages and disadvantages of the methods used in this study for a module leader or a lecturer wanting to monitor engagement in their flipped courses.

The following chapter describes Group Tagging, a tool developed to encourage reflection on group activities and improve participation. The tool can also provide both the researcher and lecturer with information about an individual student's engagement in class as well as the group dynamics in small group activities. Many of the requirements for the design of this tool are based on the results and findings of the case study in this chapter.

Chapter 5.
Group Tagging

5.1 Introduction

There is an agreement that participation in class activities is a good sign of engagement (discussed in chapter 2), but in the previous case study engagement in those activities was hard to measure, and at times viewed to be sub-optimal. In this chapter I explore in detail an intervention aimed at improving engagement in these group activities, as well as helping the lecturer understand engagement in class. This chapter introduces Group Tagging, the tool that was developed as part of this research to explore the impact of video-supported reflection on participation and engagement in-group activities in class. The chapter examines the issue of participation and engagement in small group activities and possible solutions, and also examines the requirements for a group activity to be successful in a flipped class such as Ubicomp. It then details the design and development process that led to the creation of the first prototype of the Group Tagging Application and the technologies that inspired the different features and functions included in the tool. Finally, a detailed explanation of the various modules of the app is provided accompanied by pictures of the interfaces.

5.2 Rationale for Developing Group Tagging

Many researchers have presented the flipped classroom as a teaching method that is more engaging to the students than traditional teaching (Gilboy et al. 2015; McLaughlin et al. 2014b). This idea was challenged by some studies that argue the improvement in student engagement was not due to the flipping but as a result of using active learning in the flipped classroom model (Tune et al. 2015). Active learning is an essential part of the flipped classroom model and thus it is important that the students are sufficiently engaged in class to obtain the intended benefits of using the model (Berrett 2012). Active learning in a flipped classroom includes individual or group activities that are designed to engage students with the material they already studied before coming to class. Mostly, instructors use small group activities when flipping their classes as they provide the added advantage of collaborative learning and peer support as well as making larger classes more manageable (Bergmann & Sams 2012). Collaborative and peer learning have been proven to be effective in stimulating critical thinking, developing problem solving skills, constructing shared knowledge, encouraging social interactions, improving team work and supporting the instructor in managing the different levels of skills and knowledge between the students in the class (Bossert 1989; Michaelsen et al. 1997; Roschelle & Teasley 1995; Johnson et al. 2000).

To create a successful group learning activity there are five elements that need to be present

1. *Interdependency*: a shared understanding of the value of each person's contributions to the group and the importance of depending on each other to succeed.
2. *Accountability*: each person must be aware of their personal accountability and the importance of doing their own part.
3. *Social and group skills*: the students need to be able to communicate and work together effectively.
4. *Team reflection*: the students must be able to work as a group to set goals, identify problems as well as work together to solve these problems as a team
5. *Face to face interactions* with teachers and peers to allow for timely support and feedback (Johnson et al. 1991).

All these elements are important in group activities but challenging to implement and instructors have been reporting problems that are usually a result of one or more of these elements not being incorporated into the activity. For example, the absence of interdependency can lead to disproportionate participation within a group, where one or two students dominate the discussion, leading to quieter students being unable to participate (Michaelsen et al. 1997). In addition, some students may opt not to do the work and rely on the other members of the group to get things done, which is a phenomena known as *social loafing* and is a direct result of the lack of accountability in group work (Karau & Williams 1993). There is also the issue of the group getting distracted or bored and straying off topic, which can result in not implementing proper team reflection and can also lead to a more simplistic presentation of results being reported back to the instructor (Michaelsen et al. 1997; Barkley et al. 2014).

These issues manifested in the first run of the Ubiquitous computing module (detailed in chapter 3) and it was apparent from the students' feedback that some of them did not think there were learning anything from the activities and considered them fun, but not educational. To address these issues and improve students' experience and engagement in class activities, the teaching team discussed the idea of introducing reflection to group activities as a potential solution. This was considered due to the presence of strong evidence in literature that reflecting on an experience is more effective for learning than repeating that experience (Di Stefano et al. 2014; Kharrufa et al. 2010). Reflection can be used to encourage the students to consider what they are doing, focus more on the task, and review what the group did afterwards.

Reflection can be used both during or after a learning activity (Nunes et al. 2003) to help students think about and analyse their own individual thinking (metacognition) and behaviour

(Boyle 1997). For reflection during an activity, students can be prompted by the instructor or technology to pause and evaluate their work so far (individually or as a group), which allows them to assess their progress and decide on how to proceed (Kharrufa et al. 2010). Reflection after an activity can happen by requiring students to reflect on a task with assignments such as reflective essays, videos, or face-to-face discussions with peers or the instructor. This type of reflection supports students in identifying mistakes and behaviours that can be improved. For example, the students can reflect on why a task failed and decided to try a different approach in the future. It is also useful in showing the students what they did well (whether in terms of the mechanics of their group work, or in terms of task related activities/discussions) and how it helped them in their work (Collins & Brown 1988).

In addition, introducing reflection as an assignment for the students could help the module leader evaluate activities in class and fix anything that is not working as well as provide him/her with additional information on engagement in class. The students' reflections can provide a window into group interactions that are difficult to assess by observing the groups from an outsider's perspective.

There are several ways that can be implemented using various tools and techniques during a course to prompt reflection, such as requiring the students to write a reflective essay (can be in text, video or audio), creating an e-portfolio, or discussing the activity later with other students or the instructor (Kori et al. 2014). As technology is being integrated more and more into the students' daily lives, a tool can be designed to guide their reflection and help them through the process.

5.3 Designing Group Tagging

It is important to ensure that any new technology introduced to students is designed to be useful and easy to use so as not to burden them or add undue stress. There is a need to make decisions on what features to include and why, as well as to ensure that there is a logical objective and a learning outcome from introducing this technology. The main aim of Group Tagging is reflection and so it is essential that the design of the tool provides the students with the best possible method for reflection. The next section will cover some of the literature on reflection, its benefits and how to implement it in a classroom as well as the technologies that inspired the design of the app.

5.3.1 Reflection for learning

Reflection for learning is not a new concept and there have been many studies that examined the benefits of reflection on learning. (Di Stefano et al. 2015) studied the effect reflection has

on improving learning. By experimenting in the lab and the classroom, they found that an individual's learning is strongly and positively impacted by thinking about what they did. That impact is stronger than the effect of repeating the task and lasts longer as well. They argue that reflecting after completing a task is a powerful way of augmenting the learning process. However, reflection needs to be a structured process to ensure the students get adequate support and guidance to achieve the best outcome. This problem can be addressed with reflection frameworks. Ellis et al. (2014) studied the effectiveness of what is called "Systematic Reflection", which is the process of having the learner consistently analysing their behaviour and evaluating their own contributions when completing tasks. Systematic reflection comprises of three steps that need to occur for the process to be effective. The first step is *self-explanation*, in which the learner is asked to analyse and evaluate the outcome of the task and try to explain failure or success. The second step is *data verification*, which includes exposing the learner to the data from a different perspective. The aim of this exercise is to lessen the effect of any possible bias. It allows the learner to look at the experience without being influenced by the outcome of the task and forces them to consider aspects of their performance that they may overlook otherwise. The third step is *feedback*, which includes the feedback that results from the analysis and evaluation process itself as well as any feedback given after the completion of the task.

The use of systematic reflection can be helpful for students in a flipped classroom. It allows them to look back at the activities in class and analyse their group's performance. Strayer (2012) even argues that reflection is an essential part of the feedback cycle that must be implemented for a successful flip.

For Ubicomp, it was decided to use video-supported reflection to provide the students with a different perspective on their participation in class and allow them to review the highlights of their groups' discussions afterwards. A video can provide a rich source of data on the experience and allows the student watching to see things from another point of view. It also minimizes the reliance on memory to recall what happened as well as provides the opportunity for noticing details that may not have been apparent during class (Sherin & van Es 2005). Using video reflection is method that is widely used in training and education and it has been demonstrated by many studies to be an effective method of learning (Sherin & van Es 2005; Cutrim Schmid & Schmid 2011).

An example of using video to encourage reflection is the study by Fadde et al. (2009) who designed a video-editing activity for a teachers' preparation class. The activity consisted of recording the participants' teaching in class and then giving them the video on a DVD afterward. The participants were then asked to watch the videos and write a reflective analysis

report. Later that assignment was changed, and the participants were asked to select two or three segments (2-3 minutes each) to be edited and uploaded to an online platform in addition to writing a report. The aim of the study was to see if having the participants edit the videos would make them more reflective. They found that participants who did the editing were more self-critical when video editing was added to support their analysis of their teaching. The participants reported feeling nervous about being filmed, yet they appreciated the opportunity for self-reflection. However, the activity was for individual participants and was both resource and time consuming. It was also the only work required of the students in the course, which is not the case for most other courses.

Another example is Reflectable (Hook et al. 2013), a digital learning environment that combines design activities with video-led reflection. The students work together on a design game and the process is video recorded. Each student is given a button that they can press if they feel that something important happened (Hook et al. 2013).

There are many examples where video-enhanced reflection was employed in higher education in the medical field, teachers training, and psychology (Birbeck et al. 2015). These types of training programs (medical, teaching, psychology) require students to record videos of their practice and then reflect on them by writing an essay or editing them to create short videos for a presentation. However, there is no simple tool that is suitable to be used in different classes regardless of topic or type of activity, while not requiring the students to learn new skills (such as video editing). Thus, addressing this issue and developing an app that can be used by all students in any learning environment was one of the main concerns when designing Group Tagging.

5.3.2 Technologies and tools that inspired the design of Group Tagging

There are a few tools that have been used for reflection on learning as well as tools that can be used to collect information on student engagement in class for reflection and assessment. The following five technologies were considered as a possible solution to the problem of measuring engagement in class, and then became an inspiration and a model for the design of the Group Tagging app.

1. Group Spinner

Group Spinner (Kharrufa et al. 2017) is a tool that was developed to help teachers observe students' behaviour in the classroom. The tool was developed to allow teachers to observe and record positive behaviour in group activities in class. Group Spinner aims to provide teachers with information about the students learning in a collaborative learning environment. The

process of using the tool and the resulting data gives the teacher a visual record of the gradual development in the students' learning and behaviour over time. The tool was specifically designed for classes that employ Self-Organized Learning (SOLE) (Mitra 2015). SOLE is a new learning approach where the students are given an open question and asked to work in groups to find an answer. The students use the Internet to search for information and work in their own groups without the teacher's intervention.

Figure 9 Annotated crop of Group Spinner's interface showing current and previous session graphs with some indicators (Kharrufa et al. 2017)

Group Spinner uses a five-axis radar chart, see figure (9). The axes (Information seeking, Outcomes, Collaboration, Working within SOLE, Motivation/Engagement) were chosen based on learning behaviour and activity theory, as well as the teachers input from a focus group. Each of these axes has a set of indicators that can help the teacher understand the chart and know what to look for when observing the students' groups. The teacher has the option to use the indicators themselves and assign them values that will be translated to a visual representation on the radar chart, or they can manipulate the chart directly by dragging the axes themselves to the desired location.

Group Spinner was in the development phase when Ubicomp was running, and it was suggested as a tool for in-class observations in the next year's Ubicomp. The suggestion was to provide the lecturer with a more accurate idea on students' engagement in class, and to address her concerns about whether the students where learning from the group activities.

However, upon testing the tool, it was found to be unsuitable for Ubicomp. In the first place, it was designed for classes that use self-organized learning where the students construct an answer based on research, and then present to it class. Ubicomp on the other hand is a flipped class that has different activities planned, some of them for the individual students and others for groups. The lecturer is also more involved in monitoring the students and helping them throughout than in a SOLE session. Therefore, while it was possible to use the tool with an external observer, this approach has proven to be inadequate in the previous run of the module when using the observation forms. In addition, using an external observer would not help the student reflect on their group activities, which was something we wanted them to do to enhance their learning experience. Nonetheless, Group Spinner provided an interesting insight on the benefits of visualizing engagement and using a few simple points to measure aspects of engagement as it happened in class. The study conducted with Group Spinner also offered very useful information on added workload for instructors by exploring the teachers' experience with the tool and how they managed to fit it in their class.

2. ReflecTable

ReflecTable (Hook et al. 2013) is a virtual learning environment that was designed for reflection on design activities in design education. The aim of the project was to bridge the gap between the theoretical and practical parts of the design process and to encourage students to reflect on their activity. ReflecTable consists of a paper-based design game played by 3 to 4 students, a video recording system that captures short clips with a press of a button, and an application on a tablet that can be used to review the recorded clips (figure 10). The students play the game and go through the stages of the design process, using the buttons provided to pinpoint noteworthy moments they want to record.

This could be a breakthrough moment or something they want to go back to and discuss later. After the game the students use the application individually to watch and annotate the

clips that resulted from the button presses during the game. In the end the application displays a panopticon video rendering of the whole game (figure 11).

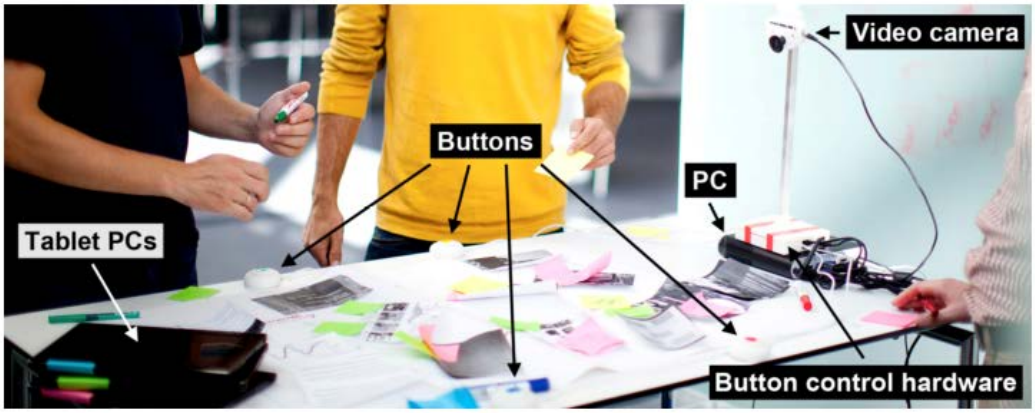


Figure 10 Key components of the ReflecTable system (Hook et al. 2013)

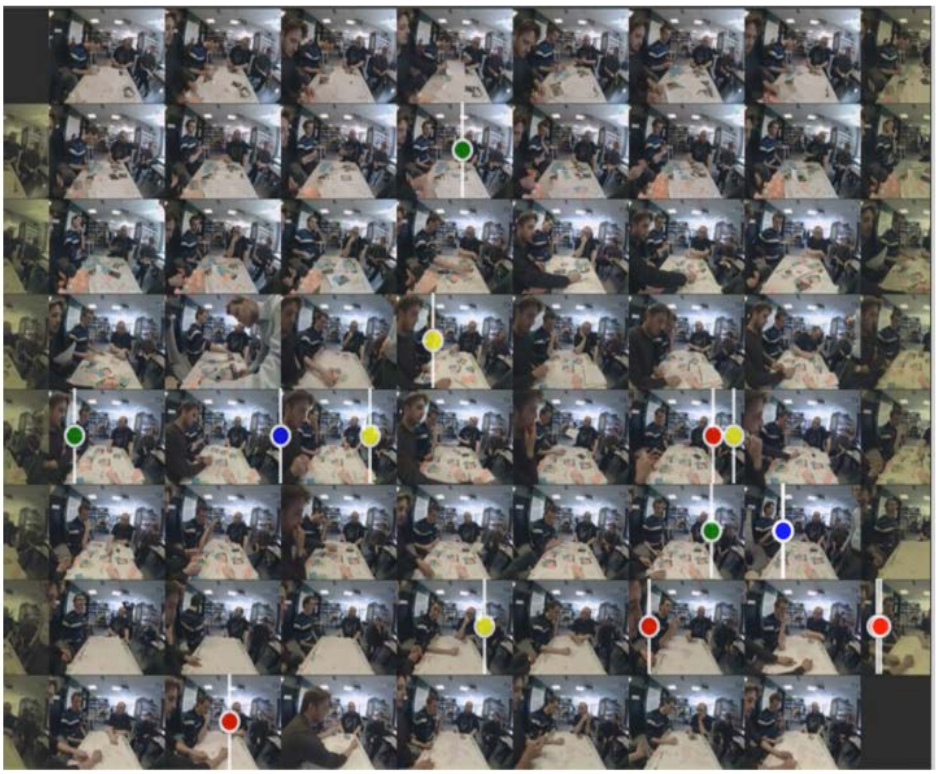


Figure 11 A Panopticon video of the design game (Hook et al. 2013)

This panopticon works by dividing the video into smaller parts of equal length and displaying them in a grid. The videos will continually and simultaneously play to allow the student to watch the video from any selected point. The interface also has colour coded markers that appear overlaying the video on all the points where a student pressed their button, they touch these markers to view the 15s clip that was recorded as a result of the button press. At this

point the students are supposed to review the marked clips and together form a research question pertaining to their design process. These videos are then used to help them reflect on the process and be able to question and find answers for questions in their approach to the activity. The study that was conducted using ReflecTable shows that the students were able to demonstrate understanding of the theoretical concepts of design and relate it to different design situations and that video was a valuable tool for reflection in this situation.

This study demonstrates one of the possibilities of using video for reflection and introduces an interesting technology that attempted to provide a structured and accessible method of reflection. It also shows the benefits of giving students the ability to record highlights and important points during the activity and be able to review it afterwards. However, upon testing, we found that ReflecTable could not be used in Ubicomp due to the equipment required not being available, so setting it up for all student groups every week was not possible. In addition, the reflection game was created for design activities, which are only a portion of the activities in the Ubicomp module.

3. Media Annotation Tool (MAT)

The Media Annotation tool (MAT) (Colasante 2011) is a tool that allows students to upload videos and annotate them online. MAT offers the ability to select parts of the videos and write text descriptions for them. A coloured marker that can be easily seen on the video timeline highlights these selections (figure 12).

These markers are links to the annotation area that have different sections for notes, comments, conclusion, teacher feedback and final reflection. MAT was designed and first piloted in a third-year undergraduate class for teaching physical education. The tool was used to help students reflect and evaluate teaching practices by uploading and annotating videos of their own teaching practice. The aim of developing the tool was to provide students with an environment that encourages critical reflection supported by the instructors. MAT supports reflection by focusing discussion and analysis on specific parts of the video to allow for deeper discussion and better understanding of what was recorded. It also offers a place for the teacher's feedback on those specific parts of the video the student highlighted which allows for more focused and thorough comments that are deemed more useful for the student. In addition, students can use the tool as a group and leave notes and feedback to each other.

Piloting MAT was successful and the students' experience with the tool was positive. The students found the most valuable features offered by the system were the ability to watch their own teaching and the peer feedback, even though there were concerns about the quality of said feedback. The study also revealed the importance of recording multiple sessions for reflection, as it is possible that one or two videos may not show problems that could occur especially if the teaching setting was different (for example teaching a big class vs. teaching a small class).

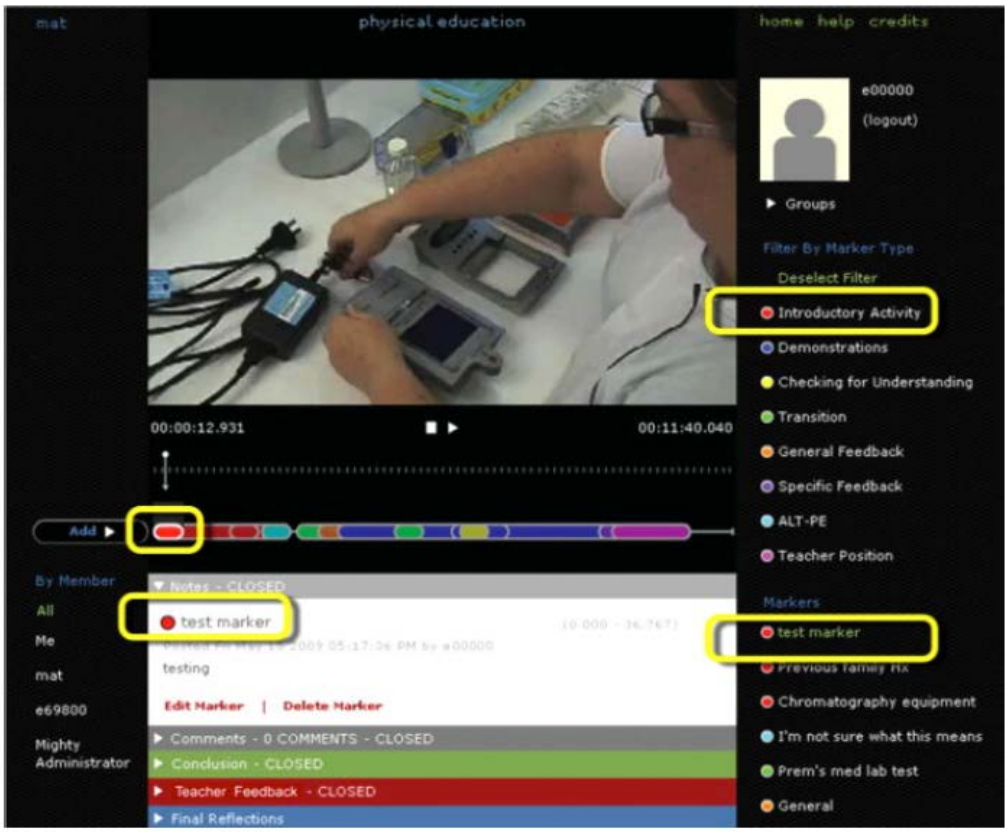


Figure 12 MAT annotation interface (Colasante 2011)

MAT has been available free online since 2013 and is being updated and maintained regularly, which made it a possible choice for a video reflection task in Ubicomp. However, the installation and use of the tool was complicated and the teaching team felt that it would require a long time to teach the students how to use it which could not be fitted into Ubicomp. Thus, while the idea and functionality was very useful, it was not easily accessible, so it was dismissed as well.

4. Bootlegger

Bootlegger (Schofield et al. 2015) is a system developed to use existing technology in smart phones to create a film crew. The system can be used by many people to coordinate and film an event together using their own devices from multiple angles. Bootlegger consists of two parts; a mobile app and a web platform. The mobile app is what the participants use to record

the videos. It allows them to join a shoot and gives them prompts about what shots to take. If it is a live event, the app will coordinate the time as well by prompting the users to start recording at a specific time and thus cover the entire event just like a professional film-crew would do.

The web platform is where the planning for the event to be filmed happens as well as the after-shoot editing. The platform provides templates that are designed to help users take the best shots and position their cameras correctly. There are several pre-designed templates for events such as concerts, biography, ball sport, etc. these templates can be used as is or customized according to what is needed for the event. The user (director) chooses a template and sets a start and end time for the event and decides on how long each individual shot should be (the default setting is 25 sec). The shoot will appear to users (film crew) on their app and they can join the shoot and start filming. The platform is where the resulting footage can be viewed after it is uploaded from the participants' phones. Simple editing tasks can be done there as well such as putting shots together to create a collective video of the event, cutting long shots onto a shorter segment, etc.

Bootlegger has been used in teaching settings as well, where students worked together to document what they were doing in a class to create video presentations. None of this work in the educational context has been published yet but it was one of the reasons why Bootlegger was the technology chosen for the Ubiquitous Computing module. As mentioned in the previous chapter, the students used Bootlegger to create the video tutorials as one part of their assessment in the module. The choice of the tool was due to the collaborative environment it provided for the students to share the process of filming their practicals. Also, it provided simple video editing capabilities that did not require previous knowledge or disadvantage students who had not done anything like this before.

Bootlegger was also one of the suggestions to address the issue of the lack of adequate data on students' engagement in class. The teaching team discussed the option of asking the students to record videos during class like they did in the practical sessions. However, the idea was dismissed for two reasons: First, Bootlegger would require the students to point the camera at the person talking or doing something, which can be very distracting during the activity. Second, there were some technical problems with the Bootlegger app and platform and some complaints about it being too complicated, which meant it might be even more distracting to use in an activity that required active participation from all students in the group. Nonetheless, Bootlegger offers a useful platform for storing, editing, and sharing videos and the studies conducted using it demonstrate the benefits of recording short clips that can be merged together to create one video covering an event or activity.

5. Electronic portfolios

Electronic portfolios or e-portfolios are widely used in Higher Education for assessment and reflection. An e-portfolio offers the capability to store text, images, video and audio as well as easy and quick access and the ability to link to external sources (Oakley et al. 2014). E-portfolios have been used as tools for reflection, a method of assessment and an approach to advertising and employability, as well as a way to share ideas and artefacts. Portfolios are often used in Higher Education to provide evidence of achievement and develop the students' reflective practices by encouraging them to write reflective comments or descriptions of their work (Huang 2012). Studies have shown that e-portfolios helped students in analysing their skill development and identifying areas of improvement by promoting active engagement and reflection on the process of learning (Klenowski et al. 2006). However, motivating students to use e-portfolios frequently and actively reflect on their work is a challenge that many instructors face. Research has found that without constant support and guidance, students reflection tends to be superficial and focuses more on describing or summarizing their work rather than reflecting on it (Oakley et al. 2014). Thus, the unsuccessful attempt at engaging the students to comment online in the first Ubicomp was the main reason using the university's e-portfolio system was dismissed by the teaching team. Nonetheless, the idea of using a work record for reflection on the group activities in the module was still of interest.

5.4 Design Requirements

Each of the previous technologies offered interesting aspects that I discussed with the teaching team when thinking of a solution to the issue of capturing and encouraging engagement and participation in the classroom. However, none of them provided a solution that has all the functionality needed or accessibility and ease of use that was essential for the use during an activity. Nonetheless, some of the features introduced in these tools where either included or modified to fit in the final design of Group Tagging. These features include:

Short video clips for reflection:

ReflecTable and the study conducted with the design students showed that recording short video clips to help the students review important parts of the activity was a useful method for reflection. The clips were enough to start conversations and remind the students of things that happened while they were busy working. Studies that used video reflection, where they recorded a whole session or activity and the students had to watch it later reported it to be a very useful but time consuming activity (Fadde et al. 2009). Thus, it is not suitable for students

who need to do a lot of work for the course (like Ubicomp). Using short video clips would be the better option for the students in this case.

Video tagging to prompt reflection during and after activities

The study with MAT showed that video annotations were useful for students as a prompt for reflection and as method of feedback from peers. However, with MAT and other video annotation exercises, the annotation happens after class when the students get to watch the video and leave their comments. For Group Tagging, the aim was to prompt reflection *during* as well as *after* the activity. It was also important not to add too much work for the students who already had to complete other assignments for the module. Thus, adding simple tags (similar to the simple axis in Group Spinner) to the short videos recorded during the activity was the solution proposed. The tags would be a short phrase representing a skill or behaviour the students are required to show during the activity (example creativity, for a design activity). The aim was to have the students actively think about their participation and try to identify those skills as they go through the activity (which is the prompt for reflection). When reviewing the clips later, the students get to see what behaviours others in their group tagged, which would serve as quick and simple feedback from peers that would hopefully spark discussion.

Reviewing activities

Activities in class are an important aspect of the success of a flipped classroom or any active learning environment. Providing the students with the ability to record important moments and contributions during these activities can be a useful tool for revision. These videos can also be used as record of their participation they can use for reflection and evaluation of their skills as well as for getting feedback from the instructor.

5.5 Technical Requirements

In order to design a tool that can be used in the classroom that provides enough information yet does not disturb the students learning, there are several things that need to be taken into consideration. These requirements for Group Tagging were taken from what was learned in the first run of the Ubicomp module, the students' experience with the tools used there, the module leader's observation on how students use technology in class, and the available literature on introducing technologies to students and working in a classroom context (Rich & Hannafin 2009). In the module, the students used a platform for curating and editing videos called Bootlegger, and they commented on their experience with the platform and the app associated with it in the interviews and the end of semester feedback. These comments are the

basis I used to understand the students' concerns when introducing a new tool and the things that needed to be addressed when designing Group Tagging.

Ease of Use:

The students commented that the Bootlegger app had an easy to use interface, but the website was more complicated. They had no problem using the mobile app to shoot the videos but the process of creating the final edits was frustrating to some and they even requested that the lecturer make a video of herself making an edit to show the steps.

Thus, to create a new tool for students it was important to make it intuitive and easy to use. The students must learn how to work with the tool in addition to all other tools in the module. They will also be using it in every session, so it should not distract from the task they are engaged in or disrupt their learning. The interface and workflow should be logical, clear and uncluttered, and the function of every part of the interface should be easy to grasp and work with.

Accessibility

A classroom is not a controlled setting where the developer of the technology can determine exactly where and how a tool is used. The nature of the classroom where there is a different number of students in each session, each with different preferences, backgrounds and needs, makes it extremely difficult to design a tool for everyone. A problem that had arisen with Bootlegger was that the app was available for Android devices only at the time, so students with other types of devices could not use it. This issue was addressed by loaning Android phones to those students but that introduced its own issues due to them not being familiar with the phones or us not having enough spare phones available. So, it is important that the tool be accessible to all students who sign up for the module.

Privacy and security

A technology designed for students must take into consideration privacy and keeping their data safe. Privacy was not an issue that the students mentioned when interviewed and they did not seem to be especially concerned, which could be due to their trust in the school policies. Keeping the students' information secure and protecting their privacy was a major concern for the developer as well as from the School's point of view.

Adequate information

A tool that is developed for assessment and reflection must be able to provide enough material for both the student and the lecturer. Assessing the student's participation in class is a challenge and the lecturer needs to have sufficient evidence of the required skills to be able to

assess the student fairly. The student also requires a good overview of the group's interactions in class and their own participation to be able to reflect on the process and highlight the areas they need to work on. Thus, the tool should be able to record the students' interaction during the activity and offer both students and lecturer with access to those recordings after class.

5.6 Development and Testing of The Group Tagging Prototype

The design team for Group Tagging consisted of five people; three from the teaching staff and two developers. The researcher did the majority of the work on designing and developing the application. The three lecturers provided ideas, critiqued the design and tested the application. The second developer worked on backend functionality required for the app to work with Bootlegger but did not contribute to the app itself.

The team discussed the technologies previously explained and whether they could be used in Ubicomp and then decided on the features that could be included for supporting reflection and measuring engagement in Ubicomp based on these discussions. Interfaces were also designed at team meetings and a couple of wireframes were created to facilitate discussions and demonstrate how the interfaces would appear to the students and the workflow of the application (Appendix H).

Development of Group Tagging was broken into several stages where I designed, coded and tested each part individually. The module leader then tested the working version of that part. Three volunteer students sat with the developer and tested the final version of the application, giving instant feedback on the interfaces, functionality, workflow, and ease of use. Another review was conducted using different browsers (on Windows, IOS, and Android operating systems) to optimize the interfaces and ensure compatibility.

To choose the optimal clip length, an experiment was conducted during an informal talk at Open Lab (Open Lab 2018h). The talk was recorded and five people attending the talk were asked to tag during it to record the highlights and important parts. The participants gave feedback afterwards about the experience of tagging and how much the resulting clips matched what they wanted to record. From this experiment, it was decided that the clips would each be 30 seconds long and that recording should start 10 seconds before the user clicks on the tag, and end 20 seconds after, to best capture what they really wanted to record. The 10-seconds before the click was added to account for the users not being able to anticipate what to record, and so they would not be losing something important if they clicked on the tag late.

Group Tagging was developed as a responsive web app, which is a website that adapts to changes in screen size and can be viewed in any device using a browser. The choice of making it a web app rather than a mobile app was due to the environment it was to be deployed in and

to satisfy the requirement for accessibility and ease of use. It was necessary to make sure that the tool was accessible and works perfectly for all students taking the module regardless of what device they used. Therefore, a browser was the best choice as all operating systems provide at least a basic browser and they follow the web standards (e.g. HTML, CSS, XML, etc.), which ensures that all students get the same experience. Another advantage of using the web is the ability to quickly update the code, which is a feature not available for mobile applications as any update needs to go through the app store and that may take a few days. This is important if a bug is discovered or a feature needed modification quickly so as not to disturb the students while using the app.

However, this choice added limitations to the prototype. For example, it made it very difficult to access the native functionality of the devices (such as cameras and network connection), which can hinder the implementation of some of the proposed features. Thus, for the purpose of this study the choice was made to separate these tasks (recording, splitting, and uploading videos) and do them manually rather than having them as a part of the application. Since it was very important that this did not affect the students in any way or add to their workload, these tasks were taken care of by the researcher (the developer).

The interfaces for Group Tagging were designed using AngularJS (AngularJS 2018a), JavaScript (JavaScript 2018f), and Bootstrap (Bootstrap 2018c). The design was meant to be viewed on a mobile phone screen and the interfaces included only the required elements for more efficiency and to make the interaction similar to a mobile application. The database was built using MySQL and all communication with it was handled via PHP to separate the database to a different server for added security. Storage and editing of videos was handled by the Bootlegger platform, which already had all required functionality in place and offered free and easy access.

An open source script (Video_split_master 2016b) written in Python which used the FFmpeg open source video library (FFmpeg 2018e) was used for splitting the videos recorded and creating the short clips. The script takes a .csv file with a list of the file names, required video length, and the start time of the desired clip on the original video. Using this information, it splits the original video recorded in class into 30-second clips.

The Bootlegger platform provided the functionality for handling the videos. The server can store, retrieve and play the clips, as well as merge them together to create an edit. The clips that resulted from the video slicing process mentioned were uploaded into the platform and AngularJS was used for retrieving the videos and displaying them to users. The users did not have to deal with Bootlegger at all and they only worked with the interfaces of Group Tagging. The platform was also used to handle signing in to Group Tagging for security and to ensure

only authorised users had access to the videos. Bootlegger uses Google and Facebook for identifying users thus making the login process easy and secure.

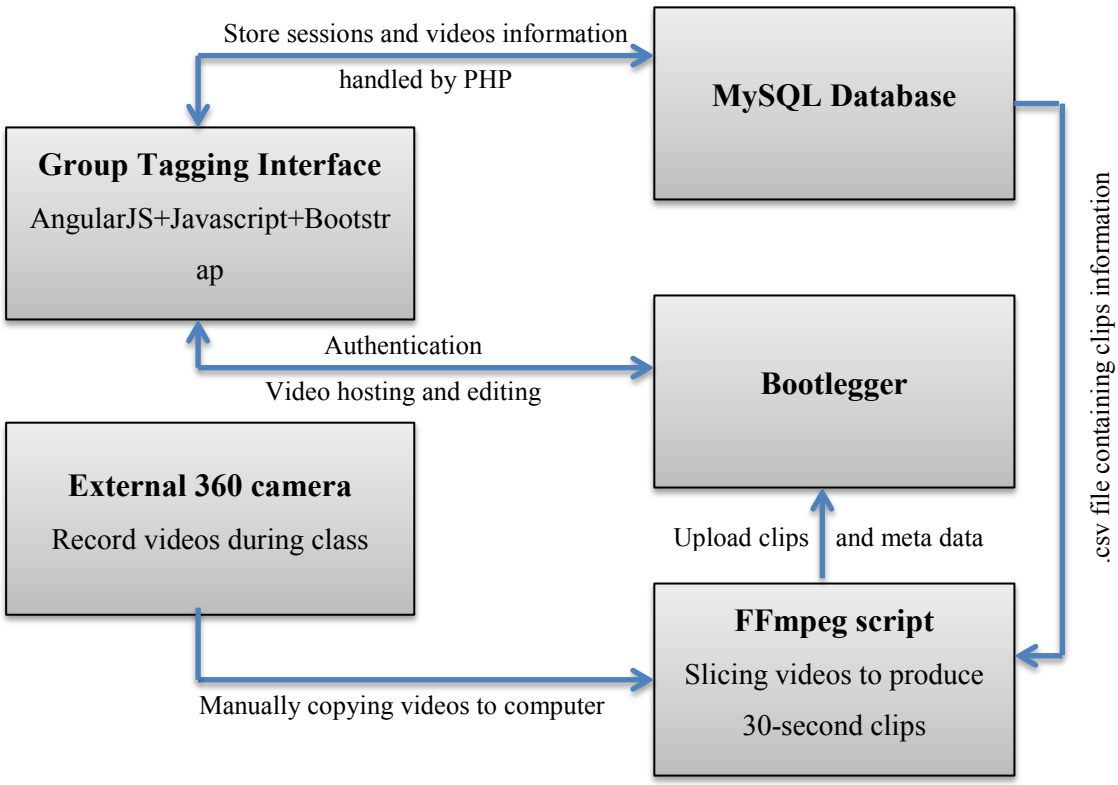


Figure 13 Data flow diagram in the Group Tagging prototype

Teaching and assessing the 21st century skills

It was decided to use the 21st century skills as a prompt for reflection in the prototype of Group Tagging in Ubicomp. The reason for this choice was the nature of activities in Ubicomp, which required the students to develop and demonstrate those skills to get through the activity together. Thus, asking the students to actively think about and demonstrate those skills could be a good way to facilitate reflection on the activity itself.

There are several conceptual frameworks that define the 21st century skills including The Partnership for 21st Century Skills (Partnership for 21st Century Learning 2015), enGauge 21st century skills (Burkhardt et al. 2003), and the Association of American Colleges, and National Leadership Council framework for college learning in a new global century (Dede 2010).

The P21 Framework for 21st Century Learning is the most widely adopted framework (Dede 2010), and it was written using input from teachers, education professionals, and business leaders to identify the skills that students need to succeed after graduation. The framework identifies several subjects that the students need to show competency in such as languages,

mathematics, science, etc. As well as six categories of skills that are necessary for them to learn:

- Creativity and innovation
- Critical thinking and problem solving
- Communicating and collaboration
- Information literacy
- Media literacy
- Life and career skills

The framework also describes what a 21st century curriculum should look like. It should teach the 21st century skills discreetly alongside core subjects as well as provide opportunities for applying those skills. It has to integrate new and novel teaching methods and technologies and support the students by providing resources outside the school walls.

Teaching and assessing those skills were one of the motivations for assessing participation in class in Ubicomp and so it is also one of the intended outcomes from developing the new tool. The aim is to provide the students with the opportunity to show their skills, reflect on them, and get feedback from the lecturer about the level of their skills. The group activities in Ubicomp provided the best setting for testing those abilities since the students were collaborating and using their skills of information gathering and communication to solve a problem or create a new artefact.

For Group Tagging, the teaching team wanted to focus on five skill categories of the six (Creativity, Critical thinking and Problem solving, Communication and Collaboration, Information literacy, Life and Career skills). The reason for not including the sixth category "media literacy" was that it was already part of another assessment in the module were students created video tutorials and the assessment has already shown its success in teaching and demonstrating said literacy (Vasilchenko et al. 2017).

5.7 Group Tagging Basic Functionality The application consists of six modules or pages (five for the students and one for the lecturer). The modules include logging in, starting a new session, joining an existing session, Tagging, working with clips, and giving feedback, figure 14 shows the flow chart and different modules of the system

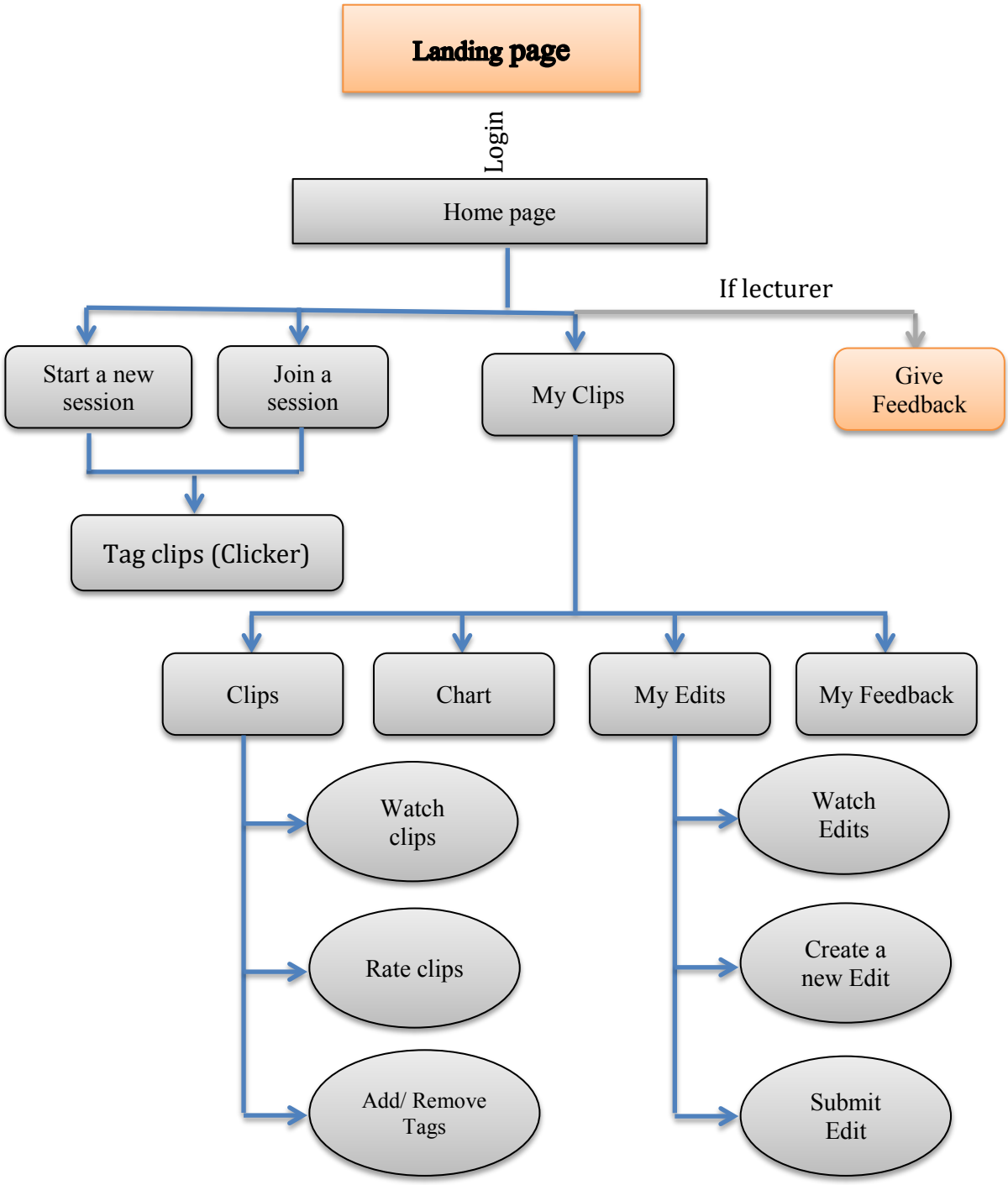


Figure 14 Group Tagging flow chart

The student's modules

Signing in to the application:

As mentioned earlier the login process is handled by the Bootlegger platform. The user is required to login using their Gmail or Facebook account to have access to the application. The other modules in Group Tagging are only accessible to authorized users to ensure the student privacy (See figure 15).

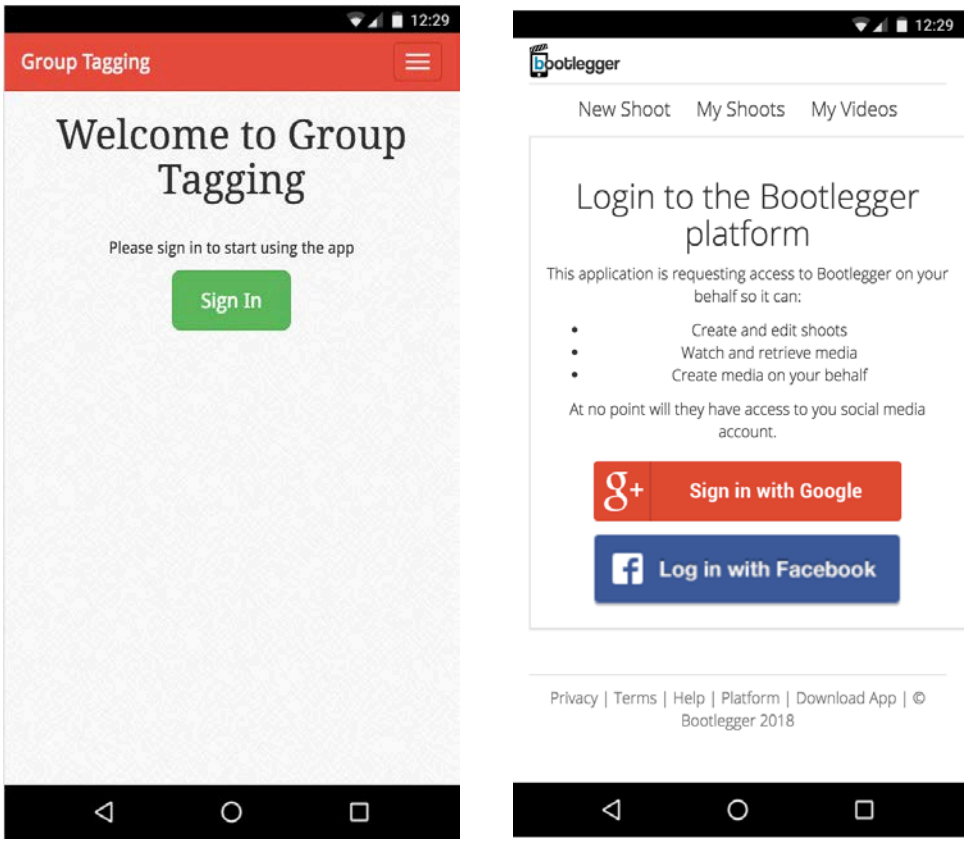


Figure 15 Logging into Group Tagging

- *Starting a new session*:

  When the students are in class and the lecturer starts a tagging activity the students in their group should choose one student to start a new session. The process is simple and only requires the user to click on the "Start new session" button, input a name for the session, input the number of the camera the group is using, and then click start (figure 16). This information is sent to the server to be saved in the database. All students joining the session, and clips resulting from this session will be linked together using the sessions id created in the module.

Joining an existing session:

After the session is created, it becomes available in the open sessions list that can be accessed by clicking the 'Join an already open session' button in the main page of Group Tagging (See figure 19). Clicking the button displays a list of all open sessions and the user can choose the one they want to join.

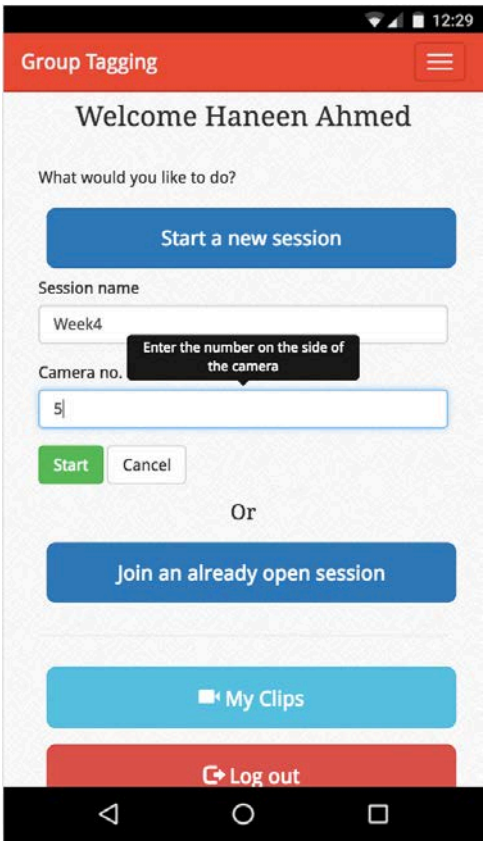


Figure 16 starting a new session

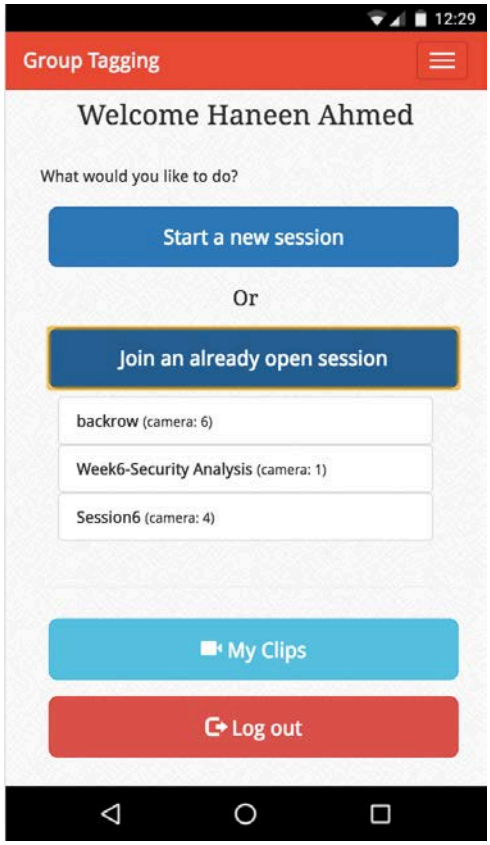


Figure 17 Joining an open session

Tagging

Both the user who created the session and all those who joined it will be directed to the clicker page (figure 18). This page includes five buttons each corresponding to a category (21st century skills for Ubicomp) that will be used as a tag when the clips are created (the choice of using only five buttons was to make the interface easy to use on the smaller screen of a mobile without having to scroll up or down). When the user clicks on one of the buttons it flashes yellow for two seconds to indicate that it is recording, and the session information along with the time of the click is sent to the server to be stored in the database. This information is later used to create the timestamps for splitting the videos. Each user will also see a counter updated in real time with the total number of tags recorded for the session.

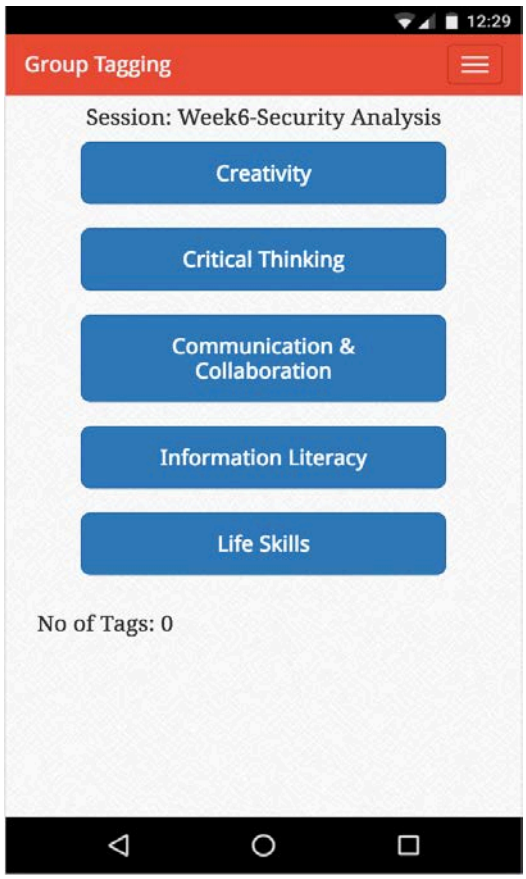


Figure 18 The clicker interface

Working with clips

This module is divided into four sub modules, all related to the clips recorded during class and accessible after the videos are uploaded:

1. The clips: The user can see all the video clips recorded during the session as a grid list with thumbnails (figure 19) by choosing the session name from the drop-down list. The clips can be filtered to view only clips with a specific tag. Clicking on the clip will allow the user to play it as well as change the tag (or add additional tags) and rate the clip (figure 20).
2. The chart: The application offers the user with a radar chart representing the number of tagged clips for each skill category (figure 21). A new layer is added to the chart every time the user joins a session. The chart displays all sessions by default, but it is possible to remove a layer or more if the user wants to compare specific sessions. The chart cannot be modified directly, and it is implemented to offer a visual illustration of the tags used in every session. It is updated automatically when tags are changed.
3. Edits: The user can create new edits by choosing up to 5 clips (one for each tag to keep the edits short) and merging them to create a single video. The first step in creating an edit is to choose which clips to include (figure 22). The user can choose one clip for each skill category

and has to include at least two clips to be able to proceed to the next step. After picking the clips, the user is asked for a title (mandatory) and a description (optional) for the edit (figure 23). They can also review the clip that were chosen and can go back and change them. Once they are satisfied they click on the button to create the edit. A message and a progress bar appear to indicate the edit is being created, and once it is done, it will appear in the edits list. All edits created can be viewed in the edits page; each edit is accessible by choosing the session that they belong to from the list. The user can view the edit and the information associated with it (title, description, feedback), and can submit the edit for assessment. The user can create as many edits as they want for each session, but they can only submit one edit for assessment (See figure 9 for the create edit interface)

4. Feedback: Once an edit is submitted, it becomes available to the lecturer for assessment and feedback. When the lecturer gives feedback, the edit will appear in a separate tab for easy access.

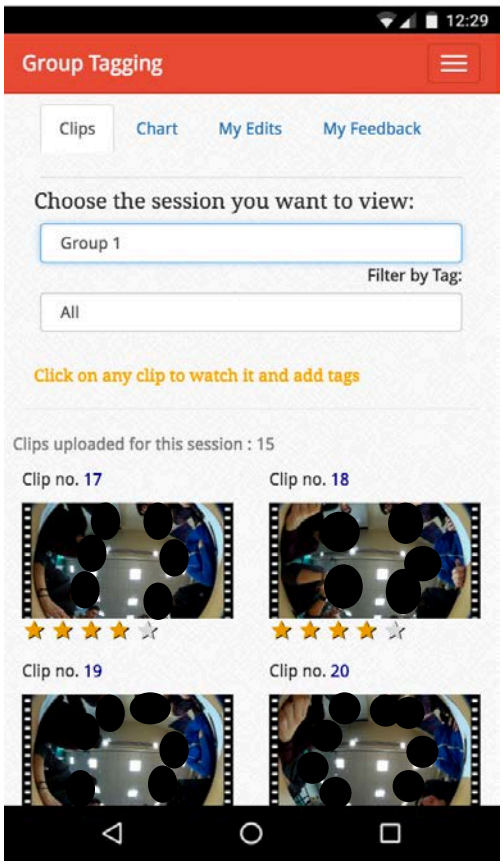


Figure 19 Clips list

Figure 20 Reviewing clips

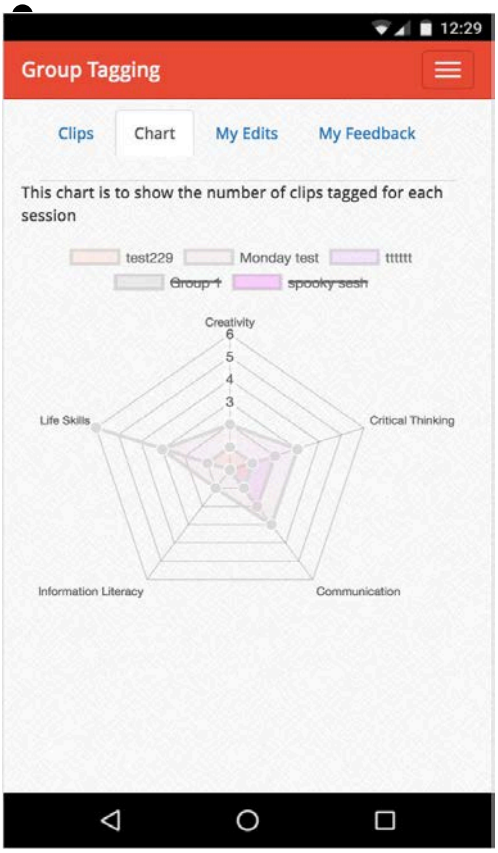


Figure 21 Skill radar chart

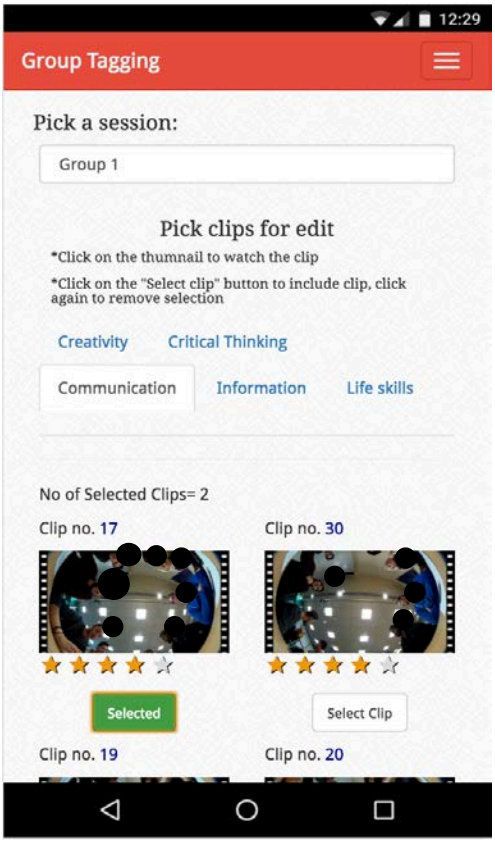


Figure 22 Selecting clips for an edit

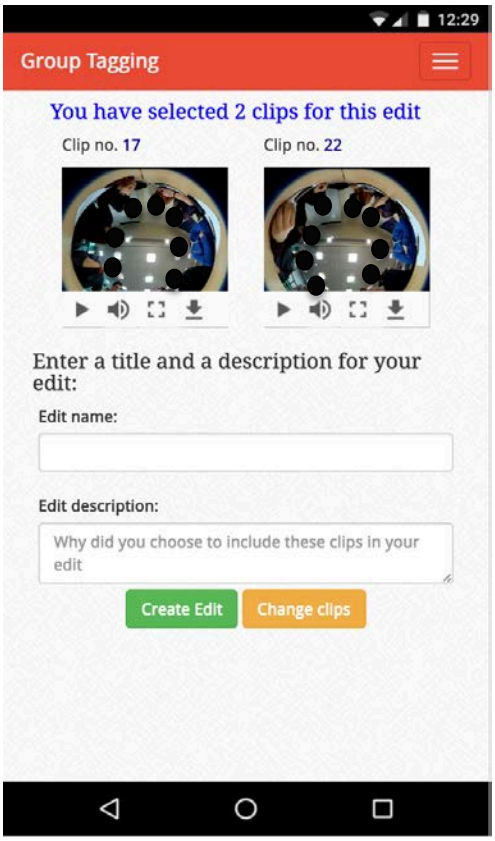


Figure 23 Creating an edit interface

Giving feedback:

This module is only available to the lecturers and staff and cannot be accessed by the students. When a student submits an edit, it will be displayed to the lecturer to assess and give feedback. When viewing an edit, the lecturer can play the video, see the title, and description as well as the tags of the original clips. The lecturer can tag the edit with the skills they think they see in the video, rate the edit, and write a short feedback message. This information is then saved to the database and used for the student's assessment. When saved, the feedback submitted by the lecturer will become available to the student and accessible through both the edits and the feedback pages.

It is worth noting that the lecturer does not get automatic access to the clips or edits in the system. If they wanted to view all the clips they must join the sessions themselves. And they have no way of accessing the edits that are not submitted for assessment as they belong to the student who created them only. This feature was implemented to allow the students to experiment with the app and create as many edits as they wish without sending them all to the lecturer. The student can choose the best edit to submit for assessment while keeping others for themselves or to share with friends.

5.8 Group Tagging Use case

The lecturer would choose an activity as a Group Tagging activity. The activity is usually between 15-30 minutes long so as not to burden the students and have them lose motivation. The lecturer would ask the students to break into groups of 5-6 and each group would be provided with an external camera.

The students access the GT app through their browser (from phone, tablet, or laptop) and log in using their Facebook or Gmail accounts.

In their groups, one student would create a session and give it a name the group agreed upon. The other students in the group then join the session and start tagging. During the session, all participants would be on the clicker page that shows five buttons corresponding to the five skill sets that the students were asked to tag for. If a student felt that a certain contribution by themselves or their group mates fits the definition of the skill they would click the button for that skill to record a 30 second clip (starting 10 seconds before the click and ending 20 seconds after). The students can record as many clips as they want and those clips will be available to all group members afterward. When the session ends, the cameras are collected back and the students' logout off the app.

After class, the clips are uploaded online and the students notified by email. Now, every student can log in to the app and access their group's videos. These videos have the associated tags

displayed and the student can change those tags if they felt that the clip matched another skill set better, they can add another tag if they thought that the clips show more than one skill. The clips can also be rated using a five-star rating, this allows the students to evaluate the quality of the clips as they watch them and give them a rating based on that to make it easier to choose clips to include in the final edit.

In addition, the app offers a radar chart that represents the number of clips tagged for each skill category. The chart draws a new layer for every new session added to the system to show the students the distribution of skills that are being tagged within their group and to give them an idea of which skills they may need to work on in the future.

After watching, tagging, and rating the clips the students are ready to create their edits. The application offers a wizard like approach to the process of creating the edits. The student starts by clicking the create edit button which would take them to a new page that shows the clips divided by the skills they were tagged with and sorted from highest rated to lowest. The student then can choose one clip from each skill category to include in the edit with minimum of two clips per edit. After picking the clips they would click on the create edit button which would take them to the next page where they can give a title and a description for the edit as well as review the clips they have chosen to include. When they are satisfied, they click the button to create the edit, which would send the clips, title, and description to the server to create one video. The students can create as many edits as they want and then view them all on the edits page. Once they have an edit they are satisfied with they can submit it for evaluation by the lecturer. They can submit only one edit per session and they will get their feedback on that edit in the feedback section in the app.

5.9 Summary

This chapter describes Group Tagging, a web application developed to support student reflection and to encourage participation in small group activities. The chapter first explored the problems associated with small group activities and collaborative learning and in particular the issue of social loafing and straying off topic.

Several existing technologies were discussed as possible solutions and later as inspiration for features and design choices that were made when designing Group Tagging. The previous studies conducted with those technologies were used to inform the design as well and provide insights on how those features were perceived by users and what problem they encountered when deploying them. Those studies alongside the findings from the first case study where the basis for the technical requirement and functionality of Group Tagging.

Group Tagging was the result of these discussions. It is a responsive web application that supports students' reflection by providing them with the ability to record 30-second video clips during activities in class. The students can later review those clips and create an edit combining few of the clips to make one video. The edits can be shared for feedback or kept for the student's personal use.

The next chapter describes the second run of the Ubiquitous Computing module and the deployment of Group Tagging in class. It examines the engagement of the new cohort of students using some of the same methods as the first study with Ubicomp 1 along with new methods that were tested there. The chapter also describes the findings from using Group Tagging in class as well as the evaluation of the application as a reflection tool.

Chapter 6.
The Second Ubiquitous Computing Module

6.1 Introduction

This chapter describes the changes made to the Ubiquitous Computing module from its first iteration as well as data and methods used to further explore the student's engagement in the module both online and offline. The second case study aimed to confirm the findings from the first case study (in chapter 3) with another cohort of students as well introduce changes to attempt to improve engagement. In this case study I also tested new methods for measuring engagement that were used to supplement or replace methods used in the first study. The chapter also includes the data obtained from the deployment of the Group Tagging app in the Ubicomp module. Finally, a discussion of the findings and results of the case study and how the students engaged in the module is provided.

6.2 Study Context

The study was conducted during the second run of the Ubiquitous Computing module (Ubicomp2) in the first semester of 2016-2017. The module's material was updated and parts of the assessment for the course were also adapted. However, the module remained mostly the same, a third-year undergraduate module that aims to teach students about the history and technologies of Ubiquitous Computing. The format of the course as a flipped classroom also remained unchanged, except for few aspects that were delivered differently (a detailed list of the changes made is listed in the next section).

The aims of this case study were the same for the first case study, i.e. to explore engagement in a flipped classroom environment and test methods for measuring students' engagement to assist the lecturer in understanding it. However, this time it is with a different student cohort, new additions to the module (assessment, tools, material) that aimed to improve engagement based on what was learned from the first case study, and new methods for data collection and analysis. The other objective of this study was to introduce the Group Tagging web application to the students and collect data on how it was used and the students' experience with having to work with it.

6.3 Changes to the "Ubicomp" Module

Based on the students' feedback and the findings from the first Ubicomp study, some changes were made to the module to enhance the students experience and engagement as well as address the issues they struggled with. The main changes introduced were:

- *Updating the material:*
The module leader updated the weekly introduction videos and changed some of the required and extra reading material (the academic papers) that the students had trouble with the first time.

- *Re-writing the quizzes:*
As mentioned in chapter 3, some students reported that the quizzes were easy to answer without having to read the papers while others mentioned that some of the questions were confusing and hard to understand. The module leader revised all the quizzes to be more inclusive of the material and cover more than the required reading to make sure that they were easy to understand and not ambiguous. This change was made to improve engagement with the online material and ensure that the students are better prepared when they come to class.

- *Introducing the credit (points) system:*
Due to the drop in the number of visits to the website at the end of the semester in the first run of Ubicomp and the declining views for the videos, a new credit system was introduced on the website. The system awarded points to users based on the actions they took while browsing the website and displayed their accumulated points in the sidebar. The intention was to introduce a bit of fun competition between the students when they compared their points. This was suggested to introduced gamification (Hamari et al. 2014) into the module, which previous research showed has promise in engaging students in online environments. Moreover, the credits could be a way of making the students aware of how active they were online as the points have no effect on the students' final grades but could be an indicator of their overall activity online.

- *Adding a discussion forum:*
In the first run of Ubicomp the students were asked to comment on the material of the week in the same blog post or use Twitter to discuss the topic. However, this created confusion, as the students were not sure what they were supposed to comment on. In addition, they did not consider the comments section or Twitter as a formal learning environment which resulted in many of them dropping it and not participating. The second Ubicomp provided the students with a formal discussion forum that they could use to post and answer topics. The lecturer used

the forum to post a weekly question on that week's topic that the students would then answer in the forum as well. There was also a sub-forum for technical support where they could post about any problems they had with the website or the tools used in the module. This forum was introduced to make the process of getting help easier and quicker, as well as have the suggested solutions to the students' problems available to all, and not just the one who asked. A second sub-forum was dedicated to questions and topics about assessment in the module.

- *Introducing the Group Tagging web app:*
The application was added to the module as an assessment tool. The application was used in class to assess participation in group activities. The students were asked to submit seven edits by the end of the semester for assessment, which contributed to 10% of their final grade (for participation).

- *Using other software in addition to Bootlegger:*
Bootlegger was still the tool provided to the students to create their tutorial videos, but they were also given the choice to use other tools if they wanted to. The choice to use other software was given later due to Bootlegger experiencing technical difficulties halfway through the module.

6.4 Methodology

6.4.1 Participants

The participants of the study were third-year students in the school of Computing Science, Newcastle University who signed up for the Ubiquitous Computing module. The class consisted of 48 students (8 females and 40 males). The study was explained to the students in the first seminar and they were informed that they could ask to be excluded anytime they wanted to. Additionally, 18 students signed consent forms allowing the use of their videos for analysis and agreed to be contacted during and after the module for additional information. Information sheet and consent form is included in Appendix I.

6.4.2 Data Collection and Analysis Methods

- *Interviews:*
Semi-structured interviews were used to collect data on the students' experience and feelings during the run of the Ubicomp module. Thematic Analysis (Braun & Clarke 2006) was used to analyse the transcripts of the interviews. A copy of interview schedule can be found in Appendix J.

- *Frequency Distribution Analysis:* Frequency Descriptions was used in this study to analyse the data obtained from the WordPress site and Group Tagging. SPSS frequencies and custom tables functions were used to conduct the analysis.

- *Correlation:* For this study, SPSS and Pearson correlation was used to determine whether there was any correlation between the results from the Motivated Strategies for Learning Questionnaire and the final grades of the students.

- *Cohen Kappa coefficient:* The Cohen Kappa coefficient (k) (Laerd Statistics, 2018) was used in this case study to evaluate the level of agreement between two coders who worked on the interviews coding. The first coder was the researcher while the second was an academic with no relation to this research who coded a sample of the interviews (20%). The inter-rater reliability agreement for the two coders was found to be Kappa= 0.79 ($p<0.001$), which is shows strong agreement.

6.4.3 Data Sources

- *WordPress website logs:*

The same traffic monitoring plugin Slimstat Analytics - Version 4.6.5 (Crouse 2016) that was used to collect data from the website for the first Ubicomp was used again for the second run of the module. Data collected included the details of every visit made by the students to the website. In addition, data was collected from the plugin myCRED - Version 1.7.9.3 (Merovingi 2016) that awarded the students points based on certain activities online.

- *Group Tagging logs:*

Group Tagging records the use of the application during sessions and when creating edits. Every clip created is recorded with metadata about who created it, when was it created, the session it belongs to and what the tag used. Edits also have meta data attached to them such as creation time, the user name, the session it was created for, the tags included, length of the video, the title and description, as well as feedback if given.

- *Group Tagging edits:*

The students submitted edits created by putting together multiple clips to showcase their participation in activities in class. The lecturer used these edits to mark the student's participation in class. 18 students consented to the use of their videos (edits and clips) for the study.

- *Attendance:*

The students' attendance was not monitored by the lecturer this time around. However, Group Tagging videos and login records were used to obtain attendance data after class.

- *Observation notes:*

Throughout the module, I kept a notebook with observations on interesting things that happened in class and a record of remarks or ideas discussed with the module leader and the students.

- *The Motivated Strategies for Learning Questionnaire* (Pintrich et al. 1991): The questionnaire was converted into a web format for easy access and distributed using Surveymonkey online survey platform (SurveyMonkey Inc., 2018) and administered through email. The questionnaire was conducted in the break halfway through the module (between week 5 and 6) and was completed by 14 students (4 females and 10 males). It was decided to use the full questionnaire rather than only select parts to test it as a method of measuring engagement in a flipped module, which required examining the whole survey.

- *Interviews:*

Five students (1 female and 4 males) were interviewed after the end of the module for more information on their experience during the module and with Group Tagging. The interview schedule was prepared based on the preliminary analysis of the data obtained from the website and Group Tagging logs as well as the observations made during class. The interviews were each 30-minutes on average, and were audio recorded. The recordings were later transcribed and analysed using thematic analysis. A copy of the interview schedule and questions can be found in the appendix J.

- *The student's grades*: The final grades were used to test the MSLQ by examining the correlation between the results of the questionnaire and the students' performance in the course.

6.5 Findings

Similar to the first study, data was collected from different sources both online and offline to cover all aspects of engagement. The findings for this study are presented in three sections 1) online data, which includes all analysis of the data collected from the WordPress website as well as the data collected from the Group Tagging web application. 2) Offline data, including attendance information and the results from the Motivated Strategies for Learning Questionnaire 3) Results from thematic analysis of the interviews.

6.5.1 Results from online data

The data from the module's website was cleaned to remove any entries by the teaching staff, students who dropped the module, and any other users who registered and made an account on the website but did not sign up for the module. Similar to the first study, there was a student using a browser that blocked the tracker and their data was also dropped from analysis for the lack of sufficient details.

For simplicity, I will be using the term "*visit*" or "*page visit*" to refer to the user clicking on a link to a page within the website. The term "*download*" will be used to describe a click on a download link, and "*external links*" for clicks on links to external web pages. The information that was collected for each visit includes data such as the date and time of the visit, resource visited (post, page) as well as browser and device information.

As for the data from Group Tagging, the term "*clip*" will be used for the tagged short video clips (30 sec) the students recorded when they used the application in class. The term "*edit*" will refer to the videos the students created by combining multiple clips and submitted as evidence of participation.

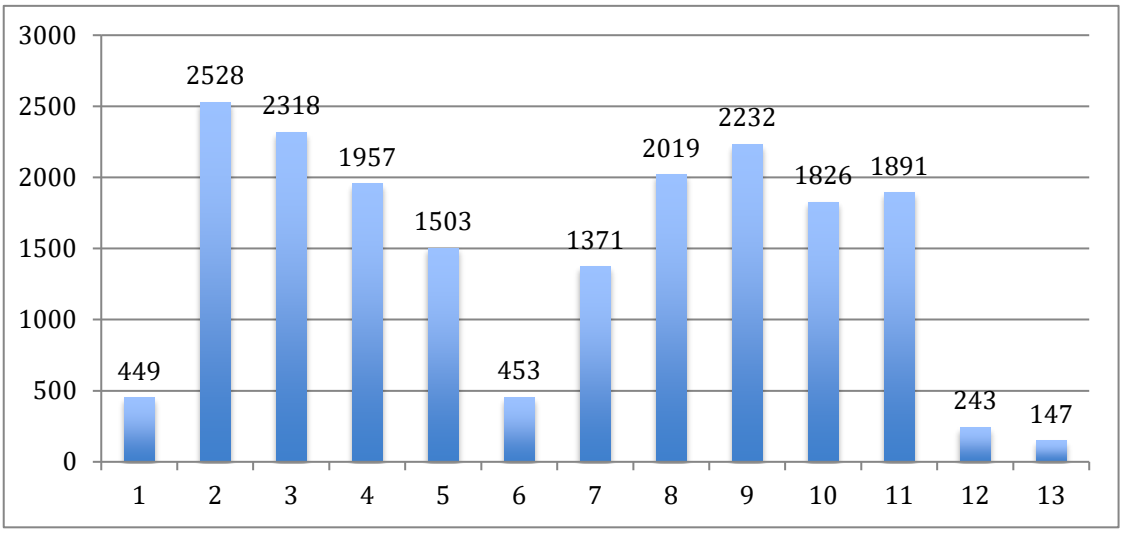


Figure 24 Total number of visits to the website each week

Website visits

Figure (1) shows the breakdown of the students' activity on the website on weekly basis. This includes logging into the website, visiting posts, clicking on links (internal and external), visiting the forum, replying to posts and downloading files. The highest level of activity was recorded in the second week when the students were exploring the website for the first time and creating their accounts.

The average number of visits for individual students was 381.9 (std= 290.91) with the highest number of visits made by one student being 1660 and the lowest 11 visits. 87% of the students were active online every week throughout the module. Figure (2) shows the total number of visits to each topic by the end of the module. We can see that the first week's topic was the most visited and the number of visits dropped after that. However, the number of visits to the other topics is close and there is no large drop of traffic for the topics at the end.

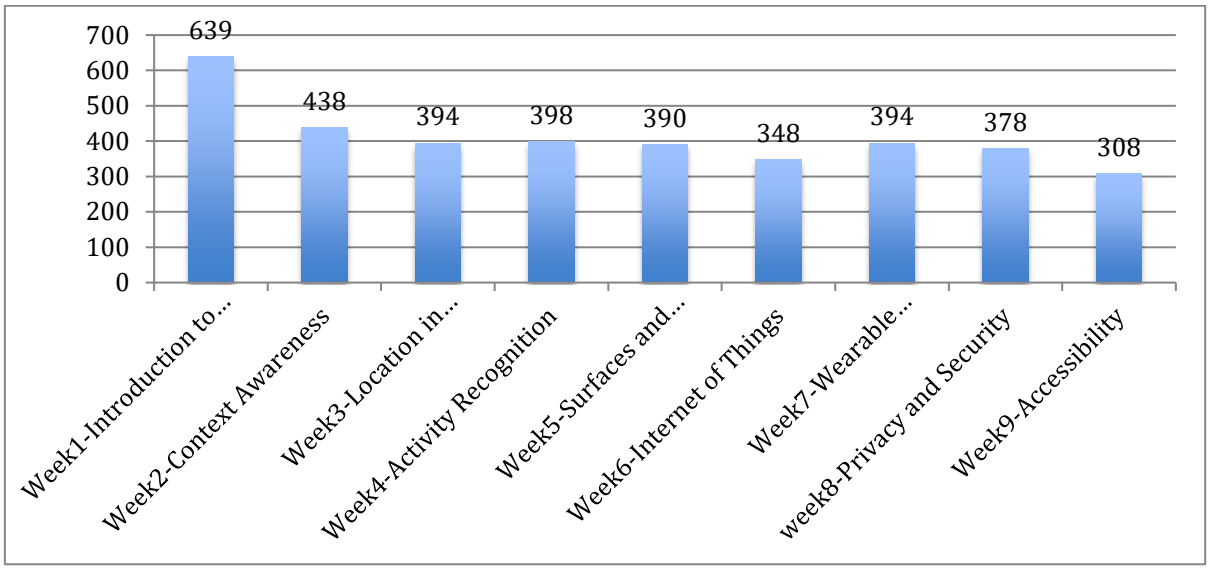


Figure 25 Visits per topic

Tables (1) contains the number of visits to each section of the website. The most visited pages were the landing page (home) with the highest number of visits (2775), followed by the course topics page (1787), which had links to all topics and is provided as a shortcut to reach the different posts on the website, and the assessment page (1386), which included details on the course work and assessment in the module. The section of the website that had the most activity was the forum with a total of (5783) visits. This number includes all visits to the general forum and the two sub forums for assessment and technical support as well as the posts and replies that the students posted to the forum.

Topic	Visit Frequency
Assessment	1386
Course Topics	1787
Course Work (sign in sheets)	111
Download	473
Feedback	48
Home	2775
Practicals	487
Privacy Policy	9
Register	68
Sign up	1338
User-pages	369
Forums	5783
Week1-Introduction to Ubicomp	639
Week2-Context Awareness	438
Week3-Location in Ubicomp	394
Week4-Activity Recognition	398
Week5-Surfaces and Tangible Interactions	390
Week6-Internet of Things	348
Week7-Wearable Technology	394
Week8-Privacy and Security	378
Week9-Accessibility	308
Total	**18321**

Table 4 Number of visits to different pages on the website

Forums

As mentioned earlier, the forums were the part of the website that had the most activity throughout the module. The students were required to respond to a question posted by the lecturer every week as a part of their assessment and that forum (the general discussion forum) was the most visited (5319). The assessment forum on the other hand was visited 104 times, and the technical support forum 360 times. Figure (3) shows the total number of forum visits weekly.

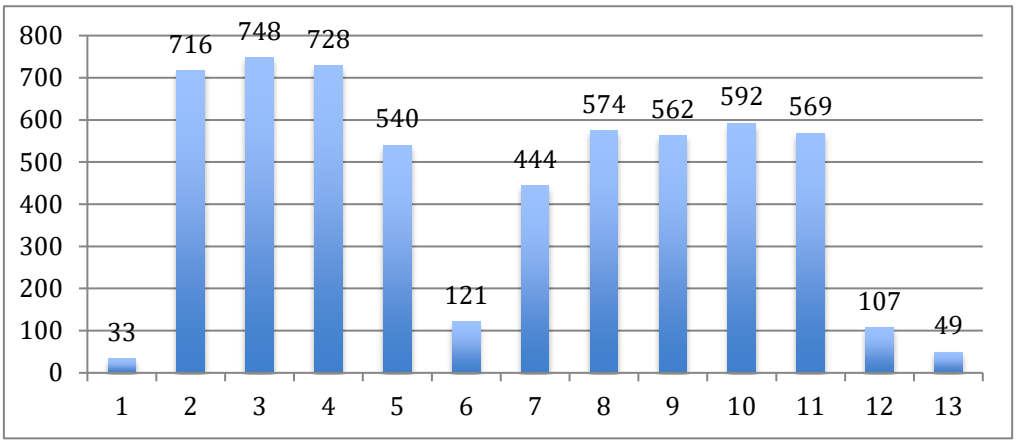


Figure 16 Total number of visits to the forum per week

The students did not create any new topics in the general discussion forum and only used it to answer the weekly question. Only one new topic was created in the assessment forum, while the technical support forum has 16 topics created by the students. The students posted a total of 318 replies to the questions in the general discussion forum with an average of 35 replies per topic. Figure (4) shows the number of visits to the different forums each week and we can see that there was activity in the forums even after the end of the semester. 'Miscellaneous' in the chart refers to entries in the data that did not have sufficient details recorded to determine which part of the forum was visited.

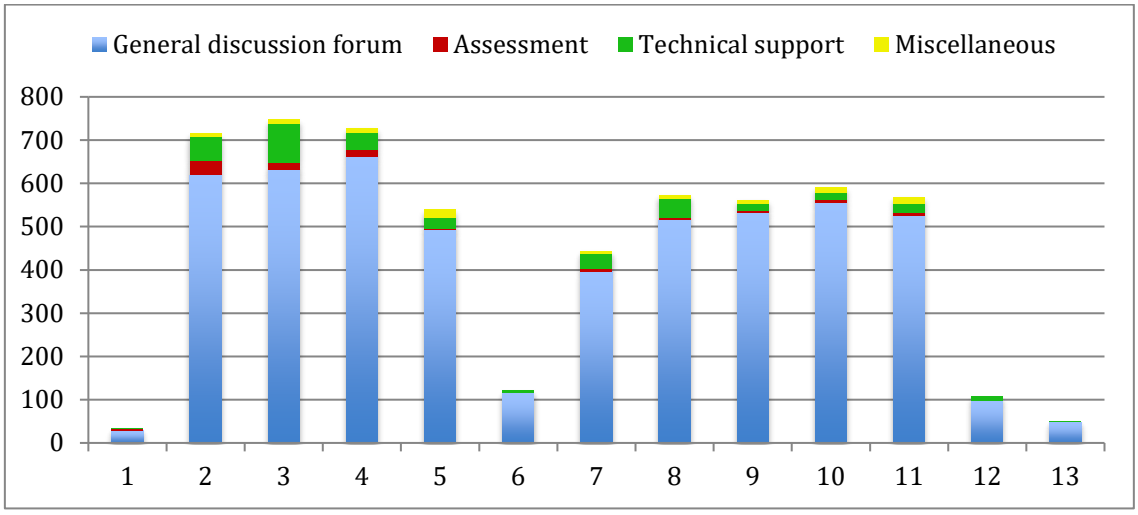


Figure 27 Visits to each forum per week

Quiz results

The students were required to complete 9 multiple-choice questions quizzes, each consisting of 5 questions. The number of students completing the quizzes was 42 out of 48 each week on average. The number of students completing the quiz remained high throughout the module with a small drop in both the second and last week (Figure (5) shows the number of students that completed the quiz each week).

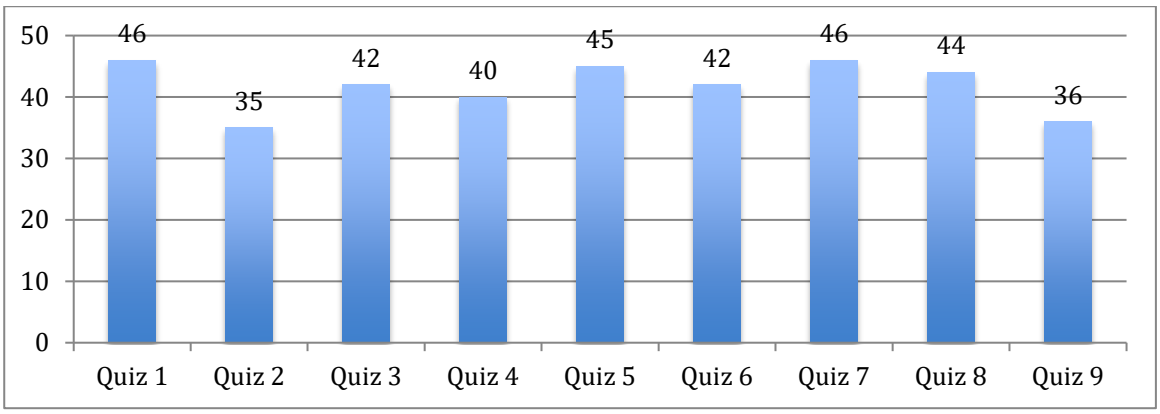


Figure 28 Number of students who completed each quiz

The results of the quizzes were also very good with an average of 8.1 out of 10. We can also see from Figure (6) that the results were improving as the module progressed.

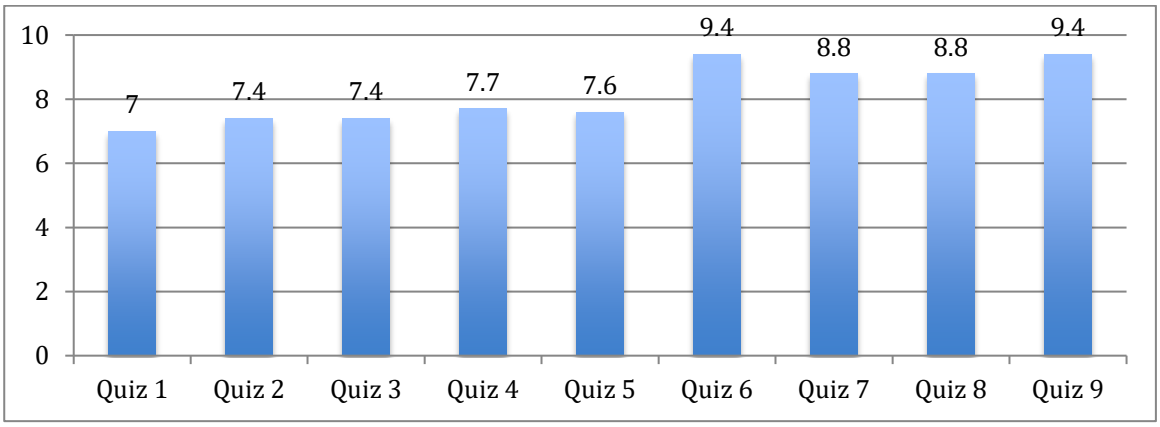


Figure 29 Average points for each quiz

Credits

During the module, the students were awarded points for completing different actions on the website. The actions included logging in to the site, visiting the week's topic post, watching the videos, downloading the required reading, accessing the forum, and posting to the forum. The points were displayed on a side widget on the website, so every student knew how many points they had accumulated. The purpose of the points and how they were obtained were not disclosed to the students until the second half of the module to find out whether knowing how to obtain points would change the students' behaviour online. Figure (7) shows the total number of points rewarded to the entire class during the module. We can see from the chart that the number of points did not rise in the second half of the module. However, it is noticeably more consistent starting from week 6.

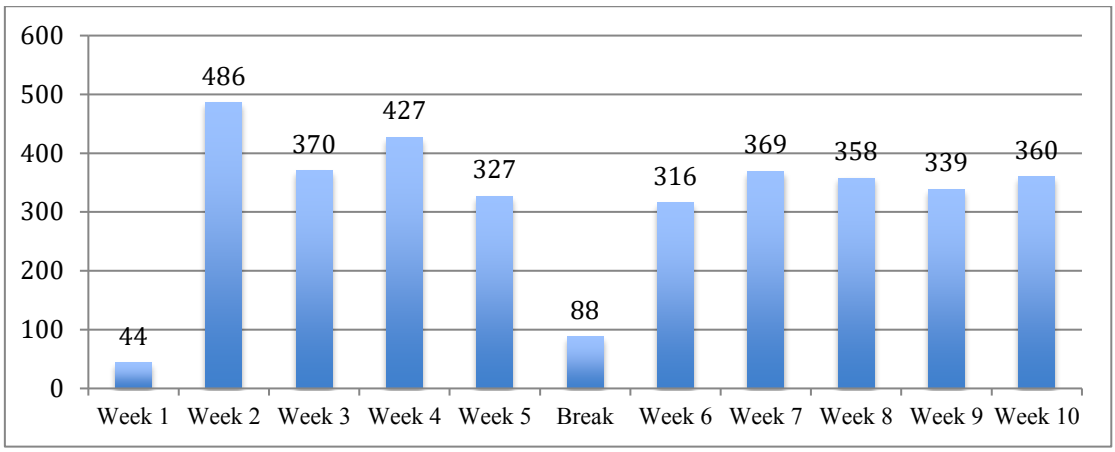


Figure 30 Points (credits) rewarded each week

Table (2) shows the result of running a dependent Sample T-test on the points accumulated during the module by comparing the first and second half.

	Half	N	Mean	Std. Deviation
Points	First	5	116.80	54.062
	Second	5	145.20	17.683

Table 5 Results from SPSS for the dependent Sample T-test

We can see that the mean for the second half is slightly higher, but the real difference is in the standard deviation, which were 54.062 in the first half compared to only 17.683 in the second. It is also worth noting that the students who were more active online in the first half continued to be so in the second half. The posting of the points' leader board and the break down for points did not cause a big shift in student's behaviour. The biggest difference in Std. Deviation between the first and second halves of the module for an individual student was 3.39 and the Std. Deviation for 52% of the class was less than 1.

Group Tagging

The Ubiquitous Computing module comprised of 10 weekly seminars, two hours each. In every seminar, the students engaged in several group activities (between 2-4), and the lecturer would choose one of these activities as a tagging activity. Students were asked to tag in every session, but they were required to submit only 7 edits by the end of the module for assessment.

The average group-tagging session length was between 15 to 30 minutes. The students recorded a total of (2174) tagged clips, with the lowest number of clips for a single session (one group) being 6 and the highest 75 clips.

Week	Activity Type	No of Tagged clips	Tags used				
			Communication	Creativity	Critical Thinking	Information literacy	Life skills
1	Discussion	138	58	16	32	12	20
2	Discussion	202	70	20	60	34	18
3	Problem solving	305	97	40	99	47	22
4	Design	296	71	75	103	23	24
5	Discussion	230	81	43	59	34	13
6	Problem solving	275	89	44	73	47	22
7	Design	238	49	79	66	30	14
8	Debate	106	22	13	51	18	2
9	Problem solving	286	69	40	118	37	22
10	Debate	98	30	13	39	16	0
Total		**2174**	**636**	**383**	**700**	**298**	**157**

Table 6 Breakdown of tags used each week

From Table (3), we can see that the most used tags are 'Critical thinking' and 'Communication', and the least used tags are life skills and information literacy (details on tags choice and 21st century skills in Chapter 4). The weeks with the highest number of clips (weeks 3,4,9) were ones were the session's length was over 30 minutes, while the sessions with the smaller number of tags (weeks 1,8) were the shorter ones (about 15 minutes). The only exception is week 10 were the session was 20 minutes long but had the least number of tags in the entire module. It is worth noting that that session took place in the last week of the semester and it had marginally lower attendance than usual with only 28 students.

The students tended to use the tags for Critical thinking and Communication more than the other three tags, with these two tags making up 61% of all clips recorded (see figure 8). 'Life skills' was the tag that was used the least and it is the only tag that was not used at all in one session and only twice in another. Other than those two instances the number of clips tagged with Life skills do not show any noteworthy difference between the various activities they were used in. The figures mostly show that the number of uses for the tags follows the number of total tags used in the session. 'Creativity' may not have a high total but we can see that there are two sessions (week 4 and 7) that show a noticeable increase in the use of the tag, these two sessions were both design activities where the students were asked to work together on making

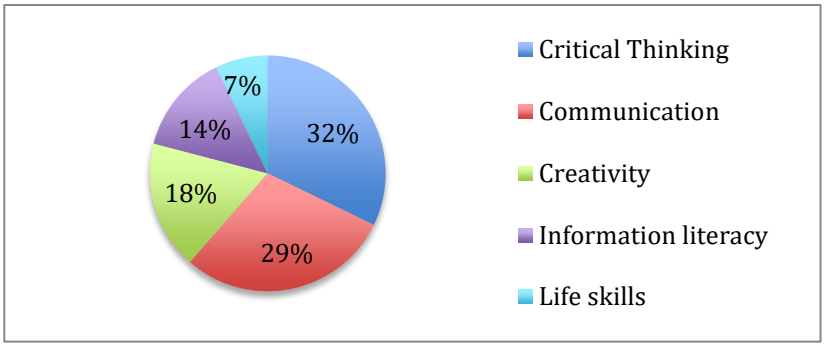


Figure 31 Total number of times each tag was used

an artefact. The number of tags for Information Literacy were the second lowest of the five tags, and the activities where it was used the most (week 2 and 5) were discussions that required the students to search and share information and opinions. Incidentally, these two activities were the same ones that had the highest number of clips tagged with communication. In addition, communication was least used on the two debate activities in the module. Critical thinking was most used in the activities about design (weeks 4), and activities about problem solving (week 3, and 9).

The students created a total of 427 edits by the end of the module, 224 were submitted for assessment. 15 of the edits created and submitted contained only one clip and thus did not count as a submission since the Bootlegger platform does not render a one clip edit and thus those edits caused an error and could not be played. Figure (9) show the number of edits that were created for each session.

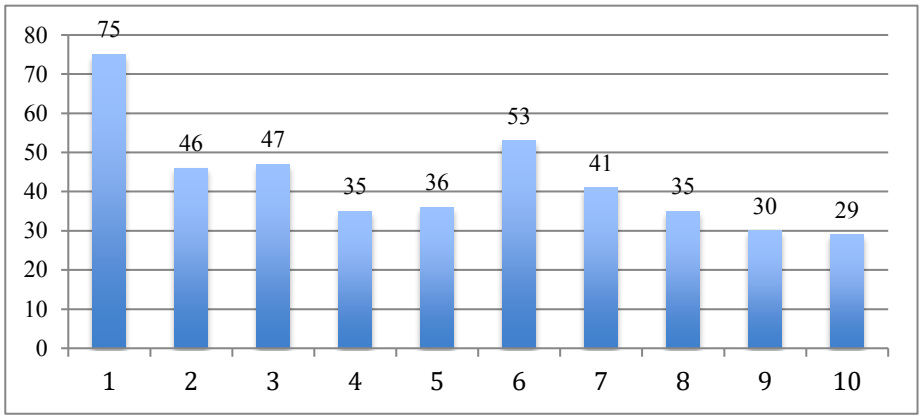


Figure 32 Total number of edits created for each activity

The first week's activity had the largest number of edits created as the students were testing the tool and learning how to create edits. However, only 9 of those edits were submitted with 4 of them considered invalid submissions as they included only one clip each.

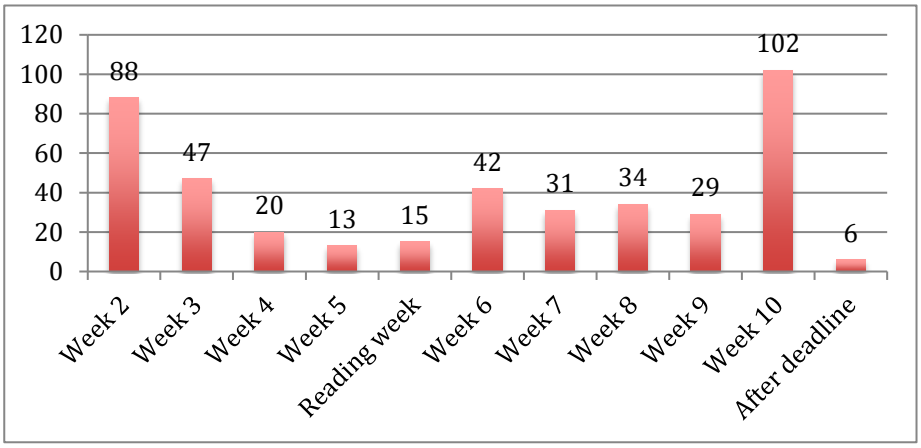


Figure 33 Timeline for creating edits

If we look at the timeline of edit creation (see figure 10), we can see that the largest number of edits was created in both the second and last week. The second week was when the students learned how to create an edit and were testing the process, while the last week was the deadline for submission. One student created six edits after the deadline and submitted all of them for assessment, but they were not considered due to late submission.

All the students enrolled in the module created at least one edit. The average mark for the assignment was 8.9 out of 10. Out of the 48 student who completed the course, 5 students submitted less than 3 edits and failed the assignment, 31 students (65%) submitted the 7 required edits, the rest submitted between 4-6 edits each. 11 students submitted more than the required number of edits.

Video analysis

As the aim of developing Group Tagging was to improve engagement in class activities and provide the lecturer with more information on how students engaged in their own groups, I examined the edits submitted by the students to investigate whether those short videos offer enough data on the students' engagement. In addition, I wanted to investigate whether the process of reflection and thinking about the skills when tagging had affected the students' skills and if the app could be used as a tool for improving professional skills.

The analysis happened in three stages. First, to better manage time, I picked the students who created 7 or more edits, which was the number of edits the students were required to submit for assessment. Out of the 18 students who consented to the use of their videos for analysis only 5 submitted the required 7 edits and thus they were chosen for the first stage of analysis. The aim of this stage was to familiarize myself with the videos and attempt to find any commonalities or differences in how the students approached creating their edits as well as how much information about the students' engagement could be found in those short edits. This exploration informed the second and third stages of the analysis. For this stage, I watched 40 videos from the 5 students. The edits were 2 minutes long on average and comprised between 2 to 5 clips. All edits included a title and in some cases a description with it. In this stage I simply watched the videos while writing notes on interesting things I noticed, such as the number of clips, titles and descriptions used, the use of tags, and the overall interactions of the students within the group.

In the second stage, I re-watched the videos more systematically, recording the specific tags used, whether the clips did show the skill tagged, any tags that could have been used with the clip but were not included. The aim of this stage was to examine whether there were any changes in how the students used the tags throughout the module and if the reflection (the intended use of Group Tagging) was useful in improving their skills (or their tagging). This stage did not reveal any important findings that would require examining more videos, thus I did not add other students to the analysis.

For the third and final stage, I re-watched the videos again and wrote a summary of all the things I found interesting in the videos. It included detailed notes on how the tags were used, what the students' preferences were when tagging videos, which student was the focus of the video, and what could be learned about the student who submitted the edit and their group from watching the videos. The aim of this stage of analysis was to understand how the students approached tagging, interpreted the tags, identified the skills, and created the edits individually. In addition, I focused more here on the group dynamics and what could be learned about the group from the short edits.

Table 4 and the next section detail the combined findings from the three stages. I am using the terms "*correct tag*" or "*tagged correctly*" for clips that showed the students demonstrate the skill in the tag. The definition of the skill is taken from the P21's Framework for 21st Century Learning definition (Partnership for 21st Century Learning 2015) of those skills since it was the definition used when creating Group Tagging as well as being the explanation given to the students. Group Tagging also provided the students with a short list of examples for the skills required and which tag they belong to every time they started or joined a session to remind them of what to look for during the session. The examples provided were:

Creativity: brain storming, reorganizing existing ideas, proposing original ideas.

Critical Thinking: applying knowledge, generalizing facts, analysing the problem, breaking it down, making connections, using personal knowledge to judge quality of information.

Communication and Collaboration: presenting ideas in clear and concise manner, helping others, work effectively as a team.

Information Literacy: evaluate and use information (personal and from sources), awareness of the ethical/legal issues.

Life Skills: flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility.

The lecturer's feedback to the students was also used to guide the analysis and identify correctly tagged videos.

Student	No. of submitted edits	Average edit length in minutes	Total number of tags used	No. of correctly tagged clips	Percentage of correct tags	No. of missed tags
St1	8	2.4	39	28	72%	0
St2	8	1	16	13	81%	5
St3	8	1.13	18	16	89%	2
St4	9	1.7	31	24	77%	4
St5	7	1.07	14	8	57%	4
	Total=40	**Total= 59.5 min**	**Total= 118**	**Total= 89**	**Average=75 %**	

Table 7 the results of the video analysis

Table 4 shows that 4 out 5 of the students were mostly tagging their clips properly, while the fifth used the tags correctly only half the time. Nonetheless, when tagged correctly, the clips (for all five) were a very good demonstration of tagged skills. The most common mistake was

including clips that were tagged with a skill but actually demonstrated another or showed the students doing something unrelated to the task. It was unclear whether those clips were included by mistake or if the students misinterpreted the behaviour.

Two students created all their edits at the end of the module while the others did it throughout. Analysis shows that the students who created all edits at the end of the module, have the shortest edits on average (included less clips). This didn't impact how they tagged the clips (they made the same mistakes in later edits that they did in earlier ones). However, the quality of the clips included improved noticeably for the students who did it weekly. The students who did it weekly were getting better at capturing the right moment when tagging and the clips they chose for their edits connected to each other better and made a more cohesive video.

Observation of individual Students Edits

Student1 (St1)

The student chose to include clips that show the entire group's contributions rather than focus on himself. This was very interesting as it gives a good idea on the group's dynamics and how they worked together. It is easy to see from the edits which students were most active, who took control or was leading the conversation, and who was quieter and did not participate much. Interestingly St1 himself falls into the latter group. He rarely talked in the videos and if he did, it was usually to give a quick response when asked. Of the 36 clips he chose to include in his edits, he was the main participant in only 2 of them.

As for the tags, St1 continuously used the Life Skills tag incorrectly. He included it in all 9 edits he submitted but only used it correctly once. Other times the clips were either an example of communication and collaboration, or just a chat that had nothing to do with the topic of discussion. He also tagged 6 clips with information literacy when they were more communication and collaboration and did not show information literacy skills. His choices for creativity and critical thinking were very good and show that he did understand what those skills were. The only time he made a mistake was in his first edit where he tagged a clip that was a good example of Critical thinking with the Creativity tag.

Overall, he gave good examples for creativity, critical thinking, communication and collaboration but struggled with identifying contributions that demonstrated information literacy and life skills.

St1 created his edits on weekly basis but he kept on making the same mistakes when tagging. There is no evidence of progress in his skills or his ability to identify those skills correctly.

Student2 (St2)

St2's edits included only 2 clips each, which show a limited number of skills. The clips he included where mostly focused on himself except for clips tagged with communication, which shows a conversation that involved most of the group. This demonstrates a good understanding of communication and collaboration and the clips he chose were excellent examples. St2 was active in the discussions and was also doing some organizational work such as taking notes and directing the conversation. However, he did not provide more clips as evidence, which he could have done by including more than two clips in his edits. He seemed to miss contributions that showed critical thinking and tagged them with either communication and collaboration or creativity. He used the creativity tag correctly 3 times and missed it 3 times.

Interesting to note that St2's descriptions, which he included with his edits, did not always match the content of the edit. The descriptions were mainly one or two sentences about what was in the clips. One edit's description mentioned him making a specific contribution, but he did not talk at all in the actual clip.

Overall, the small number of clips included did not provide enough data on the student's understanding of the skills required, and the fact that all but the first of his edits were created at the end of the module makes it hard to determine whether there was any change in his understanding during the module. He had trouble correctly identifying critical thinking skills and incorrectly tagged clips with information literacy. On the other hand, his selections for communication and collaboration, as well as life skills, were very good.

Student 3 (St3)

St3 included only two clips per edit, which as with St2, limits the number of tags to analyse. However, she included detailed descriptions with her edits that were self-critical and reflective of her participation. She mentioned what she was aiming to do in the session, what she was trying to show in the chosen clips, things she noticed that needed improving, and what she wanted to focus on in the next session. In one of her edits she included a clip that shows her interrupting someone mid-sentence and being distracted with her phone in another clip. She made a comment about how this wasn't good and how she would work on making sure this would not happen again. This was an interesting thing to do because the students were using the app to provide evidence of their contribution and they were expected to use the clips that showcase their best demonstration of skills. However, St3 chose to show what she did wrong and even point out why it was wrong and how she planned to address the issue in the future.

St3 generally was good at identifying skills as well as tagging them properly. Moreover, she chose very good clips to demonstrate the tagged skills. The only problem she had was confusing information literacy with critical thinking twice but used the tags correctly in the other clips.

She also could have tagged a few of the included clips with communication and collaboration but she didn't. St3 created her edits weekly as she was using them for reflection and the progress she made with her skills was evident and reflected in the feedback she received.

Student 4 (St4)

St4 submitted an edit for every session (9 edits) and included 3 to 5 clips in each one. He made very good choices that show his contributions and they were mostly tagged correctly. However, some of the clips he chose were for the whole group, and he had problem with the tagging for these clips. He confused creativity with critical thinking and communication a few times. He missed the information tag sometimes but when he did use it he did it correctly 3 times, and incorrectly once. St4 made some curious choices for his edits, for example his first edit was tagged correctly and had very good clips, but they were of other students' contributions while he stayed silent for most of the time. Another example was a clip that was tagged with communication and collaboration, but it showed the group talking over each other and some of them distracted with side topics. He was trying to communicate something in the clip but was mostly ignored, which makes the clip a bad example of communication and collaboration, but it was included in the edit.

St4 is different from the other students in that he changed groups twice and we can see that he participated less with the first group and was more active with the other groups.

Student 5 (St5)

St5 created all except one of his edits in the last week of the module. He seemed to have a problem finding the right tags and made multiple mistakes. He either tagged the clips wrongly or missed some tags. His edits included two clips each, except for the last one, which had three, and he tagged almost half of the clips included incorrectly. He even chose the same clip for two tags and both were incorrect. He also chose clips that were poor examples of the skills tagged, and his choices for half of the sessions shows that he did not participate much. The worst example was an edit were he only spoke when asked a direct question by the lecturer and his reply was to redirect the question to another student rather than answer it. An interesting observation is that he seemed to interact more when there were fewer people in the group. Also, in one session he joined a different group than his usual one and he was not treated well there. He was interrupted and dismissed in both clips included in the edit for that session. He did not explain why he chose those clips for his edits even though they were clearly not the best choices to show his participation.

During the analysis it became clear that the edits were too short to be used to judge skills or look for improvement or change in those skills. Encouraging the students to submit more edits or making the edits longer may help in addressing the problem for future deployment of Group Tagging. However, for this case study it was not a good indicator of engagement nor a good method of monitoring progress in professional skills.

6.5.2 Results from offline data

Attendance

Seminar attendance during the module was good. This time round the lecturer did not monitor attendance in class like the previous year. Rather, the students were required to participate in the discussion every week and submit a short video using the Group Tagging app as evidence of their participation. I used the videos recorded during class in those sessions in addition to Group tagging logs to determine who was in class. Figure (11) shows the number of students who attended the seminars each week.

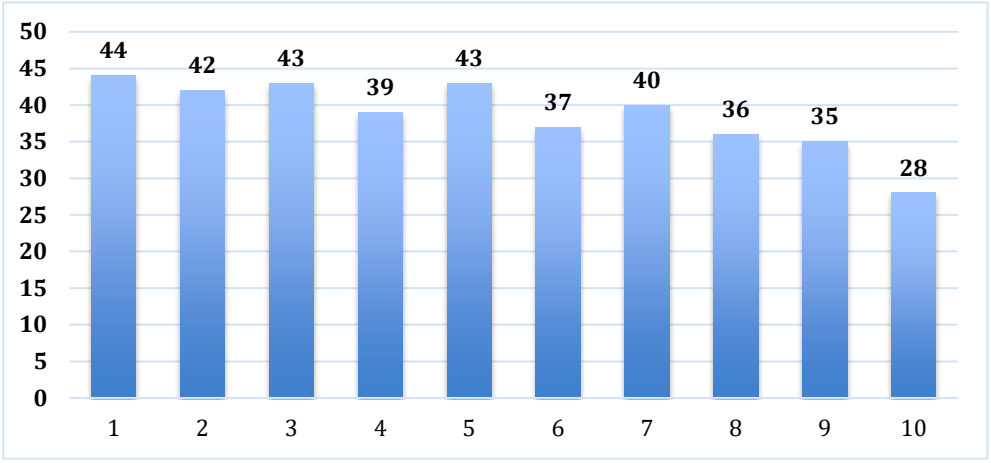


Figure 34 Number of students who attended class each week

The average number of students attending the seminars was 38.7 (81% of the total number of students) with noticeable decrease in attendance in the last week of the module. This shows a similar trend to the first Ubicomp module that had an average of 28.7, which makes up about 82% of the 35-total number of students who completed the course.

The Motivated Strategies for Learning questionnaire (MSLQ)

The questionnaire was administered in the break halfway through the module. The students received a link to the online version of the questionnaire and 14 students completed it. Students' responses were then broken down to their respective scales (Motivation and Learning Strategies) and the mean and standard deviation for each scale was calculated.

Overall the students that completed the questionnaire scored high on the Motivation Scale (mean =5.1 and std=0.5), and a bit lower but still good (mean = 4.2 and std= 0.7) on Learning Strategies.

Pearson Correlation was run on the different scales to determine whether there was any correlation with the students' final grades. However, the test found mainly very low or negative correlation between most scales and the final grade. It is important to note however that the p values were high and exceeded the significance level of 0.05, which means it is not possible to conclude that there is a significant association between the variables (the scales and the final grades). This is mainly due to the small sample size of only 14 students. Thus, the results from the questionnaire were not used to form conclusions for the research questions in the study.

Interviews

Five students (4 males and one female) were interviewed after the module ended to obtain more information on their personal experience in the course. Three of the interviewed students (2 males 1 female) were also part of the video analysis while the other two did not consent to the use of their videos. The interviews were divided into two parts, the first part focused on the module as a whole and asked the students about their experiences, likes and dislikes, and their study strategy. The second part focused on Group Tagging and the students were asked what they thought of the app, how they used it inside and outside class, how it affected their participation and what they thought of the concept of Group Tagging and this type of assessment. The themes that were identified during the analysis are presented in the following two sections. The first includes the themes that focus on the Ubicomp module, and the second consists of the themes concerning Group Tagging specifically.

The students' experience in the Ubiquitous Computing module

Overall experience

All the students interviewed agreed that the module was enjoyable and described it as being 'different'. Each had their own explanation for why they enjoyed it and what they found to be different about it, for example, one student thought that the reliance on course work and not having an exam was better suited for their learning style and that it was something rarely done in their degree. Another student mentioned that the seminars and the group activities were a nice change from sitting through a two-hour long lecture. Two students mentioned liking the topics taught in the module. They liked that is was more about real life situations they could relate to and less about theory and programming, which most their other modules focus on. As example

St 3: *"It was different to what a lot of the modules are. It was quite interesting that you turned up and, instead of just being sat in lecture two, there was actually stuff to do, which was quite good"*

St 4: *" Other ones tend to be focused quite into the programming and the more technical side of things. I quite like the people side of things because almost every piece of technology is aimed to help people do something better. I think if we focus too much on the technical aspect, we can create really amazing things, but they might not meet the needs of the people that want them. I think it was good in that respect. It was more of the people need, emotion, and help kind of thing"*

The students also highlighted a few issues they struggled with during the module. Mainly, they found some of the papers that they were required to read too long, boring, or hard to understand. They all said that they liked the idea of reading academic papers and that they thought the papers that were chosen were appropriate choices for the topics of the module, but they did struggle with some of them, for example

St 2:" *I did enjoy the readings, but I did find some of them were a bit long to fit in with everything else we've got to do at uni, […] also, they're interesting, but they're not always the easiest to read. Some of them are a bit dry. I think keeping that is good, but maybe finding some more appropriate length articles or [pick only] important excerpts out of them"*

The seminars and the practicals were the two things all five students chose as their favourite parts of the module and what they thought worked best. They mentioned that they enjoyed the different activities in class even though sometimes they were unsure how it related to the topic of the week.

St2: *"I did enjoy the seminars. We did lots of different little activities, which I thought were really good. It gets you thinking about what you're doing in a different way, like the one where you had to design the cyclist's T-shirt and the tangible objects and stuff like that"*

One student mentioned that while working in a group is out of her comfort zone and she didn't like it normally, she found that the way it was implemented in Ubicomp worked for her. She liked the prospect of small groups of students working together and thought that the activities were fun and lent themselves well to this kind of setup.

St4: *"I liked it and I didn't like it on a personal level because it was outside of my comfort zone. But I also like it because it was outside of my comfort zone. I really liked when we split off into little groups and we had to talk about something"*

Regarding study strategy, the students all said that their focus was on the required reading and completing the quizzes. The time they spent on the material before class ranged between 1- 4 hours per week depending on how much coursework they had for other modules. Only two of them said that they tried to get through everything provided (videos, reading, articles) while the

other three only did that if they had extra time. Three students were active in the forum every week and posted an answer to the weekly question.

All students did the work close to the day of the seminar and sometimes pushed it to the morning before the seminar. Only two of them mentioned having a designated time allocated to Ubicomp, the other three would do it whenever they had time before the seminar.

The use of alternative assessment

The module used various assessment methods (as outlined in Chapter 3) to evaluate the students. The assessment covered all aspects of the module online and offline and the students final grade depended on how much work they put into the different coursework required.

The students were particularly content with the online quizzes because they were a low-pressure assessment that was easy to complete, and they could do it on their own time. They also thought that it was a useful way to test their understanding of the material right after they gone through it, e.g.

St1: *"The quiz thing was really cool because it was just more of a fun way to assess you. It was a lot nicer than having a formal exam, if that makes sense, because it was a lot less pressure"*

St 2*: "I guess they were a great way to get you thinking about the reading you'd just done"*

Another assessment that the students enjoyed was the video tutorial. They thought it a fun assessment that was challenging but also different and interesting. There were complaints about Bootlegger, which had a few technical problems, but they were given the choice later to use any video-editing software, so this did not bother them too much.

St3: *"It gave us quite a lot of creative freedom to make something that was quite different. It was a different way of being assessed, of showing that you can teach someone else to do it rather than just write a bit of code and write an essay about it, which is what the other modules seemed to be mostly round, which was quite nice. It's something that I can actually show to someone else"*

As for the assessment of participation in class, which was done using Group Tagging; four students indicated that they did not mind the use of the app to assess participation since it makes it clear who participated and who didn't, and two of them even indicated that they would like to see it used in other modules as well.

St4: *" It's different. It would be nice to see it in more modules. I think if you started it off in first year, then it would be good"*

The fifth student said that he did not mind the app, but he didn't believe the edits were an accurate representation of a student's participation, so he did not agree to using it for assessment.

These remarks can be connected to the students' opinions about whether the short edits (2.5 minutes max) were a good enough representation of a student's contribution to a 15+ minute discussion or not. The students mostly agreed that it was better if the clips and edits were short to cut the time needed for reviewing the clips, creating the edits, and for the lecturer to give quick feedback. On the other hand, there were concerns that a student may only speak once or twice just so they could tag themselves and stay silent or not contribute anything useful for the rest of the session. In this case the short edits would not accurately showcase what was really happening within the group, e.g.

St2*:" you can see, this person has got a clip for each week and they've said something each week. But then really could be literally the only thing they said, and they might not have been very helpful to the group. I think it's better than just taking a register, but it's definitely still got a bit of the ambiguity of just taking a register"*

One student said that he liked the idea of the videos and tags but found the tagging during conversation distracting. He mentioned having to think on what tag to use brought him out of the conversation. So, he preferred if there was a video of the whole session that he could watch and tag later.

Credits for being active online

The credits the students were rewarded for being active on the website had no weight in their final grades. They were only used to give the student a way to see how active they were and to provide a friendly competition between the students. The interviewed students had different attitudes and reactions toward the credits. For one of them the idea of collecting points and staying at the top was thrilling and she took time out of her daily schedule to visit the website to collect the points available.

St3*:" I liked winning. I liked getting the points. I noticed someone was creeping up in points and they got quite close, so I logged on every day even if I didn't say anything, just to get the logged on point. I'm not going to lie, I wanted to win that. It was quite bad"*

For another student, it wasn't as important. He mentioned that he noticed it but that its existence didn't mean much to him. He did mention that it made some of his friends very competitive and that he found it funny but he himself didn't care much.

St2*:" I think it's fine because it encourages some people who go there every day and there are some people who just don't care, but I think it does provide a benefit overall"*

One student was not active much on the website, he only visited it to download the required reading and take the quiz. He said that he noticed that he was getting points but did not pay attention to it. He didn't even notice that the leader board was being published in the second half of the module even though it was posted in the same post as that week's topic.

The students' perception of Group Tagging and video reflection

Effect on conversation

The students identified three main effects Group Tagging had on their discussions in class. The first is that it encouraged them to participate because they knew they needed to contribute to get the marks. The students recognized that using Group Tagging made them talk more. They said that activities that used the application had more participation, which they thought was beneficial as it allowed for more opinions and viewpoints to be shared. Group Tagging also pushed them to pay more attention to the material they had to go through before class so that they could be more prepared to contribute to the conversation. In addition, it made them think critically about the brief for the activity and what was required of them to do or discuss, which made it easier to stay on topic and have useful input in the discussion.

St2*: "it got us talking; it got us all, like, properly engaged in a problem we had a common solution for. It got me really thinking about what the problem was so I could contribute something worthwhile"*

The second effect was that it made them more aware of what they were saying and thus the conversation was more formal or professional and less casual. The students thought that the awareness of being recorded made them think more about their words and how they were saying things. It also stopped them from going off-topic or using words or phrases they would normally use if it was just a normal conversation but may be considered inappropriate in a professional setting.

St1*: "It made the group a bit more formal, which was probably good because it kept us on topic. We just weren't saying as ridiculous things because we knew we were being obviously informally recorded, whereas, without that, I think the discussions would have got more off topic and less relevant. It added a little bit of authority to the group"*

The same issue was brought up by one of the students as a negative thing. He thought that it made the conversation less natural and he did not enjoy the change of atmosphere and attitude. So, even though he agreed that it's good to have professional conversations, he did not enjoy the discussions as much as he did when not using the app:

St2*: "I think for the most part when it came up, I personally was acting very professionally, and then there was maybe one occasion of people in the group, just like, 'Hey, remember we're being recorded, this isn't'… so I guess it was a good thing, because when I go and get a job [...], I've got to be professional. But it was like a burden when it came up. We were just having an easy, not easy, but a relaxed environment, and then suddenly there was this change"*

Managing the tagging during activity

The students had mixed opinions about the process of tagging while working together during an activity. In their groups, they employed different strategies for tagging what they thought worked better for them. Most students in their groups were tagging for themselves and occasionally for other group members. One group decided early in the module to choose a member to do the tagging for everyone since they found that all of them tagging together resulted in too many videos and many of these clips overlapped. Other students mentioned the same issue about the number of videos and overlapping content, but they said that they would rather have more videos to choose from than lose an important contribution.

St2*: "There was a little bit of chat at the beginning, but generally we just, "Let's just all do it." But it's better to have more than you need than not enough"*

St3*: "I think the first one or two, everyone did it, and then we decided that that got a bit not manageable. [..] Whoever was in our group would just decide one of us would do it"*

Another issue that the students faced was choosing the right tag for the clip and they were also divided on the best approach. Some of them found it hard to choose a tag on the spot and struggled to identify some skills associated with those tags while others said they enjoyed the tagging process and thought it was useful for them to think about their participation as it happened. They reported that trying to figure out the correct tag helped them think critically about their contributions.

St2*: "I found it hard to know sometimes which thing to press and also there were definitely two categories [...] where we just hardly ever had clips for them"*

St3:*" We tend to notice what skills we're looking for. It's like, "Oh, put that down as that tag," and we press the button. I think it made us think about what we were doing to make sure we hit those targets a bit"*

A solution that one of the students used to address the problem was to use the same tag for everything during the session and then later he would review the clips and tag them properly

St5*: "I would just pick the first tag or whatever tag was closest to my finger at the time, and if I felt like I was saying something I would just quickly tag it, and then after I went home, I would go look […] And then try to find the suitable skill to associate with it".*

The students mentioned that sometimes they got too absorbed in conversation and forgot to tag something important.

St4: *"If you listen to someone, you don't go, "Two seconds, I need to…" So, I found that some bits were, perhaps, lost. Not even just for me, but for other people in the group that did really good things and worked really well but didn't have it tagged"*

This could also happen if they were busy writing something or brainstorming ideas. They felt that good contributions were lost sometimes because of that.

Reflection on participation

The students thought that Group Tagging was useful as a reflection tool. It helped them think about their behaviour in class and notice details of their interactions with others that they normally wouldn't. The students acknowledged that reviewing the clips made them aware of how they behaved individually and as a group. They started noticing things like people being too quiet and not contributing much. It also helped them be more aware of the group dynamics. St3, said that upon watching the videos, he and his friend (who's in the same group) realized that there are a couple of students who were always quiet, so they started asking these students directly for their opinion to encourage them to talk more.

A student reported that she was quite upset to notice that she had the habit of talking over people and interrupting them often which she felt was rude. She was worried that her behaviour may have caused one of her group mates to withdraw and stop talking. This prompted her to be more careful about how she interacted with the group so as not to repeat the experience.

St4*: "I immediately cut ideas if I don't like them, and it's not a very positive trait. [..] It helped me realise things that I did in class and then try to change them"*

This point was highlighted by other students who were questioning whether it was appropriate to interrupt people mid-sentence, which is something that happens in normal conversations but is not polite or professional and can cause the shy and less confident in the group to pull back and not participate. The students were thinking of the right balance between having a normal genuine conversation while allowing everyone to participate so that they could all benefit.

St5: *"in a normal conversation, you are usually free to speak over someone, so if someone is saying something, you don't always wait for them to finish the sentence, right, you jump in, whereas in some of the groups I was in, people are a bit more […] laid back, so just waiting for someone to finish their point before saying something. […], it felt a bit unnatural, in that interaction"*

Group Tagging as a learning aid

The students thought Group Tagging could be a useful tool to help remember the conversation that happened during the activity afterwards. They thought it would be very useful in revision for the final exam. St1 used it to revise when he was doing his other coursework. He scheduled the submission of another assignment (writing a blog post every week) to after reviewing the videos and creating his edit for the week and used the information and ideas shared during the activity to write his blog post.

St1*: "I think it was good to make you think a bit about what had been said in class, so it was good to re-jog your memory as you were reading articles and as you were forming what you were going to do in that blog post"*

Strategies for reviewing clips and creating the edits

When it came to reviewing clips and making the edit, the students followed a similar strategy. They spent an hour (on average) reviewing the clips, correcting the tags, choosing the ones they wanted to include in their edits and then creating the edit.

St2: *"I went through every clip and noted down which ones I thought were good and then I'd go back and sometimes I would think, "That definitely wasn't that tag. I'll change that tag." But for the most part I spent an hour on each one, however long it would take to get through all the clips and a bit longer"*

The students had different approaches when it came to fitting Group Tagging into their schedule. St1 and St4 reported that they reviewed the videos and created their edits every week; St1 used the review process to remember the conversation in class and use it to inform his submission for another assignment weekly. However, he did not submit the edits for assessment until the last week. St4 liked to manage her time and finish every week's work in the same week for all of her modules, so she created the edits and submitted them regularly. St2 and St3 reported that they reviewed the clips and created the edits whenever they had time, but not necessarily every week. St2 submitted the edits in the last two weeks while St3 only submitted one at the end even though he created multiple edits, which he forgot to submit. St5 created all the edits in the last week just before the deadline. However, he did report watching some of the clips every week.

Overall, the students' strategy when using Group Tagging was dependent on how they managed their course work for the entire module and how they prioritized the work each week.

6.6 Discussion

The aim of this study was to retest some of the methods used to measure students' engagement in the first Ubicomp that showed promise, reaffirm findings from the first study as well as introduce changes to improve engagement. I also tested new methods that were added to this study or replaced ones from the first. The findings of the study were outlined in the previous sections. This section examines those results and relates them to the research questions and aims of this work outlined in Chapter 1. The first part of the discussion focuses on the students' engagement online and offline in Ubicomp2 and the second examines the new methods used in this study.

6.6.1 Indicators of engagement in a flipped classroom

Online Engagement

As was previously mentioned in the first case study (Chapter 3), Ubicomp was designed as a flipped classroom and provided the students with online material to prepare before class. The students' engagement with that material and sufficient preparation before class were very important for the success of the module as well as for providing the students with the best learning experience (Bergmann & Sams 2012). Information about the students' engagement online for Ubicomp2 came from the Wordpress site traffic, online quizzes and online credits as well as what the students themselves said in the interviews.

The website traffic shows a similar pattern to the first Ubicomp. The students started the module very active and then traffic decreased as the module progressed, which is a known issue (Chapter 3). However, there is a noticeable change from the pattern of visits to the website observed in Ubicomp1, and that is the small increase in traffic after week 6 as well as the consistent activity on the website during the same time period. This change can be attributed to publishing the points (credits) leader board and the breakdown of points each student obtained in the first part of the semester. This made the students aware of how they performed compared to other students as well as telling them how to obtain points. From talking to the students and examining individual student's activities, we can see that some students who were active in the beginning but started to lose motivation found the prospect of staying on top of the leader board to be a good incentive to continue visiting the website regularly and be active online. For other students, they either didn't care much about it or were rarely active so they missed the leader board when it was published, thus it did not affect their behaviour as much. These results confirm findings about introducing gamification to students' learning, which show that gamification can have a positive effect on students' engagement but that effect is dependent on the setting and the student's personality and motivation (Hamari et al. 2014). Gamification is being used increasingly in educational settings and there are reports of successful use of gaming aspects to motivate students. However, there are also concerns when using this approach due to some students' competitive nature and thus showing undesirable behaviour. There is also an issue of students feeling discriminated against if the weight of activities they received points for was not balanced and some gained advantage due to it (Fitz-walter et al. 2011). In the case of Ubicomp, that was not an issue since the points did not have any effect on the students marks and were only there to show them how active they were and encourage the competitive students to be more active while not pressuring others who did not want to compete. However, results of adding credits to the website showed that the module leader could use this method to improve activity online and add another incentive for the students to do the preparation before class.

The data also showed that the addition of a discussion forum to the website was another reason for the increased activity. The forum was the most visited section of the site and the students were posting weekly to answer the module leader's questions. This is a much better response than the first Ubicomp when the students used the comment section and Twitter to discuss the weekly topic. Online forums have been used for years as part of online courses and there are many studies that show their positive impact on student engagement in online learning (Gikandi et al. 2011; Barak et al. 2016). There are also studies like Alario-Hoyos et al. 2014 that examined the students' use of different types of social media in online courses (ex. Forums, Facebook, and Twitter), which found that students preferred forums to other types of social media and were more engaged with them during the course. The findings from Ubicomp2 correspond with these studies and show that the students did indeed prefer the forum and rarely used Twitter or the comments section, which was still an option to them. However, the students only used the forum to answer the modules leader's questions and did not start any discussions themselves. They only created topics in the sub forums (Technical Support, Assessment) to ask questions or report problems. For the Ubicomp module (both 1 and 2), this was not an issue as the students had a lot of face-to-face discussion every week so there was no need for the discussion online. Nevertheless, it is an issue to explore in the future to make the students' experience online richer and more interactive.

Another important observation is the results of the online quizzes. In Chapter 3, I discussed the benefits of using quizzes to test the students understanding of the online material and motivate them to prepare before class. The quizzes worked well in the first Ubicomp but there were a few issues with the questions that made them easy to answer without reading the papers or watching the videos. The quizzes were rewritten for Ubicomp 2 to address this issue and the students were satisfied with them. No more complaints were made about the questions or the quizzes, though it is interesting to note that the results of the quizzes in Ubicomp 2 were improving as the semester progressed, which did not happen in Ubicomp 1 and may indicate more work put into answering the quizzes.

Overall, the level of engagement online was high for Ubicomp2 and the students were mostly active and engaged with the forums and quizzes. The awarding of credits for activity on the website encouraged some of the students to be more active online even though that did not impact their marks.

Offline Engagement

This section focuses on the students' engagement in class and what was learned from observing their interactions in the seminars. As with the first Ubicomp, attendance was monitored in Ubicomp2 although not formally by the lecturer. Videos and logs from Group Tagging were

used to note attendance instead of a register. As the data showed (figure 11), attendance in Ubicomp2 was good but had a slight decline in the second half of the semester. This shows a very similar trend to attendance in the first Ubicomp and that trend may possibly hold for subsequent iterations of the course. The students enjoyed the seminars and were aware that they are being marked for their participation, so they attended class regularly unless it conflicted with an important coursework deadline that some of them might prioritize over Ubicomp. Thus, as was found in Ubicomp 1, while attendance on its own is not an indicator of engagement in class, it could be a useful tool to understand the students' experience in the module and whether they found the seminars worth attending.

The second method that was used to measure engagement in class was the MSLQ (outlined in page 98). The questionnaire showed a high level of motivation and learning strategy, which suggests good cognitive engagement with the module as a whole. However, as mentioned in the findings previously (page 113), there is little to no correlation between the students' overall performance in the course and their scores in the questionnaire. This makes it difficult to know whether the good motivation and learning strategy demonstrated by the questionnaire are translated to results and good learning for the students. There is also the possibility that the small sample size (14 out of 48 students) is skewing the results (hence why the questionnaire results are not given any significance in this work). Thus, while the questionnaire can help the lecturer gauge motivation and test learning strategies of the students, without the majority of them completing it, using it to make correct assumptions about engagement in the module was not feasible in this instance.

The last data source on engagement in class is Group Tagging. Group Tagging's effect was more in encouraging and improving engagement, rather than measuring it. However, it did also provide the lecturer with more data on participation and students interactions in class, which previous methods such as observations failed to do.

6.6.2 Evaluation of methods used to study engagement in Ubicomp

In Chapter 3, I discussed the methods that were used to measure engagement in the first case study and examined their suitability for use by the lecturer teaching the module. Those methods included analysing activity on the website, using observation forms, and interviews (which were also the same methods used in the second study Ubicomp2 with the exception of the observation forms). Two new methods were added in the second study, the MSLQ and Group Tagging, and this section examines how suitable those two methods are for use by the lecturer.

The Motivated Strategies for Learning Questionnaire

The questionnaire was developed to assess students' motivation and their use of learning strategies in a course. It is also accepted in literature as a method for measuring cognitive engagement (Pintrich et al. 1991; Fredricks & Mccolskey 2012). As mentioned earlier in the chapter, the questionnaire was sent to the students halfway through the module and 14 students completed it. The small number of participants made it difficult to draw conclusions about engagement for the whole class as the error ratio was too large to make any correlations to performance significant or reliable. For best results, it is necessary for the majority of the students to complete the questionnaire but that can be difficult to achieve due to the length of the questionnaire (the complete questionnaire includes 81 questions). This can be addressed by selecting only the parts that the lecturer is interested in, for example only questions on motivation since the design of the questionnaire lends itself to that. However, that still leave the added work of analysing the answers, which can be a big commitment depending on the number of questions included. The study and analysis of the 14 students' answers were not sufficient to measure engagement in Ubicomp but it could be a useful tool for a lecturer trying to examine the students' motivation or study strategy as well as to examine what is working and what needs to be improved in the course.

Group Tagging

Group Tagging was developed to improve participation and engagement as well as provide the lecturer with a tool to measure engagement. Therefore enabling the lecturer to understand how the students are engaging in class was part of the design of the software. As the findings showed, Group Tagging was successful in improving participation and encouraging the students to contribute more to conversations as well as be better prepared before class. However, the short edits the students created for assessment, which were meant to give the lecturer a window to their discussions that they could not observe during class, were not very useful for that purpose. The edits were short, and many students only included 2 or 3 clips that were focused on themselves. This was expected due to the assignment being "provide evidence of your participation" and wasn't a problem for the assessment, but it made it difficult to see how the group interacted as a whole. Still, when multiple students from the same group created different edits, the result was a very interesting look at how the group worked together, who was dominating the conversation, who was quiet, what each student contributed and how they managed the task as a group and as individuals.

This shows that Group Tagging has the potential for being a very useful tool to encourage and measure engagement but requires some changes to the design to incentivize the students and ensure they do the work and create the edits regularly.

6.7 Summary

This chapter describes the second case study exploring engagement in a flipped classroom and testing new methods for measuring student engagement. The chapter explains the differences between the first and second case studies and details the data collected and the analysis used for this study. It also describes and evaluates the new methods for measuring engagement that were introduced in the second Ubicomp and methods that replaced ones used in the first study. The findings confirm what was learned in the first study about engagement in a flipped classroom. They show that a flipped classroom can improve engagement with the right tools and that observing students' interaction online and offline is a good method to measure engagement. In addition, the chapter included a description of the pilot study of Group Tagging, the tool developed to encourage participation in group activities and support reflection. The tool was used during the module to assess participation in class and data was collected to evaluate it as a tool for reflection, and assessment, as well as a learning technology.

The next chapter discusses the findings from both case studies and attempts to formulate an answer to the research questions posed in the first chapter of this thesis. It also includes a detailed evaluation of the Group Tagging app based on the findings of this case study.

Chapter 7.

Discussion

7.1 Introduction

In this chapter, I reflect on the two case studies in chapters 3 and 5 as well as the results from the deployment and evaluation of the Group Tagging app. The findings are discussed in relation to the research questions introduced in chapter 1 and the wider literature on student engagement. The chapter starts with an examination of what was learned from the exploratory study on engagement in a flipped classroom environment and assessing the students experience online and offline to answer the first research question "What are the indicators of engagement in a university course built as flipped classroom?"

The second part of the chapter covers the methods used in both case studies to measure engagement and offer suggestions for the most suitable methods a lecturer can employ in their own class to understand student engagement. This part addresses the second research question "What are the best methods a lecturer can use to collect information on students' engagement in a flipped classroom without disturbing their learning?"

Finally, the last section discusses the findings from exploring the effect of video-supported reflection on student engagement, which relates to the third research question proposed "What is the effect of technology supported reflection on students' engagement in group activities in class?" This section includes the full discussion about the Group Tagging app based on the findings from its deployment in Ubicomp2 and the students' experience using it.

7.2 Engagement in a Flipped Classroom

The flipped classroom has been publicised as a model that increases students' engagement and performance (Gilboy et al. 2015). The claim usually cites the use of active learning in a flipped classroom as the reason for any improved engagement. Researchers and teachers have argued that students were encouraged and pushed to participate more in a flipped classroom compared to a traditional lecture due to the use of active learning (Yuan et al. 2014; Bishop et al. 2013; Jacqueline E. McLaughlin et al. 2014a). Active learning describes the learning process that requires students to be more than passive listeners in a lecture. Students must be involved in discussions, analysis, problem solving, and other high-level thinking activities to attain better learning outcomes. Active learning has been shown to improve students' performance and

engagement as well as the relationship between students and instructors (Bonwell & Eison 1991). The flipped classroom model uses active learning strategies to help students gain better understanding of material they went through prior to class. Students in a flipped class obtain knowledge first through the material provided by the instructor and then have a chance to apply that knowledge and expand on it by engaging in discussions or other activities in class (Tune et al. 2015). However, when addressing the issue of engagement in a flipped classroom, researchers and instructors usually cite the students' response to whether they found the course more engaging than a traditional lecture based module or by comparing the students perceptions of a course before and after flipping (Tune et al. 2015; Bishop et al. 2013). As mentioned earlier, the noted improved engagement is linked to active learning in class, but a flipped class involves more than what is happening inside the classroom and the whole student experience within a flipped class needs to be investigated and understood if we want to judge the model accurately on its effect on engagement and performance. Thus, one of the aims of this research was to explore engagement in a flipped classroom module by examining different aspects of the course as well as relating the students' own experiences and perceptions to data collected from observing their interactions and behaviour during the module both online and offline.

Chapters 3 and 4 detailed the two case studies conducted during the Ubiquitous-Computing Module (Ubicomp) ran in the years 2015-2016, to examine students' engagement and identify behaviours that can be considered as indicators of engagement. For the studies, I collected data from a variety of sources including the website log files, interviews, observations and surveys to cover all possible aspects of the course. The findings from both instances of the module showed a good level of engagement and participation both online and offline based on the students observed behaviour and confirmed by the interviews with the students. The next section outlines the behaviours, methods and data sources that proved to be the most beneficial to measuring engagement online and offline.

7.2.1 Engagement in class

Attendance is proven to have a small but positive relation with performance (Gatherer & Manning 1998). For a flipped class, attendance is important for the students to apply what they learned before class through the online material in a more active and collaborative environment, and this is where the role of engagement is important. It is essential that the students be engaged and satisfied with the learning experience in class in order for them to participate and even decide to attend. For Ubicomp, attendance was high in both years, with an average of 80% of the students enrolled attending every class for the whole semester. In addition, the students I talked to all described the course as "different", "fun" and "engaging" and chose the seminars

as one of the things they thought worked well in the module. The good attendance rates could be attributed to the fact that the students received 10% of their grade for participation in class (which implies attendance), and this was probably a factor as well. However, as the first Ubicomp proved, the students prioritised their time and some of them were willing to drop an assignment and lose credit if they had other coursework they deemed more important. Some students in Ubicomp 1 reported doing the minimum amount of work possible to get through class and several students did drop the last seminar in both years because it happened on the same day as the deadline for another more important assignment (the report which accounted for more than 30% of their final grade). So, the students' high attendance rates in both years suggest they found value in the class experience and were engaged enough to keep coming back every week. Thus, while attendance does not give a clear or detailed idea on how students engage in class, it is a good indication of how students perceive the course and is a quick method of noting any drop-in interest.

For more in-depth information about the students' engagement in class there are two methods commonly used by teachers and researchers: Self-report and observations. In this study, one of the main goals was to attempt to measure engagement without distracting the students or affecting their learning in class. Thus, having them answer questions (as a survey or verbally) during class to report their engagement was not considered the best option. Observations were the most non-intrusive approach and it is also what a teacher normally does when trying to gauge engagement in a class. Observations are mostly useful in identifying behavioural engagement (positive or negative) by monitoring the students' interactions in class. Two methods were tested for the observation in Ubicomp. For the first year I used a form that is completed at intervals to rate the levels of engagement (Appendix D). In the second year, the videos (edits) produced by the students using Group Tagging were used to observe behaviour and participation. Each method had its own advantages and posed different challenges. The observation forms were useful in giving a general idea on the level of engagement for the whole class at a given time, but they needed to be completed frequently throughout the seminars to capture enough data about the students' experience in class. This was difficult due to the observer having other tasks to attend to at the same time. The results from the data collected through that method in Ubicomp1 did help in showing which activities garnered more participation but there was not enough information to understand why or to be able to make a conclusive statement about engagement in class.

In the second year of Ubicomp the observation forms were dropped from the study and the Group Tagging app was used as the replacement method for obtaining data about the students'

engagement offline. Group Tagging recorded short video clips showing what all the students were doing at specific moments during an activity (in their respective groups), which I thought would provide more data compared to an all class observation (like the forms) or from observing one group at a time. However, the videos recorded were moments chosen by the students and not the entire activity and those clips were also only available to the students in the same group to protect their privacy. The only videos that the lecturer had access to and could use to measure engagement were the edits created by the students after class and shared with the lecturer for assessment and feedback. This limited the data available to the lecturer but was necessary to protect the privacy of the students and make them more comfortable using the app.

From the findings, it was clear that the short videos were not enough to measure the individual student's engagement in the activity due to how short the videos were. Also, some students raised concerns about how easy it was for anyone to game the system by participating only a couple of times every week and include those contributions in their video, which would make it look like they were engaging with the activity but in reality, they were barely participating. This was indeed confirmed when analysing the videos submitted by the students. It was clear from examining videos of different students in the same group that some of them were less active, but it is hard to tell from their own videos alone. So, it is apparent that for Group Tagging to be a good measure of engagement, it is important that multiple students from the same group all submit videos with as many clips as possible to provide the lecturer with enough data to make an informed conclusion.

Something interesting to note was that the informal chats with the lecturer teaching the module showed that she had a very good idea how the students were doing in class from her own observations. She did find the videos from Group Tagging informative because they added details to what she observed. She thought that while it did not offer the measure of engagement we wanted, it was useful for her to see glimpses of the discussion happening when she was not with that group.

Thus, if we take the findings from both case studies we can conclude that student engagement in class for a flipped classroom can vary depending on the activities. At the same time it must be acknowledged that it is very difficult to measure engagement accurately or make a definitive statement about it. There are however indicators such as attendance and the observed level of participation that can be used to give the lecturer a quick insight into how the students are responding in class. Tools such as Group Tagging can also be useful to provide more information to the lecturer's own observations. Group Tagging short videos offer the lecturer an insight to

the students' conversation when they are not close enough to listen to it or influence it themselves.

7.2.2 Engagement online

A flipped class usually uses the Internet to deliver the preparation material to the students before class, and it is important that the students engage with the material to be able to apply that knowledge later in class (Jacqueline E. McLaughlin et al. 2014a). In Ubicomp, the students' engagement online was examined using the traffic for the course's website as well as the comments and posts they made on the weekly study topics or in the forum. The results from the first Ubicomp showed that the students started the course very active online and that their activity gradually decreased every week. From talking to the students, it was clear that the reason for that was not a specific problem with the material but the increasing workload the students experienced as the semester progressed. The students have reported that due to deadlines and coursework for Ubicomp and other modules, they had to prioritize and choose which parts of the work to do every week to manage their time. This resulted in some of them dropping a lot of the preparation material and only doing the quizzes for the marks (sometimes not even that).

This problem is well known and was discussed before by researchers and teachers who tried the flipped classroom model. The solution usually proposed to address this issue was to test the students on the material they should have went through before or at the start of class to make sure that they have done their preparation adequately (Tucker 2012; Jacqueline E. McLaughlin et al. 2014a; Freeman Herreid & Schiller 2012). This was the solution that was employed in Ubicomp by adding online quizzes to the website the students were required to complete before class and was part of their final grade. The data showed that on average more than 90% of the students were completing the quizzes weekly in the first year and scoring high (average 7.7 out of 10) (chapter 3 figures 6,7). However, the results of the quizzes and the number of students completing them does not fit with the trend of decreasing traffic to the website and with the students admitting that they were doing less preparation. This showed that the online quizzes did not do an adequate job in motivating the students to go through the material or engage online. The students themselves confirmed this and related it to the quizzes being easy to answer without reading any of the provided material or that the answers could be easily found by doing a search on keywords. This had allowed the students who wanted to put their time into another coursework to quickly complete the quiz while not checking the required material. This could have also affected the students' learning in class due to some of them not having the knowledge they needed to participate effectively in the activities, which was a concern the module leader expressed in Ubicomp1.

The quizzes were changed for the second Ubicomp in the following year to be harder and more challenging while still keeping each quiz short and low pressure (no time limit). The findings from that case study showed that the number of students completing the quizzes was also high but this time there was an improvement in scores obtained as the students learned what material they needed to learn before taking the quiz. This result coupled with the consistently high traffic to the website (chapter 5 figure 24) suggests that they interacted more with the material online.

In addition to the quizzes, two other solutions were tested in the second Ubicomp to increase participation and engagement online, adding a discussion forum to the website and introducing a credit system to incentivise activity online.

In the first Ubicomp the students were asked to be active online and discuss the material in the comments section or on Twitter. However, that approach was not successful due to the students being confused about what to post in addition to many of them considering Twitter and comments on a blog to be social media and not "real learning". The students who did post also admitted that they only did it for marks and that they found little value in it. To address this issue and push the students to engage more with the topic before and after class, a discussion forum was added as the formal place to post about and discuss the weekly topics they were studying. The lecturer used the forum to post a weekly question that the students had to answer to get marks for online participation. The students received the forum very well and the level of interactions was high, with it accounting for 30% of the total traffic to the website. The students also reported that they enjoyed reading everyone's posts and learning the different opinions of their classmates. This result also confirms the findings by (Alario-Hoyos et al. 2014) who examined students' perception of social media use for education and found that they preferred forums to other social media platforms.

The other solution tested to increase students' engagement online was crediting them with points for certain interactions, such as watching videos, downloading papers and posting in the forum. The students could see the points they accumulated displayed on the sidebar every time they logged in to the site. The points had no effect on the students' grades but were there to show them how active they were and to add a bit of competition between them to get higher points. The student in the beginning did not know how many points others had without asking them, nor were they told how to get points. Thus, they had to experiment themselves to find out the specific actions that awarded them credits, which made it a little like a game. The use of gamification in education is not a new concept and the research on the topic has shown positive results especially for competitive students (Hamari et al. 2014). Thus, to make it more like a competition, the leader board was published in the second half of the module and the students

were then made aware of who was scoring higher and how they could improve their credits if they wanted. The findings from analysing the points and student behaviour and perception of the credits showed an interesting trend. The number of credits awarded did not increase significantly in the second half as we hoped, when the students found out how to get more credits, which suggests that the game did not encourage them to be more active. However, when looking at the trends of obtaining credits we can see that it fluctuated a lot in the first half of the semester but was more consistent in the second half (chapter 5- figure 30). The trend shows that while the credits did not encourage students who were not usually active to participate more, it did motivate the active students to continue engaging with the website to stay ahead in points, which was also confirmed by the interviewed students.

From the findings discussed above, it is apparent that the benefit of active learning that is observed in a flipped classroom and claimed to make the model of teaching more engaging, may not naturally extend to the online part of the course. The students needed to be motivated constantly and pushed to engage. Expecting the students to prepare just for the sake of being ready for class is clearly not enough and they needed to be reminded regularly as well as challenged by quizzes to do the work. In addition, the students' perception of the online environment can play a big role in how they interact with it, as was demonstrated when they dismissed Twitter and the comments section (or social media) as a learning tool and embraced the forum that served the same purpose simply because they considered it a more formal learning tool.

7.3 Tools for Measuring Engagement

Previously in Chapter 2, I discussed the methods commonly used to measure engagement in different educational settings. Studies on engagement have used every type of method including self-report, observations, learning analytics and biophysical sensors to examine students' behaviour, emotions and cognitive engagement (Rienties & Rivers 2014; Greene 2015; Henrie et al. 2015a). These methods all have advantages and disadvantages as well as optimal settings where they can be more suitable. For example, questionnaires are a good option for a study on engagement in MOOCs whereas other methods like interviews or biophysical sensors are difficult to apply due to the large number of participants in these courses and the distance (Henrie et al. 2015a). One of the aims of this research was to test some of these methods to examine which of them where better suited to help a lecturer teaching a flipped classroom understand their own students' engagement during the course. Thus, in this section the methods used in Ubicomp are examined by asking the following questions: Does the method add significantly to

the lecturer's workload or affect their teaching? Is it distracting to the students or impact negatively on their learning experience?

7.3.1 Self-report methods

Self-report are the most commonly used methods for measuring student engagement in literature. Questionnaires, focus groups, and interviews are widely used in studies about engagement due to their suitability for data collection on the students' personal experience and emotions (Fredricks & Mccolskey 2012). There have also been a few attempts to develop self-report tools for measuring aspects of engagement, with the most notable example being the National Survey of Student Engagement (NSSE) (Kuh 2009) and others derived from it such as UK Engagement Survey (UKES) (Anon 2016). For this study, a few self-report methods were used to collect data on student engagement in a flipped classroom, i.e. semi-structured interviews at the end of the semester, and the Motivated Strategies for Learning questionnaire (MSLQ) administered in the break halfway through the module. These methods were chosen to obtain as much information as possible about the students' experience in Ubicomp while making sure they were not disturbed during class.

With hindsight it is clear that the self-report methods used in both case studies provided very useful in-depth information about the students' behaviour, emotions, study strategies and motivation. That information was essential in understanding the students' learning experience as well as in interpreting data collected from other sources such the website or the Group Tagging app. Thus, these methods enriched the study and were very important for this research on student engagement. However, from the perspective of a lecturer who wants to obtain the information and use it to improve the course, self-report methods have some drawbacks. First is the insufficient number of students completing questionnaires or taking part in interviews. That was a problem this study faced, and a lecturer would most likely face as well. Students these days are heavily surveyed so they may not want to complete frequent surveys within class (Fredricks & Mccolskey 2012). Without enough data, making any conclusions is difficult and may not be a useful tool for a lecturer. The second issue is the time and frequency of data collection. Engagement is not a fixed aspect and is constantly changing during class and throughout the semester. Thus, collecting the data once or twice per semester would only provide a glimpse into the students' experience in the course and the changes would be missed. On the other hand, surveying the students continuously can overburden them and is potentially distracting, which also relates to the first point. In addition, conducting interviews or focus groups with these students while the course is ongoing could put the students in an uncomfortable situation due to the power relationship between a student and a lecturer. The

students are likely to say what they think the lecturer wants to hear for fear that their complaints may adversely affect their grades (Fredricks & Mccolskey 2012).

The third issue is the added workload to the lecturer, which can be an issue when using self-report methods. A flipped classroom in itself could be a large time commitment for a lecturer, especially at the beginning (Xin et al. 2013). Analysing data from surveying dozens of students or from multiple interviews can add substantially to that workload and overburden the lecturer.

Based on the previous points, it is clear that self-report methods may not be the best way to go for a lecturer wanting to understand the students' engagement within a module. However, talking to the students informally and asking for feedback could be a useful way for the lecturer to establish a connection and build confidence as well as create a friendlier environment in the class.

7.3.2 Observations in class

All lecturers and teachers use observations frequently during class to measure students' engagement on a surface level. These observations usually inform the lecturer's next step and may influence how they structure and deliver their material (Volpe et al. 2005). While this may be a useful method, it is also limited to what the lecturer can see and remember as well as it being dependant on their experience and skill. Thus, it is possible to miss important details especially in a class that uses small group activities where the lecturer can interact with only one group at a time. There are a number of observation methods that have been developed to assist teachers in measuring student engagement in class and for this study I have tested one of these methods, a form to measure the levels of engagement in the class at a given time (Appendix D).

Chapter 3 detailed the results from analysing the data obtained using the "Student Engagement Walkthrough Checklist" (Jones 2009). The main issue with the checklist was the time and frequency of completing the form to obtain enough information to measure engagement in Ubicomp. The form was short and simple to complete but it needed to be done frequently and at fixed intervals to provide adequate data on engagement, which changed depending on the activities the students engaged in. Completing the form was the responsibility of the researcher in Ubicomp and even so it was hard to do while helping in class. Thus, it is clearly going to be even more challenging for a lecturer who is teaching the class alone. Therefore, any kind of forms that require the lecturer's attention are not suitable for the task and would be a poor choice without having an independent observer doing it every seminar which is difficult.

Another method for observing student engagement in class that was tested is the Group Tagging app. The application's main purpose was to support student reflection on group activities and assess participation in class. It also provided the lecturer with short videos of the students' interactions in their groups when the lecturer was not around. Thus, it was another source of information the lecturer could use to observe behaviour and engagement. However, the videos, while very useful, were also not enough to give a full picture of what happened in the activity or how the students engaged when not being filmed. There were also concerns from students themselves about how easy they felt it was to make it look like someone was active while only contributing once or twice just to have a video. Nonetheless, the lecturer's feedback and examining the videos showed that Group Tagging could be a valuable resource for measuring engagement in class when combining the videos with the lecturers' own observations.

7.3.3 Learning analytics

Learning analytics describes the collection, analysis, and reporting of data about learners in an educational context (Siemens 2013). It is a relatively new field that emerged and gained traction due to the interest in building better understanding of learning and teaching as interest in personalized and adaptable learning increased (Siemens 2013). Learning analytics uses the traces students leave when navigating online educational systems, such as Moodle and Blackboard, as a data source. This data is collected and analysed to learn more about the students within the learning environment without asking them directly. Most studies using learning analytics have been focused on predicting performance and promoting awareness and reflection (Agudo-Peregrina et al. 2014; Verbert et al. 2014). There are also studies that use learning analytics to create an early warning system that flags struggling students and informs the teacher for a more timely intervention (Macfadyen & Dawson 2010).

For Ubicomp, learning analytics were used to understand the students' online engagement by collecting data on their interactions when using the course website. The data was analysed using SPSS and the detailed results of the analysis are included in chapters 3 and 5. As a method for measuring engagement, learning analytics showed great promise and offered good insights on the students' engagement online. The findings made it clear that the students lost interest in the online material as the semester progressed in the first year (confirmed by the interviewed students), so it was apparent that the traffic to the website was a good indication of engagement over time. In addition, the same data collected in the second year of Ubicomp reflected the changes that were made by the teaching staff to improve engagement online. While learning analytics could not be used to measure engagement in class due to lack of adequate data, it was

a very useful source of information for engagement online which is an important aspect of the flipped classroom.

However, lecturers wanting to use learning analytics in their course may be faced with the problem of the availability of tools to perform the task. Due to the large amount of data to be collected and the complicated analysis required, the right tools are essential. Currently, there are tools available for the well-known Learning Management Systems (LMS) that are usually used in universities, such as Blackboard. The same companies that developed the LMS created these tools to add an extra layer of analytics and provide reporting interfaces for benefit of the teaching staff (Siemens 2013). However, for a lecturer with no access to those tools, doing the analysis can be challenging and time consuming. There are options that can be used depending on the platform chosen to deliver the online material to the students, and this particular step needs to be considered while building the course and integrated within it. Ubicomp is a good example of this issue since the teaching team decided to use Wordpress instead of Blackboard (the LMS used by Newcastle university) to make the material more accessible to students. Wordpress is a well-known blogging platform that provided us with the ability to customize interfaces and embed videos but did not have any learning analytics tool, as it is not an educational platform. Thus, a plugin created to track traffic to the blog to find the most popular posts (for advertisement purposes), was used to collect the data for the study. The plugins provided a huge amount of information but using that data for analysis required additional work to clean the data and arrange the records to make it possible to use analysis packages such us SPSS. This option worked very well for the study but would be quite difficult and time consuming for the lecturer, especially if they needed to do the analysis on weekly basis to check the students' progress. Thus, choosing a platform that already has integrated (or the possibility to add) analytics functions is the best option for the lecturer teaching a flipped course to measure the students' engagement online.

Finally, Table 8 shows a summary of the advantages and disadvantages of using each one of the methods employed in this research for a lecturer interested in understanding engagement in their flipped courses.

Method	Type	Advantages	Disadvantages	comments
Observations forms	Qualitative	A structured method for information on the students' engagement in class.	Time consuming and require an independent observer (other than the lecturer) to obtain enough data from class for good representation of engagement	
Semi- Structured Interviews	Qualitative	Provide a rich source of information on the students' experience in the course. A very useful method for obtaining data on emotional and cognitive engagement	It is not possible to conduct interviews frequently due to it being time consuming and may make the student' uncomfortable. The power relationship between the lecturer and the students may also affect what the students say in those interviews due to fear that their grades may be affected if they criticized the course or the teaching	Formal interviews may not be a good option for a lecturer but informal talks with the students and asking for feedback from them can be very useful in building rapport and creating a comfortable and friendly environment.
Frequency analysis and visualization of online interactions	Quantitative	- A good indicator of engagement in a flipped course. - Provide the lecturer with information throughout the course. - Can be conducted using existing tools	- Complicated and time consuming if the appropriate tools were not implemented.	Choosing the right online tools when creating the course that can provide the required statistical analysis and visualization is essential

The Motivated Strategies for Learning Questionnaire	Qualitative	- Provide information about the students' motivation and learning strategies. - Considered an acceptable measure for cognitive engagement	- The full survey is long and cannot be administered frequently so it is not suitable for obtaining information on engagement throughout the course.	The survey can be broken down to parts and used to get better understanding of the students' experience
Group Tagging	Qualitative and quantitative	- Provide the lecturer with short video clips showcasing the students' participation in class activities. - Allows the lecturer to give feedback - Allow the students to review their own participation and their group working together. - The use of tags helps the lecturer understand how the students interpret and demonstrate skills and helps the students notice how they demonstrate those skills, and which thigs they needed to work on more.	- The videos while useful for the lecturer as a source of information on engagement, are also a time commitment to watch and give feedback - Most students must submit their videos every week for them to be a good measure of engagement and to give the lecturer enough data to understand how the group and each individual student is participating in class.	

Table 8 Summary of the advantages and disadvantages for each method used in the research

7.4 Video-Supported Reflection and Student Engagement in Group Activities

The third research question for this study was on the effect of video-supported reflection on students' engagement in group activities in class. To answer this question, the Group Tagging app was developed and deployed in the second Ubicomp module. Group Tagging was developed as a tool to encourage students' reflection on group activities in class as well as improve participation and engagement in those activities. It was also used to assess participation in class and provide the lecturer with more data on engagement. Data on using Group Tagging and the student experience with the app was described in Chapter 5 in the findings section. This section evaluates Group Tagging as a tool to support reflection and as an assessment method for participation. The functionality and design of the app are also evaluated to determine how well it served its purpose and what could be improved.

7.4.1 Group Tagging as a tool for reflection

To evaluate the application and find out whether it has succeeded in its intended purpose we must understand how the students used it during and after class and the effects it had on participation.

Reflection during activity:

Nunes et al. (2003) proposed that reflection during an activity happens when the student pauses to think about an action or an idea while solving a problem. The findings from Ubicomp 2 showed evidence that Group Tagging encourages this type of reflection by requiring the students to tag certain moments during an activity with the skills that were displayed at that moment. Thus, they needed to be able to identify the skill and choose the appropriate tag within seconds so that the moment was not lost.

Nunes et al. (2003) also explained that software that assesses cognitive strategies should provide the students with the ability to recognize and think about the strategies they are using when solving a problem, and that this recognition will help them expand their cognitive possibilities and gain autonomy.

The results showed that the students had different attitudes towards the tagging process, which was reported to be a challenge that was addressed differently by the student groups. Some of the students decided to take the challenge and tried to identify the skills while working. Others chose to avoid the challenge and either put the responsibility of tagging on one group member or just use the same tag for all the clips and not think about the skills involved until later. Naturally, each approach offered advantages and disadvantages that the students had to weigh against each other to make the decision on what strategy to use. Therefore, while some of the

students did not do the reflection and thinking during the activity, they had to take an extra step when reviewing the clips later after class. If we take Nunes et al.'s definition we can conclude that Group Tagging, in its current design, supported the students who wanted to do reflection during the activity and helped the other students, who chose otherwise, to come up with another strategy that worked for them.

In addition, the findings demonstrate that using the app to assess students' participation in class along with the students' awareness of being recorded pushed them to be better prepared before class so that they could contribute, encouraged them to talk more so they would have something to record and kept the conversations on-topic. So, using Group Tagging in class worked well toward addressing the issue of disproportionate participation and combatting social loafing (Karau & Williams 1993) by incentivizing participation and making it easier to spot quiet students.

Reflection after class:

Group Tagging's design and features aimed to help the students go through systematic reflection of their participation in group activities after class. This approach was proven by Ellis et al. (2014) to be effective in improving learning outcomes if the students engaged in the process every week. However, as the findings showed, the students in the module did not engage consistently, many of them created their edits at the end of the module near to the deadline of submission (Chapter 5 figure 33), which means that the reflection process was not happening when it should. Nevertheless, the students who followed the process found it very useful in improving their own professional skills and their group interactions. As the interviews revealed, some students changed their behaviour after reviewing the videos and others became more aware of the group dynamics and the lack of participation from others, which prompted them to take positive steps to address the issue.

7.4.2 Using Group Tagging to design class activities

While the analysis shows that it was not possible to measure whether there was any improvement in the students' skills due the use of the tool, the students' tagging can be useful in informing the design of the activities in class. By examining how the students tagged their clips (Chapter 5, Table 6) and which skills they used more often than others, it is apparent that there is a relation between the skill and the type of activity the students engaged in. For example, the increased use of the Creativity tag for design activities or for Information Literacy in activities that required searching and sharing information.

Group Tagging allows the lecturer to understand how students interpret those skills and choose tags based on skills they think fits their course best. Thus, by using the app with different

activities, the lecturer will be able to discern which activities may help students improve certain skills as well as what type of activities they need to include moving forward to emphasise other skills. In addition, a lecturer can use the students tag patterns to evaluate the activity to ensure that it is serving the intended purpose and helping the students with their skills. It can also be a good way to open conversation with the students about the activities, the skills they need to demonstrate and how they observe their own progress and learning.

7.4.3 Group Tagging for assessing participation in class

Group Tagging was used as part of the Ubicomp module assessment to mark the students' participation in class, which made up 10% of their final mark. As mentioned in Chapter 4, a successful group activity requires an element of accountability (Johnson et al. 2000), which can be applied by assessing each student's individual contribution. Group Tagging can be a useful tool for this assessment as it provides the students and the lecturer with proof of participation that can make assessment more objective and transparent. With Group Tagging, the students knew exactly what they needed to do to get the marks and the lecturer is provided with access to parts of the students' interactions they could not personally observe in class. Group Tagging also offers the students the opportunity to take control of their assessment by giving them the chance to include only clips showcasing their best contributions.

In addition, Group Tagging has a feedback function that allows the lecturer to comment on the students edits to inform them of how they are doing and what they can do to improve. Feedback is a very important aspect of assessment in the class as it allows the students to review their work, make adjustments and progress forward (Earl 2012).

The students that were interviewed were mostly satisfied with the app as an assessment tool, and the only complaints against it were about whether the edits included enough information for the lecturer to make an informed decision about the quality of participation. This issue would not be a problem if all students created the edits, as it would provide the lecturer with multiple points of view and different clips and interpretations of the same group's interactions. Therefore, encouraging the students to do this every week may be a challenge for the instructor. Thus, it is apparent that Group Tagging was a good method of assessment for participation in class that offered additional benefits such as reviewing discussions in class and supporting reflection.

7.4.4 Evaluating Group Tagging's design and functionality

Group Tagging was designed to fit most types of activities in class. It offers the instructor with the ability to change tags depending on the learning outcomes of the activity and what they think the students should focus on or improve. This is also augmented by the use of an external

camera that can be installed anywhere to capture the students' interactions in any setting. The customizability of the app makes it usable in any educational activity that employs small-group teaching, unlike other tools, such as Reflectable (Hook et al. 2013), which is designed specifically for design activities. In addition, the simple tagging interface with its limited options makes the process of recording the clips as easy as tapping on the phone. Students do not have to point a camera at the person speaking, which can be very distracting to the speaker as well. They do the tagging during the conversation with no pauses and without bringing attention to the camera and recording, which makes activities flow more naturally. Also, the clips the app records start 10 seconds before the tag is clicked so the students have time to decide whether the contribution is worth recording or not. These could not be achieved by tools such as Bootlegger (Schofield et al. 2015), which requires the user to actively use their phone to record and to know when to start recording, which may lead to the clips starting halfway through a sentence.

However, Group Tagging does not force any of the above interactions and the results of the deployment shows that some students chose not to use the app or leave the tagging to someone else. Some also did not review the videos every week, which affected their ability to identify skills and use the tags better. This is a design issue that needs to be addressed in the future to add motivation for the students to use the app to its full potential for maximum benefit.

Another issue that came up frequently in our analysis is overlapping in the content of the tagged clips, and the large number of duplicates produced when all students in the group are tagging at the same time. To address this issue the application needs to merge the clips that have very similar content into a longer clip that includes all the tags to reduce duplicates.

7.5 Summary

This chapter discussed the findings from the study by relating them to the wider literature on student engagement and addressing the research questions posed in the first chapter of this dissertation. The chapter outlines the findings and discusses the results of the two case studies where used to identify indicators of engagement and measures that could be used to improve engagement in this context. The results revealed that attendance, active participation both online and offline, positive behaviour in class, as well as the quiz results and website traffic were all good indicators of positive engagement.

The finding from the second case study also showed that by giving the students additional incentives, such as points for participation online, can be a good motivation for competitive students to continue engaging with the online material even if they did not receive any marks for it. In addition, using a tool like Group Tagging that supports the students through the steps

of systematic reflection proved to be useful in improving engagement in group activities in class. The use of the app encouraged the students to be more active during the activity, contribute to the discussions, and stay on topic. It also worked as an incentive for them to prepare better before class.

The next chapter concludes the thesis and outlines the limitations to the study and the avenues for future work on this topic.

Chapter 8.

Conclusion

8.1 Introduction

In this thesis I set out to explore students' engagement in the flipped classroom in higher education. The study was motivated by the encouragement for teachers and lecturer to adopt the flipped classroom model as an approach to enhance engagement and the insufficient research on why it could do so. Therefore, in this work, two case studies were conducted to collect data on students' engagement online and offline in a fully flipped course in the School of Computing Science / Newcastle University.

This work had three main objectives 1) Explore engagement in the flipped classroom and identify indicators that can be used to measure it as well as investigate the possibility of improving engagement by manipulating those indicators and measures 2) Suggest methods a lecturer can use to measure engagement while teaching a flipped course 3) Examine the possibility of improving engagement in small group activities using video-supported reflection.

Examining student's engagement during the Ubicomp module showed that attendance and active participation can be good indicators of engagement in class. While the students' activity online proved to be a very good indicator of online engagement. As a flipped classroom consists of an online and offline sections, combining data from both can offer good insights into how the students are engaging in the module. In addition, attempting to measure engagement in Ubicomp showed that flipping a course is not in itself enough to engage students even though the model is advertised as a teaching approach to improve engagement. During the two runs of Ubicomp, it was clear that the students needed to be continuously motivated and challenged to do the work and keep up with the coursework. The motivation for students in Ubicomp came from the lecturer's (and teaching staff's) constant engagement with the students in class and online. The work the teaching staff put into making the seminars enjoyable and the effort put into making the online material engaging worked well in getting the students interested in the topic and the course. The different types of assessment that required students to be involved in all aspects of the course were also a good incentive. The quizzes that tested their preparation before class, assessing participation in class pushed them to be more active, and the tutorial videos that challenged them to create something to show their understanding of the material, were all aspects of the course that students found both useful and stimulating.

Considering the best methods a lecturer can use to measure engagement in class if they wished, the study in Ubicomp showed that many data collection and analysis methods used in research could be difficult to implement for lecturers. Those methods require time and attention that a lecturer probably cannot spare during class. Most of the self-report methods also may not be very useful due to the power dynamic between lecturer and students, which can make it uncomfortable for the students. However, this study showed that there are a few methods a lecturer can use to get an idea on how the students are engaging in the course. Observing the students' behaviour in class as they usually do in addition to using a tool like Group Tagging, which offers them an insight to the students' conversations they cannot observe themselves, has proven to be a very good method in measuring and even improving the students' engagement in class. In addition, using tools that aggregate and visualise the students' activity online could also be a useful method to measure student engagement online. By combining the data from both sources (online and offline) the lecturer can understand how their students are engaging in the course. In addition, communicating with the students and asking for feedback informally can help build a friendly and safe learning environment that can encourage engagement.

Finally, the last objective of this study was to investigate the impact of video supported reflection on engagement in class activities. The issue of engaging students in small group activities is well known, as the students can easily get bored or distracted for various reasons (discussed in chapter 5). This problem manifested in Ubicomp1 and adversely affected the students' experience in the module. Group Tagging was developed for that purpose and tested in the second year of Ubicomp. The trial and evaluation of Group Tagging showed that using video tagging was useful in encouraging participation in activities and that it worked well as an incentive for the students to prepare before class and contribute to the group work in class. Most students thought of the app as a fair way to assess participation and appreciated the control they had on their assessment. The main issue that was highlighted about the use of the app was the students not using it regularly, which affected the intended process of reflection. Group Tagging was designed to support students' reflection and provide them with tools needed to make the process systematic and easy. However, some of the students did not feel motivated to use it every week and lost that opportunity for reflection. Nevertheless, this issue can be addressed with some design changes and more engagement and encouragement from the teaching staff to motivate the students. This could not be done in this study due to time constraints but is an avenue for future research.

8.2 Main Contributions

This study makes the following contributions

1. Expanding the understanding of how students engage in a higher education flipped classroom through a longitudinal study that included collecting and analysing data on students' interactions and experience both online and in class.
2. Developing and testing a new tool (Group Tagging) to support student's reflection, assess participation, and improve engagement in small group activities.
3. Critiquing methods for measuring engagement used in research and suggesting the most suitable measures a lecturer can use in their own courses.

8.3 Limitations

All data collected for this study were from one module in the School of Computing that was taught by the same lecturer. This makes it difficult to generalize the findings, as it is not possible to predict the effects of different topics or teaching styles on the students' engagement. The design of a flipped classroom and activities included can also be different and that may affect the students' engagement. The limited time of only two semesters for collecting data makes it hard to make conclusions about how different cohorts of students would engage with the same parts of the course and whether the findings will hold with multiple cohorts. It was also not possible to collect data from other (non-flipped) modules for comparison.

In addition, this thesis presented Group Tagging as a tool to encourage reflection of group activities and participation in class. It argues through the use of literature on reflection and the findings from Group Tagging's evaluation that the app helped the students stay on task, be better prepared, and be aware of their own behaviour during class and when interacting with their group mates. However, due to limited time, Group Tagging was evaluated by being deployed in one course only. While measures were taken to make sure that the students used the application multiple times to collect enough data for evaluation, it remains an issue that only the students in this class tested the app. There is no information on how students in a different year or school would react to the application and no way to find out whether the fact that the students were all from Computing Science has affected their perceptions of the usability of the software or not. In addition, the students' perspective was obtained from interview with five students who volunteered to talk about their experience. This small sample size means that the results may not be generalizable to all students. The same issue of a small sample size was also the reason why the Motivated Strategies for Learning Questionnaire results were not useful for the study.

Additionally, the added work and time to the teaching staff that using Group Tagging in a course was not considered in this study. This is an important issue that needs to be considered to understand the impact of the app on the lecturer's work load especially since a flipped classroom is known to be a large time commitment.

8.4 Future Work

A flipped classroom can be implemented in different ways depending on the topic, lecturer teaching style, tools and resources available. This thesis focused on a fully flipped course that used a website, videos, online quizzes and forums as well as collaborative group activities in class. However, a different class will have different setup and new or different data may be available to indicate engagement. A further future study may focus on how different implementations of flipped courses can affect student engagement and the impact the technology used have.

In addition, as Group Tagging was evaluated with one group of students who completed the Ubiquitous Computing module, it would be interesting to see if those findings can be replicated with other cohorts of students. It has been pointed out by the students that the introduction of the application in the first year of University can be beneficial in teaching the new students professional skills. Another suggestion was using it in meetings and workshops with postgraduate students and even non-students. Thus, it would be interesting to introduce Group Tagging to other students and other courses to explore the possibilities of its use and users' perceptions of it, and to determine if it is as useful in these contexts for contributing to the lecturer/teacher insight on engagement.

Moreover, it is necessary to test Group Tagging in different sized classes to understand how much the number of students impacts the time and effort needed to make it work and assess the students fairly.

Appendix A.

Module outline for CSC3723: Ubiquitous Computing

- Owning School: **Computing**
- Teaching Location: **Newcastle City Campus**

Semesters

Semester 1 Credit Value: 10

ECTS Credits: 5.0

Aims

Provides a theoretical and practical understanding of advanced topics in ubiquitous computing. This module extends the basic notion of human-computer interaction and considers the principles, technologies, design and evaluation of computing when it is embedded into the everyday environment. The module will aim to provide students with an historical account of ubiquitous computing and the concepts and technologies that have driven development in this area, such as natural interaction, location-awareness and context-awareness. In addition, students will develop practical skills and experiences in building interactions with a number of cutting-edge ubicomp technologies and techniques, including interactive surfaces, tangibles and wearables.

Outline of Syllabus

- A history and ubiquitous computing
- Systems, interfaces and technologies for ubiquitous computing (including: wearable, tangible and embedded, interactive surfaces and table tops, natural user interfaces)
- Context aware interaction
- Location in ubiquitous computing
- Privacy in ubiquitous computing
- Ethics of ubiquitous computing

Teaching Methods

Teaching Activities

Category	Activity	Number	Length	Student Hours	Comment
Guided Independent Study	Assessment preparation and completion	1	10:00	10:00	Development of project build
Guided Independent Study	Assessment preparation and completion	10	1:00	10:00	Completion of online quizzes.
Guided Independent Study	Assessment preparation and completion	3	2:20	7:00	Production of video tutorials
Guided Independent Study	Directed research and reading	10	2:00	20:00	Reading of weekly research papers & web resources, engagement with short video pod-casted lectures
Scheduled Learning and Teaching Activities	Practical	9	2:00	18:00	Practicals offering hands-on experience with cutting edge ubiquitous computing technologies.
Scheduled Learning and	Small group teaching	10	2:00	20:00	Small group learning sessions, including mini-lectures, SOLE sessions, debates, games

Category	Activity	Number	Length	Student Hours	Comment
Teaching Activities					
Guided Independent Study	Reflective learning activity	10	1:30	15:00	Online discussions between students relating to “big questions” & reading (Reflective log 1)
Total				100:00	

Teaching Rationale and Relationship

This course will use blended learning to offer a complementary mix of directed learning around topics of interest alongside students’ own independent learning based on resources provided within the course and beyond. Practical classes will offer student hands-on experience interacting with and prototyping a range of ubiquitous computing technologies. To support students learning in relation to the philosophy and conceptual areas of ubiquitous computing small group teaching will be configured through games, debates and other active learning activities in scheduled weekly seminars. Students will be expected to prepare to take part in these face-to-face activities through actively participating in online elements of the course, which will include watching video-based short lectures on key topics, critically reading selected materials (both from formal publications, and selected web-based resources), and participating in online forums where “big questions” relating to the material are discussed. Students are expected to spend a significant amount of time each week preparing for face-to-face teaching, as well as reflecting on learning over the course of the semester.

Assessment Methods

The format of resits will be determined by the Board of Examiners

Other Assessment

Description	Semester	When Set	Percentage	Comment
Report	1	M	40	Blog post related to a new ubicomp concept or technology. (1000 words max.)
Portfolio	1	M	30	Three video tutorials describing practical work undertaken – max length 3 min each. (7 hours max.)
Prob solving exercises	1	M	10	10 online multiple-choice quizzes which relate to online content - one per week (5 hours max.)
Reflective log	1	M	10	Participation with weekly online discussions forums (15 hours max.)
Prof skill assessment	1	M	10	Quality participation in face-to-face learning activities (debates, games, SOLEs) - (10 hours max.)

Assessment Rationale and Relationship

This course aims to encourage students to develop a conceptual and practical understanding of ubiquitous computing technologies and apply these understandings to the design and develop of a ubiquitous computing interaction using off-the-shelf prototype technologies. The hands-on and applied nature of much of the learning necessitates a coursework-based approach to evaluating students' learning (this hands-on approach is reflected in chosen teaching methods, with contact time being split between small group learning and hands-on practical classes throughout the semester). In addition, the course has been configured to require students to actively engage in constructivist learning experiences across the semester through a mixture of self-directed and directed learning experiences. Assessment relating to students' engagement in these learning processes aims to highlight the importance of participation. With multiple

assessments spread across the semester the course aims to reduce assessment-burden, while ensuring that students are able to learn and build upon their assessed work over the semester.

Appendix B.

Chapter 4: Case study 1 information sheet

Student's engagement in a flipped classroom

As a student in the third-year module CSC3723: Ubiquitous Computing, you would be a part in our research study on student engagement in a flipped classroom. The aim of this study is to evaluate the new course format and tools we are using and understand the students' experience during the run of the course.

Throughout the course we will be gathering a range of information about your engagement with the study material, your use of the tools provided, and participation in class activities, so we will be carrying observations during class and in the practical sessions and maybe have small chats with you.

What will I have to do?
You will be asked to complete two questionnaires about learning strategies at the beginning and the end of the course, and we will be inviting you to take part in interviews or focus groups that we will be conducting after the course ends to talk about your experience in the course. Other than that, you should just go through the course as you usually do.

What information will you collect about me?
We will be collecting information about your use of the course's website, participation and interactions with others in class, and learning strategies. We may also take pictures and do some audio recording during class.

What will happen to the information you collect about me?
Only the people directly involved in the study will have access to the information we collect, we will use a code instead of your name on all of the information we take for the study; this will help keep your information safe. We will store any recordings we make for the study and the information we collect encrypted in a password protected computer at Newcastle University. The anonymised recordings and information we collect may be used in academic talks and publications.

Are there any risks for me in taking part in the research?
There is no risk in taking part in this study.

Do I have to take part?
Yes, you do. We are using this course to evaluate a new teaching format so the observation of both teachers and students is necessary. However, this will have no impact on your course participation or assessment.

Thank you very much for reading this information sheet.

If you have any questions or please feel free to contact:
Haneen Qarabash

Appendix C.

Chapter 4: Consent form for student interviews

I agree to participate in the study **"Evaluation of Ubicomp 2015 module",** being carried out by the University of Newcastle.

- I have read and understood the information sheet about taking part in the study, and a team member has answered any questions that I had, I have no further questions. ☐
- I understand that I will be interviewed for the study and that this interview will be audio recorded. ☐
- I understand that the data collected for this study will be stored securely in the School of Computing Science at Newcastle University. ☐
- I understand that the information collected for this study will be used only for research purposes, and that my name and personal information will not be used on any documents or in any presentations about the research. ☐
- I understand that anonymised direct quotes from my interview may be used in publications or presentations. ☐
- I understand that I can leave the study at any time without needing to say why, and that if I leave the study this will not affect any services I receive. All data collected about me will be destroyed. ☐

Signature of participant…….....

Name ……. Date……...

Signature of team member…..……..

Name …… Date……...

If you have any questions please feel free to contact:

Haneen Qarabash

Appendix D.

Chapter 4: The Student Engagement Walkthrough Checklist

Student Engagement Walkthrough Checklist

OBSERVATIONS

	Very High	High	Medium	Low	Very Low
Positive Body Language	❑	❑	❑	❑	❑

Students exhibit body postures that indicate they are paying attention to the teacher and/or other students.

Consistent Focus	❑	❑	❑	❑	❑

All students are focused on the learning activity with minimum disruptions.

Verbal Participation	❑	❑	❑	❑	❑

Students express thoughtful ideas, reflective answers, and questions relevant or appropriate to learning.

Student Confidence	❑	❑	❑	❑	❑

Students exhibit confidence and can initiate and complete a task with limited coaching and can work in a group.

Fun and Excitement	❑	❑	❑	❑	❑

Students exhibit interest and enthusiasm and use positive humor.

Appendix E.

Chapter 4: Students' interview questions

Impressions and strategy used

1. How was your experience in Ubicomp?
2. Can you tell me something that you think worked really well in the course?
3. Would you tell me three things that did not work well (you struggled with)
4. How did you go through the preparations before class? How long did it take? When do you usually start? How much of the content did you view?
5. How do you feel about group discussions and group activities in class? Did you know your group mates? Does it matter? Did you feel uncomfortable? Can you remember a time when you were uncomfortable? Were you able to contribute then even though you were uncomfortable? Did it get easier?
6. If you were to take the module again, how would you approach it? How would you describe it to other students? What advice would you give next year students?
7. What would you want other modules to adopt from Ubicomp?

Course work and assessment

8. What do think of the assessment in the course?
9. What are your thoughts on the course work (participation, quizzes, videos, report), how did it compare to other courses?
10. How do feel about making videos rather than writing reports for the practicals?
11. What do you think of Bootlegger? Why? Did you find it useful? How can we improve your experience? Where do you think it should be used (class or practical) and by whom (students or teachers)?
12. How was the Hackathon? Was the time given for the project enough? Did you do any work outside the practicals?

Technology

13. What do you think of the website? What were your initial thoughts about us using WordPress rather than blackboard? Would you rather have us use Blackboard or keep Wordpress? Why?
14. What do think of using twitter in the module? Did you ever read the tweets from other students? Why / why not?
15. How did you use the comments section? Was it useful? How do you see it being more useful?

End

Appendix F.

Chapter4: Ubicomp1 evaluation survey

How would you rate the following?

1. Overall experience in Ubicomp?

   ( ) Poor ( ) Fair ( ) Average ( ) Good ( ) Excellent

2. Do you feel that you got sufficient support and feedback from the teacher?

   () Disagree
   () Moderately Disagree
   () Neutral
   () Moderately Agree
   () Agree

3. Did the assignments support the overall objectives of this class?

   () Always
   () Most of the time
   () Sometimes
   () Rarely
   () Never
   () Don't know

4. Thinking about time outside of the classroom, was the amount of work required…

   () Far too much
   () Too much
   () Just right
   () Too little
   () Far too little
   () Don't know

5. Please rate the learning material used in this course on its ability to engage you.

   () Excellent
   () Good
   () Average
   () Poor
   () Very poor
   () Don't know

6. Please rate the teaching staff in this course on their ability to engage you.

() Excellent

() Good

() Average

() Poor

() Very poor

() Don’t know

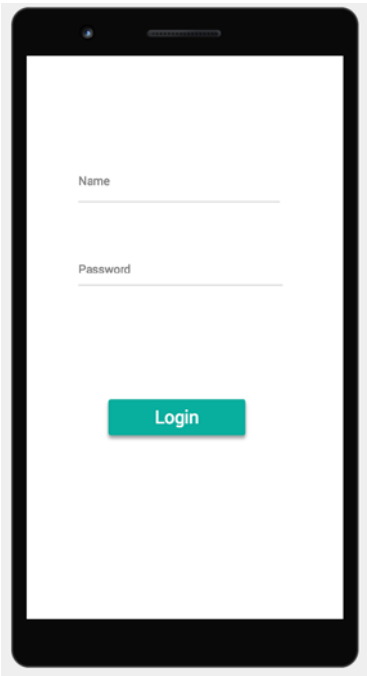
Appendix G.

Chapter 4: Module leader interview questions

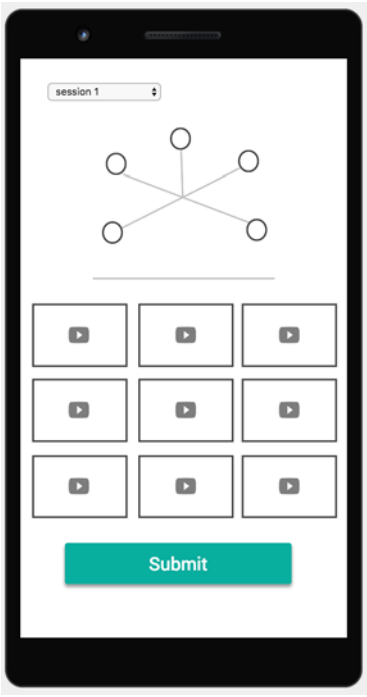
1. Would you tell me about your experience of teaching for Ubicomp module in general? (Opinion/attitude about flipped learning)
2. Can you tell me about your other teaching experience and compare it to the Ubicomp? (How much effort did you put into modules preparation?)
3. How did you feel about making videos? (Were you comfortable with video making?)
4. How much time did you spend to prepare a video part of the lecture? (both headshots and video scribe)
5. If you were asked to do the same class next year, how much time do you think it will take to prepare?
6. Was there anything particularly new that you had to learn in terms of teaching/preparations?
7. Did you find anything surprising in preparation or running the class?
8. What were the easiest things to do?
9. What were the hardest things to do?
10. Did you like your experience in general?
11. Do you think the course was a success?
12. What would you do differently next time?
13. What in your opinion make a good activity for the in-class session? Any examples? Why? What are the key things? Do you think students liked it? Why?
14. What do you think students thought about you class (the seminar)?
15. Did you feel you were a part of a team?
16. Do you think you are able to run the similar course by yourself alone?

Appendix H.

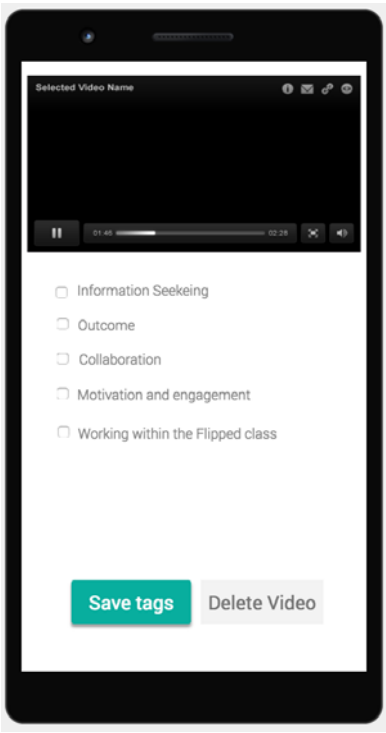
Chapter 5: Group Tagging wire frames of the initial interfaces and design



Login screen



Recorded clips for each session



Reviewing and re-tagging clips

Appendix I.

Chapter 6: Case study 2 information sheet and consent form

Student's engagement in a flipped classroom

As a student in the third-year module CSC3723: Ubiquitous Computing, you can take part in an evaluation of student engagement in new forms of teaching and learning within higher education. The aim of this evaluation is to assess the efficiency and effectiveness of the course format and tools we are using in CSC3723 as well as to students' experiences of learning in this environment and using these tools.

Throughout the course we will be gathering a range of information about your engagement with the study material, your use of the tools provided, and participation in class activities. We will be undertaking observations during face-to-face classes and will invite you to take part in an interview or focus group toward the end of the semester.

What will I have to do?

The evaluation of this course should have minimal impact on your study and learning on CSC3723. You will be asked to complete a questionnaire about learning strategies later in the course. We will also invite you to take part in interviews after the course has ended to talk about your experience of learning on this course. Other than that, you should just go through the course as you usually do.

What information will you collect about me?

We will be collecting information about your use of the course's website (as defined in the privacy policy on the site), your participation and interactions with others in class (using the Group Tagging web app), marks and assessment submissions, and the learning strategies you apply when studying (a questionnaire).

What will happen to the information you collect about me?

Only the people directly involved in this evaluation will have access to the raw data we collect. When we analyse the data, we will use a code instead of your name; this will help keep your data safe. We will store all data encrypted in a password protected computer at Newcastle University. The anonymised data and resulting analysis may be used in academic talks and publications.

Are there any risks for me in taking part in the research?

There is no risk in taking part in this study. The data collection will be managed to ensure it does not impact upon your learning experience and assessment. If you consider that the data collection is having an adverse affect upon your learning then please contact: Madeline Balaam, madeline.balaam@ncl.ac.uk

Do I have to take part?

No. You do not have to take part in this study. Even if you agree to join in at the start, you can change your mind later and your data will not be used in the analysis. You do not need to give a reason for not joining in, or for leaving later. This will not affect any services you are receiving now or in the future. To opt-out of the analysis send an email to Haneen Qarabash

Thank you very much for reading this information sheet.

If you have any questions, please feel free to contact:

Haneen Qarabash

Consent Form for participants

I agree to participate in the study **"Student's engagement in a flipped classroom",** being carried out by the University of Newcastle.

- I have read and understood the information sheet about taking part in the study, and a team member has answered any questions that I had, I have no further questions. ☐
- I understand that the data collected for this study will be stored securely in the School of Computing Science at Newcastle University. ☐
- I understand that the information collected for this study will be used only for research purposes, and that my name and personal information will not be used on any documents or in any presentations about the research. ☐
- I understand that anonymised data about my online and class participation would be used in publications or presentations. ☐
- I understand that I can leave the study at any time without needing to say why, and that if I leave the study this will not affect any services I receive. All data collected about me will be taken out of analysis. ☐

Signature of participant…….....

Name ……. Date……...

Signature of team member…..……..

Name …… Date……...

If you have any questions please feel free to contact:

Haneen Qarabash

Appendix J.

Chapter 6: Students' interview questions

Experience in the module

1. How was your experience in Ubicomp?
2. What is the one thing that you thought worked really well in the module?
3. What are the three things that did not work well? (Something you struggled with)
4. How did you go through the preparations before class? How long did it take? When do you usually start? How much of the content did you view?
5. What did you think of the credits on the website? What changed when we started to publish the credits breakdown and you found out what exactly you were credited for? Should we keep it? Change it?
6. How do you feel about group discussions and group activities in class? Did you feel uncomfortable?

About Group Tagging

7. What did you think of Group Tagging (principle)?
8. How did you use Group Tagging in class? Strategy for tagging (what did you tag, Who did the tagging)? Number of tags? How did it affect group dynamics?
9. How did you use it after class (reviewing clips and creating edits)? How many edits per session? Time spent? (Feedback)?
10. What effect did using GT have on your experience in class?
11. What do you think is the difference between using it and not for you personally and for the group?
12. What did you learn from using GT?
13. What are the problems you had when using it? The negative aspects
14. What are the benefits of using it? Most positive aspects?
15. What would you add to it?
16. What would you have removed?
17. What do you think about using GT for assessing participation in class?
18. Anything else?

Appendix K.
Chapter 6: Sample of MSLQ questions

Part A. Motivation

The following questions ask about your motivation for and attitudes about this class. Remember there are no right or wrong answers, just answer as accurately as possible. Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	**2**	**3**	**4**	**5**	**6**	**7**
Not at all true of me						Very true of me

1. In a class like this, I prefer course material that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2. If I study in appropriate ways, then I will be able to learn the material in this course.	1	2	3	4	5	6	7
3. When I take a test I think about how poorly I am doing compared with other students.	1	2	3	4	5	6	7
4. I think I will be able to use what I learn in this course in other courses.	1	2	3	4	5	6	7
5. I believe I will receive an excellent grade in this class.	1	2	3	4	5	6	7
6. I'm certain I can understand the most difficult material presented in the readings for this course.	1	2	3	4	5	6	7
7. Getting a good grade in this class is the most satisfying thing for me right now. When I take a test I think about items on other parts of the test I can't answer.	1	2	3	4	5	6	7

Appendix L.

Chapter 6: Results from MSLQ

	Motivation Scales						Learning Strategies Scale									
	Value Component			Expectancy		Affective Component	Resource management:				Cognitive and Metacognitive Strategies					
Student number	Intrinsic goal orientation	Extrinsic Goal Orientation	Task value	Control of Learning Beliefs	Self-Efficacy for Learning and Performance	Test Anxiety	Help seeking	Peer Learning	Effort Regulation	Time and Study environment	Metacognitive Self-Regulation	Critical Thinking	Organization	Elaboration	Rehearsal	Final grade
1	3.5	4.5	2.8	4.8	4.1	4.2	3.8	4	4	4.1	3.8	3.8	4.8	4.3	4.5	**54.3**
2	4	6.5	6.7	5.3	4.6	2	4.8	5.3	4	4.1	5	4.8	5.5	5.3	4.3	**56.7**
3	4	4	6.7	5.8	5.9	2.8	4	2	6.3	6	3.9	3.8	3	5.5	2	**60.5**
4	4.3	4.8	3.8	7	5.6	2	4	4	5.8	3.8	3.9	4.4	3.8	6.2	1.8	**51.3**
5	4.3	4.5	6.8	4.5	5.5	3.6	3	3.7	4.3	3.4	4.7	1.8	2.5	5.3	4.3	**63.1**
6	4.8	3.8	3.3	7	5.5	4.6	3.3	3.3	3.8	4	2.9	5.6	2.3	4	2	**41.8**
7	5	4.3	4.5	6.3	4	4.4	4.3	3.3	2.3	3.3	3.8	4	2.5	4	3.8	**52.1**
8	5	5.5	6.2	5.5	3.9	1.8	4.5	3	5.3	5.3	4.3	4.4	6.8	6.2	5	**63**
9	5	5.3	4.3	5	4.4	3.4	3.3	3	4	3.9	3.8	5.2	3.8	4.7	3.3	**43.6**
10	5	5	6	4.3	4.1	3.6	5	5.3	6.5	5.6	4.5	6.2	4.5	5.7	6.3	**51.9**
11	5.5	4.8	6.7	5.3	4.6	2.6	1	2.7	5	5.4	4.8	5.4	4.3	5	4	**43.9**
12	5.5	6.5	6.8	3.5	5.4	1.4	3.5	4.3	6.5	6.4	4.3	5	6.5	5.5	3	**49.4**

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