A comparative study of the content of two documents: The Design and Technology National Curriculum in England and New Zealand's Technology curriculum.

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ABSTRACT

This paper presents the findings of a small-scale project that looked at whether the present Design and Technology (D&T) National Curriculum (NC) for England promotes the development of technological capability to support the generation of economic value through enhancing human capital. The English D&T NC has been in existence for 30-years with a number of iterations during that time. Throughout that time-span the technological world in which D&T education exists, has changed beyond all recognition. This paper looks briefly at the concept of the knowledge economy and the development of human capital in a technological world. It then examines whether the English NC for D&T has evolved through its various iterations. A comparison between the most recent edition of the D&T NC document and the latest New Zealand Technology document through an analysis of the words used in each document was carried out utilising the frequency of all the meaningful words in the two documents. The data would suggest that there has been little change in the English version through its various iterations whereas in the NZ document there is a focus that explicitly embraces the developing technological world. The conclusion from the analysis suggests that a more overt recognition of technological change is required in the next iteration of NC D&T if those both inside and outside the D&T community are to recognise and believe in the worth of the subject for the education of students in their acquisition of human capital that will enable them to fulfil a role in the successful economic development of England and indeed the United Kingdom.

Key words: design and technology; national curriculum; knowledge economy; human capital

Introduction

This paper presents the findings of a small-scale project that looked at whether the present Design and Technology (D&T) National Curriculum (NC) for England promotes the development of technological capability to support the generation of economic value through enhanced human capital. The NC has been in existence for thirty-years with a number of iterations throughout that time. Over the same period the technological world in which D&T education resides, has changed beyond all recognition. This paper looks briefly at the constructs of a knowledge economy, the development of human capital in a technological world and the connection between these theories and the D&T curriculum. The various iterations of the English D&T NC are identified and reasons for carrying out a comparative study of the content of *National Curriculum in England: Design and Technology programmes of study* (DfE, 2013) and the latest New Zealand *Technology in the New Zealand Curriculum* document (Ministry of Education, 2017) are revealed. This is followed by an explanation of the methodology used to analysis these documents. The findings are then discussed and conclusions are drawn.

Knowledge Economy

A knowledge-based economy is an economy in which knowledge is created, distributed and used to confirm economic growth and ensure international competitiveness (Hadad, 2017). It has been agreed both from a theoretical and empirical perspective that technology is a significant factor influencing such economic growth (e.g. Sulaiman et al. 2015). The transformation from the post-industrial/mass production economy of the mid-1990s to the present knowledge economy, sometimes described as the technology/human capital economy, is continuously accelerating due to globalization and technological developments (Hadad, 2017; Houghton & Sheehan, 2000; Powell & Snellman, 2004).

The major characteristics of a Knowledge Economy (KE) have been specified as, open innovation, education, knowledge management and creativity (Figure 1) with a fundamental structural component being the technological infrastructure required to sustain such an economy, particularly in terms of ICT capacity (Houghton & Sheehan, 2000; White et al, 2012). With the expansion of intellectual capital being driven by both creativity and innovation the importance of the development of such skills during the education of any future workforce has been highlighted (Mention, 2011). Due to the nature of technology related education it is appropriate that such skills should be embraced within technology-based subjects taught in schools today.

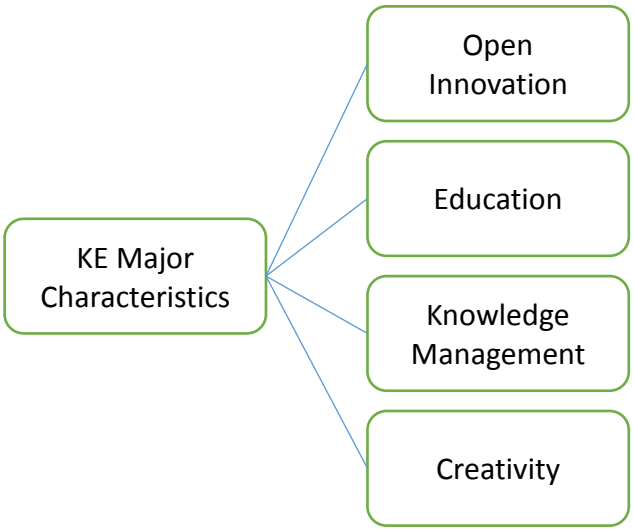

Figure 1: Major KE characteristics according to White et al. (2012)

Human Capital

Human capital, as part of intellectual capital, is seen as the stock of skills that the labour force possesses (Goldin, 2014). Bratianu & Balanescu (2008) summed these up as knowledge, intelligence and values. While Rindermann (2008) added that cognitive abilities were important not only for economic success but also for the non-economic success of individuals and societies.

A more comprehensive list of human capital skills was provided by Hadad (2017). His list included knowledge, skills, intelligence, personal agility, experience and intuition. He suggested that personal views, ideas, values, attitudes, and such abilities as creativity and know-how were also required. All of these can be skills that are developed through an appropriate technology-based curriculum. Goldin (2014) referring to human capital added her support for the importance of education, particularly in terms of technology, indicating that an understanding of its benefits to complement other learned skills would increase the return on any educational investment required. She also explained the cyclical nature of education which induced more technical change and new technologies which then increased the demand for superior skills. In other words, technological advances increase the demands for yet more human capital. In the knowledge economy people who possess, use and transfer knowledge are vital, with positive links firmly established between successful economies, human capital and education (e.g. Weber, 2011).

The History of the English D&T NC

The English D&T NC has been in existence for thirty-years with a number of iterations over that time period. The first statutory NC was published in 1989 when it was defined as being 'about identifying needs, generating ideas, planning, making and testing to find best solutions'. The next iteration was in 1995 with the introduction of a 'slimmed down' version although the philosophy and content of the curriculum changed little as the government agreed that the

principles found in the first Orders were still appropriate (Atkinson, 1997; NCC, 1992). The next version was in 1999. This time the focus of the whole NC changed to allow more time for teaching literacy and numeracy, detrimentally squeezing time allocated to other subjects. Although, once again there was little change in the NC D&T subject matter. Plans for reforms in 2007 were abandoned due to a change in government and it was not until 2010 that an 'expert review panel' reported on a new framework for the NC. This led to significant changes in NC structure with the government producing a draft edition early in 2013 followed by the final version later in the same year. In terms of D&T after vociferous condemnation of the very backward-looking draft edition (Atkinson, 2017), the final version was revised and is still in use today. It is the content of this version that is the subject of this paper.

These different iterations of the D&T NC have existed throughout a time of unprecedented, technological changes globally (Abbasi et al., 2017). New technologies have modified the way people live, work and develop their creative potential (Bonnardel & Zenasni, 2010). This paper suggests that because the English D&T NC has failed to change radically through its various iterations during this timeframe, it has been unsuccessful in keeping up with the technological world in which it sits, in comparison to some other countries' technology-based curricula. In order to garner data to support this belief a comparison was carried out of the content of the latest English document (DfE, 2013, p.1) which states that *'High-quality design and technology education makes an essential contribution to the creativity, culture, wealth and well-being of the nation'* and the latest NZ Technology Curriculum (NZ MoE, 2017, p.1) which states that *"with its focus on design thinking, …. the aim is for students to develop broad technological knowledge, practices and dispositions that will equip them to participate in society as informed citizens and provide a platform for technology-related careers".* Both quotations would appear to suggest support for building students' human capital and the economic well-being of a nation in a forward-thinking manner. This paper therefore asks the question: does the content of the English D&T document support this supposition?

Methodology

In order to interrogate each curriculum's content the most recent English and NZ documents were downloaded from the Internet and converted into Word files. An assumption was made that the words would be indicative of the underlying philosophy, expectations and content of each curriculum. Word Cloud software (WordCloud.com) was then used to analyse the frequency of words used in order to draw conclusions about the content of each document. Support for the use of such software as a viable tool for academic purposes has been signposted by McNaught & Lam (2010).

In terms of the negative aspects of using Word cloud analysis, it was recognised that at best word frequency was *"…a quantification of qualitative data that could easily be misapplied or poorly interpreted"* (McNaught & Lam, 2010, p.634). It was also accepted that no weightings and therefore significance could be scientifically attributed to the count, and that as the Quirkos blog (2017) explained using this form of analysis was simply *"a one-dimensional dive into the data"*. However, it was still considered an appropriate way forward for this small-scale piece of research as comparison of the word clouds generated from different texts have been shown to reveal the differences between the ideas contained in those texts (McNaught & Lam, 2010) (Figure 2).

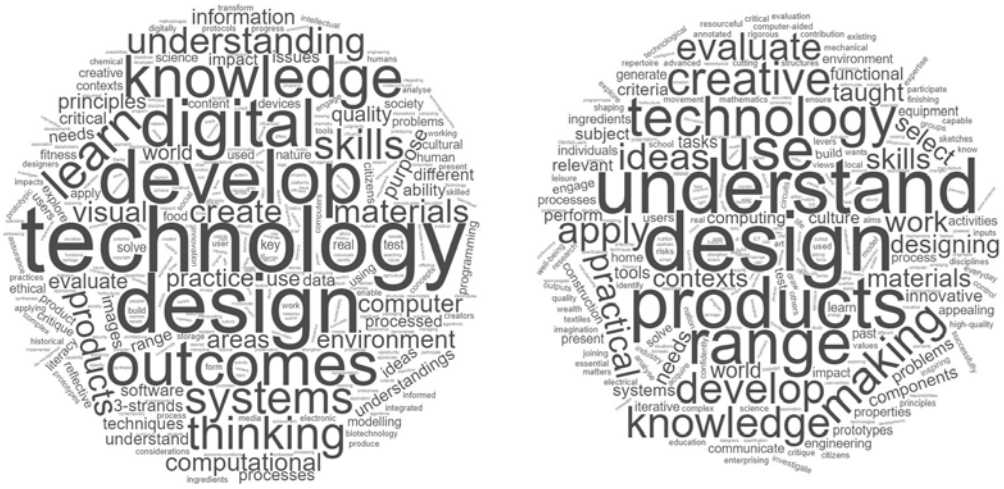

Figure 2: Word clouds of the meaningful words in the NC for D&T in England (on right) and the NZ Technology Curriculum (on left).

The first step in the analysis was the compilation of a 'stop list' of meaningless words so that the data was not swamped by extraneous words. The justification for excluding any words was carefully considered. This included removing cookery terms from the English document as food and cooking were not included in the NZ document and leaving in the associated words would have unhelpfully skewed the data.

Once the irrelevant words had been removed there remained 679 words in the English document and 841 words in the NZ document. The software produced a rank order list of meaningful words from each document using a continuum, most used word to least used word. Each word's frequency was counted (Table 1) and then calculated as a percentage of the total meaningful words in each document. This data was carefully scrutinised leading to words being compared, classified, labelled and re-labelled until seven grouping categories were established. The category labels were: learning action words; words associated with abilities; outcomes; processes; equipment; the environment and subject content and materials. The two categories labelled 'equipment' and 'the environment' were excluded from any further analysis as words in these categories each appeared only once or twice, in comparison, to an average of thirteen occurrences for a word in the 'learning action' category.

The words in the five remaining categories were then compared in terms of word frequency across the two documents looking for similarities and differences. A final scrutiny of the rank order positions of the top-ten words in relation to the five established categories enabled further conclusions to be drawn.

Table 1: Indicates the total words used in each document, the occurrence of the most and least used word, the combined total of the top ten most used words and the percentage usage of the total of the top ten words

	English Document	***NZ Document***
Total meaningful words (MW)	679	841
Occurrences of the most used word	29	55
Occurrence of least used word	1	1
Total occurrence of the top-ten most used words	190	242
Total top-ten most used words as a percentage of total words used	27%	28%

Results

Meaningful Words

The rank order of the frequency of meaningful words established that the top-ten words used in the D&T document formed twenty-seven percent of the total meaningful words while in the NZ document it was twenty-eight percent (Table 1). This supported the author's belief that these top-ten words were important and portrayed the philosophical underpinning, direction and content of each curriculum. Scrutiny of the position of individual words in the top-ten word lists indicated significant frequency differences between the two documents (Table 2). It also revealed that in the English document there was only a difference of eighteen occurrences between the most used word and the tenth most used word. Whereas, in the NZ document there was a much greater variance with a difference of forty-five. Of significance was the drop of -17 between the top and second top word on the NZ list (Table 2). This seemed to indicate how important the top word, 'technology' was in the context of that curriculum. To tease out further the importance of individual words in each document the analysis of words in relation to each of the five identified categories is reported.

Table2: Indicates the Rank order of the ten most used words in each NC document, the number of occurrences, and the percentage in terms of the top-ten words and the total meaningful words (MW) used in each document

	English Document				***NZ Document***			
RO	Word	No. of Occurrences	% of Top10	% of total MW	Word	No. of Occurrences	% of Top10	% of Total MW
1	Design/designing	29	15.26	3.68	Technology	55	22.73	6.54
2	Understanding	28	14.74	3.46	Design/designing	37	15.29	4.40
3	Range	25	13.16	3.68	Digital	33	13.64	3.92
4	Use/using	22	11.58	3.24	Developing	33	13.64	3.92
5	Products	21	11.05	3.09	Outcomes	26	10.74	3.09
6	Technology	16	8.42	2.37	Knowledge	15	6.20	1.78
7	Making	13	6.84	1.92	Learn/learning	12	4.96	1.43
8	Applying	13	6.84	1.92	Thinking	11	4.55	1.31
9	Creative/creativity	12	6.32	1.77	Systems	11	4.55	1.31
10	Knowledge	11	5.79	1.62	Skills	10	4.13	1.19
	Total	190	100%	27 %		242	100%	28%

Categories

Words associated with Learning Actions:

The first category to be analysed, 'learning action' words with an average frequency occurrence of thirteen, revealed that in the English document 'understanding' was the most used 'learning action' word, while it only appeared eleventh in the NZ document. In contrast, 'developing' was the most used 'learning action' word in the NZ document and it was only eleventh in the English document. 'Using" was the fourth most used word in the English document but it was only the twenty-second most used word in the NZ document. It was also noted that five of the six 'learning action' words were in both documents, with three of them appearing in the top-ten words in each of the NZ and English documents, although they were

not the same words in each list (Table 3). The use and importance of 'learning action' words in each curriculum was not a surprise as the subject in both countries required 'action' in order to carry out pertinent activities.

Table3: Indicates the words in each Category, the rank order (RO) position in relation to the ten-top words in each separate document and a comparison with the other document's rank order position

Words	Eng Doc RO	Comparison with NZ Doc RO position	NZ Doc RO	Comparison with Eng Doc RO position
Words associated with Learning Actions – Average occurrence of words in this category 13				
understanding	2nd	+	11th	-
developing	11th =	-	3rd =	+
using	4th	+	22nd =	-
learning	30th =	-	7th	+
thinking	-	-	8th =	+
applying	8th	+	81st=	-
Words associated with Abilities – Average occurrence of words in this category 6				
Knowledge	10th	-	6th	+
Creative Thinking	9th	+	47th	-
Skills	17th =	-	10th	+
Computation	-	-	16th =	+
Communication	-	-	16th =	+
Perform	30th =	+	-	-
Innovative	30th =	+	-	-
Criticality	-	-	29th =	+
Words associated with Outcomes – Average occurrence of words in this category 7				
Outcomes	-	-	5th	+
Products	5th	+	47th	-
Ideas	13th =	-	29th =	+
Images	-	-	29th =	+
Data	-	-	29th =	+
Drawing	162th =	-	127th =	+
Words associated with Processes – Average occurrence of words in this category 12				
Designing	1st	+	2nd	-
Making	8th =	+	-	-
Practical	13th =	+	-	+
Processes	-	-	81st =	+

Words associated with Subject Content & Materials – Average occurrence of words in this category in the D&T Document 6; Average occurrence of words in NZ document 23

Technology	6th	-	1st	+
Digital	-	-	3rd =	+
Systems	30th =	-	8th =	+
Materials	22nd =	-	12th =	+
Computing	30th =	-	16th =	+

Words Associated with Ability:

The words associated with 'Ability' with an average frequency occurrence of six, were pertinent to the aims of each curriculum (DfE, 2013; NZ MoE, 2017) and were also linked to abilities associated with human capital (Hadad, 2017) and therefore the knowledge economy (Houghton & Sheehan, 2000; Mention, 2011; White et al, 2012). However, words in this category were of a lower frequency count than found in any of the other categories (Table 3). 'Knowledge' was the most used word in both documents. In the NZ document it was the sixth most used word while in the English document it was the tenth most used word. As an isolated word its relationship to this category was not obvious. However, when its role within each document was scrutinised further, uses of the word in conjunction with other words such as 'developing knowledge' and 'applying knowledge' indicated that 'knowledge' did belong in this category.

As well as similarities this category also highlighted several differences between the two documents. The word 'Skills' was an important word in the NZ document, it appeared as the tenth most used word whereas in the English document 'skills' was placed lower, at seventeenth. 'Creative thinking', another important ability in the context of a creative subject was the ninth most used phrase in the English document although it only appeared three times in the NZ document where it was ranked forty-seventh.

Words Associated with Outcomes:

In this category there was an average frequency occurrence of seven. Initial scrutiny of the use of the words 'Products' in the English document and 'Outcomes' in the NZ document implied words with similar meanings that were each ranked fifth in the total word count. However, a subtle difference was teased out by scrutinising the full text where the interpretation of an outcome in the NZ document suggested a broader more open meaning of 'a possible result or effect of an action', whereas the word product was more specific and inferred that a physical article must be manufactured. This difference was considered important and is returned to in relation to the next category.

Words associated with Processes

In this category the average frequency occurrence of words associated with 'processes' was seven. The importance of the word 'designing' as a process was illustrated by the positioning of the word in both documents. It was the most used word in the English document and the second most used word in the NZ document. This was unsurprising as the activity of designing

has always been at the centre of both curriculum's activities. However, another example of differences in direction was the fact that 'Making' as a process word was the eighth most used word in the English document and yet, it was not used at all in the NZ document. The high count of the word 'making' was seen to link with the word 'designing' in the English document where 'designing and making products' has always been at the heart of D&T. The use of the word 'outcomes' instead of 'products' in the NZ document with its subtle lack of assumption that all outcomes must include 'making a product' could be an explanation for 'making' not needing to appear in the NZ document. This author speculates that the emphasis in the English document on designing and making products, often a time-consuming activity, could be an inhibitor to the inclusion of more time for experimentation with new technologies.

Words Associated with Subject content & Materials

In this category there were very different levels of use of words associated with 'subject content and materials'. In the English D&T document the average was only six occurrences, whereas the average occurrence of words in this category in the NZ document was twenty-three. The use of the word 'Technology' was as expected found in both documents. It was the most used word in the NZ document with fifty-five mentions in comparison to only sixteen in the English document. It was the use of this word that caused the average occurrence of words in this category in the NZ document to be so high. More evidence of technology's importance in the NZ document was found in the use of the words 'digital', the third most used word and 'systems' which was the eighth most used word. In the English D&T document the word 'digital' did not appear at all and the word 'systems' was only ranked thirtieth. A third indication of the importance of technology in the NZ document was captured when a count of all words associated with 'technology' in that document indicated that they formed 17% of all the meaningful-words. The same analysis using the English D&T document found only 8% of the words were associated with 'technology'.

Discussion and Conclusion

Although the aims and therefore philosophy of the two documents were seen to be comparable, as stated earlier, and the data indicated important similarities in some words used throughout the two documents, the various analyses carried out in this small-scale project did provide evidence that what was expected to be carried out in the English D&T and NZ Technology classroom, differed considerably. The development of the necessary technological skills and understanding which many believe are increasingly important were overtly evident in the NZ document whereas in the English document reference to the use of such skills tended to be implicit, with a lack of reference to words associated with technology being explicitly expressed.

The analysis of the data would appear to support the author's belief that the English NC for D&T has failed to change enough through its various iterations over the past thirty years and has therefore been unsuccessful in keeping up with the technological world within which it sits in comparison to the most recent Technology Curriculum provided for students and teachers in New Zealand.

The data suggests that in England there is a need for more explicit recognition of technological developments in the next iteration of the D&T NC and that this needs to happen sooner rather than later if those both inside and outside the D&T community are to believe in the worth of the subject for the education of students both in terms of developing the broad skills, knowledge and understanding that a design and technology curriculum can provide as well as enabling the acquisition of human capital that will enable students to fulfil an important role in the successful economic development of England and indeed the United Kingdom in the future.

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