Teacher perceptions of critical thinking skills within primary school design and technology

Richard Brown, University of Cambridge, UK

Abstract
Critical thinking skills and creativity have been lauded by many as key attributes sought from prospective employees for the future workplace in an ever changing world. Furthermore, a review of existing literature suggested the prevalence of critical thinking skills within design and technology (D&T) tasks. This study aimed to garner the perceptions of primary school teachers in the UK and establish, from a practitioner's viewpoint, whether critical thinking skills were evident within their classrooms during D&T sessions. The interviews followed a phenomenological approach and identified commonalities and differences between the teachers' viewpoints as they described the phenomena they had experienced. The eight interviewees were from different schools in different areas of the UK and ranged from experienced teachers to early career teachers. Teachers were asked about their experiences of teaching D&T before completing a hierarchal ordering exercise of skills they perceived were gained from D&T activities in primary schools. The data produced experiences, thoughts and opinions about teaching design and technology in primary schools and teacher perceptions of the role of critical thinking within them. Analysis of the interview transcripts identified critical thinking throughout the responses and categorised three main themes around the teaching of design and technology in primary schools: approaches, attitudes and outcomes. This study suggests that, for primary teachers to develop their pupils' critical thinking skills within design and technology, and thus develop technological literacy, there are issues that need addressing at both leadership and classroom levels such as training, resourcing and leadership priorities. Nevertheless, teachers interviewed in this small scale study confidently believed that primary school pupils benefit from promoting critical thinking within D&T activities.

Keywords
Design and Technology, Critical Thinking, Teacher Perceptions, Primary/Elementary Education

Introduction
Context
This article has been taken from a study based in the UK, interviewing teachers from English primary schools where Design & Technology (D&T) is taught to pupils aged 4-11 and the subject is part of the statutory national curriculum (DfE, 2013). The study was a Master 's level dissertation and had three research questions, one of which was related to teacher perceptions of critical thinking in D&T activities. Aspects of this article, such as summarised sections of the literature review and results, have been drawn from the dissertation but the focus of critical thinking is central to the discussion.

Through delivery of D&T projects across a variety of age ranges and schools across the UK, anecdotal evidence suggests that children, and teachers, enjoying D&T sessions. Sessions taught to trainee teachers also advocate an enthusiasm for the subject. However, this gathering

of thoughts and perceptions is clearly not based upon an empirical study. The main motivation of this study therefore, was to develop a deeper understanding of the perceptions of teachers and identify commonalities and differences.

The literature review of the study initially considered the educational benefits of D&T. One of the key conclusions from the research was that there was less research about D&T in general within the primary sector but research available demonstrated that teacher attitudes towards the subject can vary. Although work to investigate the positive links between primary and secondary D&T has been instigated by Hardy and Gomersall (2017), the concern in the primary sector is that "Just the words Design and Technology (D&T) make some people nervous." (Newton, 2005, p.1) There is also an issue about teacher anxiety when teaching D&T. There are health and safety considerations, it is a subject that is unlike others and a lack of subject knowledge, possibly stemming from a lack of Continuing Professional Development (CPD), affects teacher confidence. Research by Kimbell (2008, 2017), Stables (2012), Bell et al. (2017) highlight the concerns that D&T, albeit relating predominantly to secondary education, is becoming seen as a subject which is one that "has effectively been relegated to the confines of a subject considered to be less desirable and arguably non-academic by educational policy" (Bell et al., 2017, p.540).

However, as Bell (2016) attests, children enjoy the subject and there is a wider contribution to education that D&T provides as it allows children to explore, make mistakes and develop the often-lauded growth mindset (Dweck 2012) approach to solving problems. To support this view, the inventor and entrepreneur James Dyson suggests: "Design and technology classes should be about breaking the rules and learning from mistakes." (Dyson, 2005, p.34).

Furthermore, from this initial research, key words such as creativity, problem solving and critical thinking emerged and were investigated and researched in further detail. The terms creativity and problem solving are both well known by primary school educationalists and teachers often have well defined views and opinions of them within their own teaching pedagogy. Critical thinking, however, is perhaps less commonly used and an area which required further research into the literature before compiling the research questions.

Defining critical thinking
Critical thinking is a commonly used term used to describe problem solving or independent thinking, however many academics state that it is hard to distinguish with one clear definition (Ab Kadir, 2018; Wei, 2020; Yang & Chung, 2009).

The Organisation for Economic Co-operation and Development (OECD) defines critical thinking as a "mainly inquisitive, a detective way of thinking" and creative thinking as an "imaginative, the artist way of thinking" (Vincent-Lancrin et al., 2019, p.27). The analogy of the critical thinking detective and the creative thinking artist is potentially useful to distinguish the two but there is a multitude of research around both and many other definitions.

Willingham (2020) suggests that critical thinking is a combination of novel thinking, self-directed thinking tend effective thinking and Chew et al. (2020) as "seeing both sides of the issue, reasoning, deducing and inferring conclusions" (p.1). Lai (2011) encourages the view that defining critical thinking depends upon whether it is during the process, the end product or as a stand-alone higher order thinking skill. Barnett (1997) also has the view that defining the

concept of critical thinking is dependent upon how it is used. The most widely viewed definition is the work of Richard Ennis who suggests that critical thinking is "reflective thinking focused on deciding what to believe or do" (Ennis, 2018, p.166)

The Cambridge University Press (CUP) released a series titled Life Competencies Framework (2019), with the aim to prepare students for the changing world ahead. Originally designed for English language development, critical thinking is sub-divided into three categories:

- Critical evaluation: analysing information and identifying patterns
- Analytical framework: judging which arguments, ideas or options and then solving problems
- Synthesising ideas: generating new ideas from others

Whilst the OECD detective is a simple analogy and Ennis's definition is widely used, this study used the CUP model as a straightforward way to define critical thinking to participants during the interview.

Justifying the importance of critical thinking
The OECD reports that critical thinking and creative skills are two skills that are necessary for the future workforce and that critical thinking in particular can "contribute to a human well-being and to the good functioning of democratic societies" (Vincent-Lancrin et al., 2019, p.18). Later in the report the authors suggest that critical thinking has become even more vital "in a digital world in which a multiplicity of facts, views, theories and assumptions compete" (2019, p.20).

It could be said that with an assessment system that promotes retention of knowledge, the development of critical thinking and creativity in schools is less central. An independent panel, led by David Sainsbury, states "our education and skills system is failing to develop the skills employers seek" (DfE, 2016, p.22). Furthermore, Jagannathan et al., stated that future employers seek employees who demonstrate skills "such as creativity, effort and initiative, critical thinking and design thinking and negotiation skills which contribute to complex problem-solving in the workplace" (2019, p.2).

This can be supported by research from around the world. Trilling and Fadel (2009) in the USA state how critical thinking can "unlock a lifetime of learning" and has "become an increasingly important feature in the educational policies of many countries." Ab Kadir (2018) discusses the Australian curriculum and the inclusion of critical and creative thinking as a tool for future industry. A Chilean based study by Cáceres et al. (2020) cite and agree with Butler et al. (2017) suggesting that "mastering critical thinking is a better predictor of successful life decisions than other factors, such as intelligence." (2020, p.1)

In addition, world leaders have also recognised the importance of critical thinking. President Barack Obama challenged education leaders "to develop standards and assessments that don't simply measure whether students can fill in a bubble on a test, but whether they possess 21st century skills like problem-solving and critical thinking and entrepreneurship and creativity." (2009 p.1).

The ability to think critically, to evaluate, infer and deduce can be central to developing knowledge and understanding at a greater depth standard. Certainly, reading and maths end of key stage tests require a degree of detecting skills and in this regard critical thinking can appear to be an important skill that can be utilised in a number of situations. However, this study concentrated upon the development of critical thinking within the subject area of design and technology, and in particular within primary schools.

Critical thinking and D&T

There are many researchers that link the metacognitive skill of critical thinking as being synonymous with the subject of design and technology. Rauscher and Badenhorst (2021 p.1) state that teachers are more likely to "encourage critical thinking in design and technology". Whilst welcoming the suggestion that critical thinking skills can be linked with D&T, Ab Kadir (2018) would argue that critical thinking skills can be developed through many other subjects by utilising teacher expertise and skill.

Nicholl (2017) provides a practical example of critical thinking within D&T sessions with young people. He suggests that by designing for a purpose through a clear design brief, pupils will need to be empathetic to their client's needs and that empathy is "embodied within an overall disposition to think critically." (p.156). As an additional example, Wei (2020) analysed the design journals of junior high school students to find evidence of critical thinking and was able to identify critical thinking processes during problem exploration.

Spuzic et al. (2016) determined that within engineering, criticality and creativity are valuable skills. Whilst creative thinking can be seen as imaginative and critical thinking more analytical, both have worth in design and engineering. The report cites Adriansen's (2010) table that attempts to differentiate the two cognitive skills (Table 1). Mulnix (2012) concurs with the above and that there should be a clear distinction between creative thinking and critical thinking as they are not "equivalent".

Table 1 Idealised differences between criticality and creativity (Taken from Spuzic et al 2016, p.5)

Creativity	Criticality
Imaginative	Rational
Non-judgemental	Evaluative
Generative	Selective
Holistic	Analytical
Constructing	Deconstructing
Transcending the framework	Within the framework
Open to serendipity	Work systematically
Iterative process with detours	Linear process

Whilst the above research suggests that critical thinking can be found within D&T activities, the vast majority of research considered within this study is based within secondary schools (aged 11-16) or within further and higher education. Little evidence and research have been found within primary schools and this prompted a further research avenue of when critical thinking could, or should, be taught.

When to teach critical thinking

Both Facione (1990, 2000) and Rauscher and Badenhorst (2021) build upon the practicalities of teaching critical skills to children and young people and the 'dispositions' to developing this higher order thinking skill in the classroom. Facione (2000) promotes 'habits of mind' and suggests that this type of thinking is valuable not just for older students but can also be taught to younger children at primary level. Chew et al. (2020) agree that critical thinking "should be encouraged and instilled in students starting from a young age" (2020, p.249) and Gelerstein et al. (2016) suggest primary schooling is the most advantageous time to teach critical thinking (p.40). Willingham concurs, and after working with both older and younger children, additionally states that "children are more capable than we thought" (2020, p.45).

Whilst not necessarily directly opposing the above, Rauscher and Badenhorst (2021 suggest that the level of problem-solving skills is much higher in secondary education and that teachers in this sector, particularly technology teachers, are more likely to promote and utilise critical thinking skills with learners in their classes. Hennessey and Murphy (1999) concur in a similar fashion but also suggest that this is because more studies have been secondary based than at primary.

Best practice for critical thinking

Whilst the literature may demonstrate the benefits of critical thinking and it can be taught to younger pupils, the 'how' to teach it is more challenging, particularly at a primary school level. Willingham (2000) suggests a four-stage strategy to introduce and develop critical thinking skills with children and young people.

- Identify critical thinking skills in each domain: skills are subject and skill dependent.
- Identify the domain content students must know
- specific knowledge is required before considering it critically.
- Sequencing critical thinking skills: a sequential development of thinking skills.
- Revisiting critical thinking skills: retention of critical thinking skills.

This four-step programme could be applied to many learning programmes but it highlights that just exposing students to opportunities for critical thinking is not enough; it needs to be considered in a longer term and revisited over a period of time. To concur, Halpern and Riggio (2002) not only suggest that these skills should be taught, but also that they should be nurtured over a period of time through a process of modelling and leading. They then produced a series of journal reflections and questioning techniques within the book to aid the reader develop their own critical thinking skills.

With this in mind, educationalists might be considering how to identify and ensure that critical thinking approaches are successful. Gelerstein et al. (2016) suggest that "not enough work has been done to measure these skills in a classroom setting" (p.40) but agree with Willingham (2020) that the challenge with assessing critical thinking skills is that it is very subjective. Erikson and Erikson (2019) suggest three reasons why assessing critical thinking is so challenging. The first is also subjectivity and interpretivism; the second being that measuring learning outcomes is difficult to define and lastly that by defining critical thinking educationalists may limit the "ceiling for student ambitions" (p.293).

Nevertheless, Stupple et al. (2017) created a Critical Thinking Toolkit (CriTT) which they stated would measure student attitudes and beliefs about critical thinking and proposed would be able to determine levels of critical thinking within higher education. Likewise, Bensley et al. (2016) produced work to determine successfulness of measuring critical thinking skills but the biggest issue would be translating either into practice within primary schools.

Through the literature review, the emphasis has been on critical thinking: what it is, the benefits and the links with D&T. This area of learning has differing facets depending how and where it is used. Critical thinking skills within industry has been shown to be very desirable and there are design and engineering companies actively seeking potential employees with these skills. However, the role classroom practitioners have in this warranted further investigation and consequently three research questions were derived from the literature.

Throughout the critical thinking literature, a lot of research relates to secondary and, certainly the majority, to higher education. Considering the possibility of exploring critical thinking within primary schools and to garner the ideas and perceptions of primary school teachers would therefore be of interest. Cáceres et al. (2020) study state that "studying critical thinking from the teacher's perspective is key" as the work by teachers is often overlooked. As this area of cognition is potentially prevalent within D&T activities, it was consequently chosen as a key line of enquiry to consider teacher perceptions of D&T and their thoughts regarding critical thinking.

With the above in mind, the key research question, and emphasis of this article, evolved: '*What are teacher perceptions of critical thinking in primary schools within design and technology sessions?*'.

Methodology

To understand the perceptions of teachers, interviewing was chosen as the main source of collecting data. This would entail a requirement to interpret what has been expressed and therefore an interpretivist, epistemological stance was chosen consistent with a qualitative approach. This study aimed for an ethnographical approach, exploring the participants' experiences and seeking to understand perceptions and thus a phenomenological approach was taken. The open-ended interview was chosen for this study to gain a deeper understanding as within a more positivistic survey approach it may be more challenging for participants to fully express their experiences.

The analysis technique chosen for this study was a thematic approach. Braun and Clarke (2006) suggest that this method "works both to reflect reality and to unpick or unravel the surface of 'reality'" (p80). Cohen et al. (2011) compare Miles and Huberman (1994) Brenner et al. (1985) with the various strategies on coding, varying from 12 to 15 stages. They also cite Hycner (1985) who specifically produced advice on analysing phenomenological studies and it was through this article data analysis was influenced. Werner's orthographic principle (1957) was also considered whereby ideas that seem totally disconnected and disorganised slowly become clustered and links become more evident and understanding becomes clearer. Whilst this principle is related to child psychological development, it has relevance in this study since the aim of the data analysis was to sift, sort and allow links and relationships to emerge.

Phenomenological interviewing approach

Phenomenology is a description of a participant's experiences without bias and can be seen as a philosophical exercise (Silverman, 2013, p.99) and a precursor to future research investigations. Having been influenced by Bell's (2016) interviews with secondary teachers, this study also could not take a holist commitment to the methodology but used aspects of the phenomenological approach. Whilst interviewer bias was considered throughout and open ended questions and minimal interviewer contributions were phenomenologically sound, there was a structure throughout the interview which focused upon critical thinking and thus it became a semi-structured interview. Interviewees were firstly asked about D&T activities they had completed with their classes before being questioned about their thoughts on challenges and benefits of the subject in primary schools, completing a 'Jamboard' activity and finally being asked about critical thinking. Whilst a myriad of interesting themes transpired through the interviews, this paper relates solely to teacher perceptions of critical thinking.

Jamboard activity

Participants accessed a 'Jamboard', an online interactive whiteboard, and were asked to move 'sticky notes' into a hierarchal order. Hendley and Lyle (1996) completed a study asking pupils about the different learning attributes from D&T activities and this study used the majority of these for the sticky notes. Four notes were kept blank in case interviewees wanted to contribute their own ideas; but none of them did.
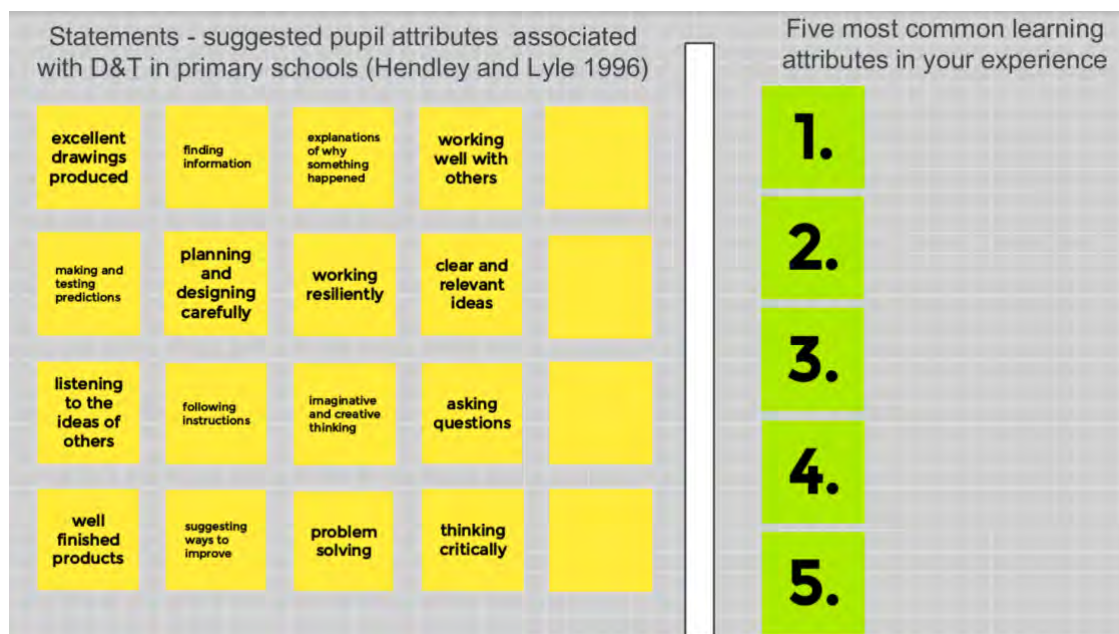
Figure 1: Jamboard example

NVivo word cloud tool

Whilst following a qualitative, phenomenology approach, quantitative methods were additionally used to analyse the transcripts as this can still aid the triangulation of thoughts within a phenomenographic study (Silverman, 2013). Using an online qualitative analysis tool (NVivo), word cloud diagrams were produced for every participant's transcript to enable an overview of key words and phrases. It must be said that any interviewer comments were

removed before this analysis in order to ensure the analysis was of the interviewee not the interviewer.

Participants

The study had eight participants gathered from social media, contacts within schools and, as can be seen from (Table 1), the majority of those who completed the interview were very experienced. I will declare here that I did know some of the interviewees but had last worked with them at least seven years prior to the interviews.

Table 1: Overview of participant experience

Which of these best describes you?	Are you the D&T coordinator (or equ
Participants who expressed interest and completed the interview	
10 years+ experience	No
10 years+ experience	No
10 years+ experience	No
10 years+ experience	No
6 years + experience	No
6 years + experience	Yes
2 years+ experience	No
Early Careers Teacher	No

Whilst having a breadth of experience was positive, having participants from around the country provided an even wider experience. This could be seen as both a positive and a negative. The benefits meant a wide range of opinions from a large cross section of the country where training and expertise might be different but conversely it might be more challenging to explain why certain beliefs and perceptions have been expressed. With a phenomenological approach however, the emphasis is upon exploring and identifying themes and raising further questions rather than reasoning why something happens.

Ethical Considerations

A section on ethics can be "extensive, and they [ethics] are reflected through the research process" (Creswell and Creswell, 2018, p.90). Before implementation, the study was approved, via an ethics form, by the Faculty of Education and followed the guidelines set out by the British Educational Research Association (BERA, 2018). Assuring the safety of the participants through core principles of anonymity, confidentiality, informed consent and the freedom to withdraw were at the forefront of any decisions throughout the process. A risk assessment was completed thereafter to ensure the safety of all stakeholders was given due consideration.

At the initial expression of interest stage, informed consent and knowledge that any views would be kept anonymous and confidential was clear. This was supported later with a letter further explaining the interview process with the aim to put participants at ease and ask for their consent to continue – these letters were emailed back to me. Finally, at the beginning and end of every interview the interviewee was asked whether they wish to continue or have their views still taken. At every point, participants could withdraw their support.

Within all stages, it was made clear to participants the expectations and the purpose of study. As I would use quotes and information from the interviews to illustrate findings in the study, I could not promise confidentiality, therefore I had to ensure anonymity. However, as the

participants came from a wide range of backgrounds and from schools throughout the country, I was confident of ensuring anonymity for individual participants by using pseudonyms and by making sure that the contextual information provided about each participant didn't make them identifiable. I also safeguarded that in every transcript, any mention of the school or location was removed.

The key role was to "operate within an ethic of respect for any persons – including themselves – involved in or touched by the research they are undertaking." (BERA, 2018, p.6). The researcher is obligated to ensure all their participants are 'safe' and that the methodology is ethically considered throughout the research design and implementation process. It is through the interview design that most of the ethical considerations were measured but every decision was made in accordance with the BERA (2018) guidelines.

Results

Word cloud analysis

Looking at the Combined word cloud, 'thinking' was the key word to come from the transcripts which could possibly be explained by the fact that critical thinking are key words within the study. Whilst one also has to remember that responses in an interview might be 'I think that...', to have the word 'thinking' with the additional suffix implies that an action, product or process is occurring and this pattern emerged throughout each participant's interview. Although not as prominent within Ada's word cloud, 'thinking' is still one of the more commonly used words within the transcript and comes up as a high percentage within every other transcript. Key words of 'design', 'skills' and 'different' also have regular appearances and were considered throughout the thematic analysis.

Table 3: Word cloud analysis

Hierarchal activity analysis

The below table 1.4 shows the outcomes of the Jamboard activity. Learning items placed as most commonly seen by teachers received 5 points, second most commonly seen learning received 4 and so on. *Working resiliently* and *problem solving* were clearly elements of learning teachers considered as beneficial from high quality D&T activities. Interestingly, *well finished products* and *excellent drawings* were not mentioned at all. *Critical thinking* was specifically mentioned by three out of eight interviewees (see Mode column representing how often each area of learning was chosen) but usually lower down in the hierarchy. The question this study suggests is whether skills such as problem solving for example, is in fact a key part of critical thinking itself.

Table 4: Jamboard analysis; in order of frequency

Areas of Learning (from Hendley and Lyle (1993))	Ada	Alex	Caroline	Elizabeth	Joe	Mary	Pat	Rosalind	Total	Mode
Working resiliently	3			5	3	4	5	3	23	6
Problem solving	1	1	1	3	1	2	4	4	17	8
Imaginative and creative thinking	2		5	4	4				15	4
Asking questions		2	4		2		2		10	4
Listening to the ideas of others	4	3				3			10	3
Working well with others	5					5			10	2
Making and testing predictions			2				3	2	7	3
Thinking critically						1	1	5	7	3
Explanations of why something happened				1	5				6	2
Finding information		5							5	1
Planning and designing carefully		4							4	1
Suggesting ways to improve				2				1	3	2
Following instructions			3						3	1
Clear and relevant ideas									0	0
Excellent drawings produced									0	0
Well finished products									0	0

Thematic analysis

Through analysis of the transcripts, three key themes of outcomes, approaches and attitudes emerged. A number of 'units of meaning' associated with each of these was recorded, quantified and transferred into a spreadsheet to demonstrate the results (Table 5). The blue coloured boxes denote the most mentioned theme within each interview, orange boxes denoting the least frequency. As can be seen, critical thinking was the most commonly mentioned emerging theme but it must also be stated that there was a question specifically about this within the interview.

Table 5 Overview of themes from NVivo; in order of frequency

Thematic analysis	Emerging theme	Ada	Alex	Caroline	Elizabeth	Joe	Mary	Pat	Rosalind	Total
Outcomes	Critical thinking	11	8	10	5	7	11	8	4	64
Approaches	Creative and cross curricular	11	6	8	8	4	5	9	8	59
Attitudes	Teacher attitudes	3	10	7	6	4	10	3	8	51
Attitudes	Leadership and priorities	6	9	10	2	6	4	6	6	49
Approaches	Resource driven approaches	6	4	6	6	2	2	6	9	41
Outcomes	Resilience and problem solving	7	2	7	3	4	2	7	8	40
Attitudes	Pupil enthusiasm	4	3	3	6	4	6	3	10	39
Approaches	Collaboration	5	4	4	3	4	10	2	5	37
Outcomes	Inclusive	8	2	4	3	7	7	3	2	36

Interview analysis of teacher perceptions

One criticism of phenomenography is the challenge for the researcher to eliminate their preconceived ideas and focus on themes and patterns analysed from the transcripts (Webb, 1997). In addition, "different people may experience the same 'thing' in different ways." (Bell, 2016) and a researcher would need to be aware of the differing opinions upon the same subjects. However, by continually being aware of researcher bias the analysis retained an interpretive stance and became demonstrative of a "reflexive, reactive interaction between the researcher and the decontextualised data that are already interpretations of a social encounter" (Cohen et al., 2011). Throughout the process, being consistent of taking a phenomenological stance was maintained.

When analysing the transcripts, examples of critical thinking were evident within the interviews, albeit not always explicitly and defining critical thinking was occasionally an area some respondents asked for clarification. The Cambridge University Press (CUP) definition of critical thinking was shared to stimulate discussion where necessary and teachers were able to openly talk about their experiences. The three key areas of 'critical evaluation', 'analytical framework' and 'synthesising ideas' became themes arising from within the interviews and teachers reflected upon occasions that they had examples of critical thinking within the classroom. Considering that critical thinking was described by interviewees but not always recognised as such is an interesting example of the perceptions of the teachers about critical thinking within D&T activities.

Critical thinking in D&T activities

Within discussion about D&T projects teachers had taught, elements of all three categories of critical thinking were apparent. Examples of critical evaluation provided by the interviewees included making predictions about the products they were making and the consequences of potential design choices. Whether this be through the design process which many teachers were able to clearly communicate, or through trial and error, the teachers were able to identify children who had the "skills to be able to explain what they were doing, and what would what they thought would work better." (Ada).

Analytical framework examples included a range of problem-solving techniques. From children identifying problems and then reasoning solutions, to how children described and justified choices within their given project. To be able to differentiate between critical thinking and

problem solving, Caroline suggested that "problem solving, to me is kind of the basis form of critical thinking, you've got problem solving where you solve a problem … whereas critical thinking is more, you're kind of anticipating problems as they come up".

The final sub theme from the CUP (2019) of synthesising ideas can be defined as solving problems collaboratively or using ideas and information from different sources to create a structured plan. Ada described this as an "understanding is how to get from A to B and use all these bits and pieces in between."

Critical thinking and pupil outcomes
The relevance of critical thinking within D&T tasks as a development of pupil outcomes is one that was mentioned favourably by the interviewees. Whilst Rosalind's view was "I don't think much about thinking critically...well, just that I haven't thought about it myself much", Alex was more forthright in the opinion that "D&T activities lend themselves perfectly to critical thinking" because they "lend themselves more than other tasks to being critically analysed".

When discussing which children Ada felt demonstrated critical thinking skills, she gave the example where children look at their designs and "think critically about it and what they could improve, I guess, yeah, there's some children that it comes automatically." Mary agrees with this whilst surmising that children "must think more critically than I had ever sort of given them credit for". However, interviewees recognised the fact that not all children will naturally have this instinct, or perhaps even have had the prior experience, and this is key to planning future teaching opportunities.

Teaching critical thinking
Pat provided an example of a teaching technique to develop critical thinking skills within an Early Years environment for 3 to 5 year olds: "we sometimes teach explicitly, not criticizing each other's work necessarily, but perhaps we'll look at maybe a piece of art or something, and we'll talk about what we like about it". Modelling skills to enable them to develop critical thinking skills is something that Ada also suggests as important and that she would "deliberately make a mistake and model those critical thinking skills so that would be beneficial to them."

Discussion
Critical thinking was evident throughout the interviews and during the analysis of attitudes towards D&T activities examples of critical thinking emerged consistently, consciously or subconsciously, even before the subject of critical thinking arose. One could suggest the importance of critical thinking within D&T activities is supported not only with the interviewee findings but also the research by Nicholl (2017), Spuzic et al. (2016) and Wei (2020) and teachers perceived skills needing critical thinking as attributes that appear within D&T activities.

Whilst nine themes emerged from the wider study analysis, elements of critical thinking were evident within many of them. Initially, some teachers needed further explanation of what critical thinking meant within a D&T context and Ab Kadir (2018) suggests that teacher subject knowledge of critical thinking is necessary in order to be promoted within classrooms. All respondents in this study gave examples of critical thinking before critical thinking was first mentioned which led me to conclude that critical thinking skills do exist within D&T activities but teachers do not necessary perceive them consciously.

The majority of research usually pertains to pupils older than the primary phase and thus the findings of this study could validate further investigation. It was also necessary to be pragmatic about how much could be achieved phenomenologically. The key themes emerging relating to critical thinking from the interviews provides justification and evidence to support future research within this age range. This could require a different research methodology. The aim of phenomenology is to gather themes and create further questions. These potential research avenues transpired through a phenomenological research stance and perhaps, for example, an action research project to gather evidence in practice through a series of observations and lesson studies may support the theories suggested from the respondents within this study and triangulate the evidence to support the notion that critical thinking is a valuable part of D&T activities.

This research has enabled me to reflect upon my own practice and consider how to utilise my understanding of teacher perceptions within the training I deliver for trainee teachers at the University of Cambridge and also within my school D&T activities as a D&T leader. The critical thinking skills and using D&T as a conduit to provide children with skills for their future materialised as important values from these interviews. The positivity from teachers within these interviews about D&T was also very pleasing.

Final thoughts

To complete further research to evidence the existence, and importance, of critical thinking within primary school D&T activities is one that I personally feel has value for us to deliver high quality activities so that pupils have the skills to make "an essential contribution to the creativity, culture, wealth and well-being of the nation" (DfE 2013). The impact described above has made my research feel validated and that the area of critical thinking within D&T is an area worth researching. Though this may be a small-scale study, I hope that it has highlighted some key areas that could be addressed by the teaching profession to deliver high quality design education that would fulfil the wishes of industry to produce critical thinkers who can generate creative ideas and can collaborate in their problem solving.

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