Can teaching about disruptive technologies such as artificial intelligence change pupils' perceptions of the value of design and technology?

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Abstract
Design and technology (D&T) is at a point of uncertainty and there are mixed views about what it should consist of and the values that it holds. This research aimed to find out if teaching secondary pupils about disruptive technologies such as artificial intelligence (AI) would alter their perceptions in relation to the value of D&T, as well as improving their learning. Two lessons, focussed on AI, were integrated into a scheme of work and pupils' perceptions of D&T's value were measured before and after the lessons. Pupils' responses and work outcomes were also considered. Following the lessons, pupils showed more awareness of D&T being related to problem solving, they displayed critical thinking, and work outcomes showed progress in problem solving skills. The research suggests that teaching pupils about disruptive technologies can have a positive impact on pupils' learning and to some extent, their perceptions of the value of D&T.

Introduction

Design and technology (D&T) is at a point of uncertainty with a significant decline in uptake at GCSE level (Design and Technology Association, 2016). A likely contributing factor is the implementation of the English Baccalaureate. D&T is not included in the list of subjects that the government expect to be taken by at least 90% of pupils in mainstream schools from the year 2020 (Department for Education, 2015), suggesting that they may see it as being less important than other subjects. On the other hand, Owen-Jackson (2015a, p.15) argues that D&T 'contributes to the development of the whole child' and that it is important that the subject continues to evolve. The Design and Technology Association (2015) believe that a lack of understanding of the value that D&T holds could be to blame for its seemingly overlooked state. It is not only government ministers who appear to underestimate the value of the subject, as teachers, pupils and parents also display mixed opinions when it come to the subject's value (Hardy, 2013). This could also explain why there is an increasing lack of enthusiasm for D&T.

The main purpose of this study was to bring about change and development in my practice as a trainee secondary D&T teacher and to have a positive impact on pupils' learning. The aim was to change pupils' perceptions of the value of D&T, giving them a more accurate understanding of the importance of the subject. Pedagogical approaches and schemes of work were altered in the hope of improving pupils' learning and their attitudes towards the subject. Disruptive technologies (artificial intelligence) were used as the focus of new lessons to determine whether teaching pupils about them would help in changing their perceptions.

The report will discuss, through reviewing relevant literature, the value of D&T, using McLaren's (2015, p.288) definition of values as being 'principles that guide behaviour, influence actions, shape attitudes and underpin, consciously or unconsciously, our decision making.' It will also discuss pupils' perceptions, possible reasons for misconceptions and how these misconceptions can be avoided/corrected. Methods of collecting data will then be discussed followed by an analysis of the data outlining positive and negative results and implications on teaching practice.

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Literature Review

Design and technology, through its lifetime, has been defined in varying ways. Its continuous development and changing nature often results in confusion about its purpose. Owen-Jackson (2015a) demonstrates that there is a lack of clarity and understanding surrounding the subject due to these issues. Teachers, parents and pupils all display mixed opinions of what values are attributed to D&T (Hardy, 2013). For the subject to be seen as imperative to pupils' education (which I believe it to be), these misunderstandings need to be addressed. This study will focus on pupils' perceptions of the value of D&T.

If pupils do not see the value of D&T, they are unlikely to be motivated to do well in the subject and to choose to study it after the compulsory stage. Motivation is described in numerous, similar ways, however I will use Child's (2007, p.226) definition as consisting of 'internal processes and external incentives which spur us on to satisfy some need'. Gervis and Capel (2016, p.162) describe factors found to be motivating such as 'pupils' interest in the subject' and 'the degree to which the subject or specific tasks are valued.' Therefore, without an accurate understanding of the value of D&T, pupils may fail to see importance in studying the subject, lose interest and become demotivated. This makes it important for values to be communicated effectively.

Hardy, Gyekye and Wainwright (2015) conducted a small research project on the values of D&T held by stakeholders likely to be involved in the pressure on D&T's curriculum content. Pupils were one of the stakeholders involved and when interviewed about what the point of D&T is, there was a significant lack of response relating to the freedom to design, the consideration of wider society issues, and the identification of problems to be solved. The most mentioned values were related to D&T providing practical life skills and the opportunity to make products.

During my time in the D&T department of two different secondary schools, talking to pupils about design and technology brought about similar responses. When pupils in a year seven class were asked 'why is design and technology important?' the most recurring answers revolved around the fact that you learn to make things, followed by learning skills that are important for everyday life. And like the results found by Hardy, Gyekye and Wainwright (2015) there were very few mentions of anything relating to solving problems or learning about the wider world and the impact that technology can have on it. Hardy, Gyekye and Wainwright (2015) mention the possibility of these issues being linked to the nature of pupils' D&T lessons.

Although developing practical life skills is important for pupils in order to become capable citizens, D&T also has the potential to help pupils develop in a range of other areas. Perhaps many pupils relate the subject to life skills and making because of the way it is taught. Spendlove (2008) demonstrates that the past has seen D&T linked largely to making things which can be taken home and that this, in some cases, has led to the 'real knowledge' behind the subject being lost. This is an interpretation of D&T that can still be seen in schools today and de Vries (2016) states that when there is too much focus on making and not enough on the design process, pupils are being deprived of the opportunity to engage in the 'creative process of solving design problems'.

A lack of design related activity in D&T could mean that an opportunity for pupils to develop multiple skills is being missed. Robson (2015) talks about 'learning through design', this relates to the wider learning that accompanies design activities. He lists social, organisational and communication skills, independence, problem solving and various kinds of thinking as some of the areas supported by this wider learning. Owen-Jackson (2015a) explains that skills of analysis and evaluation, described as high level cognitive skills in Bloom's Taxonomy (Bloom et al., 1956) can also be developed through D&T education. But if pupils are not given the opportunity to engage in activities that foster these skills, they are unlikely to see the value that learning about the subject holds.

De Vries (2016) states in his theory that pupils mostly recognise technology as artefacts and as being 'high tech' and that they rarely see the subject as something to do with knowledge (including that about humans) and few see the importance of design, therefore conceptualising technology 'primarily as its outcome and not its origin' (p.86). He suggests a reason for this being the way 'high tech' products are portrayed in the media. However, having a regular focus on making in D&T could also portray technology as being only about artefacts. This could also explain why pupils fail to mention problem solving and wider society issues in relation to the values attributed to D&T.

As well as a lack of design activity, a lack of teaching about values within D&T could have a similar impact. Middleton (2005) explains that teachers should make values an explicit part of design tasks and McLaren (2015) suggests that including in lessons the exploration of technological designs, decisions and developments and their consequences can create a values-based experience in the classroom. Here, pupils can begin to see the wider implications of design and technology and their learning will revolve around more than just designing and making. Involving discussion about values within D&T can encourage pupils to think about their own views and how others may be affected. Consequently, they will gain an awareness of wider society issues and begin to develop their technological perspective.

Barlex, Givens and Steeg (2015, p.303) believe that 'the development of technological perspective is an important and much under-represented aspect of the design and technology curriculum in secondary schools.' They suggest an effective way of developing this is to teach pupils about the nature of disruptive technologies.

They explain the features of disruptive technologies as being able to:

- disrupt the status quo
- alter the way people live and work
- rearrange value pools
- lead to entirely new products and services

(Barlex, Givens and Steeg, 2015, p.305).

They explain that encouraging pupils to consider how these technologies might affect their futures and the social impacts they may have, can make for more informed citizens who are able to become involved in debates concerning the deployment of technology in their societies. This, of course, seems appropriate considering the rate at which technology continues to evolve.

Based on the information found in the literature discussed and previous experiences in school, the study will aim to develop teaching practice by integrating values into lessons and allowing for better pupil learning and progress through teaching about disruptive technologies. Although this type of lesson content is recommended, there is a lack of research into whether it is effective.

The intention is to find out whether teaching secondary pupils about disruptive technologies improves their perceptions of the value of D&T, helping them to become aware of the potential to solve real and relevant problems and to consider wider society issues.

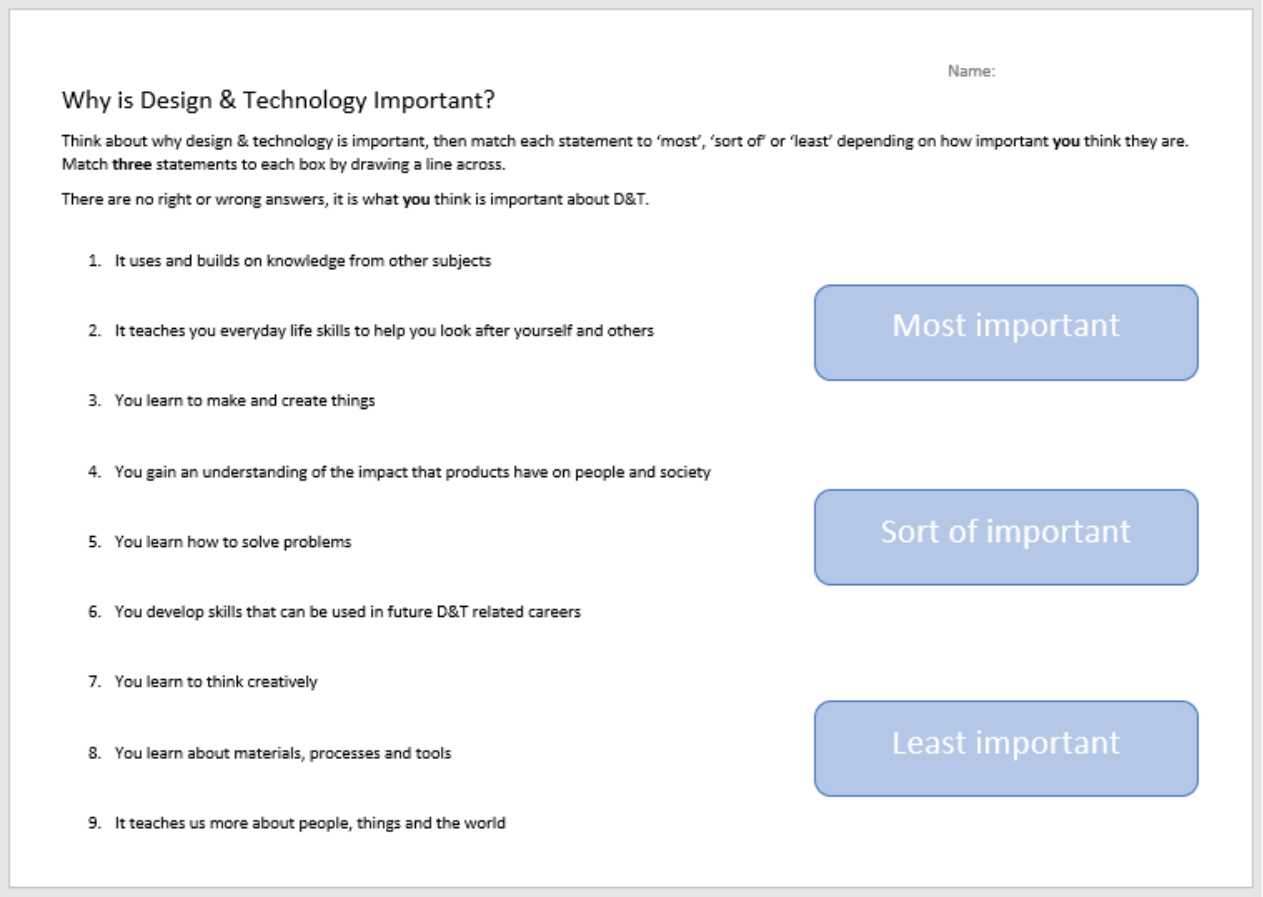
Methods

For this study, an action research approach was taken which Cohen and Manion (1994, p.194) describe as being appropriate 'when a new approach is to be grafted on to an existing system.' The new approach taken was to introduce into the schools' existing scheme of work, two lessons on artificial intelligence – a short project designed to introduce pupils to disruptive technologies. The aim was to find out if and how this would change pupils' perceptions of the value of D&T. To ensure the research remained ethical throughout, recommendations from Denscombe (2014) were used by gaining

permission to carry out the research in the placement school, maintaining confidentiality, and protecting the identity of the school and pupils involved.

Two classes were used for the research, both year seven, mixed ability. Year seven were chosen as de Vries (2016) states that the later the conceptualising of technology is introduced, the harder it will be to change perceptions that may have already become fixed, suggesting that the earlier concepts are introduced, the better. The first class will be referred to as 'class A' and the second as 'class B'. Class A was comprised of seventeen pupils, five of which had dyslexia, one of which had autism and two of which were eligible for pupil premium. Class B contained eighteen pupils including three with dyslexia and four eligible for pupil premium.

For the collection of data, a survey method was used which Moser and Kalton (1971) describe as being concerned with the opinions and attitudes of a group of people. The opinions and attitudes concerned in this investigation were those of pupils in relation to the value of design and technology. A 'match-up' sheet was designed for pupils to complete, which questioned them about the importance of D&T (see figure 1).



Name:

Why is Design & Technology Important?

Think about why design & technology is important, then match each statement to 'most', 'sort of' or 'least' depending on how important **you** think they are. Match **three** statements to each box by drawing a line across.

There are no right or wrong answers, it is what **you** think is important about D&T.

1. It uses and builds on knowledge from other subjects
2. It teaches you everyday life skills to help you look after yourself and others
3. You learn to make and create things
4. You gain an understanding of the impact that products have on people and society
5. You learn how to solve problems
6. You develop skills that can be used in future D&T related careers
7. You learn to think creatively
8. You learn about materials, processes and tools
9. It teaches us more about people, things and the world

Most important

Sort of important

Least important

Figure 1. The match up sheet given to pupils before and after the intervention lessons.

The sheet was given to pupils to fill in before and after the intervention lessons to measure any changes in their views after being taught about artificial intelligence. On the sheet, there were nine different values of design and technology. This list of values was drawn from Hardy (unpublished) as well as my own research into the existing thoughts of pupils. Hardy's (2013, 2015, unpublished) work focuses on the values different stakeholders attribute to D&T.

Class A were asked the question 'why is design and technology important?' and their responses were compared to Hardy's list of values. The values to be used on the sheet were then chosen using the most and least common values from both sources as well as information found in the literature about pupils' perceptions.

The sheet stated that pupils must match three values only, up to each of the three options. This meant that each option would have three statements matched to it making analysing the data uncomplicated. It was clearly explained to pupils that there were no right or wrong answers as it was about what *they* thought was important about D&T. Before using the sheets for the study, they were tested on pupils from class A to identify any flaws and amended appropriately.

Structured observation was also used to gain an insight into pupils' responses to lesson content involving disruptive technologies. Bell (2010) mentions criticisms of this approach, as the focus is already decided rather than being allowed to emerge, making the approach subjective and biased. However, my objectives were identified through the study of relevant literature which revealed important aspects to be considered through observation.

Throughout the lessons concerned, the reactions of pupils to certain parts of the lessons were noted. Their answers to questions and the questions they asked were recorded for reference and their work outcomes were considered.

The project spanned over two one-hour lessons and focussed on artificial intelligence (AI), a disruptive technology that Barlex, Givens and Steeg (2015) suggest is appropriate to teach secondary D&T pupils. The lessons involved:

- a teacher presentation on what AI is
- a class discussion on AI around us
- a case study on the WAYMO self-driving car using suggestions from Barlex, Givens and Steeg (2015)
- a class discussion on the effects of the self-driving car and designers' responsibilities
- a designing without making task, also using suggestions from Barlex, Givens and Steeg (2015)

A disruptive technology was chosen as the focus of the lessons to try to get pupils to start developing their technological perspective in the hope that they would begin to see the subject as being less about learning life skills and making things, and more about the wider implications of technology and the ability to solve problems.

The teaching style used was more values-based than usual and the lesson content and activity was planned to involve more opportunity for the development of valuable skills and learning. The context of technology in relation to AI was focussed on in class discussions. The case study was designed to get pupils thinking about the effects of the technology and how it could make a difference to people's lives. The design task focussed on designing without making to avoid restrictions to pupils' designs (Barlex, Givens and Steeg, 2015) and create more focus on solving relevant problems.

To help in ensuring pupils remained on-task and to check their understanding throughout the lessons, lots of pupil interaction was involved (Cohen, Manion and Morrison, 2004). Regular questioning was used and pupils were encouraged to ask their own questions. A PowerPoint presentation including video clips was used for the presentation as de Vries (2016) suggests that modern media creates more pupil motivation. To encourage interest and further motivation the lesson content was made relevant to pupils by discussing their existing interactions with AI. Owen-Jackson (2015b) demonstrates that relevance to pupils plays a part in motivation and in turn, encourages their learning. The development

of problem solving skills was encouraged through the design task which involved pupils designing a product containing AI for a specific user to solve existing problems. Wider society issues were addressed through the case study and through discussion on the effects the self-driving car may have on people and society.

To ensure the lessons were appropriate and effective, class A were used as a trial for the intervention. This informed the lesson planning, timings and resources. It also gave an idea of how pupils would respond to the lesson content. Following the trial lessons, some minor changes were made to the lesson plans to ensure the optimum outcome before teaching class B and gathering the data used for the study.

To ensure reliability of the data, control methods were used during the study. The lessons followed the end of a resistant materials project before pupils would move on to their next rotation and took place where they would usually have D&T, ensuring the intervention wouldn't seem out of place. Pupils were given the same amount of time to complete both the before and after match-up sheets. It was explained explicitly on the sheet and verbally that pupils were to think about their own views of D&T and that there were no right or wrong outcomes. The pupils' previous D&T teachers were consulted about the lesson content to eliminate the chance of repetition. Pupils had not had any lessons on AI or any other disruptive technology prior to the intervention.

Analysis of Findings

Table 1. Shows pupil responses to the match-up sheet.

Value	Before			After		
	1	**2**	**3**	**1**	**2**	**3**
1. Uses knowledge from other subjects	4	4	10	2	9	7
2.Teaches everyday life skills	8	5	5	11	5	2
3.Learn to make and create things	6	7	5	5	10	3
4.Understand the impact products have	7	8	3	6	7	5
5.Learn to solve problems	5	8	5	8	6	4
6.Develop skills for D&T related careers	12	5	1	10	3	5
7.Learn to think creatively	3	6	9	3	7	8
8.Learn about materials, processes and tools	5	7	6	5	3	10
9.Learn more about people, things and the world	4	4	10	4	4	10

Note: **1** = most important, **2** = sort of important, **3** = least important

Following the completion by pupils of both the before and after match-up sheets, their answers were recorded and the before and after results were compared.

Table 1 shows the number of pupils, out of a class of eighteen, that matched each value to 'most important', 'sort of important' and 'least important' before and after the intervention lessons.

Pupils had previously been shown to attribute certain values to D&T and fail to mention ones that were linked with valuable learning and development. The aim of this study was to see if teaching pupils about artificial intelligence would change their perceptions, making them aware of some of the values previously unthought of by most. Teaching practice was altered to implement the AI lessons in a way which would benefit the pupils' learning. In the analysis, focus will be on the two values that most pupils attributed to D&T before the intervention (according to literature and my own research) and the two values that were hoped to be attributed to D&T by more pupils following the intervention. These values are 2, 3, 4 and 5.

Value number two: It teaches you everyday life skills to help you look after yourself and others
Before the intervention lessons, most pupils (8) matched this value to 'most important' and 5 pupils matched it to 'least important'. Following the lessons, even more pupils (11) matched it to 'most important' and less (2) matched it to 'least important'. This would suggest that the lessons taught in the intervention project somehow made pupils relate D&T to everyday life skills even more.

The literature suggests that pupils may feel this way because of the nature of the activity involved in their D&T lessons (Hardy, Gyekeye and Wainwright, 2015). Yet taking away the focus on making and placing more emphasis on values did not seem to have the desired impact in this instance. This may have been down to the wording used on the design task given to pupils (see figure 2).

The design brief addressed helping a lady with her day-to-day problems, and the value on the match-up sheet read 'it teaches you everyday life skills to help you look after yourself and others'. Therefore, pupils may have linked the fact that they were helping another person (the elderly lady) by designing a product for her, with helping to look after others. In further study, different wording may need to be considered to eliminate this problem.

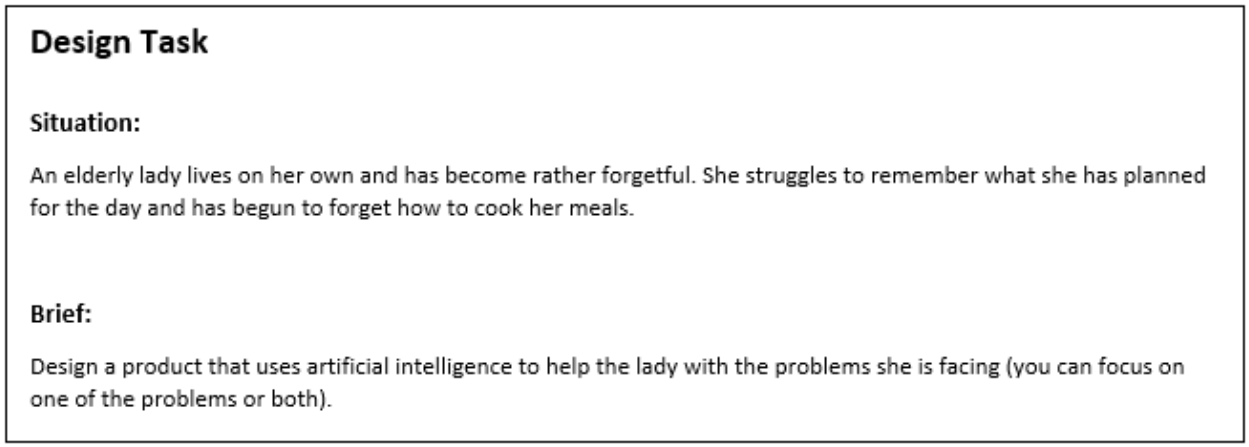


Figure 2. The design task given to pupils in the intervention lessons.

Value number three: You learn to make and create things
Before the intervention lessons, 6 pupils matched this value to 'most important' and 5 matched it to 'least important'. Following the lessons, less pupils (5) matched it to 'most important' and less (3) matched it to 'least important'. Therefore, most pupils thought of this value as being 'sort of important' before *and* after the lessons, suggesting that they see value in learning to make and create things but do not see it as imperative to D&T.

This implies that even though lessons in that particular school were regularly focussed on making, they still did not consider making things as one of the most important parts of D&T. Comparing this to class A's responses to the question 'why is D&T important?' is interesting, as the most common theme in their answers was about learning to make things. Perhaps when class B were presented with a range of values related to the importance of D&T, they could see more relevance in other values that they may not have thought about on their own.

Value number four: You gain an understanding of the impact that products have on people and society

Before the intervention lessons, 7 pupils matched this value to 'most important' and 3 matched it to 'least important'. Following the lessons, less pupils (6) matched it to 'most important' and more (5) matched it to 'least important'. This would suggest that the lessons did not have a positive impact on pupils' views regarding the wider impacts of D&T.

McLaren (2015) suggests that the exploration of technological designs can create a values-based experience and that by involving values in D&T education, pupils can start to think critically about products. For the lessons in question, focussing on the exploration of AI and its effects, according to the data, did not result in pupils seeing more importance of the impact of products in relation to D&T. However, observation suggested otherwise. During the lessons, pupils showed an interest in the effects of AI and made comments showing their thinking about its effects on people and society, saying things such as:

'The self-driving car would be good for people who have just had an operation and can't drive for a while because it would mean that they wouldn't have to get someone else to drive them around.'
'What if the AI went wrong and took you somewhere you didn't want to go? It might get clever enough to do its own thing.'

Value number five: You learn to solve problems

Before the intervention lessons, 5 pupils matched this value to 'most important' and 5 matched it to 'least important'. Following the lessons, more pupils (8) matched it to 'most important' and less (4) matched it to 'least important.' This would suggest that the lessons may have shifted pupils' thinking and made them more aware of the opportunity to solve problems through D&T.

By including a design task in the AI project, pupils were given the opportunity to experience wider learning and develop more skills (Robson, 2015). This learning was focussed on the impacts of AI on people and its ability to improve people's lives through designing a product to solve a problem. The data suggest that this helped pupils to realise the link between D&T and problem solving and that this is an important aspect of the subject. Not only did pupils engage in problem solving as part of their design activity but they were also able to think critically about how the technology would have an impact. The pupils' design outcomes showed that they had thought hard about how AI could help make the user's life better and had come up with some innovative ideas to help solve several problems.

Discussion

In summary, the quantitative data does not all suggest that teaching pupils about AI changes their perceptions of D&T. However, it did show an increase in the relation to problem solving, and the observations in the lessons showed that pupils were becoming more engaged in the impacts of technology on people and society as well as problem solving. Most pupils showed great interest in AI, asking a range of questions and participating in class discussions and this led to motivation in the work involved in the lessons and good progress. As previously discussed, pupils' motivation depends on several factors including their interest in the subject (Gervis and Capel, 2016). If pupils are motivated

to do well in a subject because of an interest they have for it, they are more likely to see value in that subject. Therefore, by engaging pupils in the lesson content discussed it would seem, from this study, that pupils can become more engaged with problem solving and thinking about the wider impacts of technology. They may then also begin to value the subject more through having more of an interest in it, resulting in more learning taking place and an increase in progression.

To gain a more accurate insight into whether pupils' perceptions would change through teaching this type of project with the teaching styles mentioned, a longer running project, considering more time is available, could be implemented. Carpenter and Bryan (2016) explain that there is a limitation on the amount of information pupils can take in at a time and that if information is delivered too quickly, it may not be received in their memory. Therefore, if pupils had more time to absorb the information they may be more likely to see things differently.

For lessons like these to have a chance of improving pupils' views of D&T and improve the learning taking place, it is important that teachers have the correct and current subject knowledge on what they will be teaching. Therefore, it is vital that continuous professional development is made use of regularly, as stated in an Ofsted report concerning the provision of D&T (Ofsted, 2011). Providing this is the case, schools' D&T curriculum content should remain up-to-date and relevant, another important factor in teaching the subject effectively.

The focus for this study was on the four values discussed and the other five values were put on the match-up sheet to distract pupils and reduce bias towards the original four. However, it is interesting to note that the highest number of pupils matched value 6 (you develop skills that can be used in future D&T related careers) to 'most important' before the lessons and the second highest number of pupils matched it to 'most important' after. It would be beneficial to look further into the reasons why so many pupils relate D&T to future careers and if this is also the case in other schools.

Conclusion

The literature and personal experience suggested that pupils most readily relate learning life skills and making things to the importance of D&T, failing to mention solving problems and the link to wider society issues. It was found that this could be down to how D&T lessons are taught and the activity involved. This not only portrays an incorrect perception of D&T but can also result in opportunities for the development of valuable skills, learning and progress being missed.

This study aimed to determine whether changing pedagogical approaches and adapting lesson content by teaching pupils about disruptive technologies such as artificial intelligence would change pupils' perceptions and improve learning. Data from completed match-up sheets concerning the importance of a range of values related to D&T showed an increase in pupils' awareness of the importance of problem solving following the lessons. The data did not show an increase in their awareness of wider society issues. However, observation during lessons showed pupils reacting well to tasks focussed around the impacts of AI on people and society. When AI was introduced into their lessons, pupils showed an increase in interest, asking more questions and showing more willingness to be involved in class discussions and becoming more motivated as a result. During discussions and tasks throughout the lessons, most pupils demonstrated critical thinking and produced interesting and appropriate outcomes.

The outcome of this study would suggest that teaching about disruptive technologies in a way that integrates values, may result in it being more likely that pupils' perceptions of the value D&T include the ability to solve problems. It is also suggested that pupils can develop more skills and become more motivated, resulting in seeing more value in studying the subject and improved learning.

For teachers to carry out lessons of this nature, it is crucial that they make use of continuous professional development to keep the lesson content relevant and it is important for teachers to plan lessons carefully to integrate the development of more skills and progress. Perhaps if this type of teaching is carried out over a longer period, pupils will begin to have an even better perspective on D&T.

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