Developing 5-6 Year olds' Social Competence using Concept Cartoons: A Neurocognitive Approach

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Abstract

Effective social skills training in schools primarily focuses on teachers having training or researchers implementing the selected programme (Bianco & Leece, 2016; Ratkalkar et al., 2017), potentially disrupting the academic curriculum due to inconsistent teaching styles (Uibu & Kikas, 2012). The present study utilises Concept Cartoons in Year 1 primary Science lessons, delivered by the classroom teacher, with no training, to develop social competence in 5-6-year-old children within a low-socioeconomic status school. This study utilises and synthesises pedagogical theory and neurocognitive evidence to establish a neurocognitive network which describes peer-peer interaction who engages within argumentation, leading to cognitive conflict. Two Year 1 teachers and 56 children took part in a quasi-experimental pre-test-post-test mixed methods design. Both teachers were interviewed at pre-test and the experimental teaching participant was interviewed at post-test. All 56 children were rated on the Social Competence Rating Questionnaire (SCRQ; Liddle & Nettle, 2006) at pre-test and post-test. Sensitivity and control elements of social competence were found to be significant in favour the experimental group at post-test along with an improvement among all means. Findings also revealed teachers need no training with Concept Cartoons to effectively develop social competence in 5-6-year-olds as well as a strong development of SEN pupil engagement. Future research would benefit the exploration of Concept Cartoon use and Theory of Mind (ToM) development and the effects of Concept Cartoons on children with SEN.

Keywords: Concept Cartoon, Social Competence, Cognitive Neuroscience, Theory of Mind

Social competence, the ability to successfully interact with another human being is critical to primary school education, as well as daily life (Bosacki, 2015). However, young children may find it difficult to socialise and have high social competence within the classroom, leading to poor behaviour and a potential academic fall (Arnold, Kupersmidt, Voegler-Lee & Marshall, 2012). Regarding the definition of social competence, it relates closely to emotional intelligence (Gkonou & Mercer, 2017) and Theory of Mind (ToM; Bosacki & Astington, 1999), however, Astington and Jenkins (1995) noted the concept of social understanding needs to be differentiated into various aspects. Social competence is therefore supported by a wide range of abilities, referred to as social skills (Reichard & Riggio, 2008), in which Riggio (1986) categorises into expressivity, sensitivity and control. Expressivity refers to one's ability to express, spontaneously and accurately, felt emotional states; sensitivity refers to one's ability to receive and decode nonverbal communication; control refers to one's ability to regulate social interaction (Graham, West & Squire, 2017). Other studies, however, simply define social competence as effectiveness in social interaction (Bosacki & Astington, 1999; Gómez-Ortiz, Romera & Ortega-Ruiz, 2017). This study aims to use Concept Cartoons – a pedagogical tool – to develop social competence in young children, but due to the multidimensionality of social competence, both definitions will be synthesised for the present study.

Developing Social Competence

Typical social deficits appear in children with neurodevelopmental disorders such as Autism Spectrum Disorders (ASD; Caçola, Miller & Williamson, 2017), and by highlighting the deficient brain areas involved, a stimulus, here Concept Cartoons, can be introduced to promote and develop such deficits (Samson & Michel, 2013). However, research on neurotypicals must be completed first to identify the rationale for further study on children with neurodevelopmental disorders. Therefore, an examination of deficient brain anatomy is completed to outline this neural network to coincide with a theoretical, neurological response to Concept Cartoon pedagogy.

Due to neurodevelopmental disorders, and social and emotional challenges within children, psychologists and schools have utilised different methods to effectively develop their social competence. For example, children with ASD have difficulty initiating and maintaining successful social interaction (American Psychiatric Association, 2013), suggesting depleted social competence. This is argued to be the neurocognitive systems

mediating autistic symptoms and traits such as, and not limited to, the fronto-temporal and fronto-parietal regions of the brain, including the orbitofrontal (OFC) and inferior-frontal (IFG) cortices and the superior temporal sulcus (STS); the limbic brain regions such as the amygdala-hippocampal complex and the cingulate regions including the anterior cingulate cortex (ACC) and the cerebellum (Amaral, Schumann & Nordahl, 2008; Ecker, 2017). Ecker (2017) further reports the neural structures that overlap in a set of brain regions, which is referred to as the "so-called social and emotional brain", including the medial prefrontal cortex (mPFC), the ACC, the IFG, the STS, the amygdala and the anterior insula (Blakemore, 2008). This suggests that ASD can be reduced to neural factors, allowing researchers to study the effects of different variables upon these brain regions, whether it be external, such as, pedagogical methods (e.g., the use of Concept Cartoons in primary Science) or internal, such as, medical treatment. However, due to the neuroanatomical overlap, Ecker (2017) notes the importance of neural similarities with other conditions, such as Obsessive-Compulsive Disorder (OCD; Pauls, Abramovitch & Rauch, 2014). This suggests that severity levels vary, but the described brain regions are exercised. Therefore, different levels of treatment and methods can be used to effectively develop these social deficits, here, social competence.

Bohlander, Orlich and Varley (2012) summarises the literature on social skills training for children with ASD, involving social skills groups, social stories and video modelling. They found peer-mentoring/training were highly effective. This suggests the act of teaching social skills is strong within most of social competence development programmes. However, Jonsson, Olsson and Bölte (2016) question the external validity of this approach and its positive applications to educational practice. This may be due to the disorder being a 'spectrum', therefore having a range of severity levels and one study cannot accurately develop an approach to treat all individuals with ASD (Morin, 2014). However, Asaro-Saddler and Bak (2013) support the efficacy of a peer-mediated approach when teaching writing to children with ASD, suggesting peer-mediation has positive effects when a core curriculum (Department for Education [DfE], 2013) and educational purpose is engaged. This is supported by Asaro-Saddler and colleagues when developing writing skills with Autistic children (Asaro-Saddler & Saddler, 2010; Asaro-Saddler & Bak, 2012; Asaro-Saddler, 2014; Asaro-Saddler, 2016). Though these studies focus on the development of handwriting, peer-mediated approaches involving strong social interaction, underpinned by the sociocultural theory of learning (Vygotsky, 1962), have positive benefits. In addition,

high social competence levels have been found to be strongly associated with academic success and resilience (Domitrovich, Durlak, Staley & Weissberg, 2017; Gil-Olarte Márquez, Palomera Martín & Brackett, 2006), suggesting pedagogical methods to induce academic success through socially conducive environments can positively affect the social competence of an individual.

Although this literature focuses on the deficient neuroanatomy of children with ASD, it highlights relevant brain regions associated with effective social competence. Therefore, a link can be developed with Concept Cartoon use based on Naylor and Keogh's (2013) key features, particularly cognitive conflict. In addition, in relation to neurotypicals, invoking social constructivist pedagogy promotes the positive impact on social interaction (Doolan & Gilbert, 2016), suggesting Concept Cartoons will effectively develop social competence abilities in young children. Moreover, science lessons, pedagogically, are grounded in social constructivist philosophy, engaging discussion and promoting a scientific mind-set (e.g., asking questions based on previous experiences).

Concept Cartoons

Maximising the benefits of constructivist pedagogy, Keogh and Naylor (1999) developed Concept Cartoons designed to intrigue and provoke discussion in the classroom (Naylor & Keogh, 2010). Posed with alternate conceptions within thought bubbles, Concept Cartoons reduce child anxiety when discussing their thoughts, motivating argumentation and dialogic talk (Kinchin, 2004; Sexton, Gervasoni & Brandeburg, 2009; Wolfe & Alexander, 2007) through purposeful social interaction (Kožuh et al., 2015). Adjudication, of which is promoted by Concept Cartoons (Naylor & Keogh, 2013), nurtures a safe environment for children to express their ideas, negating the effects of their teacher's judgement, which may affect their initial ideas (Dweck, 2000). Adjudication further empower pupils to engage in argumentation, generating cognitive conflict, leading to the elicitation of misconceptions (Kabapinar, 2008), allowing the teachers to adjust pedagogical techniques where necessary (Atasoy & Ergin, 2017; Harlen & Qualter, 2014). A key element of Concept Cartoons is the provocation of cognitive conflict (Naylor & Keogh, 2013) which involves children being exposed to new and conflicting ideas around the discussed conception. This invites children to discuss and engage in argumentation with the conflicting idea, utilising past experiences to back up their, potentially false, theory of the conception.

Social constructivist pedagogy, promoted by Concept Cartoons (Keogh & Naylor, 1999), incorporates and effectively utilises social interaction between pupils to progress learning (Needham, 1987; Cremin & Arthur, 2014). This is underpinned by Vygotsky's (1962) sociocultural theory of learning, where social interaction is prioritised with the Concept Cartoons providing the cultural context of investigation. Collaboration through social interaction encourages pupils to move through Vygotsky's (1978) Zone of Proximal Development (ZPD), developing independence (Bekiryazıcı, 2015). However, the literature is limited with the effects of Concept Cartoons on social competence. Though it implies Concept Cartoons actively develop social competence through social interaction (Naylor & Keogh, 2013), no study has looked at the effects of Concept Cartoons on its development. Recent research has found that social constructivist pedagogies develop ToM levels in children (Bianco & Leece, 2016), though criticised for not discussing the extra benefits of the training programme such as social competence (Jarrett, 2017). Research surrounding typically developing children has found relationships with ToM ability and social competence (Graham, West & Squire, 2017; Kuhnert, Begeer, Fink & Rosnay, 2017; Phalen, Dimaggio, Popolo & Lysaker, 2017; Weimer et al., 2017;), suggesting Bianco and Leece's (2016) findings on social constructivist environments promoting ToM ability can in turn positively affect a child's social competence.

Cognitive Conflict and Cognitive Control

A wide range of research focuses on the neurology and neuropsychology of social competence, such as the role of mirror neurons (Endedijk, Meyer, Bekkering, Cillessen & Hunnius, 2017), the amygdala (Schmitgen, Walter, Drost, Rückl & Schnell, 2016), the temporo-parietal junction (TPJ), STS, ACC and the mPFC (Sliwa & Freiwald, 2017; Sokolov et al., 2017; Tremblay, Sharika & Platt, 2017) and how brain dynamics may vary based on social network characteristics in response to social and emotional changes (Schmälzle et al., 2017). Similar areas of the social brain are found within Epstein, Shafter, Melara and Schwartz's (2014) neurocognitive network that orchestrates cognitive control. Based on Miller and Cohen's (2001) work, this suggests cognitive conflict generated by Concept Cartoons activates a managerial network involving the ACC and the PFC. Underpinned by the conflict monitoring hypothesis (Botvinick, Braver, Barch, Carter & Cohen, 2001; Botvinick, Cohen & Carter, 2004), evaluative functions are used to detect processing conflicts, strongly connected to conflict detection and control (Gauvin, De Bene, Brass & Hartsuiker, 2016). This description strongly correlates to the qualitative construct of

cognitive conflict and thus by understanding similarities, a hypothesis for a connection can be formed.

Bandura's (1977) social learning theory suggests children will learn based on observation and vicarious reinforcement, underpinned by mirror neuron activation which is strongly related with social competence (Endedijk et al., 2017). Incorporation of argumentation from Concept Cartoon use in classroom social interactions actively engages the mirror neuron and amygdala activity based on observation and vicarious reinforcement. For example, two children engaging in argumentation with clashing conceptualisations of the phenomenon use their previous experiences to support their conception. Other children observing this argumentation will, based on Bandura's (1977) theory of social psychology, be motivated to engage in argumentation with their peer (Helm, 2017; Nabi & Prestin, 2017**;** Stone & Walker, 2017). When reasoning with new and conflicting concepts within the cognitive conflict process, provoked by argumentation, children will need to shift their perspective to their peer's perspective and attempt to understand. From the 'lead' child in the peer-collaboration, they will need to be sensitive when expressing their conception, maintaining a state of control to prolong and sustain the social interaction. From the 'perspective-shifting' child in the peer-collaboration, they will need to exercise their ability to understand their peer's viewpoint whilst being sensitive when receiving verbal communication and acknowledging their concept, promoting control to maintain and sustain the social interaction. This successful interaction based on the cognitive conflict generated from argumentation from the Concept Cartoon, at a neurological level, incorporates: mirror neurons and the amygdala for initiation and prolongation of the social interaction (Endedijk et al., 2017; Schmitgen et al., 2016;) and the TPJ, STS, ACC and mPFC (Sliwa & Freiwald, 2017; Sokolov et al., 2017; Tremblay, Sharika & Platt, 2017) for perspective-taking abilities and the ability to prolong social interaction through sensitivity, expressivity and control. Based on the previously described managerial network that orchestrates cognitive control and thus the cognitive conflict experienced by children from the Concept Cartoons, the ACC and mPFC is further influenced due to not only different conceptions pushed by a child's peer, but also the multiple conceptions provided by Concept Cartoons.

For an educator, application of cognitive neuroscience can inform planning to not only meeting learning objectives, but to strengthen social competence. The present study predicts the experimental group, who engage with Concept Cartoons in the Science classroom, will engage the described neurocognitive network. The resulting evaluative

component will trigger adjustments in cognitive control to improve task performance, thus retrieving past experiences (Cohen, Barch, Carter & Servan-Schreiber, 1999). Past experiences vary between the children and may therefore clash with another, generating argumentation amongst the discussion (Naylor & Keogh, 2013), challenging a child's previous conception. This experience will engage and promote social interaction within children, developing their social competence through exercise and specific brain engagement.

Application of Cognitive Neuroscience and Educational Psychology in Context

The literature examined identifies the brain regions associated with social competence based on children with ASD, this was then synthesised with the neurocognitive response to cognitive conflict. This defines the process hypothesised for why the studied participants develop their social competence. Although this study does not specifically measure brain activity levels in children, it provides an insight into what is believed to be happening at a reductionist level. Future studies can incorporate the use brain scanning technology to support or refute such assertions.

The neurological processes underlying suggests a multifaceted process when engaging in argumentation based on Concept Cartoon use which invokes cognitive conflict. At the start of the interaction, after posed conceptions have been presented to the children, Peer A will express their thoughts around their current conception. At this point, the TPJ registers and monitors Peer A's physical self in relation to their current physical position whilst the posterior temporal sulcus maintains the presence of their sense of self. This phenomenon, in conjunction with amygdala and STS activation, registers facial emotions and gestures expressed by Peer B when explaining their theory. Depending on Peer A's self-efficacy and their tendency to conform to social pressure determines the action of the ACC and mPFC, whether Peer A will adjust their theory to conform with Peer B. However, if Peer A continues with their current conception, activation of the ACC and mPFC will adjust how it is expressed, adjusting sensitivity where necessary. This act establishes control in Peer A, allowing them to effectively regulate social interaction (Graham, West & Squire, 2017). At this point, if Peer B challenges Peer A regarding their conception, due to its conflict in Peer B's conception of reality, memory is utilised to retrieve past experiences, activating conditioned-context memory from the PFC processed through the thalamus (Kitamura et al., 2017). The conditioned-context memory is based upon Peer A's current conception of reality

based on one of the proposed Concept Cartoon posed conception. Currently, one opinion has been expressed and Peer B's conflicting conception is expressed with similar brain regions being activated. However, the cognitive conflict which will be experienced by both Peers at this point, places further emphasis on the ACC and the mPFC, triggering evaluative functions to establish cognitive control based upon the cognitive conflict invoked. Cognitive control is sought through discussions about Peer A's and Peer B's theory of reality and how they present their evidence to support their theory. Argumentation is key to maintain cognitive conflict and provide steps to establish cognitive control. Exercise of strong activation and emphasis on the ACC and mPFC to establish cognitive control and the children's ability to express their emotions, be sensitive to decoding nonverbal and verbal feedback and controlling the social interaction, is critical to the children's ability to develop their social competence. Therefore, regular monitoring by the class teacher is required to referee such discussions and regular opportunities for children to engage in argumentation; cognitive conflict will allow for positive social interactions.

The Present Study

The current study utilises the neurocognitive information to develop social competence through a social environment employed by Concept Cartoons. However, a focus on the cognitive conflict risen by the Concept Cartoons are hypothesised to effectively develop the social competence of the children, not just the social constructivist environment. In addition, although Concept Cartoons are developing their way through a range of subjects (i.e., Maths and English), they primarily focused on primary Science lessons due to the strong social constructivist approach typically embedded within Science lessons. In addition, the ages 5 and 6 are a critical point for the development of children's empathetic ability and therefore socialisation. Therefore, the present study focused on a Year 1 primary school sample in science lessons. Due to the lack of research in Concept Cartoon pedagogy and the effects on social competence, this paper is to be treated as a preliminary study, providing a rationale for future studies in this area with improved methodologies. Additionally, the concluding results will benefit future studies surrounding this area, particularly looking at develop the social competence of children with ASD and other neurodevelopmental disorders, based on the brain dynamics described.

Primary research question: Do Concept Cartoons in primary Science positively affect the development of Social Competence in young children?

H_1: Children who utilise and engage with Concept Cartoons in primary Science lessons develop their social competence ability based on an increase score on the SCRQ compared to children who did not utilise and engage with Concept Cartoons in primary Science

Method

Participants

Two class teachers and 56 children aged between 5 and 6 years (n = 25 for control, n = 31 for experimental) in Year 1 were recruited from one two-form entry primary school in a low socioeconomic area (Department for Communities and Local Government, 2015). The experimental teacher had fewer years teaching experience compared to the control participating teacher.

Concept Cartoon Design

Cartoon-style drawings were used as a means of presenting alternative conceptions in science (Keogh & Naylor, 1996), where each Concept Cartoon addresses a typical misconception. This includes visual representation of a specific situation relating to the selected conception with characters to portray their view of the scientific phenomenon in question. Thought bubbles are used to represent alternative conceptions per individual (typically 3 or 4). Language used is minimal to keep to the visual and simplistic attraction of the Concept Cartoons, maintaining and engaging student focus (Moschovaki & Meadows, 2005). However, this may be difficult with intricate concepts, particularly in mathematics. Overcoming this, researchers have utilised colour in Concept Cartoons in their studies (e.g., Balim, İnel-Ekici & Özcan, 2016; Topkaya & Simsek, 2016) where a plethora of research cited by O'Connor (2011) advocates the psychological effects, such as red connoting active and motivated behaviour (Lee, Cho, Sim & Lee, 2016). Therefore, based on the reviewed literature, two Concept Cartoons have been designed incorporating Naylor and Keogh's (2010) descriptions using Adobe Photoshop CC (as of 2017) and Creative Commons images, incorporating 'materials' as a theme (DfE, 2013). Due to the young age, bright colours were used to maintain engagement (Lee et al., 2016), using language in thought bubbles which were accessible by all pupils in the experimental class. This was developed and revised through conversations with the experimental teaching participant, ensuring the Concept Cartoons could reach their full potential.

Jelly Castles. The 'Jelly Castles' Concept Cartoon incorporated a cartoon image of a king with a speech bubble entailing his question: "Can I make my castle out of jelly?". This is followed by three different coloured cartoon figures with thought bubbles stating (from left to right), "Jelly is wobbly", "Jelly is strong" and "Jelly is too weak". Key words were highlighted to standout using a boldface font.

Metal Knight. The 'Metal Knight' Concept Cartoon incorporated a cartoon image of a king with a speech bubble entailing its question: "Is metal the only material for my knight armour?". This is followed by three different coloured cartoon figures stating (from left to right), "Water is good", "Wood is strong", "Plastic is flexible and strong". Key words were highlighted with a boldface font.

Both Concept Cartoons incorporate a wide range of colour as well as an image depicting what a cartoon figure has stated; this is further accompanied with a blurred background to engage the children with the theme. For example, the 'Jelly Castles' Concept Cartoon has a background of mountainous fields and the 'Metal Knight' Concept Cartoon has a background of a large castle.

Experimental Design, Triangulation and Ethics

The present study used a pre-test-post-test quasi-experimental design (Cohen, Manion &e Morrison, 2011) to measure differences in social competence within participants. However, the quasi-experimental design affected controllability, causality and generalisability of the results (Coe, Fitz-Gibbon & Tymms, 2000), depleting validity (Cohen, Manion & Morrison, 2011; Maxwell, 1992), and thus reliability (Lehner, 1979). Supported by a variety of research (Brewer & Hunter, 1989; Creswell & Clark, 2011), this was addressed through mixed methods, enhancing accuracy and meaningfulness of the conclusions drawn. Therefore, structured observations through instantaneous sampling (Cohen, Manion & Morrison, 2011) assessed the validity of Concept Cartoon use in the classroom (Naylor & Keogh, 2013). Additionally, semi-structured interviews captured the teachers' professional opinion relating to a child's social competence and its development, following the pre-test-post-test nature, adhering to Lincoln and Guba's (1985) criterion for transferability, providing sufficient details and thick descriptions.

The present study received ethical approval based on Newman University ethical guidelines (Newman University, 2013). Informed consents were retrieved by all necessary participants whilst protecting their privacy and confidentiality by using pseudonyms. A

hierarchal system was used to gain informed consent, starting with: headteacher, teacher, parent and child.

Measures

Both class teachers were interviewed at pre-test and post-test of the study, both being informed on the study and what it entails. The SSI (Riggio & Carney, 2003) was designed as a self-report measure which, as for children aged between 5 and 6, was inappropriate due to their language abilities and cognitive level. Therefore, the SSI was not utilised, however, the SCRQ was used as a measure of social competence based on teachers' ratings (Liddle & Nettle, 2006). Each child was rated by their respected teacher on the SCRQ at pre-test and post-test of the study. The SCRQ consists of 14 statements, such as, 'The child is good at dealing with others', of which is rated by a teacher on a Likert scale, from 'very inaccurate' to 'very accurate' due to their professional judgement and knowledge of the children. A total of these scores are utilised to indicate high or low social competence, a high score indicating high social competence. Internal consistency tests were used to determine the reliability of the SCRQ; Liddle and Nettle (2006) yielded a Cronbach's α of .91 for the SCRQ, noted as "very highly reliable" by Cohen, Manion and Morrison (2011, p.640), though the present study yielded a Cronbach's α of .92.

Structured observations through instantaneous sampling (Cohen, Manion & Morrison, 2011) were used by the researcher to assess the validity of Concept Cartoon use in the classroom, ensuring controllability of the independent variable. This was developed from Naylor and Keogh's (2013) key features of Concept Cartoons based on the wealth of research derived from educational research communities (Atasoy & Ergin, 2017; Ekici, Ekici & Aydin, 2007; Kabapinar, 2008; Yong & Kee, 2017). Structured observations were measured through a tally method noting the frequency of how often a key feature appeared over a set time (55-60 minutes for each lesson), where the researcher observed independent of the lesson.

Demand Characteristics. As the SCRQ is based on subjective teacher opinions, the results are subject to bias, however, in relation to an educational setting, this is typical of any formative assessment method; contributing to the natural educational and assessment environment and thus the mixed methods and pragmatic design. Therefore, the results and interpretations are open to scrutiny, however, within an educational setting, this is typical.

Procedure

Pre-test. Teaching participants were separately interviewed in their own classroom at pre-test to gauge their current theoretical knowledge and practical experience with Concept Cartoons. Both teaching participants then rated their class on the SCRQ before Concept Cartoons were introduced as a pedagogical tool to develop social competence. Both participants were aware of how the Likert scale system worked on the SCRQ, being made aware that one on the scale is "Very Inaccurate" and five is "Very Accurate". Two science lessons took place, each lasting an hour with the 'materials' theme and the researcher recorded the observations. Both control and experimental participants utilised social constructivist pedagogy in their classroom with the same topic taught.

***Jelly Castles*.** First observation utilised the Jelly Castle Concept Cartoon, involving the teaching participant modelling an investigation and children being actively involved through social interaction questioning. The teaching participant used cross-curricular learning to incorporate writing and literacy, placing a strong emphasis on language skills, providing opportunities for the children to talk.

Metal Knights. Second observation utilised the Metal Knight Concept Cartoon, involving the teaching participating modelling an investigation and the children actively carrying out their own investigation in relation to the Concept Cartoon question, engaging social interaction. Children conversed on hypotheses and the teacher utilised effective formative assessment questioning.

Post-test. The experimental teaching participant took part in a post-test interview regarding the development, if any, in social competence levels of their children. Both teaching participants rated their children at post-test on the SCRQ for data analysis to see a difference.

Results

Preliminary Analyses

Statements for the SCRQ are reported S, followed by the number on the SCRQ, i.e., S12 refers to "The child is not confident". Preliminary analyses were performed to ensure there was no violation of the assumptions required for statistical testing; due to the ordinal nature of the variables (Field, 2014), non-parametric tests were used. Exploration of

descriptive statistics and correlation matrices were used to identify trends and relationships between the variables.

Pre-test. Sum of scores revealed a difference in favour of control group at pre-test as $M = 52.00$ and $M = 50.06$ for the experimental, though this was not significant, $U = 365.500$, $z = -0.83$, $p = .41$, $r = -0.11$. All but two statements were not statistically significant. S3 and S8 on the SCRQ were statistically significant at pre-test, $U = 164.000$, $z = -3.91$, $p < .001$, $r = -0.52$ and $U = 244.500$, $z = -2.572$, $p = .01$, $r = -0.34$, respectively; in favour of the control group.

***Validity of Concept Cartoon use*.** Figure 1 represents the instantaneous sample structured observation findings for both Concept Cartoon lessons, finding *Mode* = 26 for Motivation and Engagement within the Metal Knight lesson and *Mode* = 22 for Language Skills in the Jelly Castle lesson. Figure 2 represents the sum and percentages collectively, demonstrating the addressment of misconceptions (14.29%), Motivation and Engagement (12.78%) and Cognitive Conflict (12.78%) were the top three features found. No Informal Learning Settings were used (0%). Figure 2 demonstrates most recorded features (Naylor and Keogh, 2013) are utilised, promoting ecological validity of Concept Cartoon use (Field, 2014, p.13).

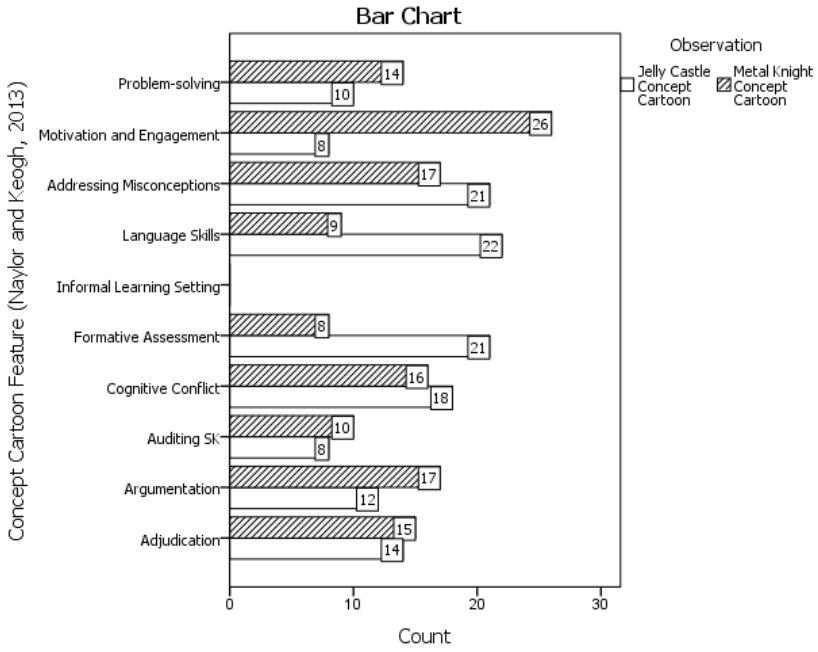

Figure 1: Lesson 1 and 2 Structured Observation

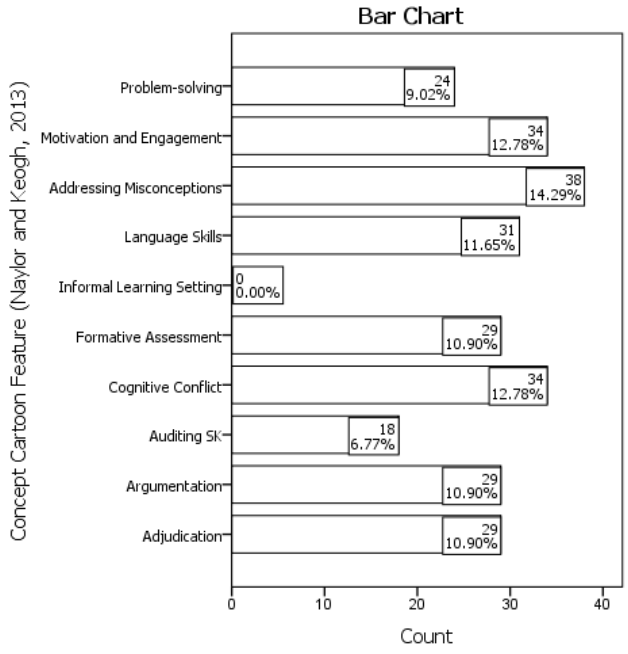

Figure 2: Collective results of Structured Observation

Post-test. Sum of scores reveal a difference in favour of the experimental group as *M* = 53.68 and *M* = 49.00 for the control group, though no significance was found, *U* = 295.500, *z* = -1.52, *p* = .13, *r* = -0.20. Statistical significance was found at pre-test for S3 and S8 in favour of control, however, no significance was found in the post-test, *U* = 302.000, *z* = -.754, *p* = .451, *r* = -0.1 and *U* = 383.500, *z* = -.071, *p* = .944, *r* = -0.09; the means scores

being in favour of the experimental group – S3: M = 29.9, M = 26.76; S8: M = 28.63, M = 28.34, respectively. Post-test analysis revealed three statistically significant results in favour of the experimental group: S9, U = 212.500, z = -2.98, p = .003, r = -0.40; S10, U = 155.500, z = -3.93, p < .001, r = -0.53 and S13, U = 219.500, z = -2.89, p = .004, r = -0.39 with strong positive correlations – see Table 1. Correlation matrix revealed S9 had strong, positive correlations with 10 statements, ranging from +.523-+.740 and the 3 other statements have a medium positive correlation (Pallant, 2016), ranging from +.312-+.466, significant at the p < .001 level.

Table 1

Correlation Matrix for pre-post test items

				Post-test:	
			S9	S10	S13
Spearman's rho	Post-test: S9	Correlation Coefficient	1.000	.734**	.554**
		Sig.	.	< .001	<.001
	Post-test: S10	Correlation Coefficient	.734**	1.000	.500**
		Sig.	<.001	.	<.001
	Post-test: S13	Correlation Coefficient	.554**	.500**	1.000
		Sig.	<.001	<.001	.

**. Correlation is significant at the 0.01 level (1-tailed).

Expressivity, Sensitivity & Control

S4 and S11 were indicative of expressivity with a moderate positive correlation (r_s(54) = .565, p < .001), S5, S9 and S10 were indicative of sensitivity with two moderate positive correlations and one strong positive correlation (S5 and S9: r_s(54) = .523, p < .001; S5 and S10: r_s(54) = .554, p < .001; S9 and S10: r_s(54) = .734, p < .001), S4, S5, S9 and S10 were indicative of control with five moderate positive correlations and one strong positive correlation (S4 and S5: r_s(54) = .638, p < .001; S4 and S9: r_s(54) = .583, p < .001; S4 and S10: r_s(54) = .468, p < .001; S5 and S9: r_s(54) = .523, p < .001; S5 and S10: r_s(54) = .554, p < .001; S9 and S10: r_s(54) = .734, p < .001). Indications of statements and their relationship

with expressivity, sensitivity and control were qualitatively selected by the researcher based on their applications in the real world from the working definitions.

Discussion

Concept Cartoons and Social Competence

The aim of this study was to investigate the effects of Concept Cartoons in primary Science on Social Competence development in young children. This was carried out in a quasi-experimental pre-test-post-test design, utilising the SCRQ questionnaire, administered by the teachers. Although the present study addresses a research gap in Concept Cartoon research, it also provides a pedagogical advantage for using Concept Cartoons as a reasonable adjustment to develop social competence. The present study finds and supports a relationship between Concept Cartoon use and social competence development, where a positive difference was found in the grand means of SCRQ scores at post-test. Though not significant, this suggests that Concept Cartoons may accelerate social competence development within Year 1 children. A closer examination of the means for each SCRQ statement reveals a positive increase for all, suggesting that participating children developed on all parts of the SCRQ compared to the control group, however, such tenuous links cannot justify inference due to the lack of significance. However, a statistically significant difference was found with specific social competence statements with small to large effect sizes on S9, S10 and S13. With S10 yielding the largest effect size, it is inferred that Concept Cartoons within an environment which invoke argumentation, leading to cognitive conflict, actively and significantly develops a child's ability to access large social networks, suggesting enhanced social skills.

From a neurological perspective, this suggests the cognitive conflict induced by the argumentation from the Concept Cartoons activates Epstein et al.'s (2014) neurocognitive network which orchestrates cognitive control. Underpinned by the conflict monitoring hypothesis (Botvinick et al., 2001; Botvinick, Cohen & Carter, 2004), evaluative functions are used to detect processing conflicts, which are strongly connected to conflict detection and control, producing argumentation. Based on this, various brain areas are engaged from the external clashes of peer social interaction, including: mirror neurons, the amygdala, TPJ, STS, ACC and the mPFC; all of which contribute to the children's ability to socialise and have an effective discussion (Bandura, 1977). It is inferred that these neurological exercises

which Concept Cartoons invoke develops and promotes social competence development in young children.

Effective socialisation within large social networks, however, involves children being good at dealing with others (S9) and not being able to shy away from challenges (S13). These two statements are statistically significant too, suggesting Concept Cartoons affects a child's ability to interact with another individual. This indicates children are effectively able to express one's felt emotional state, be sensitive when receiving and decoding nonverbal communications and to control and regulate social interaction (Riggio, 1986; Graham, West & Squire, 2017), synthesised with effective social interaction (Bosacki & Astington, 1999; Gómez-Ortiz, Romera & Ortega-Ruiz, 2017). From a sociocultural perspective, this indicates that a Vygotskian (Vygotsky, 1962) approach to teaching, utilising argumentation and cognitive conflict derived from Concept Cartoons can develop social competence within young children as well as promoting young children to face challenges.

Based on the discussed literature, theoretically, alternate conceptions posed within thought bubbles provided by the Concept Cartoons reduced child anxiety when discussing their thoughts, of which promoted the argumentation and dialogic talk experienced within the observations (Kinchin, 2004; Sexton, Gervasoni & Brandeburg, 2009; Wolfe & Alexander, 2007). This in turn involves children being exposed to new and conflicting ideas around the discussed conception, leading children to retrieve past experiences to facilitate the conception of each posed idea. Children are invited and encouraged to discuss these conceptions to progress their learning (Cremin & Arthur, 2014; Needham, 1987) whilst using evidence from past experiences to debate and support their own – potentially false – conception of reality. It is this educational and collaborative process which reduces the anxiety of approaching challenges (S13). From this, children have a rationale to take part in a scientific investigation, developing and testing their theories in conjunction with the scientific method (DfE, 2013). However, this inference cannot be fully justified without further study involving an anxiety measure in the classroom.

Expressivity, Sensitivity and Control

Although the SSI (Riggio & Carney, 2003) was not utilised, the working definitions incorporate Riggio's (1986) definition of social competence and how it is underpinned by expressivity, sensitivity and control are not set. Therefore, using Graham et al.'s (2017) interpretation of the three categories, real world applications – based on an educational

perspective – from the statements present in the SCRQ were combined to develop expressivity, sensitivity and control. However, further analysis in future studies would benefit the reliability and validity of these assumptions.

Expressivity. Statements 4 and 11 ("The child doesn't think before speaking and doing" and "The child is disruptive in the classroom" – Liddle & Nettle, 2006) were used as indicatives of expressivity; both display a moderate positive correlation. Based on the instantaneous structured sampling observation, this can be measured through motivation and engagement within discussions, of which accounted for 12.8% of both observations, a similar percentage is noted within argumentation at 10.9%, suggesting children were taking part in the session and discussing the different conceptions. Furthermore, based on reverse coding, a higher score indicates that a child does think before they speak and act, and the child is not disruptive within the classroom. Both of which allow the children the ability to express, spontaneously and accurately, felt emotional states within an appropriate manner. This suggests that during argumentation within Concept Cartoon use, children are actively expressing their viewpoint of the phenomena in question. However, expressivity was not statistically significant between the experimental and control group at pre-test and post-test. This is most likely due to frequency of exposure of the Concept Cartoons and its implementation. A longitudinal study in the future would shed light upon this along with a matched pairs design to exclude potential participant variables. Though speculation suggests increased frequency of exposure would actively develop expressivity significantly, it is important to note the means of S4 and S11 did increase from the pre-test, suggesting Concept Cartoon use positively affects expressivity. Though not statistically significant, this supports the alternate hypothesis for the present study, aligning and supporting previous studies on peer-mediated approaches (Asaro-Saddler, 2014; Asaro-Saddler & Bak, 2012; Asaro-Saddler, 2014 & Asaro-Saddler, 2016; Bohlander, Orlich & Varley, 2012) However, these studies focused on the development of children with ASD for social skills training, focusing on either social skills or writing. Nevertheless, Concept Cartoon use developed social competence and thus effective social skills in typically development pupils as well as an individual with SEN. Although no studies have been discussed regarding low social competence in typically developing children, current findings suggest Concept Cartoons can be used as a medium to accelerate aspects of social competence. However, further studies are needed, with various measures, to promote the validity of these assertions. In turn, this can provide a rationale for further study into the effects of Concept Cartoons on individuals with ASD and other special

educational needs as a reasonable adjustment. This can be coupled with studies exploring the effects of increased frequency of exposure.

Sensitivity. Statements, 5, 9 and 10 ("The child is sensitive to other people's needs and desires", "The child is good at dealing with others" and "The child has a large social network") were interpreted as indicatives of sensitivity within social competence, all of which were positively correlated, ranging from moderate and strong/high strength. Based on the structured observation, this can be measured noted through motivation and engagement (12.8%), language skills (11.7%), cognitive conflict (12.8%) and argumentation (10.9%). These constructs, though purposed for validity of Concept Cartoon use, are outcomes for the effectiveness of the social competence related statements. For example, a child being sensitive to another's needs and desires is reflected in the argumentation and cognitive conflict generated from discussion based of the selected Concept Cartoon, utilising effective language skills, all of which is grounded in motivation and engagement. Based on the described neurocognitive system, exercise of the ACC and mPFC in conjunction with other specified brain areas actively develops social competence within a meaningful and educational experience. Corroborated by statistical significance found in S9 and S10, this suggests Concept Cartoon use actively develops children's sensitivity in relation to social competence. However, S5 was not found to be statistically significant, suggesting a third of the statements that comprise sensitivity was not significant; nevertheless, a closer inspection of S5's means suggest a statistical improvement based on the pre-test. Though speculation suggests increased frequency of exposure would actively develop S5 significantly, contributing to the sensitivity contrast, however, this may be related to a child's ToM ability. Research suggests and advocates a relationship between social competence and ToM/perspective-taking ability (e.g., Graham et al., 2017; Kuhnert et al., 2017; Phalen et al., 2017; Weimer et al., 2017), and at ages 5-6, children may struggle to attribute embedded mental states (e.g. second-order ToM ability; Hsu & Cheung, 2013). This suggests children are less able to be sensitive to their peer's needs and desires in relation to the argumentation of alternate conceptions. However, it is important to note, Concept Cartoons actively developed a child's ability to be sensitive to other people's needs and desires, though not significant, it can tenuously suggest Concept Cartoons in lesson can contribute to the positive development of ToM in young children. In addition, brain areas which connote ToM ability are similar to that which social competence activates, suggesting a relationship between the two, and based on the described neurocognitive network, emphasis on the ACC and mPFC in

conjunction with the other brain areas, could develop ToM ability. In relation to children with SEN, particularly ToM deficient disorders, such as ASD, this provides a rationale into Concept Cartoons being used as a reasonable adjustment to develop ToM. As such, it has been found that Concept Cartoons can actively develop abilities relating to children's ability to receive and decode nonverbal communication with response.

Control. Statements S4, S5, S9 and S10 ("The child doesn't think before speaking and doing", "The child is sensitive to other people's needs and desires", "The child is good at dealing with others" and "The child has a large social network") were used as indicatives for control; five displaying moderate positive correlations and one displaying a strong positive correlation. Based on the structured observation, identification of where control would take place involves motivation and engagement (12.8%), language skills (11.7%), cognitive conflict (12.8%), argumentation (10.9%) and adjudication (10.9%). Regarding its output, control is significantly related to sensitivity as this relates to the children's ability to receive and decode verbal and nonverbal communication in attempt to maintain successful social interaction. It can be argued formative assessment (10.9%) can regulate control through teacher-input based on questioning and behaviour management. However, children's ability to effectively maintain sensitivity on receiving verbal and nonverbal communication is critical to the children's ability to stay in control of the social interaction. This suggests Concept Cartoons effectively enable children to think before they speak, be sensitive to other children's needs and desires, good at dealing with each other and having a large social network. However, only S9 and S10 were found to be statistically significant in comparison to the control group, suggesting Concept Cartoons at the present frequency of exposure significantly develops children's ability to deal with each other in a social context and have a large social network. Nevertheless, S4 and S5 means at a closer inspection, were greater at post-test compared to pre-test; this indicates a development, though not significant. Therefore, the described neurocognitive network suggests a development in social cognition, specifically social competence using Concept Cartoons.

Due to its similarities with sensitivity, the development of control within children can be suggested to develop ToM ability, providing further rationale to study the link between Concept Cartoon use and ToM development in young children. The present study demonstrates that Concept Cartoon use, with only theoretical knowledge of Concept Cartoons, can develop a child's social competence and potentially, in turn, develop a child's ToM ability. However, further research is required to test the generalisability of these

assumptions. As such, the present study finds Concept Cartoons can significantly develop control abilities, relating to social competence, in Year 1 children.

Educational Implications

Statements, 9, 10 and 13 are all highly correlated, suggesting Concept Cartoon use within the experimental group positively affected the children's ability to take on challenges, and deal with other children effectively due to purposeful social interaction (Kožuh et al., 2015). Therefore, mixed ability groups, with purposeful interactions, develops effective social interaction based upon expressivity, sensitivity and control. Moreover, development through mixed ability groups suggests Vygotsky's (1978) ZPD plays a significant role in the development of a child's social competence. However, although SEN pupils may have deficient brain areas associated with effective social interaction, the experimental teacher revealed Concept Cartoons developed SEN pupils' ability to become "on par" with the "more able children" academically and socially, suggesting Concept Cartoons based on the described neurocognitive network, develops deficient social cognitions. However, determination of cause and effect is questioned between social constructivist pedagogy and Concept Cartoon use within lessons. Causality in favour of the Concept Cartoon use for social competence development is supported within the control pre-test interview where they give an example of a lesson which utilises social constructivist pedagogy. This suggests social constructivist pedagogy alone does not significantly adjust and develop social competence levels compared to Concept Cartoon use. Research advocates the social constructivist impact on academic ability and social cognition, though the present study found the experimental group having increased social competence. This suggests through purposeful social interaction; argumentation; cognitive conflict; adjudication; development of language skills; addressment of misconceptions and problem-solving, Concept Cartoons have a positive effect on a child's social competence.

For an educator, the findings provide the social potential for Concept Cartoons to develop not only typically developing pupils, but also pupils with SEN. In relation to the ASD, the described neurocognitive network suggests activation and exercise in typically deficient areas of Autistic brains. However, due to ASD being a spectrum, it is difficult to make generalisations without rigorous study. Nonetheless, Concept Cartoons have also been found to allow children whom do not typically achieve, to become "on par" with "higher pupils", ensuring accessibility for all pupils. In addition, high achieving pupils have

opportunities to not only develop lower attaining children, but to also deepen their scientific reasoning skills through the scientific method (DfE, 2013) with critical and evaluative talk.

Although the present methodology utilises Concept Cartoons on two occasions, it is inferred multiple and consistent use does not deteriorate or have detrimental negative effects and will continue to have a positive and thus improved effect on a child's social competence. Furthermore, when considering the effect of Concept Cartoons had on the working definitions, leading to successful social interaction, it demonstrates the positive relationship between Concept Cartoons and social competence. However, a longitudinal study would give an understanding of increased frequency of exposure on the effects of Concept Cartoon use and social competence. Moreover, the present study measures the impact of Concept Cartoons on social competence within a naturalistic environment, suggesting only pedagogical and theoretical knowledge is required for its positive social effects, ensuring accessibility for educationalists.

In addition, the present rationale and hypothesis can inspire further educationalists to utilise cognitive neuroscience and apply it to the classroom, promoting a research based, neurocognitive discipline. In turn, educationalists will question other parts of their pedagogy in views of cognitive neuroscience and attempt to critically reflect and improve upon current pedagogical practices.

Significance of Study

No existing literature discusses nor hypothesises the positive effect of Concept Cartoons on social competence development. This paper utilised psychological and interpretative measures to identify a relationship where a positive correlation has been found relating to sensitivity and control. This study utilised cognitive neuroscience to derive an explanation for the phenomenon in question regarding cognitive conflict and argumentation, focusing on the discussion between two peers. Educational implications have been discussed regarding how Concept Cartoons can be used to develop social competence and promote scholarly practice in education settings. Furthermore, the pragmatic design sidesteps contentious issues of post-positivism and constructivism to investigate the developmental of social competence with Concept Cartoon use in Science lessons, freeing methodical constraints. Pragmatic ontologies underpinned by educational psychology axiology informed the epistemology and methodology of the present paper, providing a balanced approach to the results.

Limitations

It is assumed cognitive conflict is the source of social competence development based on the argumentation derived from Concept Cartoons. However, without neurological evidence based on scans, only a theoretical assumption can be formed based on the available data. No funding was allocated to this study; therefore, neurological equipment could not be utilised to further progress this theoretical foundation. However, further research would benefit from the use of functional magnetic resonance imaging (fMRI) and event-related functional magnetic resonance imaging (efMRI) to not only observe neural activity but to separate the elements into discrete points in time, supporting or challenging the proposed neurocognitive network.

Both participating teachers had a difference in teaching experience; the experimental participant having fewer years. Participants involved in the SCRQ were only matched on age and not ethnicity, intelligence or cognitive/physical abilities. It cannot be concluded that this influenced the results, however, a matched pair design would address this issue. However, without participant variables, the researcher would not have been able to uncover the potential developmental benefits of Concept Cartoons on SEN pupils; inspiring future research. Randomised control trials (RCT) could not be utilised on this study as it would have disrupted the Year 1 classes, negatively affecting children's learning and the teaching participants' stress levels. Research involving multiple schools could utilise RCT, moving towards a true experimental design.

The SCRQ engaged 56 participants; G*Power suggests this is not enough participants to draw any significance nor external generalisability, however, this is the entirety of a Year group at the participating school. Until future research on larger populations, external generalisations cannot be made, this is exacerbated by participant variables, though internal generalisations can be made with caution (Faul, Erdfelder, Lang & Buchner, 2007). Though this does not make a dramatic impact on differing areas, it can be hoped similar schools and localities can adapt to achieve similar results. Semi-structured interviews captured participants' understanding at the specific school at the specific time; this research does not intend or advocate external generalisations from qualitative analysis. From the researcher's perspective, each individual is different at the interpretative level – this does not stop individuals to identify with the participants' responses.

Conclusion

In summary, this paper synthesises research to address the effects of Concept Cartoon use in primary Science lessons on social competence development in Year 1 children. The present study revealed Concept Cartoon use does not develop 5-6 year olds' social competence due to no significant difference among SCRQ scores. However, aspects in control and sensitivity were found to be significant, suggesting Concept Cartoons in primary Science lessons have an impact on children in a mainstream Year 1 classroom. Additionally, although expressivity was not found to be statistically significant, there were improvements within the means upon closer inspection, suggesting further research is required to understand why sensitivity and control were positively and significantly affected and expressivity was not. However, caution is necessary when interpreting based on specific statements as there were no other social competence measure. Future research will benefit this with the use of additional measures. Critical analysis of social competence and cognitive neuroscience literature enabled a neurocognitive theory to be established, focusing on peer-peer interaction from argumentation to cognitive conflict. The findings also suggest emphasis on mPFC and ACC activation within the social brain, however, such conclusions cannot be drawn from behavioural data. Nevertheless, the present findings suggest the social pedagogy conducive to argumentation and cognitive conflict from Concept Cartoons positively affects the social competence of children. Though this sample is small ($N = 56$), the significance and effect sizes found provides rationale for further research to be conducted within this area. In addition, qualitative analysis revealed teaching participants only required theoretical understanding of Concept Cartoons and no practical experience to deliver effective and purposeful Concept Cartoon use within science lessons. This suggests an accessible teaching resource to not only provide meaningful discussions within science, but to also develop aspects of social competence in 5-6 year olds. Future research would benefit from a longitudinal study on Concept Cartoon use on social competence, utilising RCTs and multiple social competence measures and how it links to ToM based on the described neurocognitive network. This would be required before looking at its neurological basis with brain imaging techniques. Therefore, promoting a biological and neuropsychological practice towards primary teaching.

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