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EARLY AGE SUSTAINABILITY: TURNING KNOWLEDGE INTO ACTION THROUGH EDUCATIONAL AND INTERACTIVE ACTIVITIES

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ABSTRACT

Fostering sustainability by supporting young people in the United Kingdom (UK) in activities and engagement with sustainable practices has significant long-term benefits. In order to promote sustainability in schools we designed a programme: "Sustainability: turning knowledge into action" that supported participation and disseminated the merits of sustainability to school children. We utilised open source materials to facilitate an introduction to the concepts of sustainability and its consequences. We used a participatory approach where students take ownership of activities as they form an understanding of how sustainable practices affect their lives and wider community. Preliminary results indicated that early training and support of young people increased involvement and provided a framework from which active participation developed into greater understanding of sustainability and the burgeoning necessity of living in a sustainable environment.

Keywords: *education, sustainability, 'learn by doing', behavioural change, actors of change*

INTRODUCTION

The principles of sustainability have, in recent years,been widely communicated and accepted as part of a new vocabulary reflecting the need to change antiquated practices. As a result, the terminology and descriptions of sustainability have, like all language, evolved and developed from their original meanings. This has led to some misconceptions surrounding the true meaning of "being able to sustain life" – whose life? For how long? And above all: what sort of life?

Consumer participation in the development or awareness of sustainable practices could increase their understanding and attitude to its importance. The process of change being integrated with consumer demands has encouraged several researchers to promote consumer interaction(Moreira and Wood-Harper, 2015; Valencia, 2015; Young et al., 2010).

In order to motivate life cycle management and the consumer towards sustainable choices it is imperative to understand current market forces and theperceived values of sustainability as illustrated in figure 1.
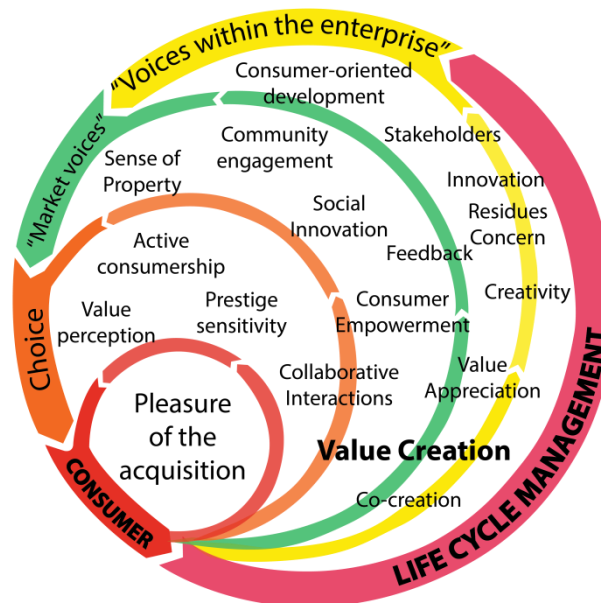
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Figure 1: Theoretical overview of value creation and consumer involvement

Over the last fifty or so years since the Stockholm Convention in 1972 (Strong, 1972),   there has been a growing sustainability discourse as a result of pollution, consumption and environmental change (Strong, 1972). Reflecting on these conversations a need was identified to increase the scope for this research from focusing on current consumers towards the next generations. Moreira et al. (Moreira and Wood–Harper, 2017) in collaboration with suppliers, fair-traders and sustainable companies identified that it would be important to introduce formal sustainability approaches, as they perceived consumers to be detached from the concept of sustainability and unaware of their part as stakeholders.

Young people in the United Kingdom (UK) are in mandatory full time education until the age of sixteen, and, in areas of social and economic deprivation, initiatives like free school meals are currently in place to support impoverished children. The UK despite being the seventh largest economy in the world has been labelled the "European capital of inequality" (Dorling, 2015). The UK whilst being economically strong has a broad disparity in wealth leading to considerable differences in the social and educational outcomes of children in the UK. The UK's approach to sustainability and the culture of recycling is considered to be relatively new. The Household Waste Recycling act (2003) updated the Environmental Protection Act (1990) requiring the separation of recycled waste into at least two bins which was implemented nationally by 2010.

The UK Government provide a webpage encouraging recycling practice (http://www.recycling-guide.org.uk/schools) with an expectation that schools will also teach their pupils about recycling and sustainability. Sustainability issues are far more wide reaching than simply encouraging the recycling of paper, although onein which the school should be participating. The Office for Standards in Education Children's Services and Skills (Ofsted 2009) in their report covering a three year period from 2005 to 2008 evaluated the progress and development of schools becoming sustainable by 2020,the criteria outlined by the Government's National Framework for Sustainable Schools UK. There were positive outcomes recorded, for example having a strong focus on sustainability such asincreasing students' knowledge and importance of leading sustainable lives. They documented beneficial effects that included better attitudes to learning, behaviour, attendance and standards similar to benefits seen in research from Porritt et al., (2009).

Ofsted (2009) and Gayford (2009) found that, in the most successful schools, sustainability was an integral part of a well-planned curriculum. The structured teaching of sustainability ran parallel to special events and activities and was experienced by students both within and outside school. The most successful schools taught sustainability byembedding sustainability practicesinto daily activity such as monitoring and reducing electricity and water usage, auditing and planning sustainable transport to and from school, making improvements to the school's grounds and habitats, and growing food for the school kitchen (Gayford, 2009; Ofsted, 2009). Gayford

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(2009)also highlighted that young people participating in the research were able to explain what they had learnt about sustainability in terms of a healthy lifestyle, saving energy, and recycling, and were able to relate this to their personal actions and sense of responsibility.

Taking into considerationthe students' need for sustained levels of motivation and engagement in order to actually interact with the programme, two approaches were deemed essential: (1) Learn by doing, which meant activities, which required attention and full engagement; (2)Encouraging competition, as during several outreach events competitiveness proved to motivate and encourage the students to pay more attention.

A series of partnerships were developed to ensure appropriate materials were being developed including The Nuffield Foundation Summer Placement who provided two students to participate in the project. It was hoped that by involving students in the design of the sustainability activities the project could remain relevant to current students and curricula.

The main themes of this paper surround the creation, implementation and dissemination of 'Sustainability: turning knowledge into action', a guideline developed by the authors which proposes effective cross-curricular links between sustainability and the National Curriculum in the UK, providing open-source materials to facilitate the introduction of sustainability to students between secondary school age to college and university students.

The paper is divided into six parts: (1) a broad review of the literature which justifies the method and the pedagogy behind it; (2) research design and methodology which presents the main principles to perpetuate knowledge; (3) the programme's structure; (4) the implementations already carried out in order to test and improve the activities proposed; (5) discussion and analysis of the implementations, the feedback given by teachers, students and other support staff involved; and (6) conclusions and future projects.

REVIEW OF THE LITERATURE
In order to understand the best practices towards the development and implementation of effective educational programmes an extensive review of the literature was developed ensuring the content's suitability to the target audience as well as pedagogic stances proposed by the authors.

2.1. Behavioural change towards sustainability
Changes in consumer behaviour have been seen as pivotal in the increase of sustainability since the first discussions on the topic during the United Nations Conference on the Human Environment – Stockholm(Strong, 1972). However, since then, developed countries have failed to create a global consensus towards sustainable development (reflected for instance in the refusal of several countries to sign the Kyoto Emissions Protocol) (Creech, 2012).

In 1991, Ignacy Sachs proposed what he considered to be the best path towards sustainability, developing strategies through five key dimensions: culture, society, environment, economy and space (Fig.2).
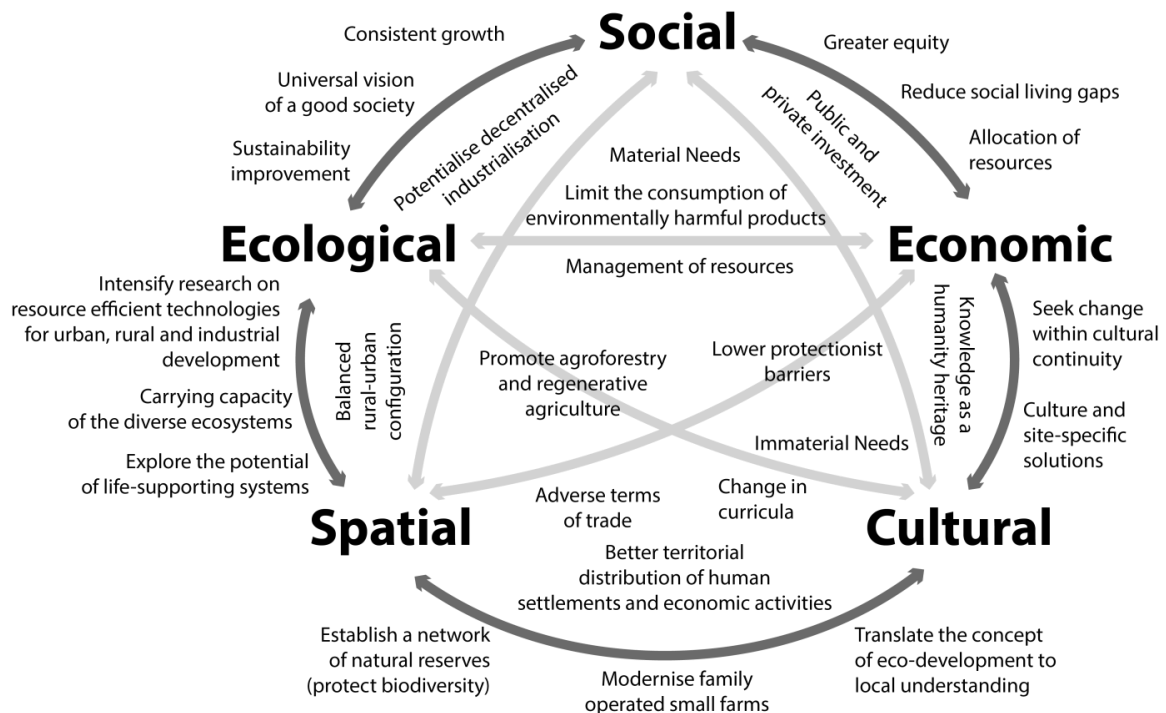
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Figure 2: Interaction proposed by Moreira et al. (2017)

Developed countries sought out cheap labour and weak environmental laws in developing nations so they could produce 'more for less'. This has fuelled concerns surrounding the fast pace of this environmental negligence seen since the 1992 Rio Earth Summit. Consequently agenda 21 states, "the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in industrialised countries (…)"(United Nations Sustainable Development, 1992, p. 18).

Hargreaves (2011) proposed a large-scale ethnographic case study throughout the UK in which behavioural change would be implemented through social practice theory. After nine months of participant observations the author found that simple changes towards instinctive office behaviour led to longer intrinsic changes, which were perceived as internal rules and unconsciously adopted by many of the site employees. The author highlightedthat practice-based group approaches proved more efficient than individual approaches.

From an implementation perspective there is literature to support the author's approach. Prince (2010) focused on early age sustainable education in New Zealand and Allum et al. (2008) analysed the effectiveness of attitude change in global citizenship in Oxfordshire (UK) schools. According to these authors, teaching pupils about 'their' importance in preserving the environment and participation in local actions can influence global issues. These findings   support this papers exploration of motivating students to learn by doing, imprinting key sustainability knowledge and attitudes onto younger generations through fun and unconventional activities during the academic year.

2.2. Generating actors of change
Participatory research is characterised by the involvement of users or stakeholders as participants in the research (Redström, 2008; Schuler and Namioka, 1993). This approach, among others, seeks to demonstrate a shift towards more positive social and environmental considerations(Muller and Kuhn, 1993; Schuler and Namioka, 1993).Previous literature defines the act of participatory research as either (1) the generation of new ideas, theories, methods, or techniques; or (2) the review, verification, adaptation or refining of existing ideas, theories, methods, or techniques through empirical studies(Johnson et al., 2004; Kemmis and McTaggart, 2005; Pain, 2004). It is an approach for collaboration, problem solving and sharing differing perspectives and experiences.
A democratic sharing of knowledge between researchers and other participants (Greenwood et al., 1993; Pain, 2004; Wallerstein, 1999)to co-generate knowledge and share multiple viewpoints and understanding forms the

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core of participatory research(Davies and Burgess, 2004). Okali et al., (1994) illustrated the empowering of 'non experts' and use their contributions to co-generate knowledge for farming systems.

Those involved in participatory research should feel empowered, not just to be there to provide information for the researchers(Greenwood et al., 1993; Macnaghten and Jacobs, 1997; Wallerstein, 1999).

There is incomplete scientific knowledge and indeterminate issues informed from various scientific sources contributing to our understanding of the complexities of sustainability(Pellizzoni, 2003; Smith, 2001; van den Hove, 2000). A participatory approach embraces this plurality of voices, knowledge and values and engages different audiences to explore and discuss them (Pellizzoni, 2003; Smith, 2001; van den Hove and van den Hove, 2000). The participation of various stakeholders including the public is important,not just in the generation of knowledge,but finding possible solutions to these global issues (Mayumi and Giampietro, 2006; Reed et al., 2005; Strager and Rosenberger, 2006).

There are, within participatory research, a variety of techniques, methods and conceptual frameworks that include design innovation, supporting participants in being involved and developing ideas in relation to future scoping and use (Greenbaum and Kyng, 1991; Schuler and Namioka, 1993). Young people have also featured within participatory research seeking to empower and include their 'voices' as experts of their own worlds (Alderson, 1995). This involvement may include their participation via peer interviewing (Young and Barrett, 2001), the design of the research (Hart, 1992), via focus groups (Bagnoli and Clark, 2010)or evaluation (Van Blerk and Ansell, 2009). The participation of consumers may increase public awareness and develop an understanding of the complex problems that society faces and of some of the methods that can assist in solving these problems (Kickert et al., 1997).

Barratt Hacking et al., (2007)argued that participatory research with children as researchers is important in building their understanding and capacityfor influencing their behaviour. There are examples in participatory projects that investigate playful approaches and use games to motivate participation and stimulate critical thinking (Brandt and Eva, 2006; Brandt and Messeter, 2004). Brandt and Messeter (2004)used games to focus on specific issues where multiple perspectives can be expressed and shared from different contexts over a five year period of participatory inquiry.

Alongside the development of the programme, 'rich pictures' (East and Metcalfe, 2002) have been used to assist in illustrating the complex concepts of sustainability. 'Rich pictures' are similar to mind maps that illustrate the relationships between activities and actors within a system (Checkland and Poulter, 2010). By providing a macro and micro diagrammatic idea of the discussed situation this approach facilitates the management of complexity(Mitroff et al., 2013).

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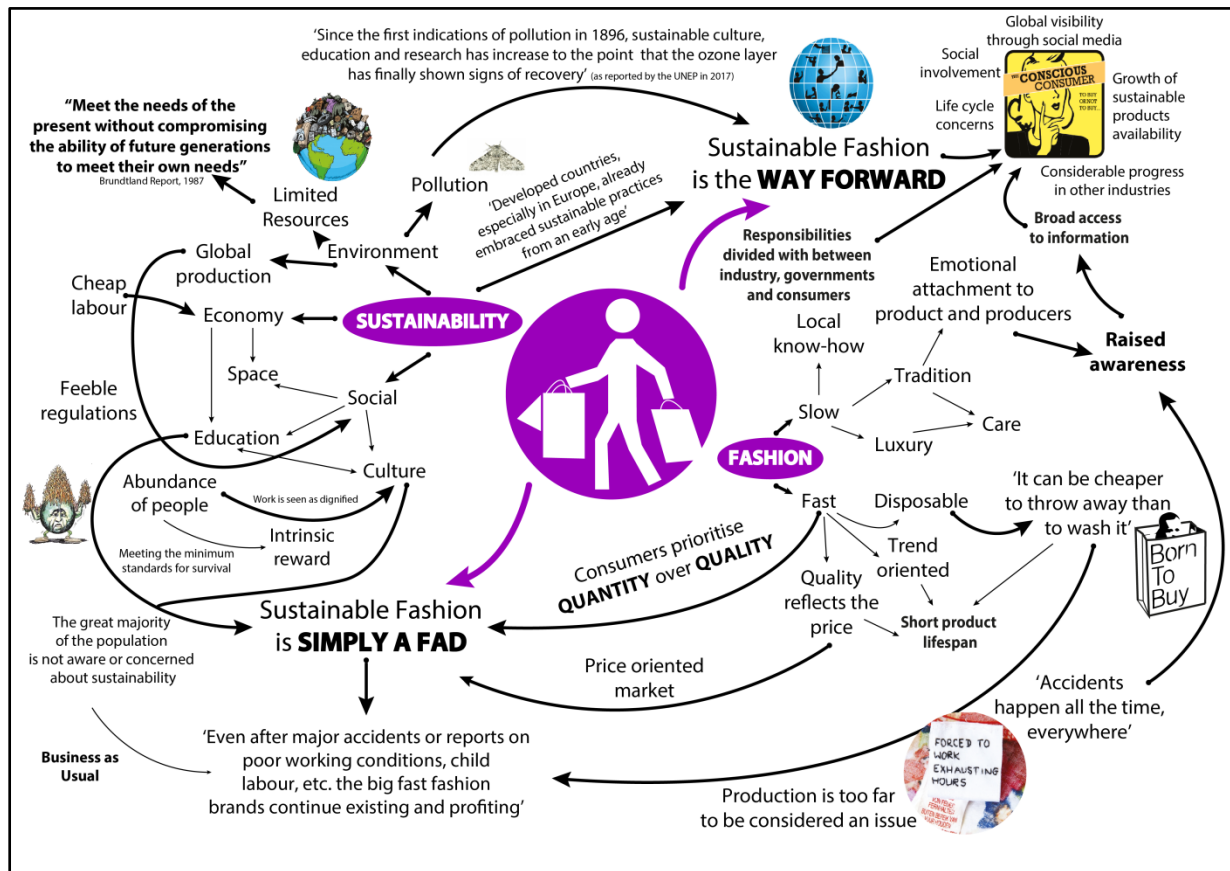# International Journal OF Engineering Sciences & Management Research

Figure 3: Example of Rich Picture (developed through discussions with undergraduate students at the University of Manchester, University of Chester and Nottingham Trent University)

'Rich pictures' involves a deep understanding of a situation the consequences of each action carried out by different actors involved in the 'problem'. They look to interpret the situation or 'problem', usually messy and improve it.

An example of a 'rich picture' developed from discussion with undergraduate students with the intention of analysing their sustainable fashion consumption beliefs is illustrated in Figure 3.

Armson (2011) indicated thatthe development of rich pictures involves considerations over each element, question, observation, understanding and insights which can be recorded in the image, bypassing the need for words which tend to limit the understanding of the situation.

The most important aspect of the systemic approach is not to accept things as they are or "less bad"and fail to use creativity as a differentiator. It is to be "good", teaching zero waste, zero emissions and above all zero ecological footprint (Morelli, 2006). Within this perspective, sustainability ceases recognising the products and the supply chain as individual parts but thatthere will be shared value in involving the whole community.Noting the current generation of waste which is an inevitable consequence of the production system, however changing the focus from end of process social cost to a new social activity (Bjørn and Hauschild, 2011). Additionally, Mitroff (2013) believes that in order to improve one part of the system the whole system will need to be improved, a concept widely adopted in this project.

Al Gore (2013) described six drivers for global change: (1) Earth Inc; (2) The Global Mind; (3) Power in the Balance; (4) Outgrowth; (5) The reinvention of Life and Death and (6) The edge.Gore analyses how the technology evolution and materialistic society has led to widespread consequences around the world. He highlights the changes seen in politics and society, mainly by the adoption of technology;and predicts a future in

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which drastic behavioural, political and economic changes will be needed shifting towards collective decision-making on a global scale.

Widening the understanding of sustainability concepts, human rights, environmental conservation, economic empowerment and social engagement are essential to the creation of 'actors of change' – people able to understand the compromises required in order to sustain life on earth as we currently know.

The complex profile and pedagogic responsibility of education and associated projects lead to the assessment of key strategies towards management and implementation. Within the literature, authors have proposed numerous models and tools to ensure adequate outcomes and imprint sustainable concepts and actions (Checkland and Poulter, 2010; Grabs et al., 2015; Sterman, 2001).

2.3. Teaching Sustainability

According to Sterman (2001), meddling with one part of a complex system without the due considerations towards the whole threatens to create new, unforeseen side effects that could potentially be more problematic and complex than the original. Through the development of soft systems, Checkland and Poulter (2010) proposed a rounded approach to the different worldviews in order to tackle problematic situations. By understanding the problem through the "eyes" of another, the authors believe it is possible to create 'arguably desirable' and 'culturally feasible' change.

In regards to everyday life, we propose a seven stage model (Figure 4): (1) identify a perceived problematic situation; (2) analyse the different worldviews; (3) identify people acting purposefully; (4) create models of purposeful activities; (5) structure a discussion about change; (6) find versions of generally accepted to-be-changed situations; and (7) implement changes to improve the problematic situation.
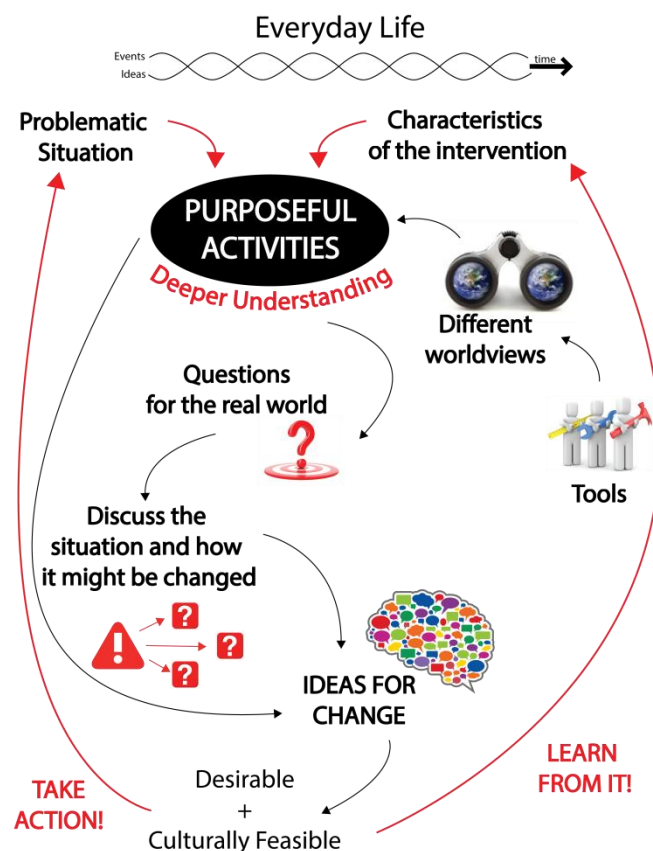

Figure 4: Graphic adaptation of Checkland and Poulter's cycle of learning for action

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The presented research explores a system thinking approach focused on taking action and learning from proposed ideas to inform the implementation of change. We present auseful interaction between the management of messes and effective modelsproposed in the literature look to ensure the implementation of change in everyday life (Armson, 2011; Checkland, 1981; Checkland and Poulter, 2010; Jenkins, 2008; Sterman, 2001).

2.4. Educational Partnerships

In the UK several groups have developed programmes and initiatives encouragingyoung people to engage withscientific and empirical evidence, widen participation and contribute to diversity.

As part of this research it was essential to create partnerships with groups currently involved in the various education levels targeting the introduction to different scientific topics and representability. The following initiatives were selected from these requirements.

2.4.1.   Science, Technology, Engineering and Maths (STEMNet)

The National STEM Learning Network, an initiative of the White Rose University Consortium, is the largest provider of STEM education and career support to schools, colleges and other groups working with young people across the UK, aiming to increase their interest in STEM subjects and careers. Divided between different communities and areas of the country, the network provides a bridge between academia, businesses and students.

Focused on increasing the number of young people progressing in STEM studies and careers, STEMNet has well stablished partnerships with the Wellcome Trust, Gatsby Charitable Foundation, the UK Government and Department of Education, Project ENTHUSE, other educational groups (i.e. The Royal Academy of Engineering) and employers, providing:

> *"teachers, school technicians and others working with young people with; STEM-specific, career-long professional development; access to free of charge, curated curriculum resources, STEM Ambassadors; STEM Clubs support; and a wide range of engaging activities with proven impact on outcomes for young people. We also work with employers of all sizes to help them maximize the return they get from their investment in working with young people, teachers and schools."*

The overall programme functions as a constant motivational tool for students and teachers to activelyengage with different sources of knowledge and skillsets. Through the STEM Ambassador programme (spread throughout the UK into 19 hubs), STEM professionals and academics (also including undergraduate and post-graduate students) can provide courses, talks, visits, etc. in order to display the opportunities in the field, engage with prospective career paths, and for teachers and facilitators to update their knowledge.

The network in England is composed of 50 Science Learning Partnerships, which provides local Department for Education supported science focussed professional development. In Scotland, Wales and Northern Ireland it provides, also locally, professional development through the Scottish, Schools, Education, Research, Centre (SSERC), Techniquest (Welsh Science Discovery Centre with 160 interactive exhibits) and Education Authority Northern Ireland.

From national and local evaluations of STEM's Continued Professional development (CPD) the network's impact has proven to motivate and generate higher levels of engagement from the teachers themselves, pupils and schools, considerably improving the teaching experience and learning exchange. As a consequence, The National STEM Learning network has proposed the following model for change:
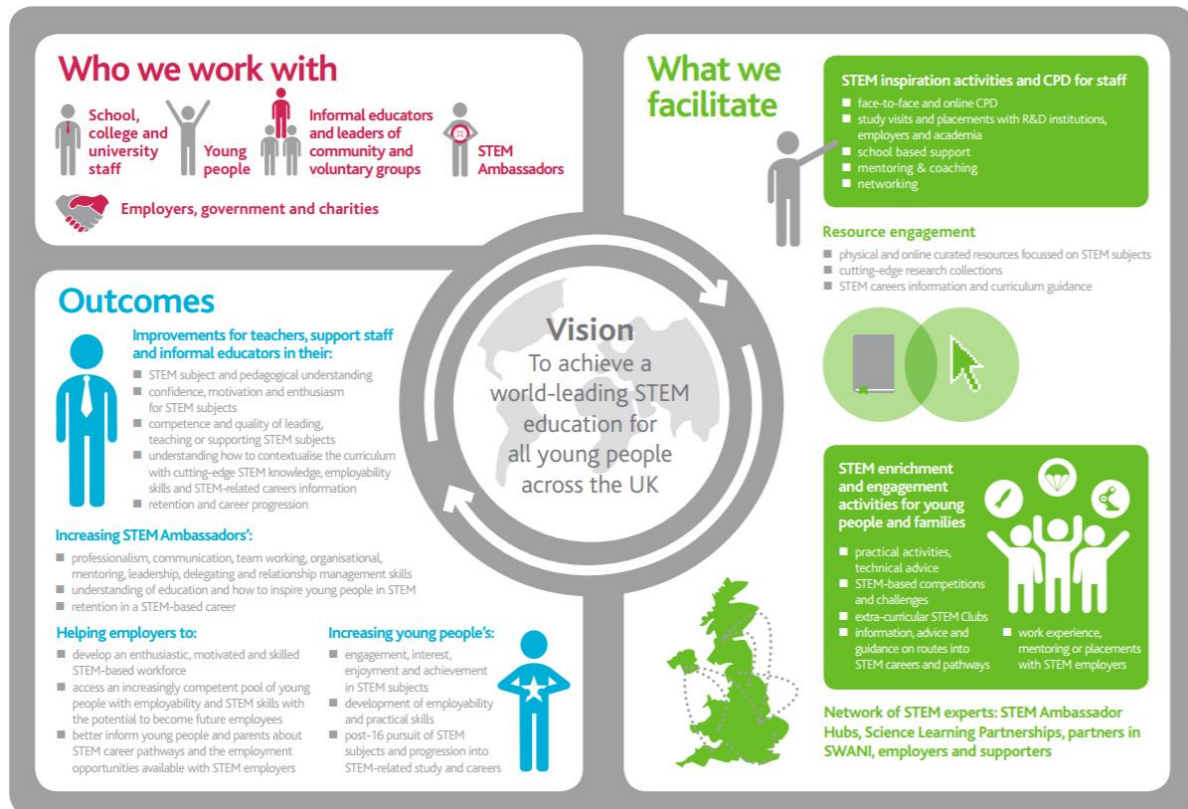
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Figure 5: STEM's model for change(STEM Learning, 2017)

2.4.2. *Reading International Solidarity Centre (RISC)*

RISC isa locally managed centre that has developed strong relationships with the fair trade communityproviding educational propositions and programmes focused on the concept of Global Citizenship. They are considerably smaller in comparison to STEMNet. Through different activities and interactions, the centre collaborates with schools and community groups exposing global issues and promoting action for sustainability, human rights and social justice.

Grounded on the United Nations' 17 Global Goals for sustainable development (6), RISC promotes global citizenship, which focuses in instigating individuals to evaluate international consequences of local practices and how it can be medicated or improved through remote assistance.

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Figure 6: The Global Goals for Sustainable Development(United Nations, 2015)

The national curriculum in the UK currently comprises concepts such as citizenship and sustainability; however, RISC's intention leans on the social aspects of sustainability as well as the environmental. Through its partnership with the European Commission, the centre was able to develop a report about its influence in educational outcomes in Oxfordshire(Allum et al., 2008). By developing a toolkit to measure attitudinal change in global citizenship (from early years to Key Stage 5 - two years of education for students aged 16-18) RISC has promoted its slogan "Think globally, act locally". RISC has assessed the efficiency of its methods towards action for change and received positive feedback from teachers and pupils implementing their material.

2.4.3.   *Nuffield Research Placement Programme*
Nuffield research placement programme also known as the Nuffield Science Bursaryfocuses on students willing to enrich their educational experience through research placements in local universities. The programme is similar to an internship where students take a role in participating in university researchprojects whilst on their first year of a post-16 science course with prospective orientation towards STEM careers.

Established in 1943 by William Morris, later Lord Nuffield, the Nuffield foundation is a charitable trust aimed at improving social well-being. Within its numerous funding programmes, the research placement was developed to improve research capacity in science and social sciences, having a medium and long-term impact on policies and practice, commissioning and stimulating different areas of research throughout the United Kingdom.

RESEARCH DESIGN AND METHODOLOGY
Jenkins (2008) proposes strategic questions which would be essential for the development of a relevant curriculum structure which enables true involvement and understanding of the topics being discussed, leading to increased motivation "providing others with challenges that will allow them to end up feeling both competent and autonomous, will promote in them greater vitality, motivation, and well-being".

Considering the above scenario factors such as:objectives, partners, targeted audience, methodological approaches and pedagogic considerations were incorporated to the research design and rationale.

### 3.1. Research problem and Objective
The research is initially concerned with the consumer's understanding of sustainability and their reluctance to adopt sustainable materials, a process grounded by the sustainability tripod (Riopel et al., 2011 - figure 7). The tripod combines three key factors in promotion of sustainability: the environment, social improvement and economic stability.

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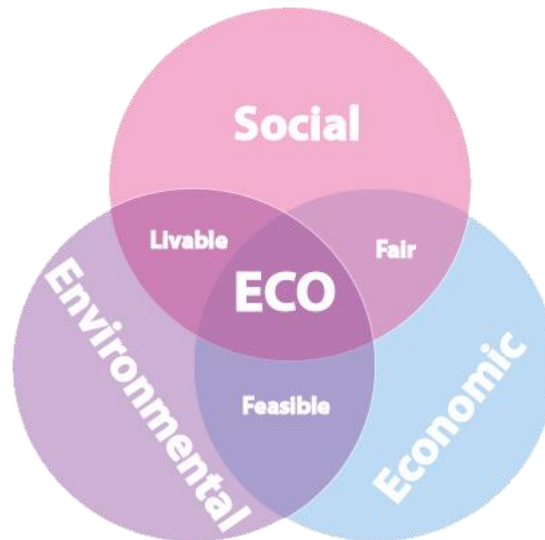
Figure 7: The three pillarsof sustainable development

Expanding the factorsto Sachs' five dimensions, practice-based group approaches consumer behaviour and education towards sustainability, this educational programme initiative originated from interviews, surveys and meetings with educational partners to inform the development of a relationship model illustrated in figure 8. An essential asset to the educational programme was identifying key actors and activities from the following three perspectives:

- current consumers who were either aware of their importance towards sustainable change or were willing to learn via interviews or workshops;
- sustainable fashion companies, fair trading shops and suppliers who considered the lack of education or value appreciation one key barrier to their growth via interviews or surveys;
- meetings with the educational partner who were looking for easily implementable yet content enriched activities that would be implemented through them in schools, colleges and universities in the UK.
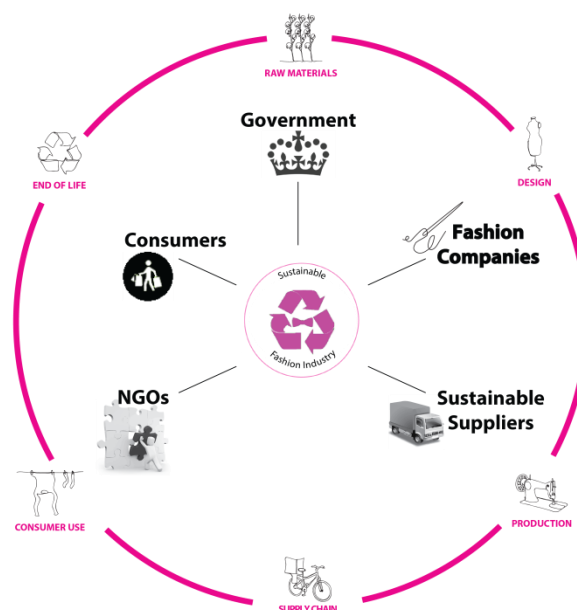
Figure 8: key actors and activities considered for the development of the educational programme

The overall problem was then defined as the creation of a multi-age group educational programme that reflected everyday life concerns, the industries involved and the complex sustainable concepts to inform the next generations of UK consumers.

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Using the current sustainability awareness programme developed by RISC as an example, the authors decided to create an open source, culturally embracing interactive programme.The programme would provide teachers and lecturers with eight workshops, to be implemented as deemed by the facilitator and which, if divided into separate activities could lead to a year-long implementation of sustainable concepts, possibly expanding into developing entrepreneurial ideas through a business challenge 'Bears Cave', designed to instigate sustainable entrepreneurship.

3.2. Methodology design

It is important to assist young people with developing knowledge of sustainable concepts imprinting societal principles and values that will be followed throughout their lives. According to Schopenhauer's psychological observations (Revans, 1980 p. 165) "There is no absurdity so palpable that it may be firmly planted in the human head, if only you start before the age of five and constantly repeat it with an air of great solemnity". In consideration of this, it was essential to consider that the implementable programme would be suitable across various age groups (in this case from the beginning of year 6).

The importance of learning about sustainability from an early age is a reflection of the concept of systems learning where the school is seen as an integral part of the community where a child is educated(Vickers, 2010).The idea of learning appreciation comes from the work of Sir Vickers (Blackmore, 2005) who proposed learning systems for environmental decision making during the late 20th century. Vickers (2010 - p. 19) proposes that "We are changed not by being talked to but also by hearing ourselves talk to others, which is one way of talking to ourselves". Considering this aspect of learning one of the essential aspects of the proposed programme was to motivate participation through discussions or verbal interactions which would require thinking, argumentative development and discussing.

The development of the programme as a didactic tool was then seen as a system in which categories and criteria are mutually related (Vickers, 2010). Science can be seen as an uninteresting subject if not implemented properly. Embracing 'hands-on' activities generates more interest from younger students; for the older pupils, the development focused on creating competitions, team work and rewards (Sterman, 2001).

3.3. Anecdotal data collection and analysis

A commonly used technique in educational research is that of anecdotal data collection and analysis (Lewis, 2010). This approach requires in-depth understanding of the topic by the researcher as it focuses on subtle behaviours and responses from the research participants without open data collection, recording and notes.

The researchers perceptions of the environment and the participants anecdotal evidence can be as rich and useful as empirical evidence (Amato and Amato, 1973). This method was chosen due to the research being implemented in diverse settings: with high school, college and undergraduate students in the Midlands and North West of the UK.

The age difference, finite timeframes and association to partners (all the implementations carried out with minors were under the supervision of the STEMNet and through the STEM Ambassadors Programme), created limitations but expanded the reach of the research. To engage in early feedback from teachers and students and anecdotal approach would allow implementation and feedback to occur in early development phases of the programme.

The longitudinal aspect of the implementation and the period of time required to analyse a change in attitude were considerably longer and extensive than the period of research would allow (between April 2015 and January 2017). However, according to Hargreaves (2011) and Allum et al. (2008)debates and discussion activities lead to an open display of the knowledge 'absorbed' by the student, which can then anecdotally be interpreted.

THE PROGRAMME

In order to motivate the "decision-makers of the future" (Prince, 2010) in their lifelong journey to sustainability, the programme was developed utilising curriculum-based learning experiences which could easily be linked to specific Science, Art and Design, Mathematics, Citizenship and Geography education curricula.

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To instigate other key principles considered by all the project's partners, the authors integrated important factors: (1) reaching out to a broad public platform, for instance not limiting the level of the activities to highly educated participants; (2) engaging ethnic minorities, youngsters of diverse backgrounds, through non-stereotypical associations; and (3) promoting gender equality throughout the material.

The content of the programme proposes an eight workshop set of activities, which can be delivered in a period as short as 8 days, one part per day, or spread over a period of a year. The programme can besplit into 17 separated activities and cover a wide variety of topics as can be seen on Figure 9.

Figure 9: Topics covered by the programme

A. Workshop 1: Sustainability, what is the fuss all about?
Introduce the participants to sustainability - Workshop containing auxiliary slides, a word search and a general introduction to circular economy, aimed at a simple yet comprehensive introduction to sustainability

B. Workshop 2: Green quiz
Start exploring sustainable concepts through a group quiz which reflects activities and objects commonly found in the UK - Workshop including 5 games, covering deeper concepts through memory games and group competition

C. Workshop 3: Social development
Present social realities which might be very distant or more complex to some students - Workshop presenting questions to motivate discussion, including a video and geographic quiz about the source of materials

D. Workshop 4: Environmental development
Approach alternative behaviours to daily activities - Workshop of environmental activities presenting daily challenges to motivate change for example the waste audit in which students analyse alternatives to disposed rubbish

E. Workshop 5: Economic development
Promote economic awareness through simple data (sometimes difficult concepts to understand for students) - Workshop that proposes useful discussions of cases where financial growth led to improvements on social and environmental aspects

F. Workshop 6: Debate
Chance for the pupils to discuss what has been learnt - Debating session - providing the opportunity to argue pro and cons of the different topics of sustainability

G. Workshop 7: Upcycling
Creative activity to promote upcycling and reusing materials - A series of upcycling challenges including instruction cards for students. Creating new objects from un-wanted products (waste)

H. Workshop 8: The Bear's Cave Final
Activity to motivate students to propose ideas using the knowledge they have developed - Students work in groups to develop a sustainable company informed by the learning developed from the previous activities

I. Extension games - A series of gaming activities have been designed to explore the knowledge acquisition from the programmes series of activities about sustainability.

Table 1: Extension games

Activity	Description	Goal
Cards for Humanity	Based on the format of 'Cards Against Humanity' this game proposes a positive take on sustainable behaviour and knowledge	The game contains 130 questions or phrase cards and 650 statement answers which should be combined to create the most interesting answer
Quiz Me	Simple quiz game with different sets of questions and a game board which should lead to the end and the most knowledgeable player	There are 300 cards in the game: 100 multiple answer questions, 100 true or false statements and 100 knowledge cards
Textile Quiz Me	Similar to 'Quiz Me', the textile version is an alternative for schools with textile programmes as there are few games based on textiles	There are 300 cards in the game: 100 multiple answer questions, 100 true or false statements and 100 knowledge cards
Battle of the Materials	Developed with the Museum of Science and Industry of Manchester this game is part of the Resource Boxes project which promotes different uses for materials	Similar to 'Top Trumps' games, these cards provide the characteristics of 60 different textile materials and each player needs to "battle" the other over one specific quality in order to win.

IMPLEMENTATION
Through pedagogy students' understanding and knowledge of sustainability can be developed(Prince, 2010). There is a consensus that young people also need to be given the opportunity for critical thinking and discussion(Allum et al., 2008).

The developed cross-curricular resource would support the students' to develop knowledge, understanding and their values and attitudes towards sustainability. The programme uses dialogue and activities specifically related to the core issues of sustainability and develop their understanding in relation to the real world around them.

To engage young people in educational environments a series of informal oral presentations and discussions were made to teachers and educational partners. These were used to gather feedback on the programme itself and also demonstrate and discuss implementation. Three vital partners involved in developing these networks were the School University Partnership Initiative (SUPI), Reading International Solidarity Centre (RISC) and The Museum of Science and Industry (MSI).

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The SUPI scheme funded by the Research Councils UK was developed to nurture relationships between the University of Manchester and schools in the Greater Manchester area to bring contemporary research to life. An annual networking event was held so that University researchers and teachers from interested schools could meet and discuss the engagement activities and resources available to be brought into schools. This discussion with teachers allowed them to think about where the programme could work alongside the current curriculum being taught in schools.

The Museum of Science and Industry part of the Science Museum Group is a STEM ambassador hub for Greater Manchester and The Trans Pennine area linking schools and youth groups with STEM volunteers.There are organised platform for networking and events provided an ideal opportunity to further discussions and network for the programme.

5.1. Engagement with participants in secondary and further education
The programme also benefited from the input of two Nuffield Research placements that provided constructive feedback highlighting further directions and activities for the programme to explore. Nuffield Research Placements give sixth form and college students the opportunity to undertake research in STEM based subjects in workplaces such as Universities in the UK. The students actively engaged in the core values of the programme and some of the activities.

Rickinson (2006)highlighted that thereis limited research of students and teachers understanding of sustainability within the UK. Nagel (2004) used formal and informal learning approaches to evaluate students understanding of environmental issues. Hopwood (2007) evaluated the learning experiences about environmental issues with a small group of pupils and how they responded to the information and whether it deepened their knowledge of environmental issues.Summers et al., (2004) examined student teachers understanding of sustainable concepts and identified that there are seven areas of interest including purpose, nature, human focus, timescale, scale, controversy and aesthetic. Walshe (2008) identified that the complexity of sustainability issues can be understood more easily to students through direct links and identificationwithissues relatable to their own lives. This approach takes into considerationwhat impact they may have, how current decisions regarding sustainability issues including policy are made and their contributions.

Hicks and Holden's (2007) research looking at young people's views of the future, found strong evidence that, regardless of age, the environment is a consistent theme in their concerns about the future. They also highlighted that providing positive supportive learning environments where they can work together is important in helping students to question and deal with their concerns. This research also shows that enabling young people to develop a sense of agency collaborative involvement and engagement in their learning can increase feelings of hope for the future findings that have also been demonstrated in the Cambridge Primary Review (Alexander, 2009) and research from (Chawla and Cushing, 2007). In support of this the Research for the National College (Birney and Reed, 2009)and the ESRC (Percy-Smith and Burns, 2009) provides strong evidence young people's involvement in discussions, decision-making and action to do with how the school and community responds to sustainability is providing a platform for their future social participation.

The networking established links with three secondary schools with varying socio-economic student cohorts: The Manchester High School for Girls, Whalley Range High School and St Paul's Catholic High School, all located within the Greater Manchester area.

The schools used the designed programme to help facilitate either planned events for example 'Science week'or a sustainability activity day.The schools' populations varied in their socio-economic status evaluated by key indicators such as the eligibility of their pupils for free school meals (FSM). Free school meals are given to pupils whose families may be on low incomes and not in full time work.

Manchester High School for Girls is anindependent,fee-paying schoolwith no students receiving free school meals. Whalley Range High School is a comprehensive girls high school with 32.5 % of pupils allocated for free school meals (DfE, 2015). Saint Paul's Catholic High School is a co-educational voluntary academy with 32.2% of pupils allocated for free school meals. According to the Department For Education the national average for eligibility for school meals is around 23%. All pupils in the study were aged between 10-16 years old.

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Learning experiences varied due to different activities being utilised from the programme prepared in partnership with the teachers to ensure the material would be suitable for the abilities of the students' in the classroom. Students' engaged with the activities in groups or as part of the larger cohort.

5.2. Engagement with participants in Higher Education

Today's graduates have a crucial influence on the future of the environment and therefore their awareness of sustainability issues highly relevant (Lozano, 2006; Waas et al., 2011; Wright, 2007; Zilahy and Huisingh, 2009). This challenge is important and with varying perspectives from their student cohorts.Svanström et al., (2008) point out the importance of systemic and holistic thinking, integrating these various perspectives whilst promoting problem solving and critical thinking (Lozano, 2006; Svanström et al., 2008). Kagawa (2007)states that in a "rapidly changing and uncertain world faced by sustainability-oriented challenges, higher education needs to play an increasingly significant role in helping students become active, responsible citizens" (Kagawa, 2007 p. 335).In additionWals and Corcoran(2006) highlight the importance of 'transformative learning' where students are encouraged to integrate and communicate with others, confront issues reconciling multiple ways of thinking and importantly handle uncertainty.

The programme has been introduced to students at Nottingham Trent University and University of Chester as part of two taught degree programmes. The sessions introduced concepts and challenges from the programme suitable for their programme of study.

5.3. Outreach focusing on game activities – MOSI, Fashion for Good

A series of playful and engaging game activities were developed to explore issues around sustainability, economic and social constructs. Prototypes of the games were demonstrated at The Museum of Science and Industry STEM event and a conference debate event at the University 'Fashion a Force for Good?' with a diverse range of people interacting and playing the games. The games highlighted discussion points and new aspects of challenges being faced on a global scale. The feedback from these events assisted in reviewing the material for the prototyped games.

5.4 Overview of implementation

Through the implementation of this programme at various educational settings we aimed to transform participants' attitudes and learning about sustainable practices.   Davis and Elliott (2003) describe 'transformative education' as educating people about living sustainably and in harmony with the planet. The limitation of this study is that there have been five implementations and currently findings cannot be generalised to the wider population. The authors experienced issues in running the workshops alongside the curriculum and being able to timetable the sessions within an already busy school timetable. .

The adaption of the activities to suit the time available shows the versatility of the programme for different settings. The ability to document lasting legacies of change orthe impact on change behaviours of participant involved in the workshops has yet to be explored. The difference in attitudes towards sustainability had certainly improved on an anecdotal level of participants understanding demonstrated through the participants' arguments on the debates or opinion demanding activities (like for instance 'Agree or Disagree' questions on the social development workshop).

5.5 Ethical considerations and research limitations

Due to the anecdotal nature of the research ethical consent was not needed as advised by the University of Manchester Research EthicsCommittee. The young people involved in the engagement of the activities have been under the supervision of their teachers. The designed programme was developed, as a platform of activity to be used in educational environments and does not require the gathering of confidentialinformation or the retention of data and therefore further consent was not needed as advised by the University Ethical Committee.

FINAL REMARKS

The development, implementation and improvement of the educational programme presented here started in February 2015 and required over two years for its publication. The initial template proved extensive and complicated for younger students, after the first implementation the importance of developing an age suitable programme, able to deal with younger and older students was then approached by hosting the college students for a month and developing/testing the activities with them.

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Having two sixteen year old students created a pivotal link between what the researchers wanted to portray and the interactivity required by the age group. After over 9 implementations and two semesters teaching sustainability for undergraduates in the University of Manchester, University of Chester and the Nottingham Trent University; the level of interaction and understanding of younger students increased considerably, providing a usable framework which can be implemented by the researchers, outreach facilitators, teachers and ambassadors.

Overall the reception to a consolidated formal programme was warm and encouraging, leading the team to winning a commendation by the University of Manchester for the 'Making a difference' Award for Social Responsibility, bestowed by the university's social responsibility team.

Considering the different countries, age groups and social level of the supporting literature, the results so far seem to be positive and reflect the level of behavioural change expected. However, two years is a limited time period to measure realistic changes towards sustainability, especially considering the age groups targeted. The students of today are the consumers of tomorrow, so the proposed programme could reflect sustained behaviour changes in the next ten or more years.

To ensure availability and decrease financial impediments the material was created as an open source booklet that can be fully downloaded from the project partners' websites as well as the authors' website. The researchers were sponsored by public agencies; this is not only a matter of principle, but also as responsibility to tax payers/ also as a sort of compensation to tax payers.

As a future plan to improve the programme and create non-academic relationships the authors are considering the expansion of the games. Projects like the resource boxes created with the Museum of Science and Industry are great toolkits. If made available across schools in the UKit could help spread sustainable behaviour already known in other countries – possibly providing the programme and games to English, Italian and Portuguese speaking countries. Furthermore adapting the resources to local cultures would increase the number of beneficiaries and scope of the activities.

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REFERENCES
1. Alderson, P., 1995. Listening to Children: Ethics and Social Research.
2. Alexander, R.J., 2009. Children, their world, their education : final report and recommendations of the Cambridge Primary Review 586.
3. Allum, L., Lowe, B., Robinson, L., 2008. How do we know it's working? a toolkit for measuring attitudinal change in global citizenship from early years to KS5. RISC and the Department for International Development.
4. Amato, C.H., Amato, L.H., 1973. Academy of Marketing Science. J. Acad. Mark. Sci. 1, 80–80.
5. Armson, R., 2011. Growing Wings on the Way: Systems Thinking for Messy Situations. Triarchy Press Limited, Devon - UK.
6. Bagnoli, A., Clark, A., 2010. Focus groups with young people: a participatory approach to research planning. J. Youth Stud. 13, 101–119.
7. Barratt Hacking, E., Scott, W.A.H., Barratt, R., web-support@bath.ac.uk, 2007. ESD: Bringing Students´ Community Experience into Schools.
8. Birney, A., Reed, J., 2009. Sustainability and renewal: findings from the Leading Sustainable Schools research project.
9. Bjørn, A., Hauschild, M.Z., 2011. Cradle to cradle and LCA - is there a conflict? In: Hesselbach, J., Herrmann, C. (Eds.), Proceedings of the 18th CIRP International Conference on Life Cycle Engineering. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 599–604.
10. Blackmore, C., 2005. Learning to appreciate learning systems for environmental decision making: A "work-in-progress" perspective. Syst. Res. Behav. Sci. 22, 329–341.

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International Journal OF Engineering Sciences & Management Research

11. Brandt, E., Eva, 2006. Designing exploratory design games. In: Proceedings of the Ninth Conference on Participatory Design Expanding Boundaries in Design - PDC '06. ACM Press, New York, New York, USA, p. 57.
12. Brandt, E., Messeter, J., 2004. Facilitating collaboration through design games. In: Proceedings of the Eighth Conference on Participatory Design Artful Integration: Interweaving Media, Materials and Practices - PDC 04. ACM Press, New York, New York, USA, p. 121.
13. Chawla, L., Cushing, D.F., 2007. Education for strategic environmental behavior. Environ. Educ. Res. 13, 437–452.
14. Checkland, P., 1981. Systems Thinking, Systems Practice.
15. Checkland, P., Poulter, J., 2010. Soft Systems Methodology. In: Reynolds, M., Holwell, S. (Eds.), Systems Approaches to Managing Change: A Practical Guide. Springer London, London, pp. 191–242.
16. Creech, H., 2012. Sustainable Development Timeline - 2012. Int. Inst. Sustain. Dev. 1–13.
17. Cutter-Mackenzie, A., 2005. "Early Childhood Environmental Education: Making it Mainstream.". In: Australian Journal of Early Childhood. Mar2005. p. 58.
18. Davies, G., Burgess, J., 2004. Challenging the "view from nowhere": Citizen reflections on specialist expertise in a deliberative process. Heal. Place.
19. DfE, 2015. Department for Education School and college performance tables [WWW Document].
20. Dorling, D., 2015. Income inequality in the UK: Comparisons with five large Western European countries and the USA. Appl. Geogr. 61, 24–34.
21. East, C.D., Metcalfe, M., 2002. Drawing concerns: a structured rich picturing approach. IFIP WG8.6 Conf. Adopt. Diffus. IT an Environ. Crit. Chang. 1-3 Aug. 2002 90–101 BN–0 7334 1989 5.
22. Gayford, C., 2009. Learning for sustainability: from the pupils' perspective.
23. Gore, A., 2013. The future : six drivers of global change. The Random House Publishing Group.
24. Grabs, J., Langen, N., Maschkowski, G., Schäpke, N., 2015. Understanding role models for change: A multilayer analysis of success factors of grassroots movements for sustainable consumption. J. Clean. Prod. 1–14.
25. Greenbaum, J.M., Kyng, M., 1991. Design at work: Cooperative design of computer systems. L. Erlbaum Associates.
26. Greenwood, D.J., Whyte, W.F., Harkavy, I., 1993. Participatory Action Research as a Process and as a Goal. Hum. Relations 46, 175–192.
27. Hargreaves, T., 2011. Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. J. Consum. Cult. 11, 79–99.
28. Hart, R. a., 1992. Children's Participation: From Tokenism to Citizenship, Unicef: Innocenti Essays.
29. Hicks, D., Holden, C., 2007. Teaching the global dimension : key principles and effective practice. Routledge.
30. Holmberg, J., Samuelsson, B., 2006. Drivers and Barriers for Implementing Sustainable Development in Higher Education. Educ. Sustain. Dev. Action 1–130.
31. Hopwood, N., 2007. Environmental education: pupils' perspectives on classroom experience. Environ. Educ. Res. 13, 453–465.
32. Household Waste Recycling Act 2003, n.d.
33. Jenkins, L., 2008. From Systems Thinking to Systemic Action: 48 key questions to guide the journey.
34. Johnson, N.L., Lilja, N., Ashby, J.A., García, J.A., 2004. The practice of participatory research and gender analysis in natural resource management. Nat. Resour. Forum 28, 28(3):189-200.
35. Kagawa, F., 2007. Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. Int. J. Sustain. High. Educ. 8, 317–338.
36. Kemmis, S., McTaggart, R., 2005. Participatory Action Research. In N.K. Denzin & Y.S. Lincoln, The SAGE Handbook of Qualitative Research.
37. Kickert, W.J.M., Klijn, E.-H., Koppenjan, J.F.M., 1997. Managing complex networks: strategies for the public sector.
38. Lewis, G.S., 2010. I Would Have Had More Success If...: Student Reflections on Their Performance in Online and Blended Courses. Am. J. Bus. Educ. 3, 13–22.
39. Lozano, R., 2006. Incorporation and institutionalization of SD into universities: breaking through barriers to change. J. Clean. Prod. 14, 787–796.
40. Macnaghten, P., Jacobs, M., 1997. Public identification with sustainable development: investigating cultural barriers to participation. Glob. Environ. Chang.
41. Mayumi, K., Giampietro, M., 2006. The epistemological challenge of self-modifying systems: Governance and sustainability in the post-normal science era. Ecol. Econ.

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International Journal OF Engineering Sciences & Management Research

42. Mitroff, I.I., Alpaslan, C.M., O'Connor, E.S., 2013. *Everybody's business: reclaiming true management skills in higher education.*

43. Moreira, N., Wood-Harper, T., 2015. *Customer Involvement in the Development of New Sustainable Products : A Review of the Literature. Int. J. Soc. Behav. Educ. Econ. Bus. Ind. Eng. 9, 2865–2871.*

44. Moreira, N., Wood–Harper, T., 2017. *DEVELOPING A FRAMEWORK TO MOTIVATE CONSUMERS AND OTHER STAKEHOLDERS INTO BECOMING AGENTS OF SUSTAINABLE DEVELOPMENT. In: SGEM International Multidisciplinary Scientific Conference on Social Sciences and Arts.*

45. Morelli, N., 2006. *Developing new product service systems (PSS): methodologies and operational tools. J. Clean. Prod. 14, 1495–1501.*

46. Muller, M.J., Wildman, D.M., White, E. a., 1993. *Taxonomy of PD Practices: A Brief Practitioner's Guide. Commun. ACM 4, 25–28.*

47. Muller, M.M.J., Kuhn, S., 1993. *Participatory design. Commun. ACM 36, 24–28.*

48. Nagel, M.C., 2004. *Lend Them An Ear: The Significance of Listening to Children's Experiences of Environmental Education. Int. Res. Geogr. Environ. Educ. 13, 115–127.*

49. Ofsted, 2008. *Schools and sustainability (070173).*

50. Ofsted, 2009. *Education for sustainable development-Improving schools – improving lives (090004).*

51. Okali, C., Sumberg, J., Farrington, J., 1994. *Farmer participatory research: rhetoric and reality.*

52. Pain, R., 2004. *Social geography: participatory research. Prog. Hum. Geogr. 28, 652–663.*

53. Pellizzoni, L., 2003. *Uncertainty and participatory democracy. Environ. Values 12, 195–224.*

54. Percy-Smith, B., Burns, D., 2009. *Exploring the role of schools in the development of sustainable communities: Full research report ESRC end of award report, RES-182-25-0038. Swindon.*

55. Porritt, J., Hopkins, D., Birney, A., Reed, J., 2009. *Every child's future: leading the way.*

56. Prince, C., 2010. *Sowing the seeds: education for sustainability within the early years curriculum. Eur. Early Child. Educ. Res. J. 18, 423–434.*

57. Redström, J., 2008. *RE:Definitions of use. Des. Stud. 29, 410–423.*

58. Reed, M., Fraser, E., Morse, S., 2005. *Integrating methods for developing sustainability indicators to facilitate learning and action. Ecol.*

59. Revans, R.W., 1980. *Action Learning: new techniques for management. Blond & Briggs Ltd.*

60. Rickinson, M., 2006. *Researching and understanding environmental learning: hopes for the next 10 years. Environ. Educ. Res. 12, 445–457.*

61. Riopel, D., Chouinard, M., Marcotte, S., Aït-Kadi, D., 2011. *Ingénierie et gestion de la logistique inverse: Vers des réseaux durables. Lavoisier.*

62. Sachs, I., 1991. *The next 40 years: transition strategies to the virtuous green path.*

63. Schuler, D., Namioka, A., 1993. *Participatory Design: Principles and Practices. L Erlbaum Associates, Hillsdale, NJ.*

64. Smith, G., 2001. *Taking Deliberation Seriously: Institutional Design and Green Politics. Env. Polit. 10, 72–93.*

65. STEM Learning, 2017. *STEM's model for change [WWW Document]. URL https://www.stem.org.uk/sites/default/files/pages/downloads/Theory of change Ambassadors infographic_Landscape_online_0.pdf (accessed 5.10.17).*

66. Sterman, J.D., 2001. *Systems Dynamics Modeling: TOOLS FOR LEARNING IN A COMPLEX WORLD. Calif. Manage. Rev. 43, 8–24.*

67. Strager, M., Rosenberger, R., 2006. *Incorporating stakeholder preferences for land conservation: Weights and measures in spatial MCA. Ecol. Econ.*

68. Strong, M.F., 1972. *Report of the United Nations Conference on the Human Environment. Stockholm - Sweden.*

69. Summers, M., Corney, G., Childs, A., 2004. *Student teachers' conceptions of sustainable development: the starting-points of geographers and scientists. Educ. Res. 46.*

70. Svanström, M., Lozano-García, F.J., Rowe, D., 2008. *Learning outcomes for sustainable development in higher education. Int. J. Sustain. High. Educ. 9, 339–351.*

71. United Nations, 2015. *Sustainable development goals [WWW Document]. URL http://www.un.org/sustainabledevelopment/sustainable-development-goals/ (accessed 5.6.17).*

72. United Nations Sustainable Development, 1992. *United Nations Conference on Environment & Development. Rio de Janeiro.*

73. Valencia, U.P. De, 2015. *Bringing Your Customers to the Lab : Barriers and Facilitators for Consumer Coinnovation José Albors-Garrigos 689–698.*

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International Journal OF Engineering Sciences &Management Research

74. *Van Blerk, L., Ansell, N., 2009. Participatory feedback and dissemination with and for children: Reflections from research with young migrants in Southern Africa. Child. Geogr. 3285, 313–324.*

75. *van den Hove, S., 2000. Participatory Approaches to Environmental Policy-making: The European Commission Climate Policy Process as a Case Study. Ecol. Econ. 33, 457–472.*

76. *Vickers, G., 2010. Insights into appreciation and learning systems. In: Social Learning Systems and Communities of Practice. The Open University- Springer, pp. 17–37.*

77. *Waas, T., Hugé, J., Verbruggen, A., Wright, T., 2011. Sustainable development: A bird's eye view. Sustainability.*

78. *Wallerstein, N., 1999. Power between evaluator and community: Research relationships within New Mexico's healthier communities. Soc. Sci. Med. 49, 39–53.*

79. *Walshe, N., 2008. Understanding students' conceptions of sustainability. Environ. Educ. Res. 14, 537–558.*

80. *Wright, T.S.A., 2007. Developing research priorities with a cohort of higher education for sustainability experts. Int. J. Sustain. High. Educ. 8, 34–43.*

81. *Young, L., Barrett, H., 2001. Adapting visual methods : Kampala action research with street children. Area 33, 141–152.*

82. *Young, W., Hwang, K., Mcdonald, S., Oates, C.J., 2010. Sustainable Consumption: Green Consumer Behaviour when Purchasing Products 31, 20–31.*

83. *Zilahy, G., Huisingh, D., 2009. The roles of academia in Regional Sustainability Initiatives. J. Clean. Prod. 17, 1057–1066.*