How, and to what extent do Geographical Information Systems (GIS) contribute to student engagement with Service Learning projects?

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How, and to what extent do Geographical Information Systems (GIS) contribute to student engagement with Service Learning projects?

Abstract

This case study investigates the potential use of Geographical Information Systems (GIS) as a means to increase students' engagement with Service Learning projects. Two enquiry projects were developed using constructivist pedagogy in the local area. They were introduced to a Year 12 Service Learning group within the Geography Department that met weekly. Group A analysed survey results to propose new developments for the local neighbourhood plan, without GIS. For Group B, the GIS-based enquiry focused on mapping crime in the local area. Findings suggest that GIS helped to contribute to student engagement with the Service Learning project; however, it was not the most important factor. Setting clear aims, group dynamics and the involvement of external staff all played key roles in fostering student engagement. GIS helped to develop spatial thinking skills and enabled students to work with real-world data. However, the case study identified shortcomings in GIS, highlighting the importance of instructing students how to use GIS. Overall, GIS has real potential as a tool to support student engagement with Service Learning by using local data and applying it in a real-world setting.

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1. Introduction

With rapid economic change and political challenges, the education landscape is constantly changing. It is more important than ever for schools to equip students with the necessary skills to thrive in a globalised and interconnected workplace (Lam et al., 2009). In Geography, the curriculum 'should inspire in pupils a curiosity and fascination about the world and its people that will remain with them for the rest of their lives' (Department for Education (DfE), 2013a: 1), and thus plays a central role in preparing students for the future. Within Geography, advancements in Geographical Information Systems (GIS) have made it a very powerful tool that supports learning; empowers students to think critically, and connects students to the community (Baker et al., 2012). GIS develops spatial thinking skills and there is 'no better high tech support system for addressing spatially explicit real-world problems than GIS' (National Research Council, 2006: 177). GIS therefore has real potential to prepare students for their future workplace (Kidman and Palmer, 2006).

Arguably, the field of GIS is still to find a place in education. It is somewhat unexplored, and is 'struggling to win a wider audience' (Baker and Bednarz, 2003: 231). Consequently, the use of GIS in the classroom is low and the status of GIS implementation in UK secondary schools is mixed (Bednarz and van der Schee, 2006; Hohnle et al., 2013). The research agenda needs to be advanced to examine the best ways to implement GIS in the curriculum, and the environments in which this can be effective (Baker et al., 2012; Kerski et al., 2013). As Bednarz (2004) suggests, this could include teaching in different contexts. These contexts need to ensure GIS is sustained within the school in order to 'make GIS a practical, useful, and effective tool for school education' (Liu and Zhu, 2008:13).

I believe that Service Learning (SL) could be a new context for GIS in secondary schools, and argue that GIS is a tool which can contribute to student engagement with SL. SL is an approach to teaching and learning that connects academic learning to community service (Felten and Clayton, 2011). GIS

is an effective tool to engage students with SL because students can develop an understanding of the social context of GIS (DiBiase, 1996). In addition, GIS provides a 'digital lens for exploring the dynamic connections between people…and changing physical and social environments' (Kidman and Palmer, 2006: 290). The closest links SL has in the GIS literature are related to citizenship formation. Indeed, this was identified as one of six research gaps in GIS education by Baker et al. (2012). This specific field focuses on the 'connection that students make with their community and country as a result of GIS-based projects' (Baker et al., 2012: 272), and is most aligned with SL.

It is therefore proposed that, by adding a spatial dimension through the use of GIS as a tool to support the learning of a Geography-based SL project, high levels of student engagement can be fostered. This would be achieved through real-world application: by applying the skills and analysis to the wider community, the students are motivated to master GIS skills. If the potential of GIS is developed in a SL programme, then another application of GIS will have been identified and the results will inform the debate about the benefits of this innovative technology.

1.1 Research context

I work at a co-educational boarding school in the South East of England with approximately 1,000 13- to 18- year olds. In this study I have used the pseudonym of Gilston. The school aims to provide 'an inspiring academic experience which is pupil-centered and stimulating...to ensure that every single child...is engaged, excited and challenged by the learning experience at all times' (Appendix 1). In addition to a rich and varied curriculum, the school creates this experience through SL.

The school has always been committed to service. Through connections with the military and community service projects, the school remains true to this tradition. When the school adopted the International Baccalaureate Diploma Programme (IBDP) Curriculum in 2009, it placed more focus on service. This led to the SL approach being chosen for the sixth form, with community work embedded within academic projects.

The school chose SL because the 'projects offer students a chance to engage in a meaningful way with the community while also expanding their depth of study in a particular subject' (Appendix 2). The projects include, for example, working with local food banks to examine the economy of the local community. Importantly, the projects allow students to use their academic subjects in a real-world setting. Despite the school placing priority on Service, it still lacks a prominent position within school life from the student perspective. There is still more scope to integrate SL so that it has a meaningful impact.

As part of the SL programme, all Departments were encouraged to run individual projects for small groups of Year 12 students. The Geography Department saw the potential of such a project for its students, the Department and local community partners. I was involved in the initial discussions in 2014 when we chose a focus for the Department's project. There was strong consensus amongst the staff that GIS was the appropriate learning tool to use. We chose GIS for three reasons. It is in line with our approach to teaching because we believe that 'spatial technologies like GIS and mobile data collection in the field will form a key focus for the future of Geography education' (Appendix 3). Second, GIS fits with the enquiry approach we take, which would be mirrored in SL, hence equipping students with key geographical skills. Using GIS with a SL project helps students 'to foster attitudes that will assist them to participate as active and informed citizens in our global society' (Appendix 3). Third, the Department has a staff member with a strong understanding of GIS, and we thus had the expertise needed to launch the project.

In the academic year 2014 to 2015 I ran the Department SL project. I was eager to lead the project for two reasons. Firstly, I was interested in GIS. Having used GIS with my classes and observed the 'revolution in my own teaching' (Biebrach, 2007: 14), and seen how it can be used as a powerful classroom tool, I was curious to use it in a different context. Secondly, I believe in the core principles of SL - of connecting the school and community. This interest developed through my own project in 2014, and I could see its significant potential as a context to work with GIS. I believe that 'using GIS frees teachers to do what they love to do best – engage students in meaningful issues' (Kerski et al., 2013: 244), and I wanted to be part of that journey.

2. Literature review

The literature review focuses on four key areas. Firstly, GIS: an overview of its role in education, and the opportunities and challenges it presents to educators. Secondly, SL: what the key features of this approach are, including the benefits to students. It is also important to discuss the UK context, as SL was developed in the United States and is most prominent there. Thirdly, I will discuss the links between GIS and SL. Finally, the term 'student engagement' must be understood, defined and placed in the context of this study before discussing its links with SL and GIS.

Therefore, there are four research questions for the literature review:

1. What are the educational benefits of a GIS-based pedagogy?
2. What are the key features of SL?
3. How are GIS, SL and engagement linked?
4. What is student engagement and how can it be measured?

2.1 GIS

2.1.1 What is the role of GIS in education?

Before discussing the role of GIS, it is important to define it. The more technical definition of GIS states that it is 'computer-based systems that capture, store, check, integrate, manipulate, analyse and display data, which is spatially referenced to the earth' (Kinniburgh, 2007: 24). Less technical definitions take a more cognitive approach and describe it as 'a set of tools that transforms geographical data into geographical information and thereby increases our knowledge and/or helps us to solve geography-related problems' (Rod et al., 2010: 22). I prefer this definition as it recognises that GIS is a tool and that we can learn *with* GIS (Kemp et al., 1992). As the UK national curriculum emphasises *learning,* I will use this definition.

GIS is an innovative tool that was first used in the 1970s. It became widespread in Higher Education (HE) between the 1980s and 1990s, but it was not until the mid-1990s that it started having an

impact in secondary education (Demirci, 2008; Kerski et al., 2013). Now it is used in schools around the world 'due mainly to the perceived benefits it provides teaching and learning' (Kerski et al., 2013: 232). There has been a plethora of research focusing on GIS in education and it is argued that it still 'needs to be deeper and broader' (Baker et al., 2012: 256). Research initially focused on teaching *about* GIS. It has now moved on to consider teaching *with* GIS (Kerski, 2003a); highlighting the opportunities, and challenges, of integrating GIS into curricula.

One of the key outcomes from the literature is that the opportunities GIS presents to students are invaluable. With regard to skills, GIS empowers student spatial thinking (Lee and Bednarz, 2009), fosters higher-order analytical thinking and problem solving (Kerski, 2003a) and enhances spatial cognition (Liu and Zhu, 2008). In the Geography classroom, using GIS leads to rich student learning (Baker and White, 2003) and develops geographical understanding (Kinniburgh, 2007, 2008). It has been argued that one important outcome is that GIS can increase student performance (Kerski, 2003a). However, I am more interested in how using GIS can lead to dynamic learning environments (Shin, 2007), support constructivist teaching (Audet and Paris, 1997; Kerski, 2008; Henry and Semple, 2012), create opportunities for learning in real world contexts (Audet and Abegg, 1996; Kerski, 2001; Biebrach, 2007; Kinniburgh, 2010a, 2010b) and help teachers to engage students in their learning (Liu and Zhu, 2008). It is for these reasons that there 'is a significant push to embrace GIS within schools' (Kinniburgh, 2007: 27), based on three key justifications (Bednarz, 2004; Bednarz and van der Schee, 2006).

Firstly, the educative argument: GIS supports the learning and teaching of Geography. Using GIS In the classroom environment enables students to make geographical sense of their own lives and further their geographical learning (Freeman, 2015). When using GIS, students are encouraged to use new and different ways in which to view and think about the world; they can see interconnections between place and space, enhancing their spatial thinking skills (Bednarz, 2004). The large data sets that exist within GIS databases provide an opportunity for students to analyse data and investigate spatial patterns and relationships at a variety of scales. Students therefore use spatial thinking skills that help them to learn Geography. Spatial thinking then develops students'

cognitive abilities: Baker and White (2003) have argued that 'the use of this [GIS] technology can foster complex cognitive activities by students using sophisticated computer applications and data, all situated in an authentic environment for learning' (Baker and White, 2003: 243).

In addition, one of the key features 'of GIS which fascinate educators is its ability to swiftly and dynamically represent the world and its issues from a variety of spatial perspectives' (Audet and Paris, 1997: 293). Students can easily use basic map tools, for example measuring distance, and can also use it to solve problems, for example testing relationships between data. The speed at which GIS enables maps to be manipulated for analysis compared to paper maps creates more time for these higher order thinking skills (Freeman, 2015) and helps students to solve geographical problems (Biebrach, 2007). Therefore 'GIS technology can be an invaluable resource for extending student learning' (Kinniburgh, 2008: 22).

Secondly, the place-based justification: GIS enables us to study Geographical issues at a range of scales. The majority of GIS in the classroom studies the local area, helping students to develop a sense of place (Audet and Abegg, 1996; Kinniburgh, 2010a). Indeed 'without a sense of place, children and young adults cannot realistically see how their personal actions have relevance on a global scale' (Sanders Jr. et al., 2001: 123). By studying localised issues 'the community is the textbook, the teacher, and the classroom' (Kinniburgh, 2007: 27). Sometimes, local data is available that teachers can use to create investigations. However, one of the principle benefits of GIS is its ability to study a range of issues at larger scales. For example, my own use of GIS in the classroom helped me to see the development of spatial understanding. I created an enquiry project exploring the use of GIS as a tool to deliver an Urban Environments unit for Year 11, specifically to explore land use, socio-economic and ethnic data for New York. They were amazed by the sheer volume of data that they could analyse at a variety of spatial scales. Studying Geographical issues on a range of scales is a strong reason for adopting the GIS approach.

Lastly, the workplace: GIS develops skills that students need for the twenty-first century workplace. My Geography Department strongly believes that 'using maps and innovative technology… and

getting to grips with the geographic information systems that underpin our lives, make geographers skillful and employable' (Appendix 3). By integrating GIS into the A-level curriculum, and through other skills, Geography is now the 'must-have A-level' (The Guardian, 2015), and makes Geography students highly employable (Rod et al., 2010). GIS is also important because it can connect subjects across the curriculum, and provide a 'continuity of education in GIS to equip the next generation with the tools to make use of spatial data [and] spatial technologies later in life' (Rod et al., 2010: 27).

For example, the spatial understanding and skills set developed through GIS is essential for the business, planning and service sectors. With such experience students have the skills to inform policy and decision-making, ultimately affecting society through Government decision-making. Indeed, Kerski (2003a) boldly stated that 'GIS technology and methods have transformed decision-making in society – in government, academia and industry' (Kerski, 2003a: 128). An article in *Nature* stated that 'geospatial technologies have changed the face of geography and broadened job prospects across public and private sectors' (Gewin, 2004: 376). Thus GIS is a powerful learning tool that can facilitate Geographical understanding, bringing many educational benefits to students of Geography, with many links to the school curriculum and outside world.

2.1.2 What is the place of GIS in the UK national curriculum?

The national curriculum states that 'pupils should be given the opportunity to learn both about GIS and through GIS in terms of its value and applications in the real world' (Kerski et al., 2013: 235). The new A-Level requires an understanding of 'what makes data geographical and the geospatial technologies (e.g. GIS) that are used to collect, analyse and present geographical data' (DfE, 2014: 12). The GCSE curriculum requires students to use 'other graphic and digital material including the use of Geographical Information Systems (GIS) to obtain, illustrate, analyse and evaluate geographical information' (DfE, 2013b: 6). The new content framework, in particular 'place', focuses 'explicitly on the idea of place and the meanings and representations of place that shape how we see the world' (Rawling, 2016: 8). It is clear that GIS has enormous potential to help us to understand these (OFSTED, 2011).

Furthermore, there is an emphasis on Geographical enquiry: 'Geographical skills, maps and fieldwork appear as a consistent strand throughout the 5-19 framework' (Rawling, 2016: 9). The Geographical Association (GA) states that 'GIS is ideal to introduce into the Geography curriculum as it provides techniques and opportunities to further pupils' geographical learning' (Freeman, 2015). A GA research project investigated how GIS can invigorate the learning and teaching of geography and highlighted that the UK curriculum 'provides plenty of opportunity for using GIS' (Fargher, 2006: 2). GIS is thus strongly connected to the curriculum (Shin, 2007).

Despite the central role of GIS in Geography, the status of its implementation in UK schools is mixed. Efforts to introduce GIS into curricula have had limited success, with progress slower than hoped (Bednarz and van der Schee, 2006). In part this could be due to the fact that there has not been much research into the use of GIS in education in the UK (Biebrach, 2007). Others have stated that 'GIS has had, to date, a negligible impact on Geography education in schools' (Wiegand, 2001: 68). The UK is not alone in struggling to integrate GIS. Further afield, research into the status of GIS in the United States found that less than 1% of the 1520 secondary schools studied used GIS (Kerski, 2001). Given that the United States has led the way for the use of GIS in classrooms since the 1990s, this rate of uptake is low. A smaller research study in Australia also found that, although the schools owned the GIS software, it was not used regularly in classrooms (Kinniburgh, 2008).

At Gilston School we are confident teaching *with* GIS and are now integrating it into schemes of work. The aim is to equip students with the tools to use GIS technology with confidence and capability, so that no student leaves without understanding what GIS is, and its role within society. There is also regular individualised professional development to ensure that staff are trained to teach confidently with GIS.

2.1.3 What are the challenges of GIS?

Despite the many opportunities, the uptake of GIS in secondary education is still low (Hohnle et al., 2013). Many argue that the GIS software is seen as complex, leading to frustration, loss of interest

and low levels of engagement. For example, as a tool it 'has a steep learning curve…it requires substantial expert content knowledge to use effectively' (Ball, 2009:201). GIS is thus devalued and the subsequent lack of use has been referred to as a 'barrier to developing geographical learning' (Biebrach, 2007: 7).

However, Kerski (2003a) argues that it is not just hardware or software issues that constrain teaching with GIS, rather it is the 'the spatial perspective of teachers and students' (Kerski, 2003a: 134). This view is supported by research highlighting that it is not only students who have difficulty: a study in the USA involving 192 students and their teachers concluded that teachers also experienced difficulty in considering the data and analysing it (Baker and White, 2003). It concluded that the lack of ability to analyse data is a key issue for GIS, and that training teachers in GIS is critical to the success of any GIS implementation in schools (Baker and White, 2003). Thus it is clear that technological barriers are no longer the key issue, rather it is the 'social and structural barriers' (Kerski, 2003a: 134).

In addition, many have argued that the main problem is that there is not a consistent pedagogic framework for teachers about how to use GIS in the classroom (Kinniburgh, 2008). Some have suggested that the lack of pedagogic framework resulted from the speed at which GIS was included in the Geography curriculum in response to a changing job market (Drennon, 2005). There is still little agreement about how to integrate GIS into the curriculum (Rod et al., 2010), or its place in the curriculum (Kemp et al., 1992). There is also disagreement over which teaching methods are most suitable to create 'optimal learning environments' (Audet and Paris, 1997: 299). Teachers do not have the support to plan pedagogy around GIS (Fargher, 2006), and hence they have not been willing to invest time or resources in GIS. This has created a gap between the amount that GIS is used in the classroom and the curriculum planners who prioritise GIS (Biebrach, 2007). Clearly these challenges need to be addressed.

2.2 Service Learning

2.2.1 What is Service Learning?

SL is an initiative developed in the United States that aims to meaningfully engage students with their academic learning and the local community (Felten and Clayton, 2011). It is an active learning pedagogy (Kindon and Elwood, 2009) that incorporates 'community action – the 'service' – and efforts to learn from that action and connect one's learning with existing knowledge – the 'learning' (Rattanamuk, 2003: 54). By drawing on experiential and cognitive learning, the gap between academic learning and the community can be bridged (Mccowan, 2012). SL generally occurs outside the classroom, and is also referred to as community-based or co-operative learning with strong links to active citizenship and civic engagement (Ehrlich, 1999; Kindon and Elwood, 2009; McMillan, 2011). These descriptions align strongly with the context of this research project.

Importantly, the majority of the descriptions focus on the interconnection and integration of community and academic learning with several core characteristics and benefits. Firstly, to advance learning by making stronger connections between conceptual and applied learning (Kindon and Elwood, 2009): what is learnt in the classroom is advanced through the SL experience as students are able to apply new knowledge and skills (Yarwood, 2005), leading to a deeper understanding of the issues (Kotval, 2003). Secondly, to work collaboratively with students, staff, community members and organisations: in doing so students develop collaborative skills and learn how to work effectively with a range of individuals, from peers to teachers and adults external to their school, supporting life long learning. SL therefore helps to promote the development of 'active socially responsible citizens' (Kindon and Elwood, 2009: 22). Lastly, to critically reflect, leading to meaningful learning and service outcomes (Felten and Clayton, 2011). I have seen all of these benefits first hand from the Department's SL programme: it creates an opportunity for Geography students to practice and advance GIS skills learnt in lessons; to work with a range of peers, non-Geographers and adults; and develop to wider skill set, leading to meaningful outcomes.

The SL experience is shown in Figure 1. Viewed through a conceptual framework, it 'aims to develop academic knowledge/skills/dispositions as well as civic learning and personal growth' (Felten and Claydon, 2011: 77). It has been suggested that these core characteristics can lead to long-term benefits. When students are actively engaged with the issues their local community faces they get 'insights to the causes of and solutions to social problems, the contribution they, as individuals, might make to solving these problems, and their responsibilities as citizens' (Mohan, 1995: 130). As such the SL approach has been advocated in the literature and it is clear that there are many positive aspects of SL for the student, school and community (Yarwood, 2005; Barcus and Muehlenhaus, 2010).

The figure originally presented here cannot be made freely available via ORA because of copyright. The figure was sourced at Felten, P. and Clayton, P.H. (2011) Service-Learning, ***New Directions for Teaching and Learning*** 128, 75-84

Figure 1: Conceptual framework for Service-Learning (Felten and Claydon, 2011: 78)

2.2.2 What is the global context of Service Learning, and how does it fit in the UK?

Most SL still takes place in the United States. However, it is a growing field in several other countries, notably New Zealand, although it does not enjoy the same popularity as in the United States. It is apparent in the literature that 'learning about active citizenship, while not rejected, is not a priority either' (Zepke, 2013: 646). For example, in a survey in a New Zealand secondary school, 376 teachers took part and results showed that '49% did not think that active citizenship was a priority at all' (Zepke, 2013: 646). In the same study 1246 students were surveyed and 'only 27% thought that learning about effecting change in community and society was very important, while 61% thought it very important to learn to apply new knowledge in the market place' (Zepke, 2013: 646). Whilst this survey took place at a University, the results are relevant to my research as engagement is applicable to all stages of education. Similar research in the UK, South Africa and Sweden also highlighted that active citizenship and civic engagement is not a priority for students, with many never engaging with it (Mccowan, 2012). Therefore, it is necessary to find ways to engage students and enhance the profile of SL in the UK.

In the UK, the most closely related literature to SL is youth social action, and in the citizenship strand of the National Curriculum. Youth social action is an area that has received much attention in the last ten years from Government and policy-makers (Brewis, 2010). For example, the 'Step Up To Serve' #iwill campaign, led by Prince Charles, was launched in 2013. It is a volunteering drive to improve engagement among 10-20 year olds by 2020 (Kirkman et al., 2016). A report on the first year of the programme strongly suggests that 'young people who take part in social action initiatives develop some of the most critical skills for employment and adulthood in the process' (Kirkman et al., 2016: 3). The former Secretary of State for Education, Nicola Morgan MP, was so impressed by the findings that the Department for Education pledged to 'recognise youth social action as an important way for all young people to develop key character strengths…ensuring every child is better prepared for work and life' (Morgan, 2015).

Citizenship classes in primary and secondary schools aim to develop social and moral responsibility, community involvement, and political literacy (DfE, 2013c). To ensure appropriate learning,

voluntary service is integrated within the curriculum (Yarwood, 2005). It has been argued that Geography is a key subject to deliver citizenship education (Yarwood, 2005), for example, by teaching students decision making skills and through active learning on fieldwork. Furthermore, GIS links citizenship education and students with their local community (Kerski et al., 2013). Despite this, it is still argued that the UK has 'provided few opportunities for students to engage formally with voluntary work in their local communities' (Yarwood, 2005: 355). In the USA, it is the responsibility of the school or University to create opportunities for SL (Felten and Clayton, 2011), and I believe that the UK needs to take more responsibility.

Partnerships between schools and local communities are a common way to enhance student engagement with SL, although 'there is much debate and discussions about the nature of these collaborations and the role of service-learning in the classroom' (Barcus and Muehlenhaus, 2010: 364). There are various arguments criticising the partnerships between schools and local communities, for example the question of who the partnership is set up to benefit: the students or the community (Lewis, 2004; Kindon and Elwood, 2009). One of the most difficult challenges schools face is how to run successful SL projects within the curriculum (Carpini and Keeter, 2000). For example, 'a good service-learning programme helps participating students to see their service in the larger context of social justice and social policy rather than charity' (Rattanamuk, 2003: 55). Without the correct framework, students do not engage, and this is a key challenge my school faces. It has been suggested that the route to success is both in the nature of the SL project and its integration into the classroom (Carpini and Keeter, 2000). I propose that one way of integrating SL and increasing student engagement is through the use of GIS.

2.3 The links between GIS and Service Learning

2.3.1 What is the pedagogical link?

Introducing a spatial perspective - through GIS - to SL projects, from any discipline, creates a powerful tool for students to use. It enables students to interpret and integrate their knowledge and understanding of the local area they are studying (Melcher, 1999). Shin (2007) argues that by using

local data that is familiar to the students, their spatial cognition and motivation to learn about that place increases because they can make a personal connection to the data. In addition, by incorporating 'place' students can apply a range of perspectives to the local issue they are investigating within a given community (Ball, 2009). The community contributes to the experience by sharing its local knowledge, and also gains from the new knowledge learnt from the students (Sanders Jr. et al., 2001: 124). Levels of student interest and confidence are thus built as students are able to share similar experiences, knowledge and understanding (Keiper, 1999; Ball, 2009). GIS therefore has the potential to increase student engagement with SL, providing long-term benefits for all.

There is a strong case for GIS to be used in SL. Key evidence from British Education Communications Technology Agency (BECTA) (2004) states that 'GIS activities can be more effective when coupled with the use of local data, in the context of authentic, real-life geographical issues' (BECTA, 2004: 2). Others appreciate that the 'strength of GIS is its ability to use the familiar, local data from the students' neighbourhoods' (Keiper, 1999: 56). Problems can be researched within the local area or with a focus relevant to the students. The learning process is thus localised, providing a real-world context for enquiry which plays a key role in the student experience (West, 2003; Kinniburgh, 2007). Importantly, enquiry-orientated GIS-based investigations are supportive of constructivist pedagogy (Bednarz, 2004; Kinniburgh, 2010a; Henry and Semple, 2012). Constructivism believes that 'learning is an active process in which learners are effective sense makers who seek to build coherent and organised knowledge' (Kinniburgh, 2010a: 76). Students are engaged in constructing their own knowledge and meaning through enquiry-based and student-led research (Henry and Semple, 2012). The links between GIS and SL are strong and suggest that the research focus will give insight into this valuable area.

2.3.2 What research exists already?

There has been little, if any, research concerning the use of GIS specifically in a SL context in schools. The majority of classroom-based GIS research has focused on studying the local community and real world problems (Audet and Abegg, 1996; Kinniburgh, 2010a). Perhaps reflecting the 'deeply-held

beliefs of many teachers about the value and wisdom of grounding learning in the local environment and students' experiences' (Bednarz, 2004: 193), this research does link to the community focus of SL.

It has been argued by Demirci et al. (2013) and Kerski et al. (2013) that GIS-based projects are one way to integrate GIS and community issues into the curriculum. GIS-based projects engage students in and out of the classroom through working on real-life problems in their own community. These projects are described as 'a powerful platform [as students] gain versatile knowledge, skills and experiences' (Kerski et al., 2013: 236). Teachers and students thus use GIS to integrate different datasets to display and analyse data with the aim of describing and explaining local social issues (Demirci et al., 2013). It is this decision making aspect of such GIS-based projects that engages students (Kerski, 2008; Milson and Kerski, 2012). Other benefits of GIS-based projects include collaboration, critical thinking, creativity and student responsibility (Keiper, 1999).

The success of GIS-based projects has been highlighted in the literature. For example, in Australia Jenner (2006) reviewed how GIS was integrated into the Geography Department of a large secondary school. They took a multidisciplinary approach to integrating GIS through community issue investigations, for example studying the features of their neighbourhood and the impact of graffiti. He commented that the project work was valued by staff, members of the local community and those involved with the GIS spatial industry, thus highlighting how GIS skills are valued. The research also highlighted how important GIS has become as a tool to encourage learning and excellence (Jenner, 2006).

Likewise in the US, Mitchell and Elwood (2012) researched a joint local History and Geography GIS-based project in a senior school. They found that GIS enabled students to connect their own life to the local community and engage with the issues. This led to higher levels of interest and civic engagement: 'increased knowledge and awareness about local places can serve as a basis for the development of young people's commitment to some form of democratic action' (Mitchell and Elwood, 2012: 155). Whilst we still search for a 'conceptually coherent and pedagogically

stimulating framework that is capable of tying a variety of topics in GIS into a unified schema' (Sui, 1995: 578), it is clear that GIS-based projects have significant potential within GIS education to engage students with social issues.

Within the HE literature field, SL within Geography has continued to grow, however there are not many that use GIS (Elwood, 2009). Frameworks have been proposed (for example Barcus and Muehlenhaus, 2010) and more recently GIS has been incorporated into community based organisations, a field known as Participatory GIS (PGIS) or Public Participation GIS (PPGIS). PGIS is a growing field (Kingston, 2007), and web-based GIS tools are being increasingly used to support it (Ball, 2009). PPGIS is primarily focused on empowering local communities by creating partnerships with individuals or organisations who have GIS technology and skills (Elwood and Ghose, 2001). The aims of such a collaboration would be determined by the priorities of those involved, in particular the local community, leading to increased empowerment for the community. One key problem with this literature is that it does not evaluate the success of such integration, thus highlighting the need for further frameworks to use in the classroom. There is therefore a strong argument for researching GIS and SL at school, and indeed at University level.

2.4 Engagement

2.4.1 What is the educational research context?

Student engagement is a current focus within educational research (Maiers, 2008), receiving widespread interest (Kuh, 2009). Some argue that the high profile of student engagement has been driven by neo-liberalism, and that student engagement 'seems to enjoy an *elective affinity* with neo-liberalism' (Zepke, 2015: 694). Whilst there is not the scope to review these arguments in detail it is important to understand the political context of student engagement as it influences the definition and research methods used in my research.

Zepke (2015) draws attention to the policy emphasis on learning as practically and economically useful; 'that learning is about performing in certain ways in order to achieve specified outcomes; and that quality is assured by measurable accountability processes' (Zepke, 2015: 695). Educational research has therefore centred on knowing what practices lead to high levels of student engagement. A range of surveys have been developed to measure these engaging practices and students' responses, thus making institutions accountable for student engagement.

McMahon and Portelli (2012) have argued for a more participatory view of engagement. In this view, the curriculum emphasises student voice and leads to success as both academic and active citizens. By taking part in active citizenship, students are collectively engaged (Brookfield and Holst, 2011) and they are responsible for doing so alongside their teachers (Charlton, 2002).

Viewing engagement through an active citizenship lens aligns strongly with the core ethos of SL (as discussed in section 2.2). Furthermore, this participatory view strongly supports the UK context, as emphasised by the UK's Lifelong Education Academy research project, which concluded that student engagement includes 'ways in which students become active partners in shaping their learning experience' (Trowler, 2010: 10). It is clear that, whilst neo-liberalism plays a significant role in the political context of student engagement, the democratic-critical views of engagement are strong within the particular context of my research.

2.4.2 How is student engagement defined?

Despite the significant research, there is no single definition for student engagement; the term has been assigned a range of meanings (Trowler, 2010). I need to therefore examine the definition I will use. The different views of student engagement are far reaching, and range from a:

> Dichotomous view that students are either engaged or not to a multidimensional view of engagement that combines diverse aspects of students' experiences. In between are notions of engagement as a measured quantity, a categorical view where engagement comprises a series of unordered categories, and a naïve view where the concept of engagement is not given further scrutiny than as a well-accepted and well-understood concept (Madsen et al., 2014: 251).

Some have suggested that it is not possible to have only one definition due to its multifaceted construct (Kuh, 2009) and rather it should be viewed as a meta-construct (Fredericks et al., 2004; Kuh et al., 2006). However, there is some agreement in the literature that, as a construct, it 'involves learners' cognitive, behavioural and emotional commitment to learning in an environment facilitated by quality teaching, supportive settings and affirming surroundings' (Zepke, 2013: 639).

As a result of the different meanings of student engagement, it has been used for various research purposes. A recent study by Zepke and Leach (2010) identified four research perspectives for student engagement in the literature: motivation and agency, transactional engagement, institutional support and active citizenship. They argue that these perspectives 'are testimony to the complexity of engagement' (Zepke and Leach, 2010: 169). Within these different perspectives, student engagement has been used to measure a range of factors, for example classroom behaviours (Kuh et al., 2006) and wellbeing (Field, 2009). The research perspectives are diverse and highlight the difficulties in establishing an agreed understanding of student engagement.

To further complicate the matter, some research argues that there are geographical differences in our understanding of student engagement between the UK and the USA (Solomonides et al., 2012a). In the USA, student engagement is constructed based on research, and therefore centres on learning behaviours that can be quantitatively measured, using the National Survey of Student Engagement (NSSE). This survey measures engagement against ten indicators (McCormick et al., 2013). Whilst the UK still values accountability and conducts surveys such as the National Student Survey (NSS) in HE, student engagement is viewed from a less generic and consumer focused perspective, as co-producers in the learning process within a constructivist framework (Trowler, 2010; Solomonides et al., 2012a). The UK thereby takes a less neo-liberal stance on student engagement, and engagement is constructed around helping to prepare students for the future (Zepke, 2015). It is clear that engagement is 'a multi-faceted and contingent phenomenon that often varies according to person, context, pace, activity, and time' (Lawson and Lawson, 2013: 461) and these factors must be considered when discussing student engagement (Zepke and Leach, 2010).

In light of the literature, the working definition that this study will take is a multidimensional view of engagement. To be more precise, the definition from Chapman (2003) will be used: 'students' cognitive investment, active participation and emotional engagement' with their learning (Chapman, 2003). I have chosen this for three reasons. Firstly, it focuses on the cognitive, behavioural and emotional indicators of student engagement and so is inclusive of the key characteristics of engagement (Fredericks et al., 2004), as discussed in section 2.4.3. Secondly, it includes the 'various relationships between the student, study and the institution, including the campus and, one assumes, society' (Solomonides et al., 2012b: 16), which is emphasised in the school context of this research project. Thirdly, Chapman's (2003) definition considers a number of research perspectives and enables a multifaceted lens to be used. For my research, this refers to an active citizenship lens.

Recognising the critiques of the neo-liberal focus on student engagement, I also place particular importance on the democratic-critical view of engagement (McMahon and Portelli, 2004). I do so because the definition then acknowledges that engagement goes beyond the classroom; it aims to develop engagement with the local community that is participatory, leading to active citizenship (Zepke and Leach, 2010). As already mentioned, this aligns with the ethos of SL and that of the school research context. Therefore, the working definition for my research recognises that engagement is an extremely complicated concept, being created by many different factors that are interrelated and continue to develop.

2.4.3 What is the nature of engagement?

Given that there are a range of meanings for student engagement, there are a range of characteristics. Fredricks et al. (2004) offer the most comprehensive framework with which to discuss engagement indicators at school level, categorised as cognitive, behavioural and emotional characteristics of engagement. It is necessary to understand what is meant by these terms, and the literature for each will be briefly summarised.

Cognitive engagement 'occurs when learners are intrinsically interested in learning – when they are willing to face challenges and invest in deep learning of concepts and skills' (Zepke, 2013: 642). For example, during a task a student will expend effort to integrate previous knowledge with new, or will practice self-regulatory strategies (Chapman, 2003; Fredericks et al., 2004). Such deep learning would see students going 'beyond the requirements, and would relish challenge' (Trowler, 2010: 5), promoting student engagement (Kuh et al., 2006). There are various competing theories as to what motivates and engages learners. There is not the scope to review the theories of motivation in detail here, however Self-Determination Theory (SDT) is strongly argued as a 'fit' for student engagement (Ryan and Deci, 2000).

SDT states that 'to be motivated means to be moved to do something – in this case, to become engaged in learning' (Zepke, 2013: 643). Intrinsic motivation plays a key role in self-determination, whereas not all types of extrinsic motivation do (Ryan and Deci, 2000). Self-determination can be enhanced when students have a sense of belonging, have autonomy in their learning, can build secure relationships and have high levels of self-belief. In the classroom, an engaged learner would 'feel competent to learn what they want to learn, believe that they can achieve their learning goals autonomously and have the ability to build relationships to support their learning' (Zepke, 2013: 643). The evidence to support the link between engagement and SDT is strong. For example, Schuetz (2008) carried out large scale research between 2005 to 2006 in Community Colleges in the United States. She tested the fit between different motivation theories and engagement and found that SDT had the strongest fit for her data. It is clear that SDT is one of the key reasons explaining the motivation that students need for cognitive engagement.

Behavioural engagement 'draws on the idea of participation; it includes involvement in academic and social or extracurricular activities and is considered crucial for achieving positive academic outcomes' (Fredericks et al., 2004: 60). Students 'would typically comply with behavioural norms' (Trowler, 2010: 5) and may be active in learning groups or activities, asking questions and solving problems with their teachers and peers. Being such a co-constructor of knowledge and co-producer

of learning is an important characteristic of engagement (Kay et al., 2012), and supports the constructivist view of education.

Emotional engagement 'is about reactions to and relationships with teachers, classmates and administrators that encourage a love of learning' (Zepke, 2014: 698). The learners become immersed in their learning; they are invested in it, showing high levels of interest and enjoyment, and this triggers personal growth and engagement (Trowler, 2010). The importance of such positive relationships for engagement with both staff and peers has been emphasised in the literature, for example Wimpenny and Savin-Baden (2013). Indeed, some literature reviews have put teachers at the very core of engagement (Kuh et al., 2006). Qualitative evidence suggests that 'teachers who spend time on developing relationships and trust, *can* make a difference to the students' levels of engagement' (Bryson and Hand, 2007: 360). Alongside these growing relationships is a sense of belonging (Fredericks et al., 2004). This is supported by research from the 'What Works?' project, suggesting that having a strong sense of belonging when learning is important (Thomas, 2012). This can be created when students work together with staff on projects (Taylor et al., 2012). Given these findings, it is clear that teachers play a key role in enhancing student engagement.

When these three engagement indicators fuse together high levels of engagement are present. Foregeard et al. (2011) describe this concisely:

> The individual has clear goals and is intrinsically interested in the task at hand; the task presents challenges that meet the skill level of the individual; the task provides direct and immediate feedback to the individual; the individual retains a sense of personal control over the activity; and action and awareness become merged, such that the individual becomes completely immersed in what he or she is doing (Foregeard et al., 2011: 84).

2.4.4 How is student engagement measured?

It is important to briefly outline the indicators used in the literature and any limitations in order to identify what I can apply to my research. As already mentioned, student engagement can be measured quantitatively and qualitatively. A wide range of indicators can be used for both approaches, as reflected by the wide range of different meanings for student engagement (Zepke, 2014). For example, on a large scale, there are national surveys such as the NSSE, the NSS and the

Australasian Survey of Student Engagement (AUSSE). Some research focuses on the use of single engagement measures (see Fredericks et al., 2004 for a detailed review). Whilst there are strengths in doing so, it does not align with the multidimensional definition of engagement chosen for this study. Therefore, I will focus on those methods that do.

The NSSE and AUSSE are based on the work of Coates (2007). The NSSE comprises five engagement scales and the AUSSE six. The NSSE scales 'survey how students respond to academic challenge, active leaning, interaction with teachers, supportive learning environments and enriching educational experiences' (Zepke, 2014: 699). The focus of these surveys is on student success, with results being used to compare engagement with performance, in line with the neo-liberal ideology. Some have argued that one of the key problems with these surveys is that they only provide a narrow view of engagement; it is a much more complex and deeper process than the surveys allow for (Hagel et al., 2011). For example, if a student does not contribute to a class discussion they are disengaged, and thus the survey does not take into account personal factors that may have influenced the student not taking part. Zepke (2014) supports the view of Hagel et al. (2011) and highlights that caution must be used when analysing such large empirical data sets as the results can suggest a 'one size fits all understanding of engagement' (Zepke, 2014: 700): it is clear that this is not the case. Further critique of the surveys by Thomas (2012) highlights that indicators of engagement often overlook important factors such as diversity, values and purpose, and could be seen to normalise the meaning. Despite these concerns, the NSSE and other similar surveys are used extensively. Therefore, when analysing data related to student engagement one must ensure that empirical data is not used in isolation, rather it should be supported with qualitative research. By doing this, the multidimensional view of engagement that I have taken is respected.

Other qualitative research has identified indicators that can be used to measure the cognitive, behavioural and emotional aspects of engagement. For example, Bryson and Hand (2007) propose three indicators based on their research with students. They undertook their research within the HE environment, interviewing 50 students in eight focus groups. Their findings from the interviews identified three levels of engagement that can be used as indicators: between the staff and students,

the staff and subject and the staff and the teaching process (Bryson and Hand, 2007). In comparison to large scale surveys, these methods enable rich data to be gathered.

On a smaller scale, there are several methods that can be used in classroom based research methods. Given the context of my research, the extensive review of this literature field by Chapman (2003) is most relevant. Self-report measures are frequently used by researchers and can be carried out as a questionnaire. This method is common, enabling the multi-faceted nature of engagement to be reflected by using a number of separate indicators to assess the cognitive, behavioural and emotional aspects. Whilst self-report scales are used extensively, they do not confirm students' levels of engagement, nor do they take into account issues related to students' assessment of their own abilities (Assor and Connell, 1992).

In order to confirm the validity of the data, direct observations can be used. However, given the wide range of meanings for engagement, different definitions are used in observations. Other ways in which to validate results include work sample analysis and focused case studies. Work sample analysis can be used to assess students' engagement with particular tasks; for example, evidence can be gathered from learning journals and student projects (Chapman, 2003). The key limitation is that the task needs to be appropriately structured, to have a suitable marking rubric.

Lastly, focused case studies are useful for research on a small student group. This method enables rich 'detailed descriptive accounts of engagement rates' (Chapman, 2003) to be collected. The method most relevant to my study is a focused case study, and the most notable research is by Linn et al. (2005), as discussed in section 3.6.1.

Whilst it is clear that there is a need to ensure connectivity between engagement research, it is important that the simplification of indicators does not lead to the erosion of the very nature of engagement. Solomonides et al. (2012b) agree, and suggest that there is pressure for researchers to identify as few indicators as possible. Such is the problem with engagement research that Zepke (2014) highlighted the key issues that pose challenges for the research community. Of importance

for my research is that I should 'recognise that engagement is more than a "one size fits all" set of "how to" suggestions…educational research should offer critique as well as practical suggestions…as well as offering recipes for engaging students' (Zepke, 2014: 704). Whilst I recognise that my research is a focused case study I hope to deeply understand what I observe; pose questions for future research, and not be afraid if there are no firm solutions.

2.5 Summary

From the literature it is clear that GIS education in UK schools has not reached its potential. Despite the opportunities this technology offers, there are too many challenges for schools to overcome. The research into SL helped to clarify that I see this as an exciting context for GIS to work with. There is a strong fit between the core characteristics of SL and the framework of a GIS-based project, and GIS provides the framework and toolbox for students, teachers and community members to collaborate. Moreover, 'key to all of these benefits is engagement – cited again and again - that students are interested and motivated not only to learn but to take action' (Kerski et al., 2013: 237-238). The review of the engagement literature enabled me to consider a much wider range of issues than I had originally thought, for example the challenges of choosing a definition and issues surrounding measurement. It helped me to refine a definition for this research project, identify characteristics to observe and choose tools for measuring. In light of this, the research questions were adjusted to:

1. What are the educational benefits of a GIS-based pedagogy?
2. How can GIS be used within a SL programme?
3. How and to what extent does using GIS lead to increased levels of engagement with SL?

3. Methodology

3.1 Research design

This research project follows practitioner research and uses case study design. A case study 'investigates a contemporary phenomenon in depth and within its real-life context' (Yin, 2008: 18). In this research, the case is the use of GIS in SL. Case study is appropriate as it enables us to create a picture of real life situations and thus can 'enable readers to better understand how ideas and abstract theories fit together' (Yin, 2008: 72). In this case, I wanted to capture the students' experiences of the use of GIS, and the context was essential to understanding engagement levels. In the GIS literature, case studies are recommended to help us 'more fully understand the effectiveness [of GIS]' (Kerski, 2003a: 134). As GIS is a recent innovation within the Geographic education field, case studies also help us to 'develop an in-depth understanding of a curricular-instructional innovation in an information-rich setting' (Milson and Earle, 2008: 228).

A mixed methodology approach was used. Mixed methods research enables the collection of in-depth data from qualitative research, and numerical data to be efficiently collected through quantitative research (Cohen et al., 2011). Three instruments for data collection were used: surveys, observations and semi-structured interviews. The survey data gave an overall picture of the case study; the field notes from observations and statements from interviews enabled a more detailed analysis to be undertaken from a range of perspectives. Triangulation of the data between methods could thus take place and the data's validity was enhanced (Chapman, 2003; Cohen et al., 2011). Such methodological triangulation is common practice amongst case studies: similar investigations into GIS have used it successfully, for example Keiper (1999) and Shin (2007).

During the research I took the role of participant observer, for two key reasons. Firstly, I was able to see first hand how students responded to GIS, and could be responsive to what took place (Cohen et al., 2011). That enabled me to see the social interactions and understand them. Secondly, it enabled me to build trust with the participants (Glesne, 1999). This was particularly important as I was only present at school for the research once a week whilst on maternity leave (see section 3.3).

Therefore, more specifically, I took the role of observer as participant; I was known to the group but did not have contact with them outside this research. During each session I was able to assist if necessary, for example answering specific GIS software questions or giving feedback on presentations; however, I did not deliver any of the sessions or instruct the students. I was aware of the effects I could have on the research, and how my experience with GIS and views of SL might affect my analysis. For example, potential bias could have been introduced during data recording (Murray and Lawrence, 2000). To reduce this bias I ensured I was as 'objective as possible by setting aside [my] personal assumptions' (Menter et al., 2011: 37).

Having conducted the research, I analysed and reflected on the findings, and related them to the theory in the literature. As the overall aim of this research would not only develop my own teaching practice but that of other teachers working with GIS, it contributes to 'promoting education change' (Rossouw, 2009: 6).

3.2 Participants

Ten year 12 (all male), and two year 13 (female) students were involved. Of the group, 8 of the year 12 group were studying A Level or IBDP Geography. The year 13 students lead the group alongside Sarah (pseudonym - see below). It is important to note that the SL group was established before my research took place. It is part of the Year 12 Service programme whereby every student chooses a particular project to volunteer with.

3.3 Collaboration

During my maternity leave, the SL group was led by Sarah, the member of staff from the Geography Department in charge of the group. I collaborated with Sarah extensively throughout the research process, and it would not have been possible without her. We developed the enquiries for the group; completed the surveys together, and had on-going informal discussions after each weekly observation. This was an extremely productive source of data, giving another perspective. I also collaborated with Andrew (pseudonym), a member of the local Parish who voluntarily helps with the Geography Department SL group, and discussed the focus of the enquiry with him.

3.4 Ethical considerations

I sought consent from the Headteacher to carry out the research, and asked for participation in the project through written consent of students, teachers and the external community partners involved (see Appendix 4).

The most significant ethical issue was the involvement of Sarah. I was aware of the influence she might have on the research process itself and the outcomes. For example, the influence she had on the change in the organisation and focus of my research from one group to two. The group initially worked as one group from September to December 2015, and conducted a survey to understand the main social, economic and environmental problems facing their community. However, Sarah was concerned about the group dynamics. Specifically, the group did not behave appropriately and had not reached the aims, so she divided the group in two. As a result, the organisation and focus of my research shifted to two groups (A and B) instead of one. I ensured that both groups were treated the same in terms of the enquiry and resources from both Sarah and Andrew, as far as was possible.

I also engaged with other ethical issues that I might encounter, for example concerns regarding students' informed consent and the impact on their learning experience. Whilst students cannot opt out of normal classroom practice (all Year 12 students have to take part in a SL group), issues might arise relating to their consent to participate in the research. I stated that if a student decided not to participate in the research it would not affect their place in the SL group. The group was reassured verbally and reminded that their decision to take part or not would have no impact on their learning experience in the SL group. As nothing was assessed this was not a concern. I reminded them that they could discuss any concerns with me at any time before and during the research process, as stated in the participant information letter (see Appendix 4).

Finally, in line with British Educational Research Association (2011), to ensure anonymity, the school, participants and data collected were anonymised, with pseudonyms used throughout, and were only seen by my supervisor and me. The data was stored on a password-protected laptop.

3.5 The enquiry.

Two enquiry projects were developed for Groups A and B to investigate during the research period. The focus of crime from the previous academic year was continued as the overall aim, as Andrew identified a real need to continue this, and he introduced the neighbourhood plan as another key focus. In line with SL ethos, the aims of the enquiries were set by the students, teachers and community members in a collaborative partnership (Felten and Clayton, 2011). Sarah worked closely with the student leaders to ensure the project had clear aims and direction within a framework planned with Andrew. Sarah was also responsible for arranging the resources and supporting students. Both enquiries were introduced to the students in January 2016 and took place from January to March (see Appendix 5 for a summary of the enquiries). Each session was one hour; however, the length of time the students had to spend on the enquiry varied depending on the schedule of the SL group.

In line with the SL ethos, the research focused on the local town and surrounding area. For the students who did not use GIS (Group A), the focus of their enquiry was to analyse survey results (from the previous school term) in detail to identify neighbourhood planning issues facing the local population which the local Parish wanted to address. The data was collected by the students themselves and also from a Parish survey that they had access to. Findings were presented to the local Parish, other local partners and the Headteacher. For those working with GIS (Group B), the focus of the enquiry was mapping crime in the area using ArcGIS software, which is the main GIS software package that most schools use. ArcGIS 'provides a comprehensive set of tools for incorporating data, building maps, and formatting the final output' (Environmental Systems Research Institute, 2016). The data came from the local Police, was edited by Sarah and was updated weekly for the students to analyse.

When designing the GIS-based enquiry for Group B, it was important that the GIS was as simple to use as possible to avoid extensive software training, for which there was no time (as also seen in Keiper, 1999; Lloyd, 2001; Shin, 2007). That also avoided the frustration that can result from over complication, which has been so well documented in the literature (see section 2.1.3.). Other GIS

studies, for example Demirci (2011), have also avoided teaching *about* GIS in line with the pedagogic framework Sui (1995) proposed, preferring to focus on teaching *with* GIS. Students did have previous experience with GIS, for example, one-off lessons mapping tectonic activity, but had not used it for research purposes. The student leaders did have experience of GIS, having volunteered for the same SL group the previous year. Therefore, the only training the students received on how to use GIS was through watching the teacher demonstrate it. Sarah had used GIS at Undergraduate level, and has also invested a great deal of her own time to train herself. I did noy give any specific direction to her as to how to deliver the GIS instructions; I was not in charge of the group and it would not have been appropriate. I also wanted to give her as much freedom as possible in the delivery.

3.6 Data collection

All three research questions required engaging with the students' experiences with SL, and involved collecting students' views (Table 1).

Research question	Data collection method
What are the educational benefits of a GIS-based pedagogy?	Literature review, observations, and interviews
How can GIS be used within a SL programme?	The GIS-based enquiry, observations, and interviews
How and to what extent does using GIS lead to increased levels of engagement with SL?	Observations, interviews, and survey

Table 1: Methods of data collection for answering the research questions

3.6.1 Survey

A survey was designed for students to complete before, during and after the research period, and was based on a Likert scale (see Appendix 6). I chose to collect quantitative data from a survey as the results would be used to gain an initial understanding of the engagement levels, and to observe any emerging trends that could be developed further through the interviews (Menter et al., 2011; Demirci et al., 2013).

The work of Linn et al. (2005) inspired the survey that I used. Their research focused on developing evaluation tools for teachers to use in the classroom when using GIS. They created an array of tools, including a chart 'to assist teachers in gathering qualitative data about student engagement when using GIS in a classroom setting' (Linn et al., 2005: 221). This particular chart was based on the work of Chapman (2003) and, whilst it is aimed at teachers' use, I adapted it for student use by building in a Likert scale.

Likert scales were chosen as they 'build in a degree of sensitivity and differentiation of response while still generating numbers' (Cohen et al., 2011: 386). They are also easily administered and easy for students to complete (Edwards and Talbot, 1994). Limitations, such as numbers having different meanings for students, do exist and data had to be handled carefully during analysis. To create the survey, I used the statements from Linn et al. (2005) regarding engagement and created five points to the scale, ranging from strongly agree (5) to strongly disagree (1). Participants were asked to answer the questions by giving a number that represented the extent to which they agreed with each statement. The Likert values were then acquired by calculating the mean for each statement. In order to easily compare the change for each statement I followed West (2003) and categorised changes as either a substantial increase or decrease (>0.5).

3.6.2 Observations

In order to get an insight into what was taking place *in situ,* I carried out weekly unstructured observations, gathering qualitative data. As my focus was on observing the participants in their everyday environment, structuring the observations would not have been appropriate. In addition, I could not predict what would take place and so did not know in advance what to look for. As the two groups met at the same time, I was only able to observe sections, alternating between the two rooms. As recommended for unstructured observations, they were recorded in my reflective diary (Edwards and Talbot 1999; Cohen et al., 2011).

Initially, I audio-recorded the observations to 'overcome the partialness of the observer's view of a single event' (Cohen et al., 2011: 470), and ensure validity and reliability in observations. However, due to the varied nature of the group interactions, and the different rooms used, I did not find this

a useful source of data to analyse and discontinued it. In order to reduce potential bias during subsequent analysis of my observation notes, Sarah and I both completed the engagement survey during each group meeting. Indeed, one advantage of the survey that Linn et al. (2005) highlight is that teachers can use the chart while students are using GIS. As I had taken a multidimensional view of engagement, we were able to estimate student engagement levels as being low, medium or high. This is more suitable than a specific measure of student engagement because it takes a more holistic approach, recognising that engagement is affected by many factors.

Sarah and I discussed our survey and overall engagement scores weekly. I did not record these conversations, as introducing such a formality would have changed the atmosphere. It was an ongoing dialogue that naturally took place; producing an i-Phone to record it would have hampered the natural flow. Instead I recorded my reflections after each discussion in my reflective diary. By collaborating with my colleague, I was able to get another perspective on student engagement for analysis, and hence reduce subjectivity (Edwards and Talbot, 1999; Cohen et al., 2011).

3.6.3 Interviews

Qualitative data was collected from semi-structured group interviews with the students and two individual interviews with Sarah and Andrew. Frustratingly, due to technical problems the interview with Andrew could not be transcribed. I designed an interview schedule that covered the research questions (see Appendix 7 and 8) and enabled me to analyse their responses. Initially I had planned to interview each group weekly so that I could cross-check my other data. However, due to time restrictions this was not possible; my school only allowed me to conduct interviews during the group sessions so there was rarely time available for this. Therefore, I carried out interviews with the students on two occasions at different stages in the research.

The first student interview took place early on during the research. It enabled me to understand several factors. I established the reasons why they chose to sign up for the Geography Department SL group; their preliminary understanding of GIS and the aims of the group, and their 'base' levels of engagement. I picked up any key points that emerged from the first survey; for example, the largest discrepancy in the scores between the groups related to their effort.

The second student interview was carried out towards the end of the research. It allowed students to reflect on their experiences, identify if their engagement levels had changed, and if any other relationships had arisen over the period. Like the first interview, I also picked up on points from the survey. In particular, I explored the concept of 'student engagement' with them as it was clear that there were various understandings of student engagement, and I wanted to hear them. The responses from this indicated that student engagement is a complex, multi-faceted concept, with behavioural and emotional engagement as the most important. This confirmed that the definition chosen for this case study is appropriate.

The student interviews were carried out in small groups to ensure maximum participants involvement. Group interviews are also beneficial to gather deeper information on participants' views of a given issue (Menter et al., 2011). I was aware of the dangers of the interview being dominated by some participants, which was indeed sometimes an issue. In response to this, I created opportunities for less confident participants to contribute, by asking 'does anyone else have another view on this?'. I found this could effectively involve everyone, and I considered these issues when analysing the transcripts.

Both the student and teacher interviews were semi-structured so that I could explore questions and ideas as necessary within a more open environment. Questions were carefully designed to ensure that participants responded to the issues most relevant to my research (Menter et al., 2011). To reduce bias during the interview, I did not assume that I understood what the interviewee was discussing if I had any uncertainty; nor did I ask leading questions (Cohen et al., 2011). I was aware that my relationship with the interviewees could introduce bias, and so used a sequence of semi-structured questions to limit this (Anderson, 1998). However, I did not want to follow a too tightly structured sequence as this could hamper efforts to understand the complexity of the issues being discussed. Using the semi-structured approach created space for me to adjust my questions to the participant responses, enabling widely ranging discussion (Anderson, 1998). The interviews were recorded on an i-Phone and subsequently transcribed. To ensure the social contexts of the

interviews in transcripts, I followed guidelines from Cohen et al. (2011) and listened to other factors such as speed of talk, tone of voice and emphasis.

3.7 Qualitative analysis

Given that I took a case study approach, and aimed to get a better understanding of how GIS can be used to increase engagement with SL, the most suitable analysis for the qualitative data was a descriptive narrative (Cohen et al., 2011). To do this, I took a selective focus and highlighted the key themes and issues that emerged from the interview transcripts and observation notes, as recommended by Cohen et al. (2011). Once each interview had been transcribed, the first level of data analysis involved identifying common themes in the data. I categorised answers into themes to be analysed and then linked these to the research questions. In line with similar GIS case study research, 'this process continued until a saturation point was approached, a point at which new data added nothing significant to the existing categories' (Keiper, 1999: 49). Each highlighted comment was then analysed. I did not include all the data in my findings and was selective, and have included an example of this process is included in Appendix 9. The descriptive narrative was then created for the second level of analysis. I presented data from individuals but also chose to 'amalgamate key issues emerging across the individuals' (Cohen et al., 2011: 539) in order to reach conclusions. In this narrative, the descriptions allowed 'for a well-rounded account' (Keiper, 1999: 49), and therefore attempted to reflect the data, whilst acknowledging anomalies.

4. Findings

The findings are discussed for each research question.

4.1 What are the educational benefits of a GIS-based pedagogy?

4.1.1 Finding 1: Participants have a mixed understanding of the benefits of GIS.

In the first interviews, students were asked about their initial thoughts on GIS as a tool to support learning. For Group B, it is clear that there was some confusion amongst them, and a range of opinions were raised. For example, a student commented '*I'm struggling to see what the ArcGIS kinda adds…we're like individually plotting data which just takes ages and is pointless*'. However, when pushed further another commented '*being able to compare and see changes is good'.* The observations of Group B support this range of views. For example, I noted in observation 2 that some were very interested in using the scale of the data, and could see the benefit of studying crime at a range of scales, whilst others simply looked at the maps.

In contrast to this, despite not using GIS, Group A overwhelmingly thought it was a useful tool, enabling patterns of antisocial behaviour to be mapped in a simplified way. However, the notes from the observations contradict this slightly. For example, in observation 4 I noted that students described GIS as '*just putting dots on a map',* thus demonstrating their lack of understanding of GIS and its potential.

In the second interview with Group B the student views on GIS had shifted slightly to an overall more positive one, acknowledging the usefulness of being able to manipulate such large datasets to look for patterns and analyse relationships. Support for this was found in the observations, for example in observation 4, I noted that students were using GIS for hot spot analysis. However, this was only two students; the rest were chatting about rugby training and did not appear to have completed research during the session. In interviews they also recognised how their experience with GIS would help them with their Geography A Level: '*It's become really useful for us…doing GIS for our geography A level as well, so it's become useful for that because we've got a head start in every*

one'. Contrastingly in observation 5, I observed some of them challenge Sarah, asking why they had to use GIS and why it was also in the A Level syllabus. It was clear there was a range of views in the group, and some had chosen this SL group because they thought it would be an 'easy' option: '*I also did enjoy doing the GIS work because… it wasn't high maintenance and it was quite nice to just sit and relax and just do it in your own time'*. This shows that some did not understand the educational benefit of GIS, and did not have the motivation to engage with it and the SL group aims.

The student leaders also had a range of views on GIS. They commented '*once you get the hang of it its really interesting to see the benefits*'. For example, they understood the significance of working with local data: '*I think having the stats and like specific details on GIS actually makes it a bit more real and if it's an area that we know*'. When questioned further about the use of GIS they commented that '*I'm sure it's useful in a lot of jobs as well'*. From these comments, the student leaders covered the three key justifications for embracing GIS: the educative, place and work.

From the teacher perspective, Sarah commented on many of the benefits of using GIS. Firstly, how GIS is suitable for enquiry and independent learning: '*there's more to engage with this [GIS-based enquiry] because there's more scope to do your own thing…pretty much come up with any questions that you want and then you've got to figure out how to do it*'. Indeed, she said you '*would be barking not to use it in geography'* given the enquiry focus of the new syllabus. This led on to a point that GIS is '*just so versatile'* and gets students thinking spatially. Not only did she agree that GIS develops spatial thinking, but also higher-order analytical thinking. She was amazed by the direction that some students took the research in, for example the seasonal analysis of crime, which then became the focus of the research.

The last key benefit she discussed was linked to the power that GIS has to connect students to local communities and help them to understand their place in the world. She commented that: '*it gives you a literal top down view…you can see where you sit in relation to other communities and groups…gives them a better sense of place and where they sit*'. Interestingly, whilst one of the advantages of using GIS is its ability to work on a large scale, it brought the students closer to the

local neighbourhood perhaps '*because it makes you think about why is my area different to the one next door*'.

4.1.2 Finding 2: When GIS was used, participants focused their understanding on the challenges of GIS.

When Group B were asked about how GIS has impacted on their engagement levels they referred to the key challenges regarding teaching *with* GIS as opposed to teaching GIS, highlighting the difficulties regarding GIS instruction:

> *Student 1: I would say by the end there were still some people who didn't fully understand how to… use it…so I think maybe throughout the start there was kind of a session like really showing everyone what you can do with it, then they'd be able to use it kind of better to obviously improve like all the other things they know.*

The observations also noted these challenges. For example, in observation 5, one student frustratedly asked the group '*but what do I do?*' and in observation 8 one student said in their presentation '*the ArcGIS was quite though, hard to understand and challenging to use*'. In addition, it was clear that some students had *'no idea what else it [GIS] can do'* and were relying on the GIS research they had carried out in their Geography classes to help them.

The student leaders emphasised that it is the software that is most challenging: '*once you get the hang of it it's really interesting to see the benefits but until that point it's kind of just quite frustrating because you don't really know what you're doing*'. They could see that GIS is a useful tool, especially '*if you get some kind of experience with it from the start*'; software training, for them, '*would've been really helpful*'. From the observation notes it was clear that the student leaders were not able to support the students with software issues, but they did introduce analysis of crime by month.

Despite all the benefits Sarah discussed, she highlighted two key challenges. Firstly, she experienced student resistance to taking on board GIS. She thought this was because it was '*new, so it requires a bit of effort*'. The resistance also stemmed from the fact that '*a couple of the lads picked it [the SL group] because they thought it was a soft option*', and not all of them wanted to put in the effort needed. There are many notes from Group B observations that support this view. From the start, I

noted in observation 2 that the students did not really know what they were doing and there was no real sense of engagement with SL. This became even more apparent in observation 5 when the student leaders were asked '*isn't this all pointless?*' after they had just explained what the group needed to work on, and the students subsequently became very distracted.

Secondly, Sarah flagged software issues and time pressures. The observation notes frequently reflect these challenges. For example, in observation 1 I saw low levels of engagement due to students waiting for the data to load. Frustratingly, Sarah had already spent several hours organising the data. Sarah faced GIS software issues during several observations, for example during observation 4 she had to spend most of the session helping students log in due to a technical fault. When Sarah reflected on what to change for next year, she said she needed to concentrate on '*making the jazz hands - when you show students that GIS is something really cool - jazzy enough that it's exciting but they can still do it'*. The emphasis here is on showing the potential of GIS whilst also making it accessible for all.

4.2 How can GIS be used within a Service Learning programme?

4.2.1 Finding 3: GIS-based enquiries in Service Learning are an effective way in which to use GIS.

The GIS-based enquiry (Group B) demonstrated how GIS can be used within SL. It was clear that by working with local data, students could build their understanding of place and make new connections to their own lives. Mapping patterns of crime thereby can take on a new meaning: it becomes something familiar, more personal and, in turn, more meaningful. They could then use this knowledge to develop their understanding of the socio-economic issues facing the local area, thus making deeper connections with the data. The results of their research were presented to Group A and Andrew. The key finding was the seasonal analysis of crime, which will be included in the next step of the Neighbour Plan, therefore benefiting everyone. The presentation can be found in Appendix 10 (and a copy of Group A's presentation is included too).

4.2.2 Finding 4: GIS training needs to be integrated into GIS-based enquiries.

As already highlighted, students did not have the GIS skills to apply the knowledge and understanding of the issues they needed to research. Students commented in the second interviews that '*there were still some people who didn't fully understand how to kind of really be able to use it*'. They recognised that having a GIS lesson at the start would be beneficial, and that teaching the group would help them all to make basic maps that could be used for analysis.

Although Sarah was present during the sessions to support students, and demonstrated how to use GIS to bring up maps, layer variables, and analyse for hot spots, she did not explicitly give the students a step- by step- guide to using GIS. When Sarah did instruct the students, there was real engagement from all. As discussed in section 3.5, she had chosen to teach *with* GIS, as opposed to teach GIS. However, as she reflected, more time must be set aside for detailed training - specifically, training next years' student leaders before the new group meets so that they are confident helping others from the start.

4.3 How, and to what extent does using GIS lead to increased levels of engagement with Service Learning?

4.3.1 Finding 5: Students demonstrated mixed levels of engagement.

Likert values from the survey were summarised as showing either a substantial increase or decrease (>0.5), as shown in Table 2 (the full data set can be found in Appendix 11).

		Group A		Group B	
Statement Number	**Statement**	**Substantial Increase**	**Substantial Decrease**	**Substantial Increase**	**Substantial Decrease**
1	Making comment or asking questions about the project whenever I see my teacher	X		X	
2	Asking relevant questions during the session	X		X	
3	Working on my own			X	
4	Helping others				X
5	Asking relevant questions of each other	X			
6	Integrating new material with previous knowledge				
7	Monitoring my own work	X			X
8	Solving task-related problems				
9	Discussing task-related problems with the teacher			X	
10	Discussing task-related problems with the others				
11	Coming to the sessions				
12	Coming to the session ready to work				X
13	Staying on task during the session on my own				
14	Taking risks				
15	Initiating action when the opportunity is available				
16	Suggesting new ideas and methods to answer questions/issues	X			
17	Coming to the sessions late *				
18	Staying after the session to work on the project	X		X	
19	Following instructions				X
20	Passive *				X
21	Giving up easily *				X
22	Not trying hard *				X
23	Bored *	X			X
24	Interested	X		X	

Table 2: Likert value changes between the two groups from the two survey collection points. Note: * statements for which scoring is reversed: a positive change implies a decrease in student engagement, and vice versa.

As shown in Table 2, some statements recorded substantial changes for Groups A and B. For example, substantial decrease change was observed in statement 11 for Group A, and statements 4, 7, 12, 19, 20, 21, 22 and 23 for Group B. Substantial increase change was observed in statements 1, 2, 5, 7, 16, 18, 23 and 24 for Group A, and statements 1, 2, 3, 9, 18 and 24 for Group B. Often substantial increase change was observed for both groups; for example, statements 1, 2 and 24. However, substantial decrease change did not occur for the same statements for both groups. Statements 7 and 23 showed substantial changes at opposite ends of the scale for both Groups.

For Group A, the survey results align strongly with the observations, with some exceptions, such as statement 11 (they had to attend the sessions) and 23 - 'bored'. The latter is interesting as many students had highlighted being interested, and not bored, as a key component of engagement. In the observations I noted many sessions where students were actively involved in the survey analysis and preparation for the presentation to the Parish Council, questioning one another and discussing it as a group. I was therefore surprised that 'bored' showed a positive substantial change and decrease in student engagement. However, statement 24 – 'interested' – showed an increase in student engagement, and this was very clear in the observations, and the interviews. In the second interview, students commented that their overall engagement levels had '*increased*' and '*increased a lot*' over the research period. They also said that if they had had the opportunity to use GIS, it would have '*made it that little bit more interesting which would make it more engaging'*. However, even without the GIS they agreed that they had been highly engaged. Some were '*almost surprised by the end that actually how kind of interested I was and how kind of engaged I could be*'.

There was also support between the survey and observations of Group B – for example, statements 3, 4, 7, 12, 19, 20, 21, 22 and 23. It was clear from the observations that the students had become passive, bored, and were less interested in trying hard and, in turn, gave up more easily, leading to low levels of engagement. Consequently, I was surprised that statements 1, 2 and 9 showed a substantial increase. Due to the way in which they divided up the GIS research, they chose to work mostly on their own, and did not work in a supportive environment, asking questions of each other or commenting on their work. However, there was some evidence in the observations of them

discussing their research with each other, for example in observation 4 and 5, but it was in stark contrast to group A, who pulled together collectively to complete their research.

Likewise, for Group B, I was also surprised that statement 24 – 'interested' – showed a substantial increase in student engagement; I rarely saw genuine interest from the group as a whole during the observations. Taken individually, some students did show this; however, the survey aimed to measure group engagement levels. This split was clear in the first interview; students commented on their low levels of engagement and recognised that '*some peoples are better than others…I don't think I am the best*'. When asked what was stopping him, one said '*I'm not that attracted to what we are doing…I'm not interested with this*'. In the second interview, they said that group engagement levels had moved from '*low to medium'* and that there was still some split between them in terms of interest. The shift towards higher levels of engagement was partly due to GIS, but other factors were also important, as discussed in section 4.3.2.

From the teacher perspective, when Sarah and I completed the survey, Group A scored a higher average Likert value than Group B in every session. With regard to the survey method, results did vary between us. Observations 6 and 8 had a substantial change for both Group A and B. Observation 3 (Group A) and 4 (Group B) also showed this, however the rest were of a minimal change. The mixed levels of engagement we scored were also apparent in the observations. For example, in observation 3, I noted that Group A were highly engaged - discussing the survey results, looking for solutions and new ideas, and taking action. Contrastingly, Group B were confused carrying out GIS analysis of crime by month, and as a result most were off task with low levels of engagement. This agreed with the teacher survey results; for example, statements 2, 4, 5, 6 and 10 showed a substantial increase change compared to Group B. In addition, statements 20, 21, 22 and 23 showed a substantial decrease change, again supporting the observation notes that Group A were overall more engaged.

Despite these results, Sarah strongly believed that GIS played a role in fostering student engagement for all students. Without GIS, the project '*would be nothing at all*'. She recognised that, although there

were issues with GIS, it did help with engagement due to its '*huge power'.* This is what led her to say that GIS '*will get better and…will continue to help engagement'.*

4.3.2 Finding 6: Other factors were important in student engagement levels: aims, group dynamics and staff.

Whilst we wanted to follow the SL principles of empowering students to set the research agenda, it was very clear from the observations that all the students needed clear aims for each session. In the first interview students commented that it was '*better to be aiming towards a target'* of '*what you're trying to achieve*' because then they have '*got things to show and can see the end result'*. For some, '*at the start we didn't really have a target or knew what we were doing*' so it was '*quite hard to engage'*. As a result of the first interviews, Sarah set aims for each session to ensure '*that everybody's got something to do and planning it so that…we work to people's strengths and don't let them get bored*'.

In the second interview with students, both Group A and B agreed that the aims had really helped them focus, move the project forward and increase their levels of engagement. For example, within Group A:

> *Student 1: We really knew what we were doing and everyone was given more responsibility and more of like an actual role…level of engagement actually increased and I think the level of interest as well. Everyone kind of became more passionate about what they were doing…you don't want to let the side down, you have a responsibility.*
>
> *Student 2: …it would get us like motivated then yes I suppose we switched on I guess like we would in a classroom.*
>
> *Student 3: Yeah, like the organisation keeps us on the right track which keeps us engaged.*

For Group B, they also suggested that their engagement levels had improved since they were given clear aims and tasks had been assigned. Their engagement '*definitely improved*' with targets and were '*more focused'* with levels of engagement increasing to *'medium engagement'.*

These comments strongly support the decision Sarah made and, in turn, highlight the significant role she played indirectly in contributing to student engagement. One student said '*Miss does a lot for the group…she does a lot of organisation that gets us on like the right track*'. The most engaged students did reflect that '*if you set your own targets you might be more driven to go for it*', hence why Sarah was reluctant to use targets from the very start. However, perhaps these could have still been clearer; '*I'm still unsure of what we're going to do with the information that we've come across*', commented one student in Group B. They further reflected: '*once the target has been given and once everyone knows their roles within that then that's when it'll definitely become pretty impressive*'.

The group dynamics also emerged as an important factor contributing to student engagement, for both groups. As discussed in section 3.4, the group had previously worked as one large group. In the first interview, Group B recognised that because they had divided, they '*actually have to do something*' and their engagement had already '*increased*'. Later in the second interview Group B also said that '*once we split up and were individually given tasks to do it was a lot easier to engage and a lot easier to become active with it'*, thus supporting the decision made by Sarah. The need for individual or small group tasks was also emphasised by Group A in the second interview:

> *Student 1: The group mentality almost doesn't really help too much because you're still kind of there in front of everyone else who is primarily like your mates, and you're still trying to play it cool in front of them. So like when everyone's in one group the engagement is not as high as I thought when we split up.*
>
> *Student 2: When we split into smaller groups of two or three then the engagement and the work rate goes up and we actually get stuff done because you can really get…be absorbed into your work and actually be passionate about it without really having to worry about like what other people think.*

Subsequently, these students had an insightful discussion about the importance of the group dynamics in terms of being comfortable with each other. They suggested that being in a comfortable environment would '*allow yourself to become engaged with the actual project rather than the awkwardness*' of the social situation. It was here that they realised the importance of the student leaders in helping to establish such an environment, and, through this inclusive environment, encourage student engagement. Whilst these comments are primarily from Group A, Group B did

recognise the direction that the student leaders gave and the environment that they helped to create, making it more enjoyable for them.

The other factor that played a key role in student engagement was external staff, notably Andrew. He worked primarily with Group A and organised the presentation they gave to the local Parish. The students commented that there were many opportunities created from this partnership and they benefited from his guidance and support throughout, being able to ask questions and discuss ideas. For example:

> *Interviewer: What opportunities did you come across during the project?*
>
> *Student 1: Opportunities to speak to other people outside of Gilston which is a big thing. That was the council and sort of general public.*
>
> *Student 2: Yeah I've never presented to people like that, so yes … that was an experience.*
>
> *Student 3: Yes we got their understanding of what goes on. I think with the whole survey process as well you really get to know a local area and the local people…*
>
> *Student 4: So opportunities to create a neighbourhood plan which none of us knew how to do before, we did that.*
>
> *Interviewer: So what influence did Andrew have?*
>
> *Student 2: He kept us engaged and he encouraged us.*
>
> *Student 1: He brings local knowledge generally, he helps us and comes up with ideas which we used and it was useful.*
>
> *Student 4: I think in terms of motivation he played a massive part.*

Some students seemed surprised how Andrew had '*actually been really impressive'* and '*made a massive impression on me*'. Andrew '*helped our engagement because we see how passionate he is about it so we want to help him and obviously reflect well on him'*. Another student said that the project had '*exceeded the expectations I had*' due to the involvement of Andrew. The local involvement was key: when the students realised '*we could actually make a difference*' they were highly engaged. It is clear that the enthusiasm and passion embodied by him and Sarah, had '*definitely helped our engagement*'.

Again the importance of external staff was emphasised by Group B. Even though Andrew did not work with them as often, they could see the potential he could bring to their group and they wanted more involvement with him and the local community. They said that had they had the opportunity to present to the local Parish they would have been more focused and engaged, as it was a clear goal to aim towards, with real impacts. In addition, they wanted to use the findings from their GIS analysis with community work. This would make it '*more engaged and more interactive'* as they would be '*physically doing something rather than just sitting here on the computer*'. For example, they had used GIS to map graffiti and they wanted to use this to help the local community by painting over areas where graffiti is. Through this, they would '*feel like a responsibility to do it'* and '*you feel like you are doing something more, you are actually making a difference'*, compared to what they did – '*I feel like I haven't really been involved that much in what we're doing'*.

The importance of the local partnerships was emphasised by the student leaders and Sarah. For example, the student leaders said that it is '*quite satisfying at the end to see the difference it made to the community'* and how this is what makes their SL group different to the others in school, because '*our project was actually moving forward with something*'. They also recognised that Andrew really helped boost engagement by connecting students to the local community. Sarah reflected that '*the thing that shifted the dynamic was when external people come in*' and Andrew enabled the group to see a purpose to their work and that '*it actually makes a difference'*.

5. Discussion

The discussion is centred around the final research question and key points that emerged from the findings.

5.1 How, and to what extent does using GIS lead to increased levels of engagement with Service Learning?

As the findings strongly suggested, GIS can increase student engagement with SL to some extent. The findings support the view that using GIS in a SL context creates a dynamic learning environment (Shin, 2007), within a constructivist framework (Kerski, 2008). In this environment, students learn using real data in a real-world context (Kinniburgh, 2010a, 2010b), connecting their life to the local community (Mitchell and Elwood, 2012). GIS thus gave students an 'effective framework for seeing connections among disciplinary perspectives and local issues, providing a critical backbone for organising new knowledge' (Ball, 2009: 199). In addition, GIS has real power to display and analyse spatial data, and did intrigue most of the students, a key feature as cited by others (McClurg and Buss, 2007). Liu and Zhu (2008) argue that GIS can help teachers to engage students with their learning. However, the GIS-based enquiry used here only helped to some extent. In this case study other factors were more important than GIS, notably the setting of clear aims, creating an optimal learning environment, and the involvement of staff.

In order to discuss the importance of GIS and these factors, one must also remember that engagement varies between individuals and depends on the time of day, context of the session, the activity and the pace of the research (Lawson and Lawson, 2012). Likewise, whilst I established a definition for student engagement, the interviews showed how students have their own understanding of it, centred around key points: being interested, asking questions, showing initiative, and being committed and actively involved. They also placed varying degrees of importance on different aspects of it, with a particular focus on behavioural and emotional engagement, thus highlighting the difficulties of using a collective definition (Trowler, 2010).

Therefore, I continue to argue that engagement must be viewed through a multifaceted lens (Zepke and Leach, 2010) and discuss the findings using the key aspects of the definition used for this research.

5.1.1 Students' cognitive investment

From the findings it was apparent that students in Group B struggled to engage cognitively. Some of the challenges of GIS that were highlighted in the literature came to light and, as a group, there was little intrinsic motivation or effort to tackle these. For example, the complexity of the software was a barrier to engagement (Biebrach, 2007). As students could not see the potential of GIS, nor how they could use it to give meaning to their research, they did not want to invest time in learning how to use it (Baker and White, 2003; Zepke, 2013). As a result, they became frustrated, uninterested and bored, leading to low levels of self-determination and engagement (Ryan and Deci, 2000; Zepke, 2013).

The findings do not support the 'social and structural barriers' (Kerski, 2003a: 134) that are suggested in the literature to be the key issue with GIS education. As stated in section 2.1.2, the research context here is quite unusual in that the school has staff who are well trained with GIS and have the spatial perspective to teach *with* GIS. Furthermore, as reported elsewhere in the literature, one of the key challenges for teachers is sourcing databases and base maps to use (Keiper, 1999; Bednarz and van der Schee, 2006). Kerski (2003b) also commented that accessing maps in the UK in particular was difficult and costly. However, the department have established a working relationship with the local Police and Parish and this was not an issue. This further suggests that the technological barriers were a key issue in student engagement. With appropriate support and expert instruction, this barrier could have been worked around, creating higher levels of engagement (see section 5.2).

Group B had opportunities to take ownership of the direction of the enquiry, be involved with decision making and increase their autonomy. In doing so one would have expected their engagement to increase (Zepke, 2013; Kerski, 2008; Milson and Kerski, 2012). However, they did

not demonstrate any willingness to take control, instead preferring to have aims set for them by Sarah. Interestingly, this increased their engagement, which was not suggested in the engagement literature. Whilst SDT was found to be a strong fit with engagement, it is clear that not all aspects of it are important. On the other hand, it could be that the enquiry did not help students to develop a sense of competence, leading to lower levels of engagement (Zepke and Leach, 2010). Perhaps the setting of clear aims gave them structure that helped them to feel secure amidst the uncertainty that came from using GIS.

Interestingly, such an approach is in line with the GIS literature and GIS-based research methods whereby project aims are normally pre-chosen by the teachers (Demirci et al., 2013). However, here the community partnership still remained collaborative. Such a collaborative approach does come with challenges, as the project can 'shift in ways that no longer meet specific learning goals of the course in which the participating students enrolled' (Kindon and Elwood, 2009: 24). Sarah was also trying to balance the students' needs with those of the local community, and it was difficult to define research aims in advance as the process itself was unpredictable (Elwood, 2009). It is clear from these challenges that, whilst it is essential to create a framework, it has to be flexible enough to respond to changes (Barcus and Muehlenhaus, 2010; Felten and Clayton, 2011).

Contrastingly, Group A demonstrated higher levels of cognitive engagement. The main barrier the students faced was having to give a presentation to the local Parish; however, they relished this. The presentation gave students a sense of purpose and motivated them to invest in the learning required to deliver a presentation that they would be proud of. They also had control over the presentation in terms of its structure, content and delivery, giving them autonomy, which generated engagement (Trowler, 2010). During the preparation for the presentation, the group worked collaboratively, creating a sense of belonging which helped them to build stronger relationships with each other and with Sarah and Andrew (Brookfield and Holst, 2011). By encouraging students to contribute to the development of community issues (Summerby-Murray, 2001), student perceptions, practices and learning were transformed to some extent (Clayton and Ash, 2004; Felten and Clayton, 2011). All these aspects of the enquiry meant that self-determination was higher and therefore engagement

was increased (Ryan and Deci, 2000; Zepke, 2013). Students in Group B did not have the same opportunity as Group A to work with Andrew due to time restrictions, and, based on the findings from Group A, it is clear that this would have led to higher levels of engagement.

5.1.2 Students active participation (behavioural engagement)

Both Group A and B did show behavioural engagement. Both groups were involved in studying local issues and followed the behavioural norms, for example, working in small groups on particular tasks (Trowler, 2010). However, the level of active participation varied between groups, with Group B showing less than A. As discussed in section 4.3, the group dynamics were an important influence on student engagement, arguably more significant than GIS. Research from SL projects at Michigan State University has highlighted that managing group dynamics and structuring the group is 'one of the toughest aspects of the… course [and] establishing small groups of four to six students helps maintain strong interdependence and accountability' (Kotval, 2003: 303). As was found in this case study, all students clearly indicated that they preferred working in groups of two to three, as it gives them 'a more personal, fuller and challenging educational experience' (Kotval, 2003: 298). Working groups like this have been referred to as learning communities, and are positively associated with engagement levels (Zepke and Leach, 2010). Active learning in small learning communities does have risks though; for example, Group B's members may have found GIS too high a risk as they did not have the level of support they felt they needed from Sarah and Andrew, or indeed from each other. Lizzio and Wilson (2006) did find that risk is associated with disengagement, unless students have the appropriate support. Therefore, it is suggested that students in Group B struggled to create a balance in the group dynamics that enabled them to experience a low-risk learning community that could generate higher levels of engagement.

Other aspects of behavioural engagement include asking questions and solving problems with both peers and staff (Trowler, 2010). As the findings highlighted, Group A were more successful, collaborating with both Sarah and Andrew frequently. Thereby the students became co-constructors of knowledge, leading to higher levels of engagement (Kay et al., 2012). In addition, by learning how to work with a range of people the students developed new skills and became more

active citizens (Kindon and Elwood, 2009). On the other hand, Group B worked independently, in isolation from one another and from the peer support they could have benefited from. Occasionally they were 'passive observers [rather than] active participants and contributors' (Mohan, 1995: 130). It is clear from the literature that interaction with peers is the strongest factor affecting engagement, and perhaps if Andrew had been more present with this group, they would have been able to work collaboratively with him, connecting with the local issues and with each other (Mitchel and Elwood, 2012). In turn this would have given them the intrinsic motivation to overcome the challenges of GIS to engage with purpose with SL (Zepke, 2013). Unfortunately Andrew was not able to attend every session, and ways around this are discussed in section 5.2.

5.1.3 Students' emotional engagement

Emotional engagement was arguably one of the most important aspects that led to engagement with SL, from both groups. The findings strongly indicate that relationships between students, teachers, the school and local community are the most important in contributing to student engagement. As has already been suggested, Group A had the right mix of ingredients to make this possible, whereas, whilst Group B had the innovative technology of GIS, they were missing the key ingredient to help them become immersed in their learning: relationships.

When analysing the findings for Group A, the contrast in emotional engagement is highlighted, and explains how students in Group A were interested in the enquiry and enjoyed participating. For this group, the community was at the heart of what they were doing and trying to achieve. A strong sense of place was established and students understood how their actions would have an impact on a wider scale, evidenced so clearly from their presentation to the local Parish and feedback on this. Andrew was at the very heart of the group, representing the voice of the community, and students established a strong relationship with him. He was approachable; prepared an exceptional range of resources; frequently questioned and challenged the students, and sought to get the best out of every student in the sessions. These characteristics have been identified in the research (Kuh et al., 2006; Bryson and Hand, 2007; Mearns et al., 2007) that found that 'teachers who provided deep learning experiences promoted student engagement' (Zepke and Leach, 2010: 171). When a

trusting and secure relationship was established between the students and Andrew, it also helped to develop their sense of belonging (Fredericks et al., 2004; Thomas, 2012). The student leaders worked hard to foster this sense of belonging and to ensure that students felt accepted, to increase engagement (Zepke and leach, 2010) This is in line with much of the literature, which highlighted that positive relationships are at the core of engagement (Kuh et al., 2006; Wimpenny and Savin-Baden, 2013). Importantly, Sarah established a positive relationship with Andrew too, thus strengthening relationships between the school and the local town (Kerski, 2003a). Other GIS research has highlighted how 'GIS increased the teachers' ties to the surrounding community and to their own professional community' (Kerski, 2003a: 134); this case study adds support to that literature. The evidence presented here further supports the argument that such relationships really can make a difference to engagement (Bryson and Hand, 2007).

Conversely, Group B were not able to develop the same positive relationships. Consequently, they were not immersed in the enquiry and took a 'surface approach to learning' (Zepke and Leach, 2010: 171), experiencing lower levels of engagement. Whilst GIS – and the local community- was at the heart of their research, it was not enough; they needed more to motivate them to use the data for real purpose. However, they did demonstrate some emotional engagement at this local scale; GIS helped them to visualise and understand an experience that was familiar to them, leading to some meaningful enquiry (BECTA, 2004; Kerski et al., 2013). Many other GIS classroom based studies also focus on the local (for example Kinniburgh, 2010b), thus suggesting that the educative justification for GIS needs to be reviewed to recognise the significance of the local compared to the range of spatial scales (Bednarz, 2004; Bednarz and van der Schee, 2006). It also supports the emphasis on 'place' in the new content framework, giving new meaning to local places (Rawling, 2016).

5.2 How can GIS be effectively used with Service Learning?

It is important to consider how GIS can be used effectively to create optimal engagement with SL. Here we are looking to combine all three aspects of engagement - cognitive, behavioural and

emotional – within a constructivist framework suitable for GIS-based enquiry projects. A quote by Foregeard et al. (2011) stated in section 2.4.3 highlights what such high levels of engagement could look like, and I interpret the quote within this case study context.

Firstly, the research must focus on the interconnection and integration of academic study and the local community. The community aspect to the research and 'the richness of the educational context in which GIS was integrated' (Audet and Paris, 1997: 297) is absolutely central to its success. A research topic should be chosen that benefits both the school and community. Several local partners should be involved to ensure that all students have the opportunity to build relationships with them: this is key. A learning environment and community needs to be created that will foster these relationships (Zepke and Leach, 2010).

Secondly, the SL group need clear goals. As already discussed, teacher input in setting the aims plays an important role. However, some autonomy must be handed to the students, in turn driving their intrinsic motivation. Related to this is that for 'students to see problems and learning methods as authentic, they must also be seen as relevant to the student's individual and immediate and future goals and ambitions.' (Madsen et al., 2014: 263). Therefore, there is perhaps a need to connect the goals to all aspects of the students' lives - the individual, the subject, the school, the community and life beyond school.

Finally, the GIS-based enquiry required for the project has to strike a balance between challenge and appropriate skill level. If it is too challenging, students may not overcome this and may disengage (as was seen in this case study). Likewise, if there is no challenge they may lose interest. GIS software training has to be integrated within the overall project planning to ensure that technology is not a barrier, and hence time must be set aside for this. Unfortunately, there is not the scope to discuss this in detail here, and the guidelines from Keiper (1999) are recommended. Students also need to receive feedback and support regarding GIS, from peers, teachers and the local partners. By following these guidelines each individual in the group should become immersed in the project, to cement engagement with SL.

6. Evaluation

The research process for this case study was successful in several areas; however, there are areas that I would change for a future study. With regard to the methodology and studying students' engagement with GIS, a longitudinal study would have been beneficial. Through this I would have been able to add a temporal dimension to the case study, for example over the two-year period in Sixth form, giving more context to the students' engagement. Taken together, the tools I used to measure engagement were effective; however, the survey would not have been successful as a stand-alone data collection. Despite using the student engagement chart as recommended by Linn et al. (2005), I still found it subjective and difficult to measure engagement. Collaborating with Sarah was an effective way to reduce this difficulty. Doing so is in line with other research, for example Madsen et al. (2014), who took a holistic assessment when investigating engagement levels in GIS during a University course with eight students. The researchers carried out their analysis independently, before discussing with colleagues, thus ensuring triangulation of the data. I would have liked to have been able to collaborate with other colleagues in the Department but, unfortunately, this was not possible due to timing. It is clear that more reliable tools still need to be developed for easy use in the classroom, and as the research develops so too will a more holistic view of student engagement.

For my research, there were ten participants, plus two student leaders. I recognise that this is small, however it is representative of GIS in the SL context of this case study and therefore was suitable for the purposes of this research. Indeed, the case study approach is suitable for small numbers (Menter et al., 2011), and GIS research has used similar case study sample sizes; for example, Demirci (2011) was of 15 students in two classes in the same school. Despite this, 'it is often heard that case studies, being idiographic, have limited generalisability' (Cohen et al., 2011: 294). As I have already emphasised, the findings presented here are representative of this specific research context and, as such, are applicable to other SL and GIS contexts, offering a guide for teachers. The research

therefore contributes to this research field and, in the future, a longitudinal study and multiple case studies in different schools would contribute more data, thus confirming (or not) the findings (Thompson, 2007).

The participants had a range of prior experience with GIS, and as a result some of the students may have started with higher levels of engagement. For example, some students who already knew how to use the software for analysis may have benefited from this as they started with a higher 'base' GIS experience. The findings did suggest that there were often two or three students in Group B who were more engaged than the rest, and so their previous exposure to GIS could have affected their engagement. Lee and Bednarz (2009) also found this regarding spatial thinking ability.

7. Conclusion

The literature review clearly highlighted that there is a gap in the GIS research field and a need to identify a new educational context for GIS. There is also a need to find ways in which to engage students with community work, and in the particular context of this case study, with SL. I argue that using GIS with SL can fill this gap and engage students. I believe that GIS and SL are a perfect match, being both constructivist in their approach and with real power to connect students to their local communities. Indeed, GIS is 'an ideal tool to create a learning environment in which students learn by doing' (Bednarz, 2004: 193), using local data that will 'give the student powerful motivation of using the familiar for a valuable, real purpose' (Keiper, 1999: 56). The purpose here is clear: to connect academic learning with community work through SL.

The data from the observations, interviews and survey all support the proposal that GIS has the potential to increase engagement with SL, acting as a tool to support active and meaningful enquiry. It also highlighted the challenges and opportunities that GIS presents, and several key factors need to be carefully planned for in order for full engagement to take place - aims, group dynamics and staff. Hence, key ways forward for GIS and SL have to be based around these, and could form future research areas. For example, it would be interesting to examine relationships between local partners and schools that already exist and create 'best practice' for existing SL teachers around the world. Additionally, it would be important to examine other GIS-based projects, identifying effective ways in which to teach *with* GIS for teachers to use. Particularly it would be important to understand how to teach students how to use GIS whilst keeping the '*jazz hands jazzy enough*' so as not to disengage them.

I have proposed a framework for how to run successful GIS-based projects in SL and given solutions based on the findings. In addition, I have used an existing GIS research method and contributed towards increasing the reliability of GIS research. Consequently, I have added to the research field in both GIS and SL, and plan to share this through publication. I hope this 'recipe' for engagement inspires teachers to try GIS. Britz and Webb (2016) said that 'no study proves GIS to be worth the time and effort of implementing it in schools'. Whilst this case study concludes that GIS can only

increase student engagement to some extent, the barriers to fuller engagement can be avoided through careful planning. Therefore, this case study does show that GIS is worth the time and effort, and does have the potential to increase student engagement with SL.

During this process of research, I have reflected deeply on my own practice. I gained a valuable insight into the challenges students face using GIS, and sensed the real frustrations that teachers experience with GIS. Taken together this will help me to teach *with* GIS in the classroom, creating an optimal learning environment that engages all students. The practical implications of this research for teaching and learning can be seen at many scales. Personally, they will help me to plan GIS-based projects more effectively, using the key points identified by the participants to avoid disengaging my classes. My Department have benefited from the findings, which were shared with them through a presentation, and Sarah has adjusted the framework for 2016 – 2017 accordingly to integrate clear aims into the project. My experience of working with Andrew has given me the confidence to start a Geography Department SL group, reaching out to local partners in the community and establishing working relationships with them. This is particularly important as I move to a new school in September and feel ready to take on this personal challenge now. The benefits of such a project would be significant, with impacts on both the students, school and local community: this research has enabled me to reach out to a wider audience.

8. References

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9. Appendices

Appendix 1: excert from Gilston School website: Vision

Our Vision

XXX was established in 1853 as the nation's memorial to XXX. The College builds on the honourable legacy of the 'greatest Englishman that ever lived' by combining the best traditions and values of the past with the energy and ambition of the present. With grounds and buildings of unsurpassed beauty and with access to truly outstanding facilities, all of us at XXX feel a deep sense of privilege to live and work here.

Academic

We are completely committed to providing your children with an inspiring academic experience which is pupil-centred and stimulating. We have adopted a pioneering, global and independent approach to what we teach. All of our pupils study GCSEs and, in the Sixth Form, they can choose between A Levels or the IB Diploma.

The issue is not so much what is taught, but how it is taught and our excellent staff are recruited for their passion, their enthusiasm and their imagination in communicating with children to ensure that every single child in their classes is engaged, excited and challenged by the learning experience at all times. We know that learning is too important to be spoilt by mediocre delivery and our staff are restless in their focus on the needs of individuals. This has led to outstanding results for our pupils, which have propelled us to the top of the co-educational boarding schools in Britain.

Our excellent performance has led to XXX College being appointed by the government as a lead "Teaching School".

Pastoral

Simultaneously, we are deeply committed to opening the hearts and minds of our young people in every way. We believe that boarding teaches young people how to live independently and our warm, friendly and experienced boarding staff support and guide XXX on that journey. Our highly regarded well-being programme and our unique eight aptitudes approach to education ensures that we develop the whole person – we focus specifically on the individual needs, strengths and talents of each and every pupil and we ensure that our outstanding extra-curricular provision, including sports, arts, clubs and societies, CCF, leadership and challenge activities, all add up to an holistic education.

Service

Our outward-looking approach and our belief that we can and must change the world we live in is also reflected in our ambitious and extensive Service programme. It is there in our pioneering partnership with the XXX, our work with XXX and other international partners, in our CCF, in our education festivals and in our extensive conference and lecture programme.

We continue to reflect and develop all that we do, staying connected with an outside world which is changing faster than at any time in the past both nationally and internationally. We are immensely proud of our achievements and of the community we are building here and in our sister schools. We hope to have the opportunity to share that with you and your children.

Appendix 2: excert from Gilston School website: Community Service

Community Service

Service is an importance element of what it means to be a XXX, and one particular aspect of the service programme is Community Service. Wednesday afternoons are the most common time of the week for pupils to undertake Community Service placements, with all year groups involved.
We actively engage with the local community who, in addition to the Wednesday afternoon programme, have been invited to join XXX pupils on Summer Service Days. In the past couple of years these events have included "The Great XXX Tea Service", "The XXX Wellness Games" and "The Big Lunch", where local residents have exchanged ideas, undertaking sporting and artistic activities, become involved in a cake competition and elements of a traditional summer fayre, all supported and facilitated by our pupils. A flavour of our community service programme is given below.

In Sixth form the service learning programme is embedded within academic projects, ensuring that service explicitly relates to the subjects the students study. Service learning projects offer students a chance to engage in a meaningful way with the community while also expanding their depth of study in a particular subject.
Examples of service learning projects include partaking in an oral history project working with the local elderly community, examining the local economy through work done with a local food bank, and teaching a foreign language to a local school. All service learning projects allow students to apply an academic interest to a real-world setting.

Appendix 3: excert from Gilston School website: Geography Department

Geography

"You can travel the seas, poles and deserts and see nothing. To really understand the world you need to get under the skin of the people and places. In other words, learn about geography. I can't imagine a subject more relevant in schools. We'd all be lost without it." Michael Palin (b.1943) Actor, Writer, Comedian, TV Presenter

Geography is fundamental for everyone. It starts very early, when a young child encounters and begins to **discover the world**. Geography can nourish and enrich a whole lifetime of learning.

Geography fascinates and inspires: the beauty of the earth, the terrible power of earth-shaping forces - these things can take us out of ourselves. Geographical investigation both satisfies and nourishes **curiosity**. Geography **deepens understanding**: many contemporary challenges - climate change, food security, energy choices - cannot be understood without a **geographical perspective**.

Geography serves vital educational goals and gives students a holistic view of the world, combining the natural and social sciences: thinking and decision making with Geography helps us to live our lives as knowledgeable **global citizens**, aware of our own local communities in a global setting.

Geographers are skilful: using maps and innovative technology, mediated images of people and place, numerical data and graphical modes of communication and getting to grips with the geographic information systems that underpin our lives, make geographers **skilful and employable**. From environmental management to globalisation to peace and justice, Geographers have the skills and knowledge to deal with variety of issues including business sustainability in the 21st Century.

Geography at XXX is taught using contemporary methods of instruction and delivery. Spatial technologies like GIS and mobile data collection in the field will form a key focus for the future of Geography education into the future. The department has adopted an enquiry approach to the teaching of Geography and this approach equips students with the knowledge and skills of investigation, critical thinking, problem solving and communication. As a result, students are equipped to foster attitudes that will assist them to participate as active and informed citizens in our global society and to appreciate and apply the concept of sustainability. Geography is indeed a subject vital to the education of every young student in the 21st century.

Appendix 4: ethical approval letters

CUREC letter to Headteacher

Dear XX,

I am writing to enquire about conducting research in school this academic year. As you know, I am studying for the Master's in Learning and teaching at Oxford University, supervised by Dr XX. In my final research project, *How, and to what extent do Geographical Information Systems (GIS) contribute to student engagement with Service Learning projects?*, I will explore the extent to which GIS contributes to student engagement in the Geography Department Year 12 Service Learning project.

The research will take place with 12 Year 12 students who are part of the GIS Service Learning project. In this context, GIS is seen as a tool that supports learning. The purpose of this research is to learn ways in which GIS can be applied and the extent to which it leads to increased engagement in Service Learning projects. Should the investigation show that GIS leads to increased student engagement, it will inform the ongoing debate about the benefits of this innovative technology.

By participating in the research, the school would be contributing to a project that will deepen the Department's understanding of GIS learning for students, and so contribute towards developing ways of improving the use of GIS in the school in the future. It will also contribute to Geography education more widely.

I hope to conduct this research between January and April 2016. I would audio- and film-record students and the teacher engaged in whole class discussion, observe and take notes, and photocopy some of the students' work. The video camera will primarily focus on the students, however it will also record the teacher and/or the board throughout and any incidental images of students will not be seen by anyone else or used for research without further explicit permission.

Oxford University has strict ethical procedures on conducting ethical research with teachers and young people, consistent with current British Educational Research Association guidelines. As practitioner research however, the University recognises that schools have the highest ethical standards in any event. Therefore only your consent is necessary, and not that of parents. Throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teacher and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor and myself, and not used other than specified without further consent. All tapes would be destroyed at the end of the research period, and kept in locked conditions until then.

If you feel you would like to take part in the study, or need more information about what is involved, please contact me.

I look forward to hearing from you.

Yours sincerely,
XX

Participant information letter

Dear all,

I am studying for the Master's in Learning and Teaching at Oxford University and the Course Director is Dr Nigel Fancourt. In my final research project, *How, and to what extent do Geographical Information Systems (GIS) contribute to student engagement with Service Learning projects?*, I will explore the extent to which GIS contributes to student engagement in the Geography Department Year 12 Service Learning project. I'd like to invite you to participate in this research.

By participating in the research, you would be contributing to a project that will deepen the Department's understanding of GIS learning, and so contribute towards developing ways of improving the use of GIS in the school in the future. It will also contribute to Geography education more widely. You have been chosen as a potential participant as you are already a member of the GIS Service Learning project, having volunteered to take part in the project in September 2015. Participation will involve completing short questionnaires about your perceptions of GIS and Service Learning in the Lent term. You would complete it at the start, middle and end of the Lent term, therefore a maximum of three times. You will also be invited to be interviewed about your responses to the questionnaires, as part of the group, a smaller group or an individual interview. You may also be asked whether you'd be willing to allow me to use the GIS work you complete during the project as data.

All research will take place at Gilston. All participants, including teachers and the school, will be made anonymous in all research reports; anyone you may mention in your responses will also be anonymized. The data collected will be kept securely, available only to my supervisor and me. Once this project has been completed, the data will be destroyed unless used for further academic research or publication.

You are very welcome to email me, or speak to me in person, before you decide to participate in the research. It is up to you whether you choose to participate and it will not affect your place on the project if you decide not to take part in the research. You are also welcome to withdraw from participation in the study at any point.

This project has been reviewed by, and received ethical clearance through the University of Oxford Central University Research Ethics Committee. The University of Oxford is committed to the dissemination of its research for the benefit of society and the economy and, in support of this commitment, has established an online archive of research materials. This archive includes digital copies of student theses successfully submitted as part of a University of Oxford postgraduate degree programme. Holding the archive online gives easy access for researchers to the full text of freely available theses, thereby increasing the likely impact and use of that research.

If you agree to participate in this project, the research will be written up as a thesis. On successful submission of the thesis, it will deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published with open access, meaning it will be available to every internet user.

Participation in this study will benefit you by helping you to reflect on your GIS skills and engagement with Service Learning and will enable us to improve our school's future GIS provision which you will be invited to participate in.

I do not believe that there are any risks involved in participating in this study.

If you have a concern about any aspect of this project, please e-mail me at XX or speak to me in the Geography Department and I'll do my best to answer your query. If you remain unhappy and wish to make a formal complaint, please contact the Research Ethics Committee at the University of

Oxford (ethics@socsci.ox.ac.uk; +44 (0)1865 614871; Social Sciences & Humanities Inter-Divisional Research Ethics Committee, Oxford University, Hayes House, 75 George Street, Oxford, OX1 2BQ, UK).

Thank you so much for your help.

Participant consent form for MSc Dissertation:

"*How, and to what extent do Geographical Information Systems (GIS) contribute to student engagement with Service Learning projects?*"

- XX is the researcher and is contactable by email at xx
- Please could you make the following declarations that you:
    - have read the participant information sheet;
    - have had the opportunity to ask questions about the study and has received satisfactory answers to questions, and any additional details requested;
    - understand that you may withdraw from the study without penalty at any time by advising the researchers of this decision;
    - understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee;
    - understand who will have access to personal data provided, how the data will be stored; and what will happen to the data at the end of the project;
    - where the research will be written up as a student's thesis , understand how personal data included in that thesis will be published and stored;
    - agree to participate in this study;
    - understand how to raise a concern and make a complaint.

Participant's name (printed)……..
Participant's signature and date……
Researcher's name (printed)……..
Researcher's signature and date……

Please return this form to me.

Thank you so much for your help!

Appendix 5: summary of GIS enquiries

Session number	Group A (non-GIS group)	Group B (GIS)
1	The problem: students discussed the key problem of identifying a location for a new car park and sports centre in town. Planning: broke into smaller groups to discuss the problem and started research.	The problem: students discussed the key problem of mapping crime and types of crime. Planning: chose to identify relationships between different types of crime and allocated data sets to individual students. Considered type of analysis they needed to carry out in GIS (hot spot analysis) and how they wanted to present this (series of maps).
2	Solutions and recommendations: presenting and sharing findings from session 1. Final choice discussed and justified, and located on a map.	Analysis: identifying and describing relationships between crime data for a given month.
3	Planning: various tasks divided up to prepare for the presentation. (Research interviews also took place).	Analysis: identifying relationships between crime data for a given month. Research interviews also took place.
4	Planning: preparing for presentation. Analysis: analysing results from Parish survey to use to support presentation.	Analysis: identifying relationships between crime data for a given month.
5	Planning: finishing presentation.	Planning: preparing presentation for group A.
6	Planning: practising presentation with feedback from Sarah and Andrew. Presentation of findings: the presentation of findings took place out of the school day.	Solutions and recommendations: student leaders led feedback session on how they have addressed their research problem, and set targets for presentation.
7	Creating: post-presentation feedback and discussion of future areas of research for the following academic year.	Planning: preparing for presentation to group A.
8	Presentation of findings: presentation to group B. Evaluating: a review of their work and discussion about what went well and what did not work well, with an overall evaluation.	Presentation of findings: presentations to group A. Evaluating: a review of their work and discussion about what went well and what did not work well, with an overall evaluation.
9	Research interviews.	Research interviews.
10	Debriefing exercise: Year group reflection session.	Debriefing exercise: Year group reflection session.

Table 3: Summary of what took place during each session for group A and B.

Appendix 6: engagement survey

Student engagement survey

Please answer the questions by giving a number that represents the extent to which you agree with each statement:

I am……	**Strongly agree**	**Agree**	**Undecided**	**Disagree**	**Strongly disagree**
Making comment or asking questions about the project whenever I see my teacher	5	4	3	2	1
Asking relevant questions during the session	5	4	3	2	1
Working on my own	5	4	3	2	1
Helping others	5	4	3	2	1
Asking relevant questions of each other	5	4	3	2	1
Integrating new material with previous knowledge	5	4	3	2	1
Monitoring my own work	5	4	3	2	1
Solving task-related problems	5	4	3	2	1
Discussing task-related problems issues with the teacher	5	4	3	2	1
Discussing task-related problems issues with the others	5	4	3	2	1
Coming to the sessions	5	4	3	2	1
Coming to the session ready to work	5	4	3	2	1
Staying on task during the session on my own	5	4	3	2	1
Tasking risks	5	4	3	2	1
Initiating action when the opportunity is available	5	4	3	2	1
Suggesting new ideas and methods to answer questions/issues	5	4	3	2	1
Coming to the sessions late	5	4	3	2	1
Staying after the session to work on the project	5	4	3	2	1
Following instructions	5	4	3	2	1
Passive	5	4	3	2	1
Giving up easily	5	4	3	2	1
Not trying hard	5	4	3	2	1
Bored	5	4	3	2	1
Interested	5	4	3	2	1

Appendix 7: interview schedule

Interview Number	Focus	Date
1	Student Group A	27/1/2016
2	Student Group B	27/1/2016
3	Student Group A first half	16/3/2016
4	Student Group B first half	16/3/2016
5	Student Group A second half	23/3/2016
6	Student Group B second half	23/3/2016
7	Sarah	27/4/2016
8	Student leaders	4/5/2016
9	Andrew*	8/6/2016

Table 4: Interview schedule. *Due to technical difficulties the interview with Andrew was not able to be listened to or transcribed for analysis.

Appendix 8: Key points covered in interviews

Interview number	Focus	Key question	Sub-questions
1, 2 + 7	Rationale	What were your reasons for choosing the Geography Department Service Learning group?	What interested you? What were your expectations?
	GIS	What do you understand about GIS? What are the aims of the group?	What have you used GIS to do before? What do you think it can be used for?
	Engagement	How would you describe your levels of engagement?	What were your engagement levels like last term? Have you noticed any change?
3 - 9	Engagement	What do you understand by the term 'engagement'? Did the survey agree with this?	What does it mean? What does it look like in the classroom? What are the key characteristics? What statements in the survey did/didn't agree with your understanding of engagement?
	Challenges and opportunities	What challenges did you face? What opportunities?	How did you overcome these challenges? How can you pursue these other opportunities?
	GIS	Did GIS affect your engagement? Did it increase your engagement with Service Learning? What else affected your engagement?	How? Why? What else is needed? How important were the group dynamics and setting of aims? How can GIS contribute to Service Learning?
	Reflection	What future GIS-based projects can you investigate? Has the Service Learning met your expectations?	Has the GIS helped you to meet these expectations? What would you change?
7 - 9	Leadership/ roles	What was your role in the group? What does the role mean to you? How do you see your role?	What were your levels of engagement like as leaders/teachers? What challenges and opportunities did you face? What impact do you think you had?

Table 5: Questions used for semi-structured interviews.

Appendix 9: example transcript analysis

The data is from a segment of the transcript from interview number 5. This example shows how I begun the process of analysis by looking for themes in the responses that I broke down into sections for analysis. I highlighted sections of the response that gave me insight into their GIS and Service Learning experience, and used this to link to the research questions. I repeated this analysis throughout the research project for the transcripts.

Interviewer: So what is your understanding of engagement?

Student response	**Interpretation**
Well for me personally I think **engagement counts for being interested**, so if I'm obviously not interested very much I tend to not be as engaged I guess but I suppose that's just general engagement for everyone I suppose.	Engagement definitions: interest most important.
Yes…yes it's kind of… it's really the mixture between **being interested and kind of how passionate you are** about that… and then also the **work you put in** and you can kind of see, especially if someone's not interested in something you can see that if they've put that kind of hard work in that does show kind of a real engagement especially if they're not so passionate but they're still willing to put the work into kind of …	Engagement definitions: effort also important.
Yes… so yes between **effort and interest** kind of makeup engagement I think.	Interest and effort as most important factors in engagement.

Interviewer: And how do you feel that your own engagement has changed during, think right back to the beginning, the first session I was there, to now, how has your engagement changing during the project?

Student response	**Interpretation**
I think we were all pretty **passive to start** with because we **didn't really know what's going on** but especially when we took this project …	Engagement level changes during the project. Highlights importance of other factors: aims.
Yes and when we **split into the two groups** as well.	Highlights importance of other factors: group dynamics.
Yes and when we **split into the two groups** and …and we really **know what we were doing** and everyone was kind of given **more responsibility** and more of like an **actual role** in the thing the kind of level of **engagement actually increased**. And I think the level of interest as well everyone kind of became **more passionate** about what they were doing, because when you're kind of assigned a role …in the team …… and a task [unclear-0:04:34.4] you don't want to let the side down, **you have a responsibility** and you kind of perform.	Highlights importance of other factors: group dynamics, aims. Also responsibility. Links between to initial understanding of concept of engagement.

Interviewer: Is that through your [unclear] group or would you say that's true for the whole group?

Student response	**Interpretation**

I suppose if they assigned the same sort of roles that we did I guess [unclear-0:04:49.2] as well, but obviously we've only been in one half so we only see it …	
Yes from our half.	
Yes I mean I actually started in the other one and then moved over and I'd actually have said that the **engagement was better** in the one I moved to, especially because when you're **presenting** to the outside group, obviously the **parish council** you do **make an impression**, you're kind of [unclear-0:05:10.6] and all that so you want to make an impression so you kind of, it's also like **your reputation almost and your image to consider**.	Highlights importance of other factors: external staff and formality/deadline of presentation. Particular importance of external member of the community and significance of presentation in terms of engagement levels. Stated difference in engagement levels between the groups.

Table 6: Example transcript analysis. Note that this is from a direct transcription from the interview audio recording. I have included all pauses with '…' and any conversation that was not audible with [unclear].

Appendix 10: student work

Group B presentation to Group A, student leaders, Sarah and Andrew

The ArcGIS Squad

By X, X, X, X, X

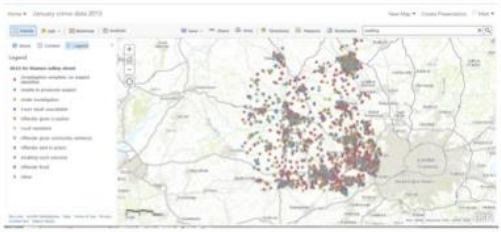
Led by X and X



What have we done?

- Used the ArcGIS software
- Made hypotheses about the crime patterns
- Analyse crime data from 2015
- Observed the data patterns and sought to understand why the patterns were there
- Drew conclusions and made judgements as to why the patterns occurred and what that could mean for the future

What does the ArcGIS software look like?



Example – July



* July

There are lots of vehicles crimes in July, maybe due to the fact people are away on holiday so leave vehicles unattended which leaves lots of opportunity for criminals to take peoples cars. Crimes tended to occur on the eastern side of Crowthorne, more toward Edgebarrow, and closer to 'rougher' towns like Bracknell. Also, there are crime centred near the centre of Crowthorne around the high street, in an area surrounded by Dukes ride and lower Broadmoor road. The crimes in Crowthorne seem to be mostly asbos, due to the high youth population.

Reflection



- Good
  - ➢ Splitting up to analyse individual months
  - ➢ We were able to learn new skills
  - ➢ Fun
- Bad
  - ➢ The software can be challenging at times

Group A presentation to local Parish council, including their Headteacher

Development in XX

Geography Department Service, GIS Mapping, Neighbourhood Planning

Introduction

- As a service group, we have carried out research to provide a sufficient set of data to analyse what needs improvement within XX, through surveys.
- We carried out 3 individual surveys within XX (2x High street, Primary School), which allowed us to obtain suitable data enabling us to identify areas of dissatisfaction amongst XX

The Surveying

Questions included:

- Whether or not they lived in XX, as well as the length and method of their commute.
- How safe they feel (on a scale of 1-5) and how happy they are with certain aspects of the town (e.g. Shops, Parking, Transport etc.) in addition to 3 things they would like to change.
- Whether or not they are aware of the development going on in XX and how happy they are with it.
- Finally, the survey concluded with some optional, personal questions asking about where they lived, as well as age, gender, housing type etc. This was to allow further depth in the data, adding another dimension to it.

Their Response

- We identified an array of responses to the survey. Most interestingly, answers included:
- **Leisure** – 38.8% of people aged 26-40 thought the sport facilities are adequate, leaving an unacceptable figure of 61.2% of people who think the facilities are inadequate
- **Parking** – Of the 232 people who took the survey, only 37.1% thought the parking availability was adequate
- **Transport** – 17.5% use public transport regularly. Of these, 26.3% think it's adequate, whilst 73.7% think its inadequate.

Our Response

- After the analysis of the survey data, we came to the conclusion that a number of areas needed improvement:
- Leisure – Sports Centre
- Transport
- Parking

Sports Centre

The production of the sports centre would come with multiple benefits for the XX citizens:

- Socially
- In terms of their health,
- In respect of the XX as an area itself. The Appearance of the area – increases the attractiveness of the area among many other advantages shown on the following slide.

- **It will include:**
- A pool, gym, sports hall, squash + racket courts, multiple toilets, reception, café.

Advantages + Disadvantages

Advantages

- Locals get to exercise
- Brings money to area
- Social aspects
- Reflects well on the area
- Attracts people to XX
- Creates jobs

Disadvantages:

- Costs a lot to construct initially
- Takes up space which could be used for something else
- Noise pollution when building it, affects locals
- Money could be spent on something else

Where it will go



Transport

- To improve XX we will implicate the following initiatives:
- Every 45 minutes there will be a direct bus service from the Lidl carpark to X and X from 18:00 to 23:00 to allow people to go to use the leisure services that these places provide which XX does not.
- Happens every day of the week apart from Sunday but expected peaks on Friday and Saturday.

Cost of Transport Rejuvenation

Cost

- £7,000 - £10,000 to get a second-hand minibus. £14,000 for 2.
- Driver £7.85 per hour (living wage).
- £2.50 for round trip(there and back).

Advantages + Disadvantages

Advantages:

- Frequent service
- Book online
- Flexible
- Runs late at night
- Young people areable to leave XX.

Disadvantages:

- Long pay back time / long term investment
- Possibility for irregular flow of customers.

Parking

- After analysing what else XX could improve on, we decided that increasing parking space is a must.
- To increase parking, the only possible solution is to build more parking lots on more land or building levels of parking on current car parks, such as in LIDL.

Where it will go



Advantages + Disadvantages

Advantages:

- More space for people to park
- Near the centre
- Have to pay, therefore you could end up making profit
- Less blockages in the roads à less traffic in XX
- Has the potential to bring more people to XX for longer as they can stay for longer periods of time

Disadvantages:

- Have to cut down trees
- Will make the area more crowded
- Will cost a lot to build

Improvements

- Increasing the number of people we survey
- Assess the views of the citizens at different points of the year
- Change the area of surveying
- Approach the newcomers – The families who have just moved in

Conclusion

- Throughout the project not only did we thoroughly enjoy ourselves, but we also gained an insight into our local community: something we might not normally have experienced.
- We interacted with members of the XX community with whom we might not usually connect.

Appendix 11: data set results from student survey

Group A

Statement Number	Mean Pre-	Mean Mid-	Mean Post-	Change	Substantial Increase	Substantial Decrease
1	2.8	2.3	3.4	0.6	X	
2	3.2	3.5	3.8	0.6	X	
3	3.3	3.3	3.4	0.1		
4	3.3	3.5	3.4	0.1		
5	3	2.8	3.6	0.6	X	
6	3.2	2.8	3.4	0.2		
7	2.3	2.8	3.2	0.9	X	
8	3.3	3.5	3.4	0.1		
9	3.6	3.3	3.4	-0.2		
10	3	3	3	0		
11	5	4.5	4.2	-0.8		X
12	3.7	3.8	3.8	0.1		
13	3.3	3.5	3.6	0.3		
14	2.7	2.5	2.8	0.1		
15	3.2	3	3.4	0.2		
16	2.8	2.5	3.4	0.6	X	
17	2.2	1.5	2	-0.2		
18	2	1.5	2.6	0.6	X	
19	4.2	4	4	-0.2		
20	2.8	2.8	2.6	-0.2		
21	2.2	2.5	2	-0.2		
22	1.8	3	2	0.2		
23	2.5	3.8	3.2	0.7	X	
24	2.6	2.5	3.4	0.8	X	

Table 7: Data set results from student survey for Group A

Group B

Statement Number	Mean Pre-	Mean Mid-	Mean Post-	Change	Substantial Increase	Substantial Decrease
1	2.3	3.2	3.5	1.2	X	
2	3.2	3.6	3.8	0.6	X	
3	2.7	3.8	3.3	0.6	X	
4	3.5	3.7	2.7	-0.8		X
5	3.2	3	3.3	0.1		
6	3.8	3.7	3.5	-0.3		
7	3.3	3.8	2.8	-0.5		X
8	3.5	3.5	3.8	0.3		
9	3	3	4.3	1.3	X	
10	3.5	3	3.8	0.3		
11	5	4.8	4.8	-0.2		
12	4.7	4.2	3.5	-1.2		X
13	3.3	3.7	3.3	0		
14	2.5	3	2.3	-0.2		
15	3.2	3.3	3.3	0.1		
16	3.2	2.8	3.3	0.1		
17	1.8	2.1	2.8	1		
18	1.7	1.5	2.3	0.6	X	
19	4.2	3.8	3.5	-0.7		X
20	3.3	3	2.8	-0.5		X
21	3.2	2.3	1.8	-1.4		X
22	3.3	2.3	2	-1.3		X
23	3.5	3.2	2.8	-0.7		X
24	2.5	3.2	3.5	1	X	

Table 8: Data set results from student survey for Group B