



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Does inclusion of sustainability topics, such as electrical waste, in the GCSE

**Computer Science specification affect young adults and their parent's
attitude and actions towards sustainability?**

Megan Wynne
2006150

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Abstract

This paper examines if inclusion of sustainability topics, such as electrical waste, in the GCSE Computer Science specification affect young adults and their parent's attitude and actions towards sustainability. Adding to growing research on action competence for sustainability research this paper seeks to understand this issue in the context of Computing education. This dissertation uses both qualitative and quantitative data with 10 participating GCSE Computer Science students (and their chosen adult), in a UK Secondary School. Our analysis shows that while knowledge increased of sustainability topics surrounding Computing, action competence for sustainability in both students and adults did not change. We conclude that further research needs to be done to reduce the gap between knowledge of individuals, and willingness to act upon this knowledge, specifically within this Computing context.

1.0 Introduction

‘There is something chilling in the idea of the majority of young people today believing that the future (their future) is going to be a worse time to live in than the present’.

(Huckle and Sterling, 2016)

This dissertation sets to focus on sustainability education within GCSE Computer Science education in the UK school system. Mann et al. (2007) linked computing and sustainability within academia by quoting then, United Nations Secretary General Ban Kin-moon who argued that “information and communications technologies (ICT) are crucial in spurring development, dignity, and peace.” He urged us to “turn the digital divide into digital opportunity” and said that ICT should be promoted “in fighting poverty, illiteracy, and disease; in protecting the environment; and in empowering women and girls” (United Nations, 2007). Huckle and Sterling (2016) argue that ‘it has become blindingly obvious that we are educating young people for a world that has already ceased to exist’. Mann et al. (2007) argued that ‘as computing educators charged with creating those computing professionals, we are doubly responsible, as we have put in place the system to get us there’.

The focus of this research is on GCSE Computer Science, specifically the Edexcel Computer Science GCSE. ‘To attempt EFS in the secondary curriculum can be a difficult or suicidal task’ argues Webster (2016). The course specification, however, includes within section 5.1.1 of the course that students should be able to ‘understand environmental issues associated with the use

of digital devices (energy consumption, manufacture, replacement cycle, disposal)' (Pearson Edexcel, 2020). This dissertation will therefore attempt to establish if inclusion of sustainability topics, such as electrical waste, in the GCSE Computer Science specification affect young adults and their parent's attitude and actions towards sustainability.

At first, this dissertation will attempt to shed some light within its literature review of various discussions surrounding this topic including; what is sustainability, what is sustainability education, how is sustainability linked with the Sustainable Development Goals, sustainability and Computing, and finally literature around action competence for sustainability. The second chapter will focus on the research methodology, expanding upon the reasoning behind the chosen approach. Following this, chapter three is focused on data analysis and discussion. Chapter four details limitations to this study, and the dissertation will culminate with key conclusions and recommended areas of further research from this dissertation.

2.0 Literature review

Huckle and Sterling (2016) argue that there has been ‘little attempt to reflect on the underlying and emerging theory and practice’. This literature review therefore will begin to reflect on the research within the Education for Sustainable Development field.

2.1 What is sustainability?

The Brundtland Report authored by the World Commission on Environment and Development (1987) described sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. Similarly, National Geographic (2023) define sustainability as ‘the practice of using natural resources responsibly today, so they are available for future generations tomorrow’.

2.2 What is sustainability education?

‘Put succinctly, sustainability demands learning’ (Holden et al., 2008). Sustainability education (also referred to as ESD – Education for Sustainable Development), allows ‘learners of all ages the knowledge, skills, values and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources and inequality’ (UNESCO, 2023). Sherren (2008) proposes that ‘education has a role to play in contributing to solutions for social problems and in teaching critical skills so that citizens are able to make well-informed choices when participating in society’.

‘Both sustainability and education for sustainability have a range of meanings in theory and practice’ (Huckle and Sterling, 2016). Short (2010) highlights that moving forward ‘a citizenry capable of understanding the complexity of environmental issues and actively participating in their resolutions is vital. The ultimate goal of environmental educators should be to facilitate the creation of this active citizenry’. Ardoin et al, (2017) found that within peer reviewed literature focusing on students within the American school system between kindergarten to twelfth grade (5 to 18 years), it was found that most articles reported positive outcomes of environmental education.

Lambrechts et al. (2017) built upon the work of philosopher John Dewey, and applied Dewey’s theoretical framework to ESD, specifically within the context of the Flemish community in Belgium. Dewey asserted that ‘education has the aim to prepare citizens to lead flourishing lives, framed within and connected to progressive societal improvement’ (Lambrechts et al., 2017). The framework was based on Dewey’s perspective on the ‘aim of democracy and the critical role of education’, specifically focused on two constructs of ‘initiative and adaptability’ and ‘values and virtues’. Lambrechts et al. (2017) highlight that in this context, with this philosophical perspective, the importance of both these constructs within ESD is strong and ‘enable citizens to actively, creatively, and critically contribute to social improvement in society’.

2.3 Sustainability education and sustainable development goals.

The United Nations ‘Decade of Education for Sustainable Development’ took place between 2005 and 2014. It was ‘an international resolution adopted by United Nations to promote sustainable development in education worldwide’ (Liimatainen, 2013). A large focus was

placed on Higher Education having an important role during the decade (Sterling, 2010). Alongside Higher Education, all educational institutions were to be ‘interdisciplinary and holistic, and so embedded across the whole curriculum; explicitly values driven’ (Sterling, 2010). This period, therefore, contributes a large amount of research and papers during this period.

After this ‘Decade of Education for Sustainable Development’, the ‘2030 Agenda for Sustainable Development’ was adopted by all United Nations Member States in 2015, which the UN describes as providing ‘a shared blueprint for peace and prosperity for people and the planet, now and into the future’ (United Nations, 2023b). ‘The increasing attention to Education for Sustainable Development (ESD) has led to a stream of publications in which education is attributed the goal of contributing to the solution of sustainability issues’ (Lambrechts, 2020). Fagan (2016) for example argues that education for sustainability ‘involves a commitment to a framework of specific, global, ethical goals which speak for justice, equality and democracy’.

Sustainable development goal four is to ‘ensure inclusive and equitable quality education and promote lifelong learning opportunities for all’ (United Nations, 2023a). Target 4.7 is to ‘by 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development’ (United Nations, 2023a). An indicator of success for this target includes the extent to which sustainable development are ‘mainstreamed’ in curriculum, teacher education and student assessment (United Nations, 2023a).

Lambrechts (2020) highlights that ‘education is increasingly expected to prepare students for the complexity and uncertainty of sustainability issues in society’. Lambrechts (2020) attribute this to initiatives such as the ‘United Nations Decade of Education for Sustainable Development’ and the SDGs. Lambrechts et al., (2013) however, highlights that ‘the original concept of competence, holistic in nature, was integrated into the old, educational context in a muddled and fragmented form’ which has led to ‘certain competences as well as values, essential in the context of sustainability’ to be ‘insufficiently addressed’.

2.4 Sustainability and Computing education

There is limited literature focusing specifically on sustainability and Computing. Fisher et al. (2016) argues ‘Until sustainability is in the bedrock of computing education, few students, professionals, or researchers are conscious of the possibilities of the computing/sustainability nexus to transform society’. Simon (2015) highlighted the growing focus on Computing education. The link between the two disciplines however, remains limited within literature.

A recent paper from Peters et al. (2023) describes the approaches taken in Computing to address the issue of sustainability. Peters et al. (2023) highlight that sustainability and Computing is not a new concept, with early research into areas such as energy usage, which was referred to as ‘Green IT’ (Murugesan, 2008).

Peters et al. (2023) found during their analysis of Computing research three perspectives on the role of IT in sustainability:

- ‘An incremental perspective where the focus is on adjusting computing to reduce its footprint’
- ‘An enabling perspective where IT is the means to address society-wide sustainability issues’
- ‘A disruptive perspective’ where ‘IT norms, practices and processes must change to align with and support the core principles of sustainability’

At higher education level, Fisher et al. (2016) argues that integration of sustainability into Computing education happens at two levels: course level, and component-level. Course level, Fisher et al. (2016) argue occurs by introducing Computing courses that combine Computing and sustainability, for example ‘a course on Agent-Based Modelling offered by the Department of Earth and Environmental Sciences’. Alternatively, component level inclusion of sustainability may occur with introduction of lectures and projects with sustainability themes, for example sustainability projects within an artificial intelligence course (Fisher et al., 2016). This research comprises of component level inclusion of sustainability within the GCSE qualification. ‘The GCSE was introduced in 1988 and is available in a wide range of subjects’ (Crisp, 2008). This research will focus on the Computer Science GCSE, specifically from the Edexcel exam board. As previously mentioned, sustainability topics are covered in one small section 5.1.1 of the Computer Science course. Many teachers ‘suggest that the national curriculum leaves little scope for education for sustainability’ but there is ‘considerable scope within statutory frameworks and that teachers can develop their own forms of mutual support’ (Huckle and Sterling, 2016). It must be noted that multi-academy trusts do not have to follow the national curriculum, however they must follow qualification specifications if students are sitting the exams, as in this research project focus’ situation.

Similarly, to Fisher et al. (2016), Peters et al. (2023) highlight sustainability education within Computing can be presented in two categories;

‘(1) Context: computing vs sustainability as the main context of learning

(2) Purpose: training vs emancipation’.

This first category mirrors Fisher et al (2016). Peters et al. (2023) argue that Computing and Sustainability education could be ‘transformative’ if sustainability was placed as the focus within the education. The second category ‘is about what education aims to achieve’ (Peters et al. 2023). Figure 1 furthermore depicts Peters et al. (2023)’s categorisation of sustainability in Computing Education into components such as Computing-specific topics, Sustainability-specific topics and the educational organisation.

Figure 1

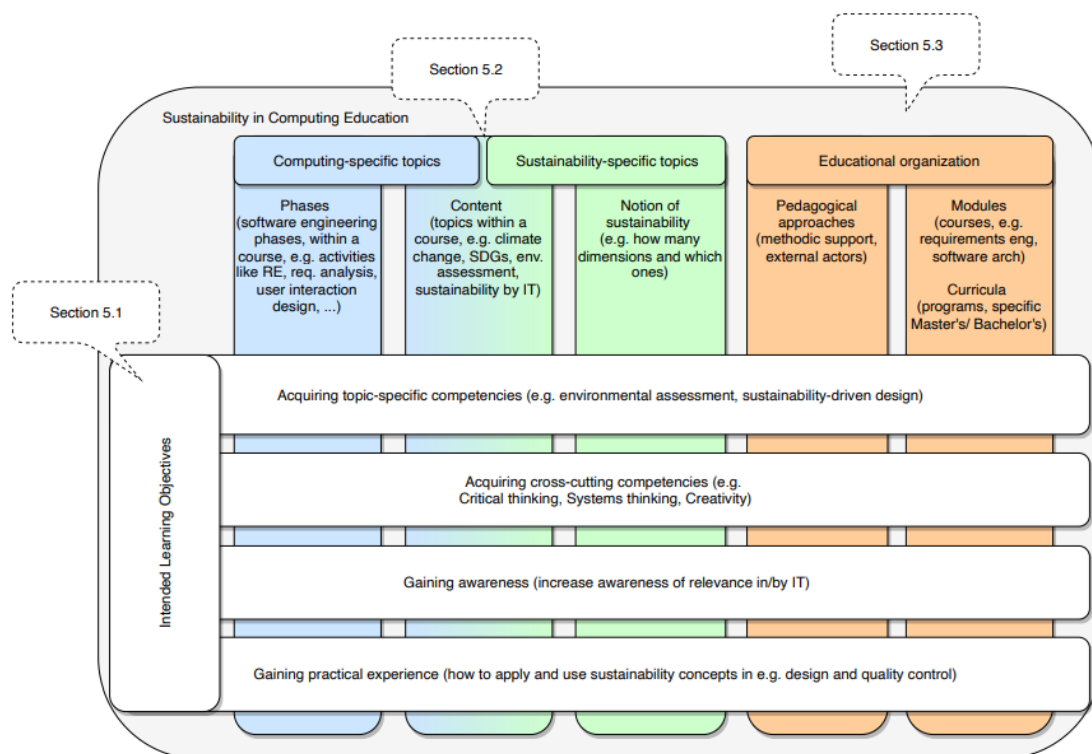


Fig. 3. An overview of the different educational components in education for sustainability in computing

(Peters et al., 2023)

2.5 Teaching sustainability across the curriculum

Godemann (2008) argues that ‘educational structures and practices are widely characterized by disciplinary compartmentalization’. Sustainability, it could be argued should be taught across the curriculum. In agreement with this argument, Sterling (2004) argues that there is a ‘necessary transformation of higher education towards the more integrative and more whole state implied by a systemic view of sustainability in education and society’. Meadows (1982) argued similarly that ‘the world is a complex, interconnected, finite, ecological-social-psychological-economic system. We treat it as if it were not, as if it were a divisible, separable, simple and infinite’. Meadows (1982) argues that ‘our persistent, intractable, global problems arise directly from this mismatch’. In a successful study by Selby (2009) educators were ‘encouraged to make interdisciplinary links wherever possible given the multidimensional nature of sustainability’.

An example of sustainability across the curriculum is within financial accounting education. Creel and Paz (2018) argue that ‘it is important that we add aspects of sustainability into accounting classrooms to help prepare students for what they will see in the workplace’. Within the accountancy classroom, Creel and Paz (2018) aim to ‘help students learn not only accounting but how to be better citizens with a global perspective on sustainability’. Creel and Paz (2018) highlight that there are many areas which can be discussed for example ‘discussing performance measures such as the Triple Bottom Line or the Green Balanced Score card...’. Creel and Paz (2018) argue that more research needs to be done on the ‘benefits of including sustainability as part of university and business programs’.

Symons (1996) suggests that ‘primary school teachers should meet the challenge of education for sustainability by combining their long tradition of nature study, which develops an affinity

with the rest of nature and an understanding of ecology, with a radical social education tradition which addresses such concepts as equity and social change’.

Sterling (2010) argues that there is much further work to be done to improve education of sustainability, highlighting that ‘around the world, we see the earnest and critical work of students, scholars and administrators embedding sustainability across the higher education curriculum’. Sterling (2010) argues that these examples, such as above, ‘gives us hope that systemic sustainability education is possible’.

Within a study highlighted by Jones et al (2010), materials focusing on sustainability were created ‘allowing for time-economic injections of sustainability related materials into class sessions’ this allowed them to ‘pre-empt the objection of there being little space in a crowded academic curriculum to incorporate sustainability content’.

Sterling (2010) argues that while other systems, such as human and natural systems, can be studied individually, sustainability must be studied as a whole. To study it, in isolation, Sterling (2010) argues, would impede ‘what might be termed a more holistic understanding and perspective’. Schmidt (2008) highlights ‘disciplinary reduction is undercomplex and hence cannot cope with real-world problems because such problems are too new, complex, wicked, hybrid, or too risky (for instance environmental/global change problems).’ Meaning sustainability is too complex of an issue for it to be taught in isolation. Further authors have promoted these more holistic approaches in education (Colonna, 2020; Hall and Tandon, 2020; Mantatov et al., 2020; Hopkins et al., 2020; Singer, 2020).

2.6 Secondary schools as modern institutions in a postmodern world

‘The recurring theme is that education for sustainability is essentially process-driven, is participative and empowering, is liberatory and continuous, and that it is necessitated by the possibilities and dangers presented by an emerging ‘postmodern’ world.’ (Huckle and Sterling, 2016). Webster (2016) however describes secondary schools as ‘modern institutions in a postmodern world’. Webster (2016) highlights how the curriculum and sustainability education will be limited in the current educational system. Webster (2016) argues that the curriculum ‘hits a brick wall because the implementation of a radical, essentially postmodern curriculum innovation in a modern institution will only succeed in so far as the institution is not threatened by it; which of course it is, eventually’.

Lambrechts (2020) argues that education has largely impacted by neoliberalism and ‘economisation’ of education. Lambrechts (2020) asserts that the focus of education has been with an economic focus to provide students with the correct skills for work, and a separation between knowledge and skills has occurred. Lambrecht (2020) claims that this has created ‘the impression that education is isolated from the social and societal issues, while of course the two cannot be seen separately from each other’. In agreeance with this, UNESCO (2013) highlights that ‘ESD is a lifelong learning process and an integral part of quality education. It enhances the cognitive, socio-emotional and behavioural dimensions of learning and encompasses learning content and outcomes, pedagogy and the learning environment itself’.

Sterling (2010) argues that sustainability requires a ‘fundamental change of epistemology, and therefore education’. Sterling (2010) asserts that ‘changes are necessary in curricula, pedagogy, policy and institutional structures. Huckle and Sterling (2016) argue that ‘education must itself be transformed if it is to be transforming’.

2.7 Weak vs Strong sustainability

Sustainability according to (Huckle and Sterling, 2016) has a ‘core contradiction’ between the ‘weak’ sustainability advocated by liberal and social democratic reformers and the ‘strong’ sustainability advocated by green socialist and utopian radicals. Huckle and Sterling (2016) argue that ‘environmental politics is dominated by the former and there are strong pressures on education to encourage support for such sustainability while ignoring its stronger variants’. From the context of the school within the research, students cover sustainability in Geography and Science lessons only.

‘Education for weak sustainability is more acceptable than education for strong sustainability and teachers who seek the latter are advised that there is important work for them to do in their everyday interactions with students’ (Huckle and Sterling, 2016).

Even within literature, these opposing opinions on sustainability can be seen. Huckle and Sterling (2016) highlight to the reader that ‘they are likely to recognise a difference between the political ecology or green socialist position supported by one of the book’s editors, and the ‘darker’ green or systemic view supported by the other’.

2.8 Action competence for sustainability

Short (2010) highlights that ‘to date, nearly all evaluations of environmental education (EE) have focused on educational outcomes. Evaluations of impacts to environmental quality linked to actions resulting from EE efforts will be necessary if this discipline is to remain relevant in a world facing a century of great challenge in protecting environmental integrity while meeting the needs of our growing and increasingly consumptive population’.

A shift towards research into education resulting in action has begun. Within literature, these actions are referred to with various terms such as ‘key competences for sustainable development’ (Barth et al., 2007), ‘uncertainty competences’ (McCune et al., 2021), ‘individual sustainability competences’ (Ploum et al., 2017) or ‘action competence for sustainability’ (Sass et al., 2020) as it will be referred to in this dissertation.

Over the past decade there has been an increased focus on research into action competence for sustainability. It is argued that Education for Sustainable Development (ESD) has ‘shifted from the informational deficit model of education, towards sustainability competences’ (Redman et al., 2018). UNESCO (2023), highlight that sustainability education should ‘empower learners of all ages to make informed decisions and take individual and collective action to change society and care for the planet’. In agreeance with this, Lambrechts (2020) argues that individuals should not only have the knowledge but also the ability to act upon their knowledge. Olsson et al (2022) argues that ‘this kind of education, educational for sustainable development, is described as a teaching approach where action competence for sustainability as at the very core of education’. Fagan (2016) goes further and argues that Sustainability education ‘must be linked to the reality of its clients, it must marry action to intellect; it cannot and must not allow any one section of education to invade and persuade local people that to think ‘about’ is a fair exchange for thinking about and taking action’.

A study by Olsson et al., (2022) concluded that ‘ESD has effect on students’ action competence for sustainability’. The students involved in the study, however, ‘did not significantly develop the action competence component confidence under their own influence’ (Olsson et al., 2022), which highlights the importance of specific, explicit teaching of sustainability action within ESD.

Chen and Liu (2020) conducted for example a review of educational research on ‘developing students’ action competence for a sustainable future’. They found that within 170 peer-reviewed articles published between 1997 and 2017, ‘a total of 94% studies reported positive outcomes, which meant the majority of the studies exhibited that the participants developed their action competence in these educational proposals’ (Chen, Liu, 2020). Chen and Liu (2020) highlight that most articles were published after 2010, which supports the argument of increased focus on action competence for sustainability. Children and adolescences were the focus of most studies, but research expanded to the ‘roles of in-service teachers and community stakeholders’.

Riemer et al., (2016) found that within their study ‘students indicated cognitive and affective connection with the environmental issues’. Their environmental actions, however, returned to the state of before the knowledge in the long term. Riemer et al (2016) argue that ‘personal transformations are not sufficient in creating long-term change’ and highlight that to create extended action, continuous support would be necessary. Olsson et al, (2022) however highlight that ‘the goal of ESD is not a ‘mere’ behavioural change among students, but rather a teaching and learning process where students’ sustainability knowledge, skills, and competences are strengthened’.

Lambrechts and Van Petegem (2016) argue that ‘advanced competences are required to cope with the complexity and uncertainty of super wicked problems’ such as climate change. A study by (Olsson et al., 2022) aims to ‘contribute more knowledge to the ESD research field by investigating the effectiveness of ESD on students’ action competence for sustainability’. The longitudinal study focuses on student’s competency for sustainability over a two-year period (Olsson et al., 2022). The students are based in an upper secondary school in Sweden

where the study had 775 participants, and a control group of 228 participants attended a technology or science programme (Olsson et al., 2022). Olsson et al (2022) conclude that ‘the willingness to act is possible to develop in young people through their teachers’ teaching approaches’. A limitation of this study, however, is that not all participants engaged with all three data collection waves, and therefore some data had to be modelled using statistical software (Olsson et al., 2022).

Olsson et al (2022)’s conclusion was that ‘a holistic approach to content as well as pluralistic approach to teaching have positive effects on students’ action competence’. This study appears to further strength the results of research by Boeve-de Pauw and Van Petegem,. (2011) who completed research on the ‘effect of Flemish eco-schools on student environmental knowledge, attitudes, and affect’.

Mogensen and Schnack (2010) built upon the German concept of ‘bildung’, introduced by the philosopher Hegel, theories around self-cultivation, where education and philosophy are linked (Friedrich et al., 2006). Mogensen and Schnack (2010) argue that ‘the very essence of action competence can be derived from the notion of ‘action’. Criteria when using the competence approach, to ensure quality, should include, according to Mogensen and Schnack (2010); ‘focus on enhancement of teaching and learning; reflect the democratic values that ESD seeks to promote; be co-elaborated by the relevant stakeholders; and foment institutional as well as individual learning’.

Wals (2011) argues however that it would be more effective to focus on developing student’s capacity building and critical thinking rather than focusing on changing their behaviours. This would allow ‘citizens to understand what is going on in society, to ask critical questions and determine for themselves what needs to be done’ (Mayer and Tschapka, 2008). Mayer and Tschapka (2008) argue that influencing people’s ‘environmental behaviour in a predetermined

way' is close to indoctrination. Hadjichambis et al. (2020) highlights 'while forcing children to accept socially desirable values would be considered as an unethical teaching practice, education for Environmental Citizenship should be able to, directly and indirectly, promote those values to pupils, providing an opportunity for their reflection and consideration'. Wals (2011) asserts that as there is continuous change and uncertainty of what is truly sustainable, and that there are no universal answers, individuals should be taught the ability to think critically, so they can adapt to this ever-changing context.

Sinakou et al. (2019) combine three aspects of 'a powerful learning environment in ESD into one conceptual framework'. These aspects are Holism, Pluralism and Action-Orientation. Sinakou et al. (2019) argue that 'if one of these dimensions is lacking, ESD teaching will fail at stimulating students' action competence in relation to SD issues'.

Other than action competence, other competences are highlighted like Wals (2011) detailed above. In addition to critical thinking, de Haan (2010); Rieckmann (2017); and Wiek, Withycombe and Redman (2011) assert that key competencies for sustainability are: 'systems thinking', 'anticipatory', 'normative', 'strategic', 'collaboration', 'self-awareness', and 'integrated problem-solving competency'.

Sinakou et al. (2019) developed upon the CILA framework introduced by De Corte et al (2004) framework for creating strong learning environments for education. This model focused on the interconnectedness of competence, learning, intervention and assessment within education. These included specific educational goals, theory, targeted pedagogy to improve the learning process and assessment of the educational outcomes. Sinakou et al. (2019) applied the framework by De Corte et al (2004) in detail to the context of ESD. Sinakou et al. (2019) went

further to use this CILA model to develop an action-oriented framework to be used specifically for education for sustainable development. This framework consists of five elements:

- Action taking
- Students' leadership
- Peer interaction
- Community involvement
- Interdisciplinarity

3.0 The Research Design

The scope of this dissertation, the period of time and context of within a school environment pointed towards the following approach of both quantitative and qualitative data analysis.

There are three main research paradigms; positivism, interpretivism, and critical theory (Rehman and Alharthi, 2016). This research will use the critical theory approach. It is essential to choose an appropriate paradigmatic framework, as Guba and Lincon (1994) suggest, it ‘provides with the world of views that define the nature of the world as well as the range of possibilities for its holders in relation to reality’. Critical theory is also ‘an approach that goes beyond the traditional formulations of quantitative and qualitative research to explore and challenge the socio-historical constructs of knowledge production’ (The University of Sheffield, 2023).

This research aims to ascertain if inclusion of sustainability topics, such as electrical waste, in the GCSE Computer Science specification affect young adults and their parent’s attitude and actions towards sustainability. For this purpose, the research methodology carefully considers and is adapted to the teenage participants. Masson (2004) highlights that ‘it is not enough to treat children and young people as adults: research must be designed and conducted to give children and young people real choices about participation, and to ensure that their views and understandings are properly captured’. Lewis (2004) argues that ‘research with children and young people is crucial’. ‘It can advance understanding of how they develop and live their lives; it can contribute to theoretical debates and its outcomes can impact directly and indirectly on the lives of those researched and others in similar situations’.

3.1 Research process

Year 10 Computer Science students were provided with a pre-learning questionnaire to complete prior to any in school education on environmental issues with Computer Science lessons. They also chose one adult at home to complete a pre-learning questionnaire also. A limitation of this research project needs to be highlighted on this aspect. As the student is choosing the adult at home to participate in the study, this may provide inconsistent results, for example, the student may choose the adult of which they have most access to, and perhaps not the adult most educated on sustainability issues.

They then underwent the scheme of work based on 5.1 Environmental topics of the Edexcel Computer Science GCSE qualification Specification with their usual class teacher, and using the standard pedagogy used at Astrea Academy Sheffield, which is described further below.

They were then set an at home learning activity, as seen in Appendix A, to complete with the same adult at home. The learning activity included many exploratory tasks such as researching what energy ratings, and the manufacturing process of devices at home. Fagan (2016) asserts that home learning ‘accepts that local people, parents and young people are perfectly capable of enabling their own learning given help and support in doing so’. Fagan highlights that ‘it challenges the notion that knowledge belongs to the intellectually rich, that local people are wrong until proven right and that learning is the domain of an educational hierarchy’. (Fagan, 2016). ‘It uses their frame of reference and encourages them to generate knowledge; and it celebrates their view of the world, their learning and their own selves as researchers and activists’. (Fagan, 2016). As detailed in the literature review Mogensen and Schnack (2010) argue that independent learning is an essential element of action competence for sustainability education.

After the completion of learning activity, both the student and adult completed a post-learning questionnaire.

3.2 Lessons on sustainability

This following section will outline the lessons on sustainability that were taught to the population GCSE Computer Science class. As the research population were students at Astrea Academy Sheffield, the lessons followed the school's standard pedagogy which will be explained below. It must be noted that the content of the lessons taught were part of the standard scheme of work, as part of Edexcel GCSE Computer Science specification subject content '5.1 Environmental' where students should 'understand environmental issues associated with the use of digital devices (energy consumption, manufacture, replacement cycle, disposal) as seen in Figure 1 below.

Figure 2

Subject content	Students should:
5.1 Environmental	5.1.1 understand environmental issues associated with the use of digital devices (energy consumption, manufacture, replacement cycle, disposal)

(Pearson Edexcel, 2020)

The topics covered as part of this scheme of work included the following three subtopics, which covered the specification above:

- Subtopic 1: Energy consumption
- Subtopic 2: The manufacture of digital devices
- Subtopic 3: Disposal of digital devices

Astrea Academy Sheffield, hereinafter AAS, uses booklets to teach curriculum. For this research project therefore, a booklet was created for topic 5.1 sustainability, as seen in Appendix B. AAS follows the guidance of Doug Lemov who argues that lessons should ‘take the shortest path’ to knowledge (Lemov, 2021). The booklet contains all essential information and activities for the students. As Rosenshine (2012) highlights ‘education involves helping a novice develop strong, readily accessible background knowledge. It’s important that background knowledge can be readily accessible, and this occurs when knowledge is well rehearsed and tied to other knowledge’.

Rosenshine (2012) argues that teachers should ‘present new material in small steps with student practice after each step: only present small amounts of new material at a time, and then assist students as they practice this material’. The booklet therefore contained frequent activities for students to engage and practice the chunked knowledge.

Documentaries and video clips were embedded into the booklet and the environmental lessons. Clemens and Hamakawa (2010) ‘maintain that the sustainability field is a particularly fertile terrain upon which to sow silver-screen pedagogy’. As Clemens and Hamakawa (2010) highlight is important to ‘identify the relevant learning objectives that correspond to the specific films’. Key clips were found to highlight key issues in the environmental topics, for example, a documentary called ‘Is the cloud damaging the planet?’ by BBC’s Panorama series

which highlighted the intensive use of water and energy for data storage in the technology industry. In support Clemens and Hamakawa (2010) highlight it is ‘paramount to carefully select appropriate video material’ so multiple clips were viewed before choosing the specific videos to be included in the scheme of work. Clemens and Hamakawa (2010) argue that ‘today’s learners are more apt to respond favourably to the dominant stimuli in which they were raised—that is, electronic media’. It can be argued, however, that the most effective pedagogy is not the use of video, and this ‘remains a largely supplemental instrument (Champoux, 2006). Clemens and Hamakawa (2010) argue that ‘effective use of film in the curriculum requires more time and effort than would be the case for typical class preparation’. Whereas Hobbs (2006) would argue that teacher’s use film to compensate for poor planning within a scheme of work. Another consideration when including the use of documentaries in this scheme of work was the management of the ‘technology-in-the-classroom logistics’ (Clemens and Hamakawa, 2010) for this scheme of work, it was necessary to book alternative classrooms that were more suitable for the viewing of documentaries, as the normal classroom is a computer room, where viewing of the main board is hampered by the individual monitors.

At the end of the booklet students completed exam style questions on the environmental topic. Rosenshine (2012) asserts that ‘independent practice provides students with the additional review and collaboration they need to become fluent’. These lessons were therefore prepared, considering the aforementioned CLIA model for successful learning environments, developed by De Corte et al. (2004). Olsson et al. (2022) highlighted however that there are very little examples of best practice for educators within ESD. Coe et al. (2014) define effective teaching ‘as that which leads to improved student achievement using outcomes that matter to their future success’.

3.3 Questionnaire design

As previously mentioned, a pre-learning questionnaire, as seen in Appendix C, was distributed to participants (students and their chosen adult) before the scheme of learning commenced. Post learning, and completion of the learning activity at home (as seen in Appendix A), the second questionnaire was distributed, as seen in Appendix D, This following section will detail the considerations that were made during the creation of the questionnaires.

Physical copies of the questionnaire to be distributed

Due to the lack of IT equipment available to the students and their parents due to disadvantage and the school's catchment area falling within the most deprived 5% of the UK (Consumer Data Research Centre, 2022), it was decided that paper copies of the questionnaires should be used.

Coloured paper

The questionnaires were printed on pink coloured paper with the intention of improving response rate (Etter et al., 2002). Phipps, Robertson and Keel (1991) argue that colour questionnaires are 'more noticeable and less likely to be misplaced'. Keeter et al (2001) however assert that the colour of paper has no impact on improving response rate. Greer and Lohtia (1994) support this, however, do argue that the intention of the questionnaire has a greater impact on response rate than paper colour, for example a university study compared with a marketing questionnaire.

Layout

The questionnaire had a consistent layout and design. Strong formatting of a questionnaire allows for easily completion by respondents, which is the main purpose of a questionnaire (Bradburn et al., 2004). In agreeance with this, Gehlbach and Artino (2018) argue consistency allows for clarity which allows the respondent to complete the questionnaire more efficiently. It will furthermore reduce the measurement error within the data as respondents will be less likely to misread or miss questions (Dillman, 2000). Dillman (2000) furthermore assets that clear formatting reduces any apprehension of respondents in their involvement and would increase the trust towards the questionnaire.

Instructions such as ‘for any questions you do not wish to answer, please circle ‘Do not wish to answer’ were included in the questionnaire. Babbie (1973) argues that ‘the appropriate placement of instructions reduces the user’s apprehension about what they’re supposed to do, and allows them to focus on providing the information needed by the survey’.

Dillman (2000) argues that questionnaires must ‘take advantage of why a person would respond to a survey’. Dillman (2000) argues that motivation lies within the Social Exchange Theory, that completion of a survey will meet some of their needs. Fanning (2005) suggests that ‘perhaps the survey provides respondents with an opportunity to voice their concerns and incept change’.

Question wording

The questions within the questionnaires were carefully considered. Questions were phrased with positive language, for example ‘What sustainability actions do you currently do?’. The use of positive language, rather than using reverse scored or negative language tends to increase understanding. Swain, Weathers, and Niedrich (2008) assert that ‘negative words are more difficult to process cognitively, which leads these items to take longer to answer and leads to misresponse’.

Fanning (2005) highlights that the first question ‘should be general but pertain to the purpose of the survey’. Dillman (2000) highlights that the first question should connect with the topic of the questionnaire and be easy to complete with a few seconds to encourage engagement with the questionnaire. For this research’s questionnaire the first question was ‘How concerned are you about environmental issues’ as seen in Appendix C. The respondent was encouraged to circle one answer from a Likert scale from ‘Not at all concerned’ to ‘Extremely concerned’. Babbie (1973) expresses that the first question should always be a closed response, as used in this questionnaire.

The order of the questions was also considered with the importance of this highlighted by Fanning (2005) and Dillman (2002). The questions were grouped, for example, those surrounding digital devices leading on from one another.

Response options

The pre- and post-education survey included questions with a Likert scale response:

- Not at all concerned
- Slightly concerned

- Somewhat concerned
- Quite concerned
- Extremely concerned.

Questions with answer scale used five response options. Gehlbach and Artino (2018) assert that ‘scales bolster accuracy’ as each question is representative of a ‘cross-section of the experience’. According to Weng (2004) and Nielsen et al (2017) this number of responses is the “sweet spot”. Equal spacing between each response option will yield less biased responses (Artino and Gehlbach, 2018).

3.4 Focus group

In addition to the two sets of questionnaires, participants will be invited to a focus group to further discuss their feelings around the research topic. Byers and Wilcox (1988) assert that focus groups can be used as a method of qualitative data which ‘may provide a new opportunity for communication researchers who are tired of the well-used hammers and provide the scientific community with a means of gathering information otherwise not obtainable’. Vaughn, Schumm, and Sinagub, (1996) assert that ‘focus group interviews have the potential to bring the investigator closer to the research topic through a direct, intensive encounter with key individuals’.

The rationale behind choosing a focus group was chosen rather than individual interviews was that the data that could be potentially collected are often more detailed than the data available from an individual interview (Lederman, 1990). Folch-Lyon and Trost (1981) argue that ‘group interviews can be superior to individual interviews for obtaining perceptions and beliefs’.

3.5 Research ethics

Prior to commencing this dissertation, it was necessary to submit an ethical considerations form to supervisor Dr Alex Bell. The following aspects were considered before the research took place.

As the research project is with Year 10 students who are aged fourteen and fifteen years old, ethics and the law surrounding research with children must be considered. 'Within the UK the term 'child' means anyone below the age of 18 years' (Masson, 2004). The University of Wales Trinity Saint David's Research Ethics and Integrity Code of Practice (2022) states that research that involves contact with children are required to obtain an advanced Disclosure and Barring Service check, as a teacher, this was already in place prior to this research.

As the class teacher with the research group, my students, it was important to ensure that ethical research takes place. 'Power relations which exist between researched and researched affect the process of research' (Lewis, 2004), and in this situation, there is further power relations as the class teacher. It was important therefore to make clear to the students that participation in the research was voluntary and non-participation would have no adverse effect on their education, nor my attitude towards them as their sole Computer Science teacher. As Masson (2004) highlights 'not everything that is legal is ethical and researchers must ensure that only are they working within the relevant legal system but that their research meets appropriate ethical standards',

Masson (2004) argues that 'children are 'rarely' entirely free to decide for themselves whether or not to participate in research'. During the distribution of the questionnaires and during the

explanation it was important to ensure that the students knew that participation was voluntary. Masson (2004) highlights that 'researchers in the fields of education and health relied on the consent of teachers or parents to gain access to children but rarely sought to explain to children or young people the purpose of their studies, or tried to reflect their concerns or give them the option of not taking part' (Masson, 2004).

Prior to beginning my research, permission was sought from Headteacher at Astrea Academy, Mrs Emma Gover. The Headteacher acted as a Gatekeeper. 'Gatekeepers have a positive function in ensuring that children are protected from potential harm. Researchers should expect gatekeepers to test their motives for wanting access, and to act as a barrier to poorly thought out or potentially damaging research' (Masson, 2004).

While the Year 10 students are mature, consent was sought from parents or guardians of the child. Masson (2004) highlights that 'researchers who wish to include young children who are not mature enough to decide about participation for themselves must obtain the agreement of at least one person who has parental responsibility for the children'. The parents received a letter (appendix E) detailing the research proposal, methods and data storage details. Masson (2004) argues that 'researchers should engage with parents and provide them with the information that allows them to decide whether to permit their child's involvement'. Some of the participants in the Y10 class are individuals with special educational needs, and therefore it was specifically important to ensure parental consent for these individuals, as Masson (2004) highlights 'researchers who wish to include young children who are not mature enough to decide about participation for themselves must obtain the agreement of at least one person who has parental responsibility for the children'. Lewis (2004) highlights 'researchers need to develop ways of engaging children in a wide range of different circumstances, including those with special educational needs and disabilities, in order to obtain high quality information that

is not otherwise available. While doing this they must also satisfy those who care for or work with children that their rights are not undermined, and children's rights are safeguarded'.

With the students experience of higher education limited, it was important to further explain the purpose of a dissertation. With only five students out of thirty of student's parents having studied to university level. Masson (2004) argues that 'in order to give valid consent, a child needs to understand the nature of his or her engagement with the researcher, and that it differs from that of other adults who may seek information in order to take decisions about or for the child. A child must be able to understand that information is collected only so that the researcher and other people can understand the particular topic better'. This also highlights a limitation of this research. One student (five percent of non-participants) said they did not understand why they should complete the questionnaire. Perhaps with a greater understanding of university research, more students would participate in research.

The questionnaires and homework activity were to be completed anonymously by the students and their parents. Research confidentiality was explained and no names or identifying information was sought within the questionnaire. Masson (2004) defines research confidentiality as 'disclosing information only in ways which protect the identity of those who provided it'. Masson continued to describe that 'all research participations, including children and young people, need careful explanations of research confidentiality when (or before) their consent to participate is sought'. The research followed the guidance and regulations from the Data Protection Act 2018 and the General Data Protection Regulation 2018. This research respects the University's responsibility to ensure there are 'appropriate organisational and technical measures in place to protect personal data' which is outlined in the Research Ethics and Integrity Code of Practice'. The data was processed with regard for lawfulness, fairness

and transparency, purpose limitation, data minimisation, accuracy, storage limitation and integrity and confidentiality (University of Wales Trinity Saint David, 2022).

4.0 Data analysis and discussion

The following chapter will include questionnaire response analysis and discussion around these topics. Both student and adult responses from the questionnaires will be discussed in this chapter and following subsections. Bivariate relationships between the dependent variables will also be reviewed.

The questionnaire was completed by 10 student respondents and by a family member of their choice that they live with over the age of 18. Due to the demographic of the students, multi-generational living is the norm for many students at Astrea Academy Sheffield (Sarfraz, 2015). The following section analyses the parents and their chosen adult's response to question. For the ease of reading the family member is referred to 'adult' in the following section. The statistical limitation of this data set is discussed further in the limitations section of this dissertation.

Question 1: How concerned are you about environmental issues?

Prior to the in-school learning, most students (60% (n=6)) said they were 'slightly concerned' about environmental issues. When asked why they feel that way, one student, for example responded "it does not affect my daily life". Post learning, this figure did not change, and one student, responded "'it can't change by one person". Hamann and Reese (2020) highlight that 'it is easy to be overwhelmed into inaction' and that 'individual action is trivial, pointless and ineffectual'. Kagawa and Selby (2010) assert that 'educational spaces should build a culture of learning awash with uncertainty and in which un-certainty provokes transformative yet precautionary commitment rather than paralysis'.

Hagen (2021) argues that one person can make a difference for the following three reasons:

1. An individual's carbon footprint is significantly large
2. Each individual, the 'micro' makes up the 'macro' system.
3. Sustainable actions have a 'ripple effect' on those around the individual.

Levermann (2019), argues however that 'individual sacrifice alone will not bring us to zero. It can be achieved only by real structural change; by a new industrial revolution'. If this research project was to be repeated, the lessons on sustainability could be adapted to include further research on the role of the individual within sustainability.

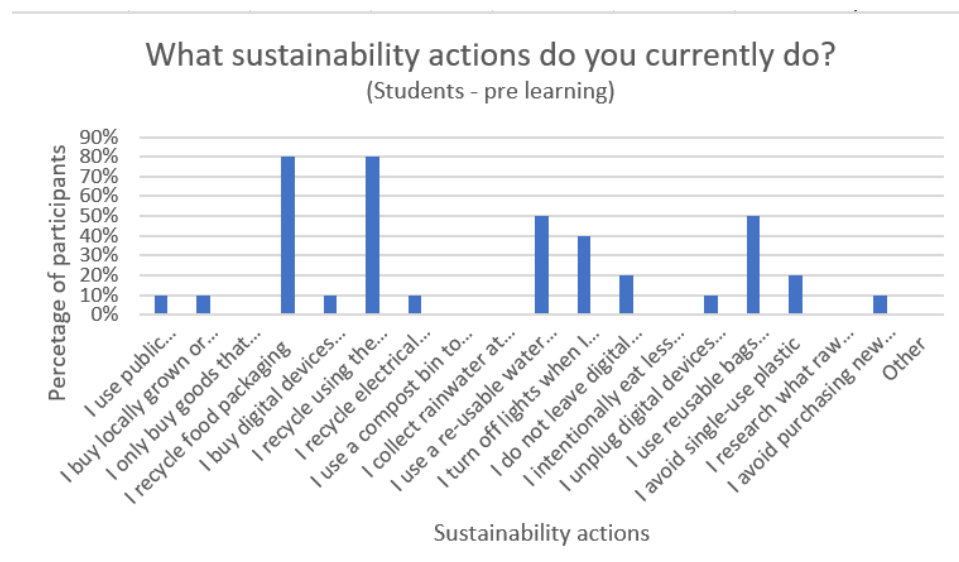
Research considered the sociodemographic, knowledge and attitudinal variables in predicting environmental concern and indifference in young people aged 13 to 16 years (Lyons and Breakwell, 1994). Lyons and Breakwell (1994) found that the 'best discriminator was self-reported level of knowledge about specific environmental issues'. Lyons and Breakwell (1994) concluded that 'age contributed only slightly in predicting environmental concern and indifference, and sex and personal commitment to science made no significant contribution'.

Adults prior to the home learning activity, 60% (n=6) responded that they were 'slightly concerned', 40% (n=4) responded that they were 'somewhat concerned'. One adult responded that is it "easy to ignore this issue". Post learning activity with their child, this figure did not change. Zielinski (2010) highlights that currently it is easy for many individuals to ignore climate change as it is not impacting them personally, for example permafrost in the Arctic which does not immediately impact individuals in other locations around the world.

Question two: What sustainability actions do you currently do?

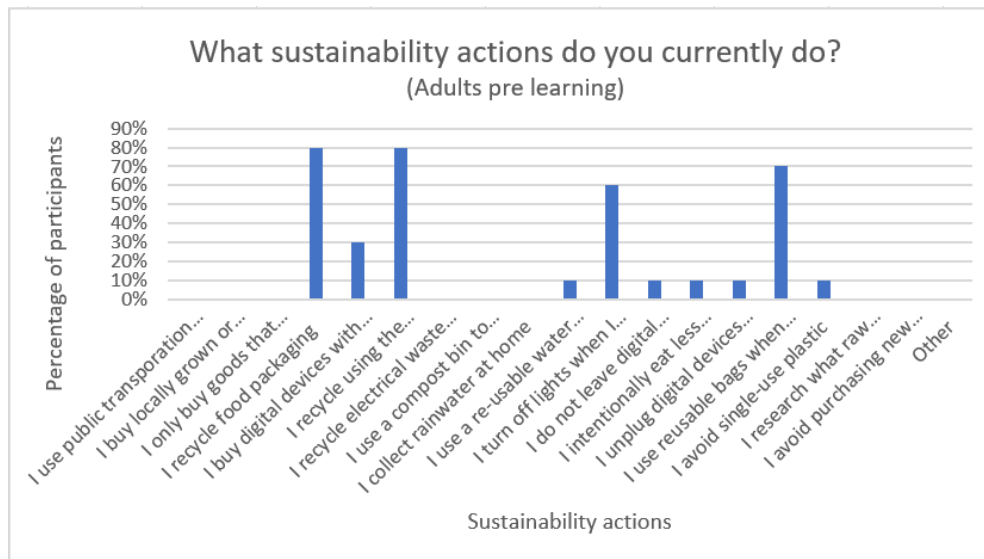
The results of this research have shown that the knowledge of students has increased significantly, however the actions of the student participants have not changed. The second question, for example, ‘What sustainability actions do you currently do?’ showed that there was no change to students nor the adults' actions, post the in school and home learning.

Figure 3 Student



The most common sustainability actions for students were recycling of food packaging (80%), recycling with council provided recycling bins (70%) and using a reusable water bottle (50%). These seem to correlate with the most common sustainability campaigns in the city currently (Sheffield City Council, 2023). Research has shown that ‘early and positive childhood experiences in nature may provide formative opportunities for individuals to develop positive adult views of nature’ and that sustainable habits developed as a child, will continue into adult hood (Broom, 2017).

Figure 4 Adults



The most common sustainability actions for adults were recycling sing council provided bins (80%), recycling food packaging (70%) and turning off lights when leaving the room (60%). Could the sustainability action of turning the lights off when leaving the room be explained by financial motivation? Increased energy prices have meant that many individuals are reducing energy consumption to manage the price increases (Lawson, 2022).

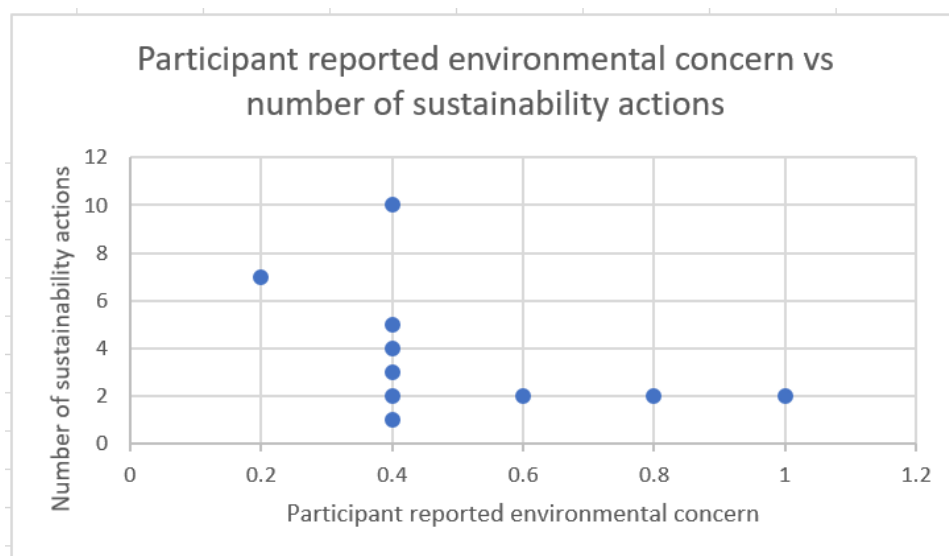
Interestingly, only 30% of students said they turned off lights when they left a room. Mattsson and Laike (2022) argue that there is ‘no causal connection between the obtained knowledge and turn-off behaviour’. Arhardt-Martinez et al. (2010) argue that interaction on this topic at school, may help with this situation, and better engage all household members.

Similarly, to switching off lights, only a small percentage (30% or below), of students do not leave devices on stand-by mode nor unplug devices when not in use. Fell and Chiu (2014) highlighted that ‘there was evidence of a wide range of levels of engagement with energy use in children's home lives, with most children and parents indicating that it is a subject that is little discussed’.

Jensen (2002) has highlighted that ‘knowledge does not per se lead to much-needed action’. Jensen (2002) argues that in formal education, sustainability education is ‘not sufficiently action-oriented’. Boeve-de Pauw et al (2015) asserts that ‘it is not enough for the students to be exposed to sustainability content in teaching’, they must also be explicitly taught how to participate in sustainability actions. Jensen (2002) goes further and argues that for the environmental education to be action-oriented it must ‘strive to explore and develop all four dimensions of knowledge about sustainability problems’, what, why, where, and how of each issue. On reflection upon the lessons prepared for the sustainability topics, it could be argued that there was not sufficient coverage on all four aspects of each environmental issue surrounding issues such as electrical waste.

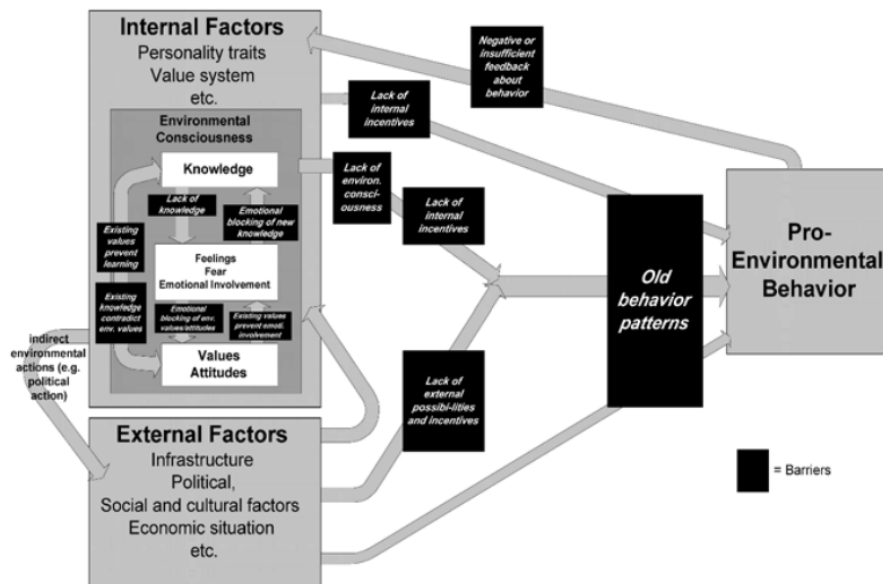
Using bivariate analysis on student’s reported concern of the environment pre-learning and their actions we can see further that there is no strong correlation between these two variables.

Figure 5



Kollmuss and Agyeman (2002) conclude that they ‘do not attribute a direct relationship to environmental knowledge and pro-environmental behavior’. Kollmus and Agyeman (2002) developed a model, as seen in figure 5, below which they see ‘environmental knowledge, values and attitudes, together with emotional involvement as making up a complex we call “pro-environmental consciousness”’. Their findings are in agreeance with Fietkau and Kessel (1981) who did not find a direct relationship. Kollmus and Agyeman (2002)’s model demonstrates how different factors influence each other with arrows. The two more narrow arrows from internal and external factors go directly to pro-environmental behaviour, for example financial motivation to spend less on energy usage. The largest arrow represents the ‘biggest positive influence on pro-environmental behavior’, Kollmus and Agyeman (2002) state that this is when ‘internal and external factors act synergistically’. The black boxes, furthermore, ‘indicate possible barriers to positive influence on pro-environmental behavior’, for example lack of knowledge. While Kollmus and Agyeman (2002) state that there is not a direct relationship between education and actions, they do contribute some influence for competence for sustainability on knowledge of sustainability issues. Kollmus and Agyman (2002) assign most importance, within the largest black box, showing ‘old behaviour patterns’, they believe that this often is overlooked in sustainability literature, and ‘that old habits form a very strong barrier’ to action for sustainability.

Figure 6 -



(Kollmus and Agyman, 2002)

Question three: Are you aware of any issues around the replacement of digital devices?

Pre learning, 10% (n=1) of students said they were aware, with 90% (n=9) unaware of any issues around the replacement of digital devices. Post learning 100% (n=10) of participants were aware of issues around the replacement of digital devices. Pre-learning, 20% (n=2) of adults were aware of issues around the replacement of digital devices. Post activity 30% (n=3) of adults were aware of these issues.

With the 70% (n=7) difference in awareness of issues between students and adults, it appears that within the research project, that parents were not fully engaging with their child in the learning activity. Within the results of the research there is a trend between gap of knowledge on these sustainability topics between student and adult. The Varkey Foundation (2018) found in their Global Parent's survey, that only 11% of parents in the UK spent more than one hour a day helping their child academically with homework or literacy. The Social Mobility

Commission (2022) argues that ‘lack of confidence plays a key role in why parents do or do not engage with their children’. Discussed further in the limitations section of this dissertation, it must be noted that 43% of participants have English as an additional language, and none of the adults participating have English as their native language. The Education Policy Institute (2020) furthermore highlights that the poorest children, as are the participants in this research project, leave school ‘18.1 months of learning behind their more advantaged peers’.

Question four: what are two ethical issues related to the disposal of digital devices?

Pre learning no students could name two ethical issues, but one participant could name one ethical issue. Post learning all participants could name two ethical issues. No adults could name two ethical issues prior to the home learning, post learning this increased to 10% (n=1) of participants being able to name two ethical issues. Olsson et al (2022) argue that ‘when teachers explicitly address environmental and sustainability content in their teaching’ students develop their knowledge about these issues.

Question five: What are two ethical issues related to the manufacture of your digital devices

20% (n=2) of student participants could name two ethical issues. 10% (n=1) did not wish to answer. 70% (n=7) furthermore responded that they did not know. Post learning 90% (n=9) of students knew. For the adult participants none of the adults could name two ethical issues. Post learning activity with their child, 10% (n=1) of adults could name two ethical issues.

Both questions including the word ‘ethical’ had results which suggested that the adult participants did not learn from the learning activity with their child. Wu (2012) highlights the

difficulty of learning key terminology in a second language, when that language is largely different from your native language, for example Arabic to English. It is therefore believed that the key term 'ethical' may have been a barrier for the adult participants in this questionnaire. The student participants were explicitly taught the meaning of the word 'ethical', whereas adults, if not already aware of the word, were reliant on their own knowledge or the teaching from their child.

Question six: Do you currently know where to dispose of unused digital devices or electrical waste near your home?

Only 10% (n=1) of participants prior to the learning and home research activity knew where to dispose of unused devices or electrical waste, post the learning, all participants knew where to dispose of these items. 30% (n=3) of adults knew where to dispose of e-waste prior to the learning activity with their child. This increased to 80% (n=8) post learning activity. During the focus group one student shared that they do not throw away digital devices, instead they sell or give to family members. This is also confirmed by the contents of the learning activity where all participants answered 'none' to 'How many devices do you have at home that are no longer in use?'. Again, this research could be repeated in a more affluent area of Sheffield, to see if this response differs. As, for example, 'Mobile recycling company CompareMyMobile found that in the UK there were £13 billion worth of phones' in people's homes at the start of 2016 (Peckham, 2017). It appears, therefore, that low-income families in this participant group are more like to participate in direct reuse as mentioned above. This is a waste prevention activity (Read et al., 2009).

Question seven: Do you know how much energy your devices consume when in use, and when in standby mode?

90% (n=8) of participants did not know how much energy their devices at home consume when in use. The same result was received for the question ‘Do you know how much energy your devices consume when in standby mode?’. Post learning 50% (n=5) of participants, increased from 10% (n=1) knew how much energy their devices at home consume when turned on and in standby mode. 20% (n=2) of the adult participants knew how much energy their devices consume, post learning activity this increased to 80% (n=8) of adults. In terms of standby mode, no adults knew how much energy their devices consumed. This was a surprising figure with the cost-of-living crisis, the expectation was that a high number of individuals would know the cost of running devices at home. (Trotta, 2020) highlighted that during their research on electricity awareness and consumer demand for information, that the ‘level of consumers’ awareness about electricity bills, prices, and costs is low’.

Post learning activity the knowledge of energy consumption increased to 80% (n=8). Feedback, however, from the learning activity with the question ‘how did you find the experience of completing the learning activity with your parent?’ one participant commented ‘hard, we don’t know how much the device cost of electricity’ [*sic*]. Equally another participant suggested that it would have been useful to provide more information to complete the learning activity. Trotta (2020) found that ‘more than 70% (n=7) of the “electricity unaware” respondents are willing to receive additional information to improve their knowledge about energy consumption and how to save energy’. It seems that if this research’s community is similar to those in Trotta (2020)’s, then there may be opportunity for further informational campaigns for individuals in this community and could create ‘long-lasting behavioural changes’ (Trotta, 2020). ‘Such an approach is impervious to working with communities to facilitate sustained understanding and enhance trust’ (Willis et al., 2021).

Question eight: Do you know how the digital devices in your home were manufactured?

20% (n=2) of students pre-learning knew how they were manufactured. 70% (n=7) did not know. Post learning, 50% (n=5) of students knew how the digital devices in the home were manufactured. None of the adult participants knew how the digital devices were manufactured. Post activity with their child, 20% (n=2) of participants knew.

10% (n=1) (n=1) answered outside the purview of the questionnaire with 'somewhat'. The questionnaire, therefore, has a flaw with this question with a missing response category, as the options available to participants were 'Yes', 'No' and 'Do not wish to answer'. Prior to distributing the questionnaire, a pre-test of the questionnaire was completed with five individuals. This was done to identify any 'potential problems in intent, clarity and navigation' (Fanning, 2005). This research project however could have benefited from further questionnaire pretesting (Presser et al., 2004). According to Sheatsley (1983), 'it usually takes no more than 12-25 cases to reveal the major difficulties and weaknesses in a pre-test questionnaire'. This is supported by Sudman (1983) who highlights that '20-50 cases are usually sufficient to discover the major flaws in a questionnaire'.

Question nine: Do you know of three rare earth materials, toxic chemicals, oil-based plastics may be contained with your devices?

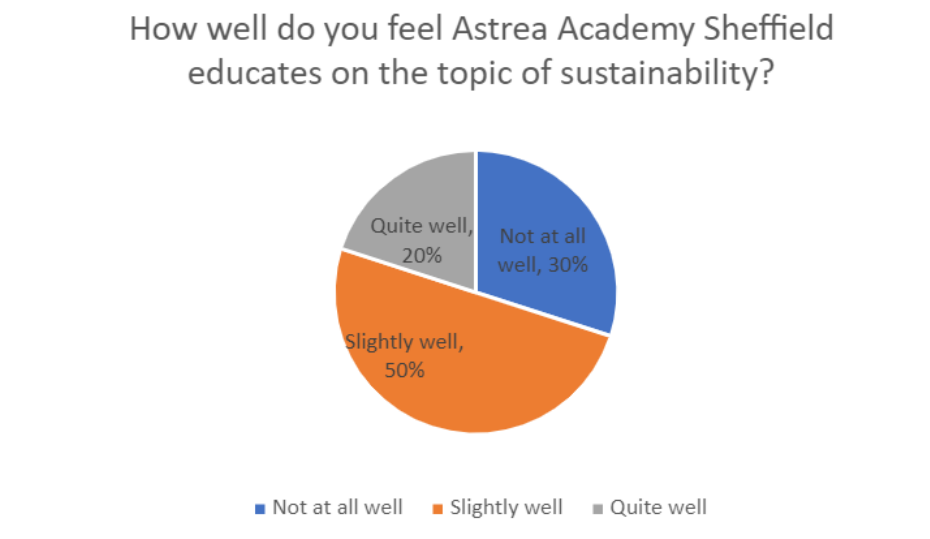
Prior learning 10% (n=1) of students could name the raw materials within devices. Post learning 100% (n=10) of students knew. Prior to the learning activity, none of the adults could name raw materials within devices. Post learning with their child, 50% (n=5) were able to name three materials.

Question ten: How well do you feel Astrea Academy Sheffield educates on the topic of sustainability?

This question used a Likert scale which included the following response options:

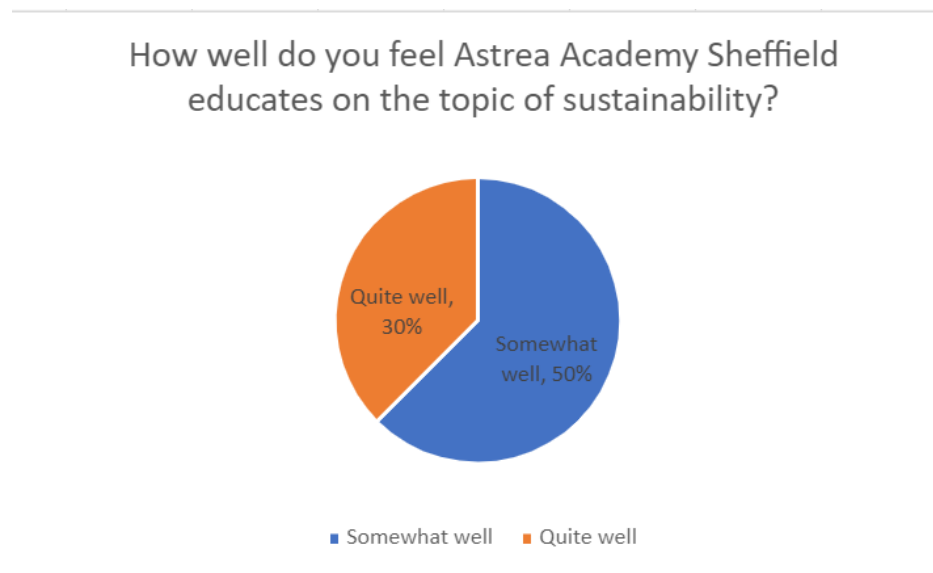
- Not at all well
- Slightly well
- Somewhat well
- Quite well
- Extremely well

Figure 7: Pre-learning student



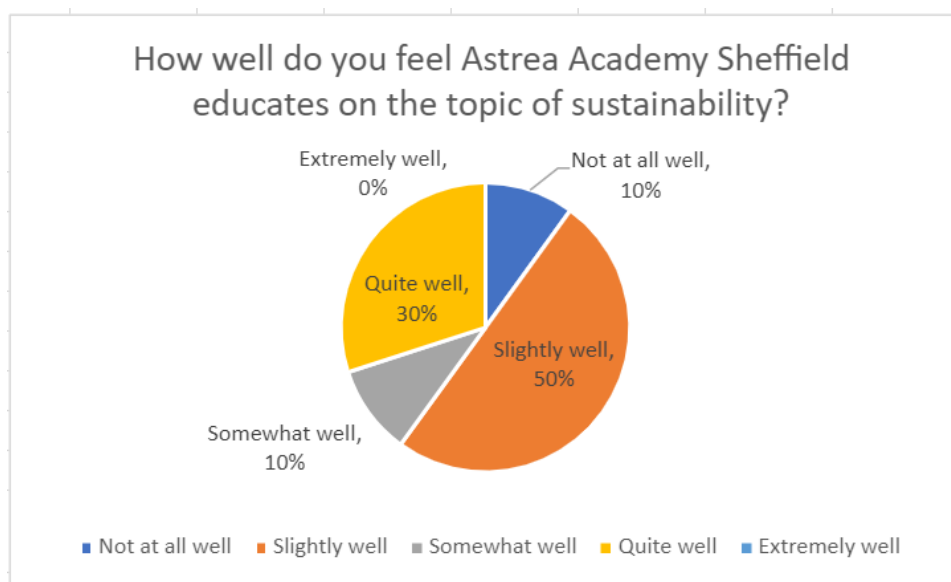
Pre-learning, 50% of students responded that Astrea Academy Sheffield educates on the topic of sustainability ‘slightly well’, which was the most common result.

Figure 8: Post-learning student



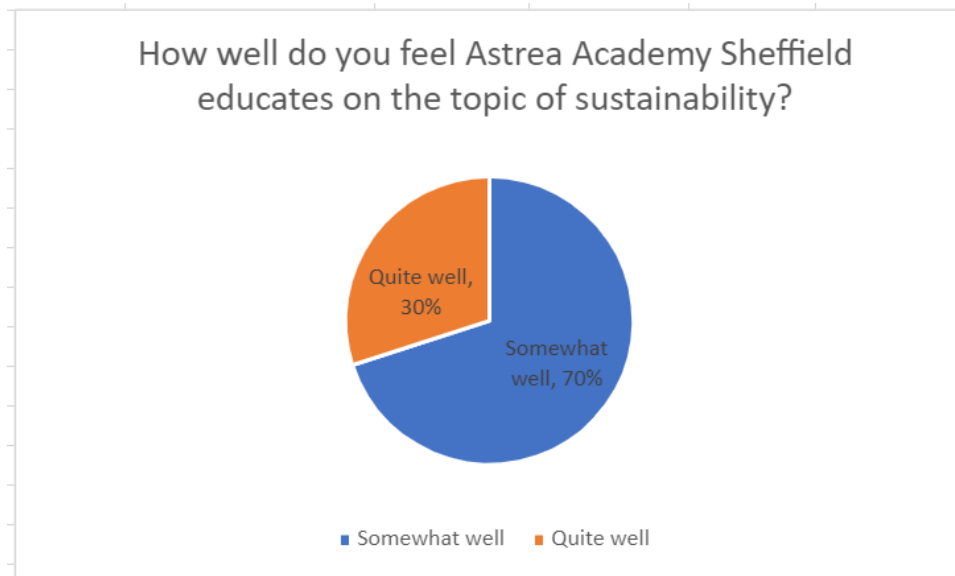
The opinion of the scholars who had previously responded ‘not at all well’ (30%) was improved, with all students responding post learning to sustainability education as ‘quite well’ (30%) or ‘somewhat well (50%)’. No students felt that the sustainability education was ‘extremely well’ within the school, therefore there is further work to be done.

Figure 9: Pre-learning adult



Prior to the learning, 50% of adults felt the sustainability was ‘slightly well’ taught within the school. Like the students, no adults felt that sustainability was taught ‘extremely well’.

Figure 10: Post-learning adult



Post-learning, 70% of adults now felt that sustainability education was at the standard of ‘somewhat well’, and 30% believed ‘quite well’. Again, none believed it was taught ‘extremely well’.

As seen in the charts above, the attitude towards the education of sustainability at Astrea Academy has improved slightly after the learning activities. This dissertation notes that further research which involves parents could improve the school’s relationships with parents and their attitude towards the school. The school’s recent Ofsted report, published in December 2022, highlighted that Senior Leadership ‘know that there is work to do to engage positively with the wider community’ (Ofsted, 2022).

Varela-Losada et al. (2015) highlight that true participation is required to create a ‘culture of sustainability’. In all sustainability education with a focus on action competence for

sustainability ‘interaction with the community and collective actions must be encouraged from the school, helping to create committed groups and networks which can maintain sustainable conditions and lifestyles while building knowledge’ (Varela-Losada et al., 2015). Supporting this concept, Hadjichambis et al. (2020) argues ‘the most straightforward way for competence development is student participation in real-life projects’.

Question eleven: Are there any actions you believe Astrea Academy Sheffield should take in terms of sustainability education?

Student participants commented that the school should teach more about these topics, and wider topics within sustainability such as pollution. One student participant shared that they feel it should be taught in more subjects, and in assemblies.

In April 2022, the government approved a new GCSE qualification by exam board OCR a GCSE in Natural History. This qualification will be available for students from 2025. Astrea Academy Sheffield could consider offering this qualification to improve the sustainability education within the school. Mary Colwell, Environmentalist has argued that ‘a GCSE in Natural History could be a game-changer for the nature of Britain. Everyone will have the opportunity to be nature-literate, to learn about British wildlife and how it relates to the rest of the world, which is essential for a sustainable, green future’ (Davis, 2022).

4.2 Focus group

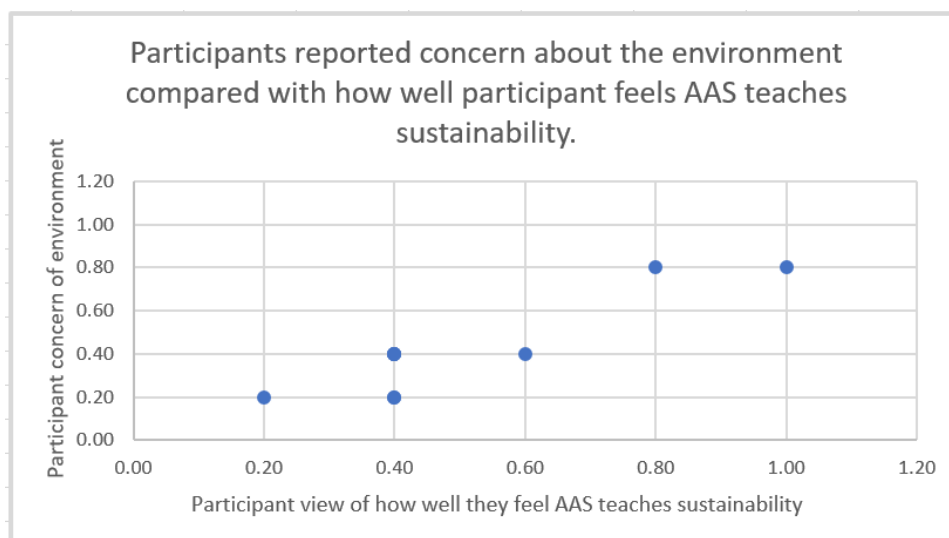
Three participants were selected to participate in the focus group. This provided further detail to the research. During the focus group, additional detail was provided by participants based on what other fellow participants shared. Hess (1968) would describe this as ‘snowballing’ which is when ‘the statements of one respondent initiate a chain reaction of additional comments’. Comments, for example, when asked about why they felt nothing had changed despite the in-class and home-learning activity, one participant said that they are “already sustainable” and do not “throw away devices”. This prompted another participant to share that they currently sell unused devices and they do not get thrown away in their household.

Spontaneity (Hess, 1968) was also seen when one participant shared that when they are older, they can share what they have learnt with their future families and make decisions what occurs in their household. This could also be seen as an example of ‘security’ which is when ‘the group provides a comfort and encourage candid responses’. Vaughn, Schumm, and Sinagub, (1996) agree with this and suggest that ‘the group format offers support for individual participants and encourages greater openness in their responses’. Schoenfeld, (1988) highlights that ‘responses that are made may be more genuine and substantial’. The use of a focus group in this research project, therefore allowed ‘the opportunity to elicit a range of opinions’ (Byers and Wilcox, 1991).

Participant concern about the environment pre-learning and how well they believe Astrea Academy teaches sustainability pre-learning.

The following section will use bivariate analysis to compare two variables from the research project, with the intention of highlighting any correlations between these variables. Bivariate analysis is commonly used to establish any relationships between the variables, notably used in research projects such as Michalos et al. (2005). When comparing participant concern about the environment pre-learning and how well they believe Astrea Academy teaches sustainability pre-learning, we can assign a numerical value to the participant's view of how well they feel AAS teaches sustainability. 0 was assigned to 'not at all well', with an interval of 0.2 through the Likert scale, to 1 for 'extremely well'.

Figure 11



As shown in the scatterplot above it appears that there is a medium strength relationship between the two variables of participant concern about the environment and how well they believe Astrea Academy Sheffield are teaching Sustainability. Further research could be undertaken to establish if there is a true correlation between how concerned an individual is

about sustainability, and how satisfied they are with education on this topic. Similar research has been conducted by Bakaki et al. (2019) which researched and modelled a triangular system lining policy output, media attention and public opinion about environmental quality. Bakaki et al (2019) found that the amount of media coverage impacts public opinion. Bakaki et al (2019) suggest that ‘it is possible that the public simply suffers from ‘news fatigue’ in relation to climate change coverage: the more the issue is covered, the more hopeless things look and the more pointless individual action may seem; cognitive dissonance sets in, leading to the thought that the problem is not important’. In addition, Milfont (2012) found that ‘knowing more about global warming and climate change increases overall concern about the risks of these issues, and this increased concern leads to greater perceived efficacy and responsibility to help solving them’.

5.0 Conclusion

5.1 Limitations

The following section will reflect on the limitations of this research. ‘Reflection is a vital part of the research process and is one way in which researchers can develop their expertise and advance their research’ (Lewis, 2004). The focus of this research is Computer Science students, in a socio-economic deprived area within the UK, therefore may not be valid in other settings or subject areas. It is difficult to conclude that the results are applicable therefore to a larger population than the target population.

Questionnaires and home learning activities were distributed to all thirty Computer Science students. Ten of these thirty individuals decided to participate. The twenty scholars who decided not to participate were asked in a one question, questionnaire, as seen in Appendix F, ‘why did you not participate in the research project’ with the following options for response:

- Not interested in participating in research
- Do not have time to answer
- The questionnaire looked too long
- The questions were too difficult
- The information required was too sensitive
- My parents would not understand the English language activities
- I did not understand why I should complete the questionnaire
- I did not understand the questions in the questionnaire
- There was no consequence if I did not complete it
- Other

Twenty percent of the non-participants said they were not interested in participating in research, thirty percent said they ‘do not have time to answer’. At Astrea Academy Sheffield, most students are Muslim. The majority of the Computer Science class (the participants in this research) are male (twenty-six out of a class of thirty). Interestingly, one student responded ‘other’ and shared that they are ‘too busy helping my mum and sister move house’. Observationally, the male students at the school, often comment on their role looking after female members of their household, for example, it is common that the fathers of the students return to their home country, for example Pakistan for long periods of a time. In this situation, it is the oldest male child that bears the perceived responsibility to look after the female members in the household. Bani and Pate (2015) highlight that ‘Men are tagged as the “QAWWAMUN” that is, the protectors and the maintainers of women, in the Qur’an’. Further research, therefore, could be completed, focusing on increasing male Muslim students’ engagement in research projects, and more generally their experience in the UK education system.

Twenty-five percent of the non-participants said ‘my parents would not understand the English language activities’. Whilst in the context of public health, Willis et al., (2021) highlight that this is a barrier to research, and the methods to ‘accommodate the language needs of under-served ethnic minorities, some of which might have low first language literacy... or English language proficiency’ is an under-researched area’. The Computer Science class of participants consists of individuals of British, Ethiopian, Pakistani, Somalia, Nigeria, Yemini, Indian, and Chinese ethnicity. Forty-three percent of the students in the class have English as a second language, with varying languages spoken, for example with Pakistani students, languages include Hindko, Pashto, Panjabi, Urdu and English. As the research was conducted in English, and questionnaires and the homework activity involved parent contribution, further actions would be needed to engage these groups of individuals in the research. ‘Engaging a substantial

proportion of such groups to make the recruited sample more representative of the target population is unlikely to be easy or cheap. Simply translating a document into a heritage language is unlikely to be an effective solution for this complex challenge.’ (Willis et al., 2021).

Limitations to this research furthermore were the nature of education and unforeseen events impacting time in the classroom. During the research period, Sheffield, where the research took place, had two days of school closure in March 2023 due to snow. There were furthermore school closures at Astrea Academy for celebration of Eid, and six days of school closures due to national and regional teacher strikes. This led to reduced contact time with the research participants. One non-participant, in the questionnaire why they did not participate, responded other with ‘I did not know there was a research project’. One issue facing education post-pandemic is school refusal. Three students within the class are frequently absent, and therefore were not introduced to the research project at the same time as other students. ‘Following school shutdowns, the rate of persistent absence has shot up to the highest level on record. In the academic year 2021/22, 22.5 per cent of children were persistently absent’ (Centre for Social Justice, 2023). Astrea Academy Sheffield is based within Yorkshire and the Humber, which ‘had the highest rate of persistent absence in Summer 2022’ at 28.7 percent meaning 204,045 children. (Centre for Social Justice, 2023). As previously mentioned, the school runs within an area of deprivation within Sheffield. According to National statistic figures analysed from Centre for Justice (2023), ‘30.0 per cent of children living in the most disadvantaged areas were persistently absent over the course of 2021/22. For comparison, 14.3 per cent of children living in the most affluent areas were persistently absent over the same period’. Outside of this research project these students are missing key sustainability education, whether that be within Computer Science lessons, Geography or Science.

With only ten participants in this research, further research needs to be carried out with greater numbers of GCSE Computer Science. Research conducted in this school was limited to one

class that exists for GCSE Computer Science at Astrea Academy Sheffield. Nationally, however, there increasing number of Computer Science entries. In 2022 there were 79,135 students entered for the qualification (BCS, 2022).

Further research could be undertaken to understand the impact of socio-economic factors on a child's and their parent's attitude and actions towards sustainability. As previously mentioned, the participants are in a low socio-economic situation. The same research could be conducted in further schools within Sheffield, in more affluent areas, to research if there are any differences in results. 'In the least deprived neighbourhood in Sheffield, 0.3% of people are estimated to be income deprived. In the most deprived neighbourhood, 45.7% of people are estimated to be income deprived. The gap between these two, which we will call internal disparity, is 45.4 percentage points in Sheffield' (Office for National Statistics, 2021). From the focus group, we know that the participants do not throw away old digital devices, and these are instead sold. Could the participant's current sustainability actions be through necessity rather than intentionally and proactivity acting in a more sustainable way. Previous research on the distributional consequences of austerity in the UK found that 'it is the poorest families with children who have suffered the biggest losses in income and that it is families who have suffered the largest cuts in services' (Cantillon et al., 2017).

5.2 Concluding remarks

This dissertation set to ascertain if inclusion of sustainability topics, such as electrical waste, in the GCSE Computer Science specification affect young adults and their parent's attitude and actions towards sustainability.

As can be seen from the literature review, there is increasing focus on action competence for sustainability, however there is a lack of research specifically within Computing education. My findings are not in agreeance with the majority of previously mentioned studies, where it was found that there was a direct causal link between education and action competence for sustainability.

Due to the small number of research participants, the results cannot be generalised. It is, however, possible to make some broad observations which can inform thinking about sustainability education in the context of Computer Science education. This section draws together the findings presented above and considers possible implications for further research into this area.

From the observations and analysis described in this study, together with the inferences from the researched data, with the participating students and adults there was an increase in knowledge on sustainability issues surrounding digital devices and Computer Science. As previously discussed, there was, however a gap of knowledge gained between students and adults. Further research should be completed on how to reduce this knowledge gap.

There was no reported change for action competence for sustainability in the students nor the adults. Wals (2011) argues 'providing information, raising awareness and changing attitudes is not enough to change people's behaviours. People's environmental behaviours are far too complex and contextual to be captured by a simple causal model'. Again, further research,

should be done, to the growing literature in this area. There is a lack of research, however, specifically focusing on action competence for sustainability in low socio economic and immigrant communities in the United Kingdom.

There was no reported change also in the concern for sustainability issues from both students and adults, despite the increase knowledge on these issues. Further research would be beneficial in this discrepancy between knowledge and reported concern on the issues, specifically in this context as mentioned above.

Global programs such as the United Nations Sustainable Development Goals, have not yet succeeded in the aim to increase significantly the sustainability education within the UK's education system. Counsell (2018) argues that 'curriculum is all about power. Decisions about what knowledge to teach are an exercise of power and therefore a weighty ethical responsibility. What we choose to teach confers or denies power'. This dissertation has highlighted that there is further work to be done improving the education system, specifically on Sustainability education. Further research needs to be undertaken to clarify how sustainability education, can turn into tangible actions by individuals. There is hope, however, Huckle and Sterling (2016) highlight 'societies are faced with making an unprecedented and historic change in a short period of time if they are to achieve a sufficiently sustainable form – environmentally, socially and economically; education will have to play a key role in any such transition; education will itself be transformed in the process; and it is necessary and possible to build on the limited progress already made'.

5.3 Recommendations for future research

Future research should examine:

- Potential differences on sustainability education between various exam boards with the GCSE Computer Science qualification.
- The discrepancy found in this research project between knowledge and reported concern on sustainability issues surrounding Computing.
- Action competence for sustainability in low socio economic and immigrant communities in the United Kingdom.
- Differences in action competence for sustainability in various socio-economic groups.
- Knowledge acquisition and retention differences between adult and child surrounding sustainability.
- Chosen teaching pedagogy and its impact on action competence for sustainability within Computing education.

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Appendices

Appendix A - Home learning activity



Digital devices investigation home task.

Please complete this with an adult at home.

What digital devices do you have at home?

What energy rating are your devices? (Tip: Look out for stickers on your device or use the internet to research these)

What is 'stand-by' mode?

Are there any devices that you leave on stand-by?

If there are any digital devices that you leave on stand-by calculate the energy usage of those devices?

Device	Approx energy usage per hour when in standby mode	Approx energy use when in use.
E.g. PlayStation 5	1.5W	

|

Choose one device in your home. Complete some research on the making of this device.

How was it manufactured?

For this same device, does it contain any of the materials we have studied?

Material	
Rare earth metals <u>e.g.</u> lithium, cobalt	
Toxic chemicals	
Oil-based plastics	
Others?	

How many devices do you have at home that are no longer in use e.g. old mobile phones? What are they?

Did you know?
Electronic waste must be disposed of correctly in accordance with the Waste Electrical and Equipment Regulations (WEEE) 2009, which is designed to ensure that less harmful electrical waste is sent to landfill.

Using the Veolia website, find where is closest to your home to recycle electrical waste:
<https://www.veolia.co.uk/sheffield/recycling-site-finder>

|

Did you know?

By the end of 2024, all mobile phones, tablets and cameras sold in the EU will have to be equipped with a USB Type-C charging port. From spring 2026, the obligation will extend to laptops.

Reference: <https://www.europarl.europa.eu/news/en/press-room/20220930IPR41928/long-awaited-common-charger-for-mobile-devices-will-be-a-reality-in-2024>

Explain to your adult at home the environmental impact of 'the Cloud'. What actions could you do to reduce your family's personal contribution to this issue?

Appendix B - In lesson resources for topic 5.1 on Edexcel GCSE Specification



Name	
Class	
Tutor Group	

Subject content	Students should:
5.1 Environmental	5.1.1 understand environmental issues associated with the use of digital devices (energy consumption, manufacture, replacement cycle, disposal)

GCSE Computer Science

5.1.1 Environmental

Key terms	
Carbon footprint	The amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organization, or community.
Cloud computing	The practice of using a network of remote servers hosted on the internet to store, manage, and process data, rather than a local server or a personal computer.
Digital devices	A piece of physical equipment that uses digital data, such as by sending, receiving, storing or processing it e.g. a digital camera or mobile phone.
E-waste	Discarded electronic appliances such as mobile phones, computers, and televisions.
Precious metals	Metals that are rare and have a high economic value.
Semiconductors	A material which has an electrical conductivity value falling between that of a conductor, such as copper, and an insulator, such as glass.
Replacement cycle	The period of time between the purchase of assets such as digital devices and their replacement with equivalent assets.

It is hard to imagine what life would be like without the internet, social media, search engines and e-commerce. Global demand for smartphones, search engines and other digital devices, including embedded systems, web servers, sensors and data storage drives is growing rapidly every year.

At the same time, the pace of new product releases and consumers' desire to own the latest model are shortening the lifespan of these devices. The average life expectancy of a smartphone, for example, is estimated to be less than two years. The more digital devices we buy, the more we dispose of.

Not surprisingly, the manufacture, use and disposal of digital devices has a significant impact on the environment, using dwindling supplies of non-renewable materials, creating massive piles of potentially harmful e-waste and consuming vast quantities of energy.

Impacts on the environment occur at various stages during the life of an electronic device. The product life cycle below shows the stages which all have effects on the environment:



You do:

What effects may there be on the environment during each stage?

Subtopic 1: Energy consumption

Whenever a digital device is used, it uses energy. That energy has to be supplied from somewhere. A computer that is plugged in will be using electricity. Even when a device is not plugged in, if it is turned on it is still using electricity from a battery. Rechargeable batteries, such as those in a mobile phone, need to be charged by plugging them into an electricity socket.

Electricity can be generated from a number of sources, some of which cause damage to the environment more than others:

- coal power plants

- fracking
- solar power
- wind power
- nuclear power plants

You do – renewable energy sources

Read <http://tiny.cc/RenewableEnergy> about renewable energy sources. Identify and describe at least two renewable sources of energy.

Renewable energy source	Description

You do – extension

Using the renewable energy sources you chose above, explain why those renewable energy sources still have an effect on the environment.

Renewable energy source	Effect on the environment

Large data centres, such as those used by Google, Microsoft and Apple, require large amounts of power. When you store data in the cloud, you store that data in a large data centre. Therefore, data stored in the cloud also requires power and has an effect on the environment. It may be clean energy if the data centre runs purely from renewable energy such as solar power. Similarly, personal digital devices can use renewable energy such as solar energy or kinetic energy.

Is the cloud damaging the planet? - Panorama (BBC iPlayer)

You do

1. What is the cloud?
2. Why could the cloud be described as 'greedy'?

3. Where is the first cloud data centre they visit?
4. What was the purpose before the data centre?
5. What do the servers hold?
6. Why is it warm within the data centres?
7. How much energy does one data centre use?
8. How much energy does a 5 minute internet search use?
9. What are some examples of data stored online?
10. What percentage of global greenhouse gases do they estimate that the cloud is responsible for?
11. What is in Arizona, Texas?
12. What are some businesses that have data centres planned or exist here?
13. What has been built to power the data centres?

14. What do the tech companies say they are doing about the water usage?

15. Why do some tech companies say they are already carbon neutral?

16. How many acres will the new data centre in Ireland cover?

17. Why have campaigners in Ireland fought against the new data centre plans?

18. How many data centres are in Ireland now?

19. How many data centres are in Slough?

20. What is the problem with the old photos and data stored on the cloud?

Extra notes:

Solving the problem

Other measures to make data centres more energy efficient include:

- Using a hot-aisle/cold-aisle configuration to increase cooling system efficiency; using blanking panels to minimise recirculation of hot air; and sealing the floor to prevent cooling losses.
- Investing in research to develop a new, less energy-hungry alternative to silicon-based data storage. Graphene may have the potential to do this. Graphene is a single layer of carbon atoms, tightly bound in a hexagonal lattice. Carbon nanotubes are cylinders of carbon atoms with walls one molecule thick. They could be five times faster and use less energy than silicon chips.
- Ration internet usage – possibly by imposing a tax on uploading data – and/or educate users so they behave in a more environmentally responsible fashion. Simply switching from colour to black and white photos when uploading to social media sites would have significant impact.

Subtopic 2: The manufacture of digital devices

Before a digital device can be manufactured, raw materials need to be extracted from the earth. These can include:

- copper from copper mines
- silicon from rock, sand, clay and soil
- mercury
- gold
- lead for soldering components
- plastic for connectors and insulation of cabling

Although in developed nations the extraction of raw materials is well managed, in other parts of the world there is a lack of management. This can lead to problems such as degrading quality

of land, soil erosion and water pollution. It can also mean there could be a shortage of some raw materials in the future.

Extracting raw materials requires energy too. This could be in the form of electricity, petrol and diesel which require raw materials themselves, or more environmentally friendly renewable energy sources. In 2017, The International Energy Agency estimated that the world will be using 113 million barrels of oil by 2030 and that the world's oil supply will run out by 2050.

Where does your phone come from? (The Economist YT video).

Where does your phone come from?



What raw materials are in a smart phone?

Material	Examples of use
<i>E.g., Polychlorinated biphenyls (PCBs)</i>	<i>Toxic compounds added to plastics, circuit boards, and connectors to make them more fire retardant.</i>

The EU Restriction of Hazardous Substances (RoHS) Directive was brought into UK law in 2013.

It restricts the use of all six following materials, forcing manufacturers of computing technology to replace them with safer materials.

- Cadmium
- Lead
- Mercury
- Hexavalent chromium
- Polychlorinated biphenyls (PCBs)
- Polybrominated diphenyl ethers

You do – Raw material extraction e

Read <http://tiny.cc/MineralsEnvironment> and complete the table below by writing a single sentence about each environmental effect of raw material extraction.

Environmental impact	Description
Pollution	
Destruction of land	
Sunsidence	
Noise	
Energy	
Biological environment	
Long-term supplies	

Cobalt

What is cobalt?

Special report : Inside the Congo cobalt mines that exploit children



1. What country is the documentary clip based?
2. Why is cobalt in demand?
3. How old are the boys?
4. How much do they earn?
5. What does the World Health Organisations about handling and breathing in cobalt?

6. What health issue did Akito have? What did he think has caused it?

7. Where does the Cobalt get sold to?

Lithium

What is Lithium?

Going Green with Lithium has environmentalists torn

Going Green With Lithium Has Environmentalists Torn



- 1) What is lithium used for?
- 2) Where does most of the world's lithium come from currently?
- 3) What do they plan to build in Nevada, USA?
- 4) How much lithium will they mine per year?
- 5) How do the miners defend the mining of the land?

- 6) Why do they want to stop Thacker Pass mines?
- 7) How many mine sites are abandoned in the USA?
- 8) Why is this argument a bit different?

Subtopic 3: Disposal of digital devices

When a digital device reaches its end of life, it is often thrown away and ends up in a landfill site. This impacts the environment because chemicals and toxins, including lead and mercury, leak into the soil and can find their way into the water supply. The same problem happens when components are burned. This can cause serious illness when people drink contaminated water or eat crops that were grown on contaminated soil.

It has been estimated that 50 million tonnes of e-waste were generated globally in 2019. Half of this is personal devices such as computers, screens, smartphones, tablets and TVs. The remainder consists of larger household appliances and heating and cooling equipment.

Large amounts of e-waste are shipped overseas to developing countries where it is dumped in landfill sites or dismantled to extract the minerals. Many of these countries are now refusing to take this waste and are threatening to send it back. Developed countries are therefore having to make new recycling arrangements.

[Computer recycling West Africa style - Click - BBC News](#)



- 1) What is the man looking for?
- 2) What is the “take home” pay?
- 3) Where do the men come from?
- 4) Why did they come?
- 5) What are the health consequences of the E-waste processing?

6) What is the impact on the soil and the air?

7) Why is Ghana cautious of introducing legislation against this?

Solving the problem

The Waste Electrical and Electronic Equipment (WEEE) Regulations (2013) sets targets for the collection, recycling and recovery of computing technology and other electronic items. They apply to businesses but not to individuals.

The aim of responsible recycling is to recover valuable metals and reusable components such as plastic, glass and metal, and to dispose of dangerous substances safely.

Major manufacturers of computing technology now have recycling programmes. In developing countries, there are some promising initiatives to create state of the art recycling plants that can turn e-waste into an e-opportunity.

Exam style questions:

You do

State two environmental issues associated with the disposal of digital technology (2 marks).

Describe two environmental issues associated with the manufacture of digital devices (4 marks).

State two ways in which governments are attempting to control the environmental impact of digital device manufacture (2 marks).

Explain how having a short replacement cycle for digital devices is harmful to the environment.

Discuss the impact of computing technology on the environment (6 marks)

Explain one reason why data centres use large amounts of energy

Give four measures that can be taken to make data centres more environmentally-friendly (4 marks).

A legal firm replaces all of its computers on a three-year cycle. Explain one advantage to the firm and one disadvantage to the firm of doing this (4 marks).

Appendix C – Pre-learning questionnaire

ADULT

Pre-education questionnaire.

For any question you do not wish to answer, please circle 'Do not wish to answer'.

How concerned are you about environmental issues?

Please circle one answer.

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Quite concerned
- Extremely concerned.

Do not wish to answer.

Why do you feel this way?

Do not wish to answer.

What sustainability actions do you currently do?

Please tick those which apply.

- ☐ I use public transportation or walk rather than personal vehicles
- ☐ I buy locally grown or seasonal vegetables
- ☐ I only buy goods that have been manufactured sustainably
- ☐ I recycle food packaging
- ☐ I buy digital devices with low energy consumption ratings
- ☐ I recycle using the council provided recycling bins
- ☐ I recycle electrical waste e.g., old mobile phones or cables
- ☐ I use a compost bin to recycle my food scraps
- ☐ I collect rainwater at home
- ☐ I use a re-usable water bottle
- ☐ I turn off lights when I leave the room
- ☐ I do not leave digital devices on standby when not in use
- ☐ I intentionally eat less meat
- ☐ I unplug digital devices when they are not in use
- ☐ I use reusable bags when shopping
- ☐ I avoid single-use plastic
- ☐ I research what raw materials are included in the digital devices I buy
- ☐ I avoid purchasing new digital devices to reduce e-waste
- ☐ Other _____

Do not wish to answer.

Are you aware of any issues around the replacement cycle of digital devices?

Please circle one answer.

Yes

No

Do not wish to answer.

If yes, what issues are you aware of?

Do not wish to answer.

What are two ethical issues related to the disposal of digital devices?

1)

2)

I do not know.

Do not wish to answer.

Do you currently know where to dispose of unused digital devices or electrical waste near your home?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how much energy your devices consume when in use?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how much energy your devices consume when in standby mode?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how the digital devices in your home were manufactured?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know of three rare earth materials, toxic chemicals, oil-based plastics may be contained within your devices?

1)

2)

3)

I do not know.

Do not wish to answer.

What are two ethical issues related to the manufacture of your digital devices?

1)

2)

I do not know.

Do not wish to answer.

How well do you feel Astrea Academy Sheffield educates on the topic of sustainability?

Please circle on answer.

- Not at all well
- Slightly well
- Somewhat well
- Quite well
- Extremely well.

Do not wish to answer.

Are there any actions you believe Astrea Academy Sheffield should take in terms of sustainability education?

Do not wish to answer.

STUDENT

Pre-education questionnaire.

For any question you do not wish to answer, please circle 'Do not wish to answer'.

How concerned are you about environmental issues?

Please circle one answer.

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Quite concerned
- Extremely concerned.

Do not wish to answer.

Why do you feel this way?



Do not wish to answer.

What sustainability actions do you currently do?

Please tick those which apply.

- ☐ I use public transportation or walk rather than personal vehicles
- ☐ I buy locally grown or seasonal vegetables
- ☐ I only buy goods that have been manufactured sustainably
- ☐ I recycle food packaging
- ☐ I buy digital devices with low energy consumption ratings
- ☐ I recycle using the council provided recycling bins
- ☐ I recycle electrical waste e.g., old mobile phones or cables
- ☐ I use a compost bin to recycle my food scraps
- ☐ I collect rainwater at home
- ☐ I use a re-usable water bottle
- ☐ I turn off lights when I leave the room
- ☐ I do not leave digital devices on standby when not in use
- ☐ I intentionally eat less meat
- ☐ I unplug digital devices when they are not in use
- ☐ I use reusable bags when shopping
- ☐ I avoid single-use plastic
- ☐ I research what raw materials are included in the digital devices I buy
- ☐ I avoid purchasing new digital devices to reduce e-waste
- ☐ Other _____

Do not wish to answer.

Are you aware of any issues around the replacement cycle of digital devices?

Please circle one answer.

Yes

No

Do not wish to answer.

If yes, what issues are you aware of?

Do not wish to answer.

What are two ethical issues related to the disposal of digital devices?

1)

2)

I do not know.

Do not wish to answer.

Do you currently know where to dispose of unused digital devices or electrical waste near your home?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how much energy your devices consume when in use?

Please circle one answer.

Yes

No

Do not wish to answer.

|

Do you know how much energy your devices consume when in standby mode?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how the digital devices in your home were manufactured?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know of three rare earth materials, toxic chemicals, oil-based plastics may be contained within your devices?

1)

2)

3)

I do not know.

Do not wish to answer.

What are two ethical issues related to the manufacture of your digital devices?

1)

2)

I do not know.

Do not wish to answer.

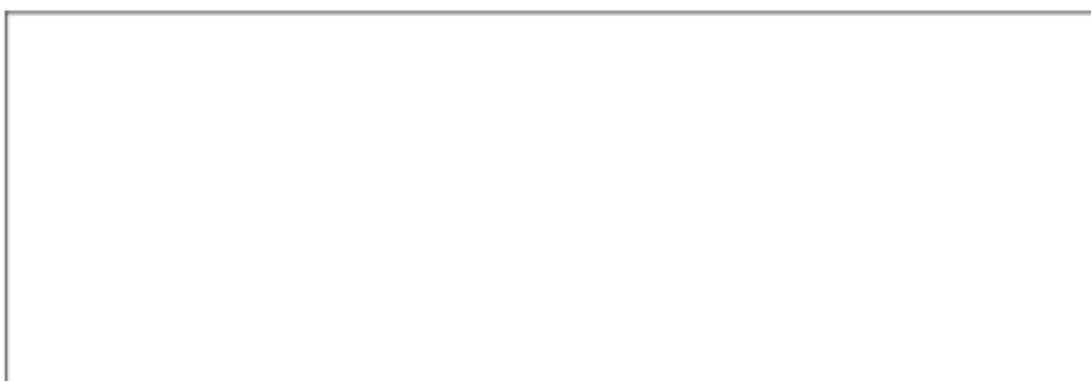
How well do you feel Astrea Academy Sheffield educates on the topic of sustainability?

Please circle on answer.

- Not at all well
- Slightly well
- Somewhat well
- Quite well
- Extremely well.

Do not wish to answer.

Are there any actions you believe Astrea Academy Sheffield should take in terms of sustainability education?



Do not wish to answer.

Appendix D – Post- learning questionnaires

STUDENT

Post-education questionnaire.

For any question you do not wish to answer, please circle 'Do not wish to answer'.

How concerned are you about environmental issues?

Please circle one answer.

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Quite concerned
- Extremely concerned.

Do not wish to answer.

Why do you feel this way?

Do not wish to answer.

What sustainability actions do you currently do?

Please tick those which apply.

- ☐ I use public transportation or walk rather than personal vehicles
- ☐ I buy locally grown or seasonal vegetables
- ☐ I only buy goods that have been manufactured sustainably
- ☐ I recycle food packaging
- ☐ I buy digital devices with low energy consumption ratings
- ☐ I recycle using the council provided recycling bins
- ☐ I recycle electrical waste e.g., old mobile phones or cables
- ☐ I use a compost bin to recycle my food scraps
- ☐ I collect rainwater at home
- ☐ I use a re-usable water bottle
- ☐ I turn off lights when I leave the room
- ☐ I do not leave digital devices on standby when not in use
- ☐ I intentionally eat less meat
- ☐ I unplug digital devices when they are not in use
- ☐ I use reusable bags when shopping
- ☐ I avoid single-use plastic
- ☐ I research what raw materials are included in the digital devices I buy
- ☐ I avoid purchasing new digital devices to reduce e-waste
- ☐ Other _____

Do not wish to answer.

Are you aware of any issues around the replacement cycle of digital devices?

Please circle one answer.

Yes

No

Do not wish to answer.

If yes, what issues are you aware of?

Do not wish to answer.

What are two ethical issues related to the disposal of digital devices?

1)

2)

I do not know.

Do not wish to answer.

Do you currently know where to dispose of unused digital devices or electrical waste near your home?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how much energy your devices consume when in use?

Please circle one answer.

Yes

No

Do not wish to answer.

|

Do you know how much energy your devices consume when in standby mode?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how the digital devices in your home were manufactured?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know of three rare earth materials, toxic chemicals, oil-based plastics may be contained within your devices?

1)

2)

3)

I do not know.

Do not wish to answer.

What are two ethical issues related to the manufacture of your digital devices?

1)

2)

I do not know.

Do not wish to answer.

How well do you feel Astrea Academy Sheffield educates on the topic of sustainability?

Please circle on answer.

- Not at all well
- Slightly well
- Somewhat well
- Quite well
- Extremely well.

Do not wish to answer.

Are there any actions you believe Astrea Academy Sheffield should take in terms of sustainability education?

Do not wish to answer.

How did you find the experience of completing the learning activity with your parent?

Do not wish to answer.

How do you feel about the lessons on the environment?

Do not wish to answer.

Do you have any further comments or questions that you would like to share?

Do not wish to answer.

ADULT

Pre-education questionnaire.

For any question you do not wish to answer, please circle 'Do not wish to answer'.

How concerned are you about environmental issues?

Please circle one answer.

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Quite concerned
- Extremely concerned.

Do not wish to answer.

Why do you feel this way?

Do not wish to answer.

What sustainability actions do you currently do?

Please tick those which apply.

- ☐ I use public transportation or walk rather than personal vehicles
- ☐ I buy locally grown or seasonal vegetables
- ☐ I only buy goods that have been manufactured sustainably
- ☐ I recycle food packaging
- ☐ I buy digital devices with low energy consumption ratings
- ☐ I recycle using the council provided recycling bins
- ☐ I recycle electrical waste e.g., old mobile phones or cables
- ☐ I use a compost bin to recycle my food scraps
- ☐ I collect rainwater at home
- ☐ I use a re-usable water bottle
- ☐ I turn off lights when I leave the room
- ☐ I do not leave digital devices on standby when not in use
- ☐ I intentionally eat less meat
- ☐ I unplug digital devices when they are not in use
- ☐ I use reusable bags when shopping
- ☐ I avoid single-use plastic
- ☐ I research what raw materials are included in the digital devices I buy
- ☐ I avoid purchasing new digital devices to reduce e-waste
- ☐ Other _____

Do not wish to answer.

Are you aware of any issues around the replacement cycle of digital devices?

Please circle one answer.

Yes

No

Do not wish to answer.

If yes, what issues are you aware of?

Do not wish to answer.

What are two ethical issues related to the disposal of digital devices?

1)

2)

I do not know.

Do not wish to answer.

Do you currently know where to dispose of unused digital devices or electrical waste near your home?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how much energy your devices consume when in use?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how much energy your devices consume when in standby mode?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know how the digital devices in your home were manufactured?

Please circle one answer.

Yes

No

Do not wish to answer.

Do you know of three rare earth materials, toxic chemicals, oil-based plastics may be contained within your devices?

1)

2)

3)

I do not know.

Do not wish to answer.

What are two ethical issues related to the manufacture of your digital devices?

1)

2)

I do not know.

Do not wish to answer.

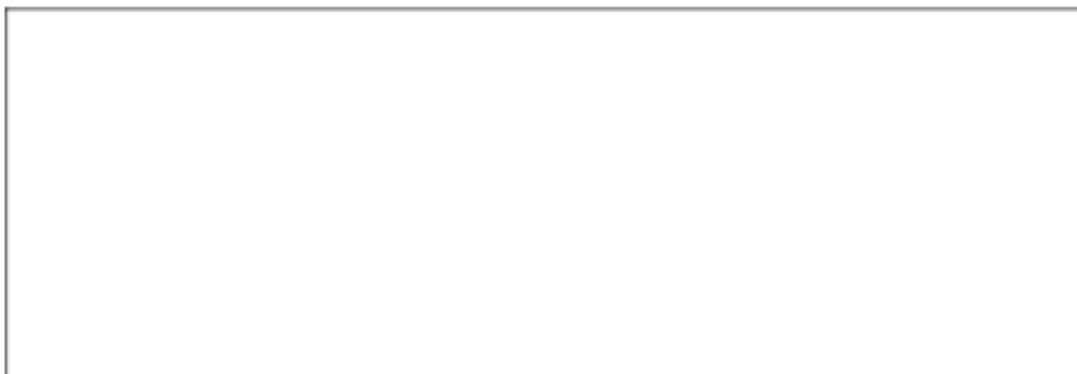
How well do you feel Astrea Academy Sheffield educates on the topic of sustainability?

Please circle on answer.

- Not at all well
- Slightly well
- Somewhat well
- Quite well
- Extremely well.

Do not wish to answer.

Are there any actions you believe Astrea Academy Sheffield should take in terms of sustainability education?



Do not wish to answer.

Appendix E – Letter to parents



Astrea Academy Sheffield
Andover Street
Sheffield S3 9BE
Tel: 0114 553 9110

info@astreasheffield.org
www.astreasheffield.org
Co – Principal – Rachel Flemming
Co - Principal – Mrs Emma Glover

@AstreaAcadSheff

AstreaAcademySheffield

27th February 2023

Dear Parent/Carer,

RE: MBA Sustainability Leadership research project

I am currently completing my MBA (Sustainability Leadership) at The University of Wales Trinity Saint David. I am about to commence my dissertation project, and would love your support.

The aim of the research project is to study: Does inclusion of environmental issue topics, such as electrical waste, in the GCSE Computer Science specification affect young adults and their parent's attitude and actions towards sustainability?

These topics are currently within the Edexcel exam board, and will be examined on in your child's final exams in Y11. I want to find out if there may be potential consequences of sustainability education, further than exam success.

This research will involve:

- A short questionnaire prior to the teaching of sustainability, to be completed by your child, and an adult at home.
- The standard teaching of the sustainability topic (5.1.1 of the Edexcel specification).
- A learning activity to be completed at home by child and parents.
- A post learning activity questionnaire, to be completed by your child, and the same adult at home.

Participation in this research is voluntary. Refusal to participate in this research will have no effect on the education of your child. The 5.1.1 topic will be taught regardless, as an examinable topic within the Edexcel course. You may withdraw from this research at any time, for any reason. Your data will be treated with full confidentiality, and will anonymously be collected, and safely stored.

Please complete and return the slip below to Miss Wynne by Monday 6th March 2023 to confirm that you are happy for your child to participate in this research. By completing the parent questionnaire, you are consenting to engage in this research.

If you have any questions or require any further information, please do not hesitate to contact me at: Megan.Wynne@astreasheffield.org

Yours sincerely,

Miss M Wynne | Head of Computing

Scholar's name: Scholar's form:

I, as the parent/carer of the above scholar, give permission for them participate in this research project.

Signed: Date:

Appendix F – Why did you not participate questionnaire

Why did you decide to not participate in the research project?

(Please circle at least one option)

- Not interested in participating in research
- Do not have time to answer
- The questionnaire looked too long
- The questions were too difficult
- The information required was too sensitive
- My parents would not understand the English language activities
- I did not understand why I should complete the questionnaire
- I did not understand the questions in the questionnaire
- There was no consequence if I did not complete it

Other
