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Investigating Developmental Trends in Metacognitive Knowledge with School-aged Children using Pupil Views Templates

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This thesis explores developmental trends in metacognitive knowledge with school-aged children using Pupil Views Templates (PVTs). PVTs were developed in the mid 2000s to explore pupil views of learning. Informed by the findings of previous research, the empirical data collection used a more systematic and stratified sampling technique. A systematic review of tools and methods to measure or assess metacognition was included as a way of codifying PVTs. The systematic review makes an original contribution to both this study and the field; in a field as vast as metacognition it provides a valuable summary.

The exploration of metacognitive knowledge is based on, but does not completely replicate, the pre-existing approach to coding PVTs. A rigorous examination of relevant literature rationalised and grounded the focus on metacognitive knowledge. This underscored ambiguity around defining metacognition, sub-divisions of it and crossover between these. Thus, the clarity of defining metacognition for and within this study was key.

The mixed method approach to PVT analysis was distinctive in its application of traditional statistical analysis and emergent interpretivist methods including word clouds. Analysis confirmed the utility of PVTs as a means to explore metacognition in school-aged children. It supported the assertion that PVTs are a tool that can be used with a wide range of ages to explore metacognitive knowledge, including children as young as four years old. There was evidence of developmental trends in metacognitive knowledge and indications to support inextricable links between underlying cognitive skills and metacognition. This study also showed the importance of considering how metacognition is explored; including the definition of metacognition applied, how it is operationalised and then analysed. If a study does not have clear links between the concept, its measurement and outcomes it becomes difficult to determine validity and subsequent value both within and for the field.

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Statement of Copyright

The copyright of this thesis rests with the author. No quotation from it should be published without the author's prior written consent and information derived from it should be acknowledged.

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I would like to dedicate this thesis to my grandparents, Ted and Eva, both of whom were excited at the prospect of me completing doctoral study but sadly are not here to see it finished. Thinking of you always.

"A bird doesn't sing because it has an answer, it sings because it has a song."

Maya Angelou

Chapter 1 - Introduction

Metacognition is a popularly researched, yet extremely complex field spanning both education (the discipline of this thesis) and psychology. Emerging research about metacognition, including research using Pupil Views Templates (PVTs) is beginning to contest long held assumptions about the development of metacognition. This chapter introduces metacognition and presents the context and rationale of this study. The context and rationale centres on two fundamental questions: Why metacognition and Why PVTs?

Flavell's (1976) definition of metacognition or rather his coining of the term, is unprecedented in its popularity and referencing within the field. Flavell's definition refers to a persons' knowledge of their thinking or learning[1]:

> *"Metacognition" refers to one's own knowledge concerning one's own cognitive processes and products or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in metacognition (metamemory, metalearning, metaattention, metalanguage, or whatever) if I notice that I am having more trouble learning A than B; if it strikes me that I should double-check C before accepting it as a fact…*

(Flavell, 1976, p. 232)

In 1979 Flavell simplified his definition of metacognition to: "knowledge and cognition about cognitive phenomena…" and suggested that young children are "quite limited" in this (p. 906). Metacognition today, particularly when translated into practice, is broadly referred to as '*thinking about thinking*' and sometimes as higher order thinking (Livingston, 2003). Livingston (2003) asserted that although metacognition was not overtly conceptualised until the late 1970s, it has been around for "as long as humans have been able to reflect on their cognitive experiences" (p. 2). However, Williamson (2005, para 2) noted that now "the term [metacognition] has become so widely used, that for some critics it is now muddled to the point of being meaningless". Considering the complexity of metacognition is of paramount importance, being careful to avoid both the difficulties of over complication and oversimplification.

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[1] When Flavell's (1976) original definition of metacognition is referred to from this point on, this is the definition being referenced.

Prior to introducing the background, context, rationale and approach, the use of the word 'children' should be problematized. An awareness of the power relations and homogeneity that the word 'children' may imply, alongside the ethical responsibilities of a researcher working with children is imperative (see 3.9.2). Alternative words (e.g. pupils, learners, students) were not as compatible with the 'school-aged' prefix that was necessary to make the school setting clear. In light of this and as outlined by McLaughlin (2015) this study sought to align with an approach to research that challenges adult-centrism in research with children. It aims to show the clear value of children's contributions about their learning, using PVTs, by way of contribution to the field of metacognition and existing research using PVTs.

1.1. Background

This study uses Pupil Views Templates (PVTs) (Wall, 2008; Wall & Higgins, 2006; Wall, Higgins, & Packard, 2007) with a systematic sample of school-aged children (4-16 years)[2] to explore patterns in pupil comments about learning that are classified as metacognitive. From this point on, the phrase school aged-children will be used to refer to this age range. PVTs are a visual tool developed pragmatically in the mid-2000s, in response to literature around pupil views on learning. PVTs are an empirical research tool, but also a pedagogical tool that can be adopted to facilitate discourse about learning in the classroom (Wall et al., 2012). PVTs were established as a research tool within the context of several action research projects; these projects involved teachers examining their own practice alongside pupil views on learning (Wall & Higgins, 2006). The relevance of PVTs in terms of their utility to explore learning with and for students, and their teachers was recognised early on:

> *Few studies have explicitly looked at the learning process. In particular, the research detailed above has not looked at pupils' perceptions of themselves as learners or their metacognitive thinking. (Wall & Higgins, 2006, p. 41)*

PVTs responded originally to the needs of action research and teachers' exploration of their own practice in the classroom. However, they have also been used to research

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[2] In England the age of compulsory education has been raised to when students turn 18 for those born after 1 September 1997. However, this does not mean students have to stay in school after Year 11 (15-16 years). Post-16 education can include apprenticeships and part time education and training until students turn 18 years old (DfE, 2014b)

metacognitive development in research about children's views of their own learning (Wall, 2008; Wall, Higgins, Remedios, Rafferty, & Tiplady, 2012; Wall, Higgins, & Smith, 2005).

Pragmatically completed from an educationalist perspective, this thesis focuses on the development of metacognition in school-aged children. It is located at a point on the metacognition continuum where metacognition intersects between both practice (metacognition in schools and policy) and the research community. This study is a systematic approach to exploring metacognition with PVTs, but always with an eye to its relevance for practice. With reference to Hammersley (2003), Wall et al. (2012, p. 2) succinctly encapsulated the inextricable link to practice in the field (education) where PVTs are located:

> *We are educationalists. The field in which we work is important as it provides the context for this research as well as giving insight into our priorities for the research process. Education is a discipline where impact on practice is fundamental (Hammersley, 2003).*

The sample and location of this study (school-aged children, in school settings) combined with evidence in the literature regarding positive student outcomes and metacognition (1.2.1) make the links between research and practice clear. These links are explored further with regards to the context and rationale in 1.2.

1.2. Context and Rationale

Prior to stating the research questions, it is imperative to set the scene for the context and rationale. Setting the scene incorporates the overarching questions of why this research should be done, and what the contributions that it makes are? What follows considers why this study is meaningful in terms of research about metacognition, and research using PVTs: Why metacognition? Why PVTs? Section 1.2.1 illustrates the increasing importance of metacognition both in and for pedagogy and begins to consider the development of metacognition.

1.2.1. Why metacognition?

Since its conceptualisation in the 1970s, exploring metacognition and its development with school-aged children has become increasingly important. This importance stems from increasing recognition of the developmental nature of metacognition, but also an awareness of positive outcomes for children that are associated with metacognition.

Kuyper et al. (2000) noted the positive outcomes associated with metacognition, but also underlined the need for further research in this area. School based initiatives aimed at improving outcomes for 'at risk' students like the Pupil Premium (DfE, 2014a) mean that schools are interested in cost effective ways to fulfil and improve academic outcomes. Second only to effective feedback (very high impact, low cost), in comparison to other strategies including peer-tutoring, early intervention and one-to-one tutoring[3], metacognition has been shown to be a high impact, low cost way to improve attainment (Higgins et al., 2012). The importance of metacognition in pedagogy has been consistently highlighted in research that draws positive links between metacognition and student outcomes including attainment (Akyol, Sungur, & Tekkaya, 2010; Dignath, Buettner, & Langfeldt, 2008; Higgins, Hall, Baumfield, & Moseley, 2005; Kuyper, van der Werf, & Lubbers, 2000; Prins, Veenman, & Elshout, 2006).

Thinking about the development of metacognition in the literature, there was debate about the links between metacognitive development and child development as early as the late 1970s (Brown & Smiley, 1977). Developing his definition of metacognition from the initial definition given in 1976, Flavell (1979) indicated that young children are limited in their metacognition and monitoring abilities thus inferring that the development of metacognition is instigated at an older age than these 'young children'. Hofer and Sinatra (2010) and Kuhn (2000) both argued the importance of non-linear approaches to children's development, Kuhn emphasised the usefulness of a developmental framework to explore metacognition. The notion of framework does not necessarily imply linear development, but rather emphasises the importance of looking at the whole picture.

The age(s) at which metacognition develops is a continuing debate; conflicting research evidence supports the development of metacognition (and distinct elements of it) at different ages, this debate will be explored further in 2.3. Perhaps more accurately, the debate is entrenched in consideration of at what age(s) metacognition (or specified elements of it) can be observed or assessed. Established belief is that metacognition does not develop until 8 years old or beyond (Bartsch, Horvath, & Estes, 2003; Kuhn, 1999b; Veenman, Wilhelm, & Beishuizen, 2004). The belief that metacognitive skills do not develop until much later than metacognitive knowledge is also well established. Kuhn (1999a)

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[3] For the full list of 21 strategies please see Higgins, Kokotsaki, and Coe (2012).

explained that the meta-knowing underlying higher order thinking develops somewhere between 3-5 years of age. The belief that metacognitive skills are not thought to develop until as late as 10-12 years is widely held (Veenman, Kok, & Blöte, 2005; Veenman et al., 2004).

In contrast to established belief, research with PVTs has suggested evidence of metacognition (both metacognitive knowledge and metacognitive skilfulness) in children as young as 4 and 5 years old (Wall, 2008; Wall et al., 2012). Comparably, Leutwyler (2009, p. 112) asserted that children aged as young as three show "the first roots of metacognition". In a study with children aged 3 to 5 years old, Whitebread et al. (2010) concluded that observation based methods "enabled the clear identification of early metacognitive skills in young children" (p. 237). All of these examples underline contradictions to established belief with regards to metacognitive development and age. This dichotomy in the field raises questions about the different methods that have been used to explore metacognitive development: questions about the potential limitations of different methods, the ages they are and can be used with, and the impact(s) of this upon subsequent findings. Intrinsically linked to this question of development, is a question of measurement – how is metacognition elicited in order that its development can be explored? PVTs are one method by which evidence of metacognition has been elicited in school-aged children, what follows provides an overview of why they are used in this study and the contribution that this seeks to make.

1.2.2. Why PVTs?

A pertinent reflection on the field coined by Desoete (2008) and introduced in detail Chapter 2 (2.1 - Systematic Review) is revisited throughout this thesis: "How you test is what you get" (p. 204). The advice here to consider the outcomes of a 'test' alongside how the test is conceptualised and applied, is key and provided the inspiration for attentiveness to clarity around defining metacognition in Chapter 2. The findings of the systematic review highlighted that PVTs were one of only two included methods (PVTs and Think Aloud Protocols (TAPs)) applied to a wide age range of children (across 10 years of the included 13 from 4 – 16 years) in the included records. The uniqueness of this wide age range, combined with knowledge that post- review publications (Wall et al., 2012) have used PVTs with students aged from 4 - 15 years old (increasing the age range to 12 years), leads to the second overarching question of 'why PVTs?'.

Existing research using PVTs is limited; there has been no systematic use of PVTs across the entire school age range to explicitly explore developmental trends in metacognition[4]. This study is essential, to develop an understanding of the position of PVTs within wider metacognition research and to explore the utility of PVTs to examine the development of metacognitive knowledge within a systematic sample. Specifically, this research has a survey aim, using one design of PVT across the entire age range of 4 – 16 years to investigate metacognition; previous PVT research has not done this. In peer-reviewed research using PVTs a range of ages has been sampled and PVTs have been used for a variety of purposes. Research foci include Learning to Learn (L2L) (Wall, 2008; Wall et al., 2012), pupil views of learning and digital portfolios (Wall, Higgins, Miller, & Packard, 2006) and pupil views of learning with interactive whiteboards (Erikson & Grant, 2007; Wall et al., 2005).

A more systematic approach to sampling is where the contribution of this study lies in furthering research with PVTs. Only one of the examples in Table 1 (Wall et al., 2012) has a sample spanning both primary and secondary education. Systematisation is essential if data from PVTs is to be used to explore developmental trends in metacognition as it has in previous research (Wall, 2008; Wall et al., 2012). In addition to the need for more systematic research using PVTs existing research asserts that further research, focussing on the utility of PVTs to explore developmental trends in metacognition, is necessary (Wall and Higgins, 2006). Thus far the use of PVTs has been justified by outlining some of their unique characteristics within the field (wide age range, use by practitioners and researchers) and by explaining why there is a need for further research exploring metacognition with PVTs (a more systematic sample).

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[4] The use of the word systematic in this context refers to the lack of stratification in the sample across the age range for compulsory schooling (4-16 years). PVTs have been used with children aged 4-15 years in one study (Wall et al., 2012).

Table 1: The sampling and age ranges for previous research using PVTs

Record	Sampling			Age range
	Students	Schools	Templates	
Wall et al. (2005)	80	Unknown (3 LEAs*)	80	10 - 11 years
Wall et al. (2006)[5]	60	3 (12 in project)	60	7 – 10 years
Erikson and Grant (2007)	138	1	138	10 - 13 years
Wall (2008)	210	7	210	4 – 11 years
Wall et al. (2012)	451	12	548	4 – 15 years

Note: * LEA refers to Local Education Authority, the area of authority in which a school resides.

PVTs have been used as a tool to explore metacognition (Wall, 2008; Wall et al., 2012), but they have also made important advances in terms of facilitating pupil voice via talk about learning (Wall, 2008; Wall and Higgins, 2006). Pupil voice has become a central concept in education in the UK, undoubtedly influenced by the UN Convention on the Rights of the Child (United Nations Convention on the Rights of the Child, 1989). PVTs are a visual tool that can be used to elicit pupil views on learning in multitude of scenarios (e.g. working in a pair or group, working with computers, working outside of the classroom). Talk about learning facilitated by PVTs has been observed as useful for both pupil and teacher reflection, and evaluation. The PVT mediates interactions between the researcher (or teacher) and pupils:

> *The template we have designed can be understood as a 'semiotic tool' (Vygotsky 1978; Wells, 1994) and forms the basis of a mediated interview about the teaching and learning situation. By providing an image of the context on which the research is focusing…the process becomes a three-way interaction between the researcher (or teacher), the pupils and the template...*

> *(Wall & Higgins, 2006, pp. 41-42).*

PVTs have a familiar worksheet format and are conducted as part of a discussion or mediated interview (in class groups, or smaller focus groups); they are not far removed from conventional classroom based activities.

PVTs comprise a picture that depicts a particular learning scenario; examples include paired working, group work, working on a computer and art (Wall et al., 2007). The format

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[5] See also Higgins, Miller, Wall, and Packard (2004)

of one such template for group work is illustrated in Figure 1, speech and thought bubbles placed alongside a picture depicting the given learning scenario (in this example 'Group work'). The purpose of the speech and thought bubbles on PVTs is to facilitate reflection on learning. Wall and Higgins (2006, p. 42) explained that this "has its inspiration in work completed by the bubble dialogue team; for example, McMahon and O'Neill (1992) and Jones and Price (2001)." Wall (2008) clarified that speech and thought bubbles are used with the aim of delving deeper and facilitating talk and thought about metacognition, rather than gathering simple views on learning. Speech bubbles provide a focus on factors that are external to the individual (e.g. teachers, parents, other pupils) and thought bubbles the 'internal processes' (e.g. individuals' learning, metacognition). Wall (2008) noted a crossover between the speech and thought bubbles, including "the impacts on the learning of themselves and others" (Wall, 2008, p. 26).
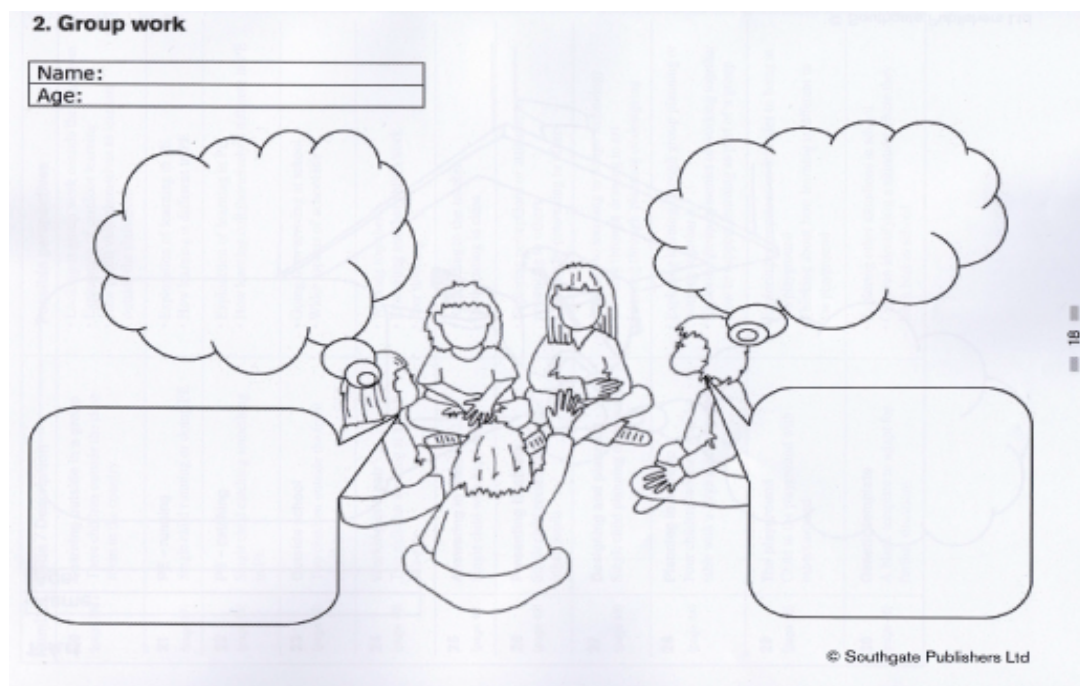
Figure 1: A PVT for group work (Wall et al., 2007, p. 18)

PVTs facilitate a three-way interaction between the pupil, researcher and stimulus (the PVT). Figure 2, replicated from Wall and Higgins (2006), illustrates how each of the three aspects interact to form the mediated interview format of PVT completion. The mediating quality of the PVT in the interactions seeks to negotiate the power relations that often present challenges in research with children (1.1). PVTs can be used either by the researcher (or the teacher depending on the context) as a prompt that illustrates the aspect

of learning or the learning situation that they want to initiate discussion and questioning about. The use of the PVT to initiate discussion and annotation (on the PVT) leaves the researcher (or teacher) and pupil with a record of the discussion that has taken place. This study focuses on analysing the text on the individual PVTs for evidence of patterns in cognitive skills and metacognitive knowledge.
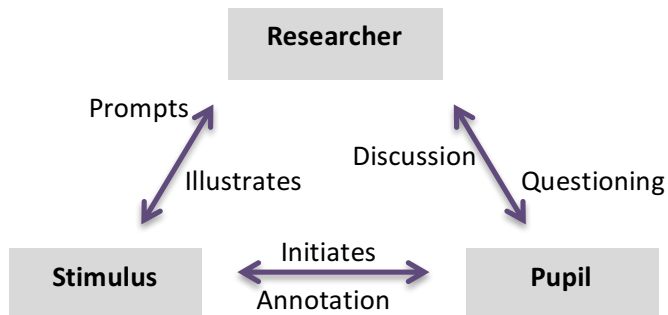
Figure 2: The model of interaction using Pupil Views Templates, from Wall and Higgins (2006, p. 42)

The discussion record (text on the PVTs) produced in the mediated interviews or focus groups is analysed for evidence of cognitive skills, metacognition and affective comments to learning (Wall, 2008). The deductive coding scheme is rooted in the Moseley et al. (2005a) 'Integrated model for understanding thinking and learning', encompassing both analysis of cognitive skills and a metacognitive/self-regulatory element (strategic and reflective thinking). From this point onwards this model will be referred to as the 'Moseley model' (see 2.2.1). Existing research using PVTs (see Table 1) has used this deductive coding scheme with a wide age range and has demonstrated high inter-rater reliability (see 3.7.2).

Previous analysis of data collected using PVTs (Wall, 2008; Wall & Higgins, 2006; Wall et al., 2012) coded for affective comments to learning, cognitive skills and, strategic and reflective thinking (the latter two pertaining directly to the Moseley model). This research has demonstrated value in this deductive coding scheme for extracting evidence of metacognition (Wall, 2008 and Wall et al., 2012). Text coded as strategic and reflective thinking (Moseley model) and therefore as having evidence of metacognition, was subsequently reanalysed for evidence of metacognitive knowledge and metacognitive skilfulness based on definitions given by Veenman et al. (2005). Strategic and reflective

thinking is the metacognitive/self-regulatory element of the Moseley model. It is important consider the reasoning behind this classification as opposed to describing strategic and reflective thinking solely as metacognition and/or self-regulation. Moseley et al. (2005a) explained that they aimed to encompass "all kinds of thinking, feeling and trying as potentially open to self-awareness and self-regulation" (p. 312) as opposed to other authors who may associate metacognition "only with thinking processes and skills at the 'higher' end of the domain" (p. 312). The expression *strategic and reflective thinking* is used as an easily accessible and non-contentious alternative to metacognition in the Moseley model. This is a practical and measured approach given the complexity of defining metacognition that Chapter 2 will explore.

At the time of its abstraction the Veenman et al. (2005) distinction between metacognitive knowledge and metacognitive skilfulness was pioneering in terms of the accessible and clear definition of two elements of metacognition that it presented. Its use does however have some difficulties in terms of debate around online and offline measures or assessments of metacognition, this debate is explored further in 2.1. The key issues centre on deliberation around what elements of metacognition (e.g. knowledge or skilfulness) may or may not be accessible with online or offline methods. Many have argued, including Bryce and Whitebread (2012), that metacognitive skills are better assessed with online measures whereby data is collected concurrently with task completion. The rationale behind this is that online measures are perceived to be a fairer and truer representation of metacognitive skills, offline measures being less accurate or potentially obstructive in the case of *Think Aloud*. Similar questions can be asked with regards to observation-based methods and the representation that they present. In discourse about the evidence of metacognitive knowledge and metacognitive skilfulness gathered using PVTs, Wall (2008) argued for a consideration of the weight that should be placed upon the value of the individual declarations of pupils on PVTs. In PVTs, individual declarations of knowledge about metacognition are completed by the pupils as 'first' person as opposed to evidence from observation completed by a 'third':

> *The comments written down by the pupils give evidence of both metacognitive understanding and skilfulness. With this latter facet of metacognition it could be argued that because these templates rely on pupils declaring and expressing their knowledge about metacognition, skilfulness could not be truly evidenced. However, the counter argument would be that evidence from a template where an individual has declared knowledge of metacognitive process, while also expressing that they are consciously using them in their learning would surpass any subjective evidence from*

observation completed by a third person. These pupils not only have the knowledge about metacognitive skills and process, but they also know how they are using them in different learning contexts. This, the author believes, fits with understandings of Veenman et al.'s (1997) definition.

(Wall, 2008, p. 32)

Debate around the online/offline distinction is important but not something that can be definitively resolved within the scope of this study, if indeed at all. Nonetheless it is imperative to understand the ramifications of this for data about metacognition collected using PVTs. It is not within the scope of this thesis, given the focus on metacognitive knowledge to explore online/offline debate in detail. However, as Chapter 2 will exemplify, the complexity of metacognition means that there are overlaps and blurred boundaries between distinctly described concepts (e.g. metacognitive knowledge of strategies and metacognitive skilfulness[6]).

Returning to the analysis of metacognition in PVT data (Wall, 2008; Wall et al., 2012), it is important to consider the deductive approach applied. Deductive coding was based on the Moseley model (Moseley et al., 2005a), it helped to facilitate manageability of the data in large datasets. The size of the proposed sample (> 370 PVTs) (3.5.1) therefore similarly requires a limited number of codes to retain the integrity of the coding process. However, by limiting the number of codes then it could be argued that the full complexity of metacognition may not be represented. Analysis of PVT data in this study is based on previous analysis in Wall (2008) and Wall et al. (2012) but does not replicate it wholly - it does not include an analysis of metacognitive skilfulness as has been presented in previous research. Justification of this basis on, rather than direct replication of previous analysis is outlined in 3.8.1. Therefore, although developed from previous research using PVTs, this thesis will also consider a more in-depth analysis of metacognition beyond the metacognitive knowledge and skilfulness distinction used previously.

In this research the analysis framework presented in Chapter 3 will not discount the approach to metacognition used in existing research, including definitions of metacognitive knowledge and metacognitive skilfulness proposed by Veenman et al. (2005) and used by

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[6] Note the spelling of skilfulness here, taken directly from Veenman et al. (2005), later papers by the same group authors use a different spelling and this is reflected in the reference list (van der Stel & Veenman, 2008, 2010; Veenman, Kerseboom, & Imthorn, 2000)

Wall (2008) and Wall et al., (2012), indeed it is largely derivative of this. However, it will focus on a finer grained analysis of metacognitive knowledge as opposed to both metacognitive knowledge and skilfulness. Section 2.3 will explore different conceptualisations and facets of metacognition with an eye to how this could be accommodated in terms of PVT coding, while still on a manageable scale. This will mean this study will present a more in-depth analysis of patterns of metacognitive knowledge in PVT data placed alongside the previously established analysis of cognitive skills and strategic and reflective thinking. It is important to retain this basis in the existing research in order to fulfil the survey aim (1.2.2), yet also build upon (with a more systematic sample) the exploration of metacognition in PVT data. Having underlined the unique contribution of PVTs and the reasons why further research using PVTs is necessary, what follows introduces the research questions and approach.

1.3. Focussing on this Study

Metacognition is a vast field of study; PVTs are an innovative method requiring further exploration in terms of their utility to explore developmental trends in metacognition and to establish their location within the field. The focus of this study is developmental trends in metacognitive knowledge in school-aged children, in data gathered using PVTs. It is central to situate PVTs within the wider field of metacognition research and secondly further research using PVTs is necessary in order to:

- Have a more systematic sample encompassing the entire school age range of 4-16 years.
- Focus on metacognition as the first priority of the study
- Explore metacognition in more detail with PVTs, beyond the splitting of metacognitive knowledge and metacognitive skilfulness with a particular focus on facets of metacognitive knowledge (including knowledge of person, task and strategy).

1.3.1. Research questions.

Epistemologically speaking this study is pragmatically situated within an educationalist perspective, where research and practice transect (1.1). The complexities of metacognition are considered alongside their relevance in practice. A rigorous approach to exploring and defining metacognition and situating PVTs within their wider field facilitates a

defensible study, from which conclusions can be drawn about: the utility of PVTs, the wider field in which they are situated and the development of metacognitive knowledge in school-aged children.

The aims of this study have a clear focus on metacognition and PVTs, more specifically examining their utility to explore metacognition with school-aged children. The main research question for this study is:

In a systematic sample of PVTs collected across school-aged children, what associations are apparent in pupil comments about their learning that are classified as metacognitive?

This overarching, main research question has clear links to the title of this thesis and wider trends in the literature around developmental trends in metacognition. Associations referring primarily to associations between comments about learning classified as metacognitive, in particular metacognitive knowledge, and age (developmental trends). In order to answer this question, the situating of PVTs within the larger field of metacognition and its measurement or assessment is imperative. The main research question is supported by four subsidiary research questions relating not only to existing research using PVTs but also themes from wider research in metacognition that have been introduced in this chapter:

   i.   **How has metacognition been researched with school-aged children, and how do PVTs fit into this field of research?**
   ii. **In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as cognitive skills (Moseley et al., 2005a)?**
   iii. **In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as metacognitive knowledge?**
   iv. **What are the advantages and disadvantages of PVTs as a tool to collect data across a systematic sample of school-aged children?**

Figure 3 illustrates how the key concepts and aims of this study overlap and how they have grown out of the need identified in existing research with PVTs for additional research (1.3). PVTs are explored within a two-stranded wider context: how metacognition has been measured or assessed and wider literature around metacognition and defining it (since its conception in the 1970s). The notion of how metacognition is defined (in this study, in previous research using PVTs and when assessing metacognition with other tools or

methods) is central to situating research with PVTs and conceptualising the components of the analysis framework that will be explained in Chapter 3.

Overarching (main) research question:

In a systematic sample of PVTs collected across school-aged children, what associations are apparent in pupil comments about their learning that are classified as metacognitive?

Rationale

This study

Starting point: Existing research and the need for more research using PVTs

Systematic sample (4-16 years), focus on metacognition

PVTs

Measuring or assessing metacognition

PVTs need to be situated, their use compared and evaluated alongside other tools

Focus on metacognitive knowledge and underlying cognitive skills with a more systematic sample. Evaluation and critique of the field (assessing metacognition) grounds PVTs in this study and conceptualising the framework applied in this study for analysis of PVT data.

Metacognition: theory and practice

Defining metacognition in this study

Figure 3: Mapping the rationale of this study

1.4. Summary

Chapter 1 has demonstrated where this study fits into existing research using PVTs, and why there is a need for further research. This chapter has outlined the main aims of this thesis and given context and rationale, including addressing the questions of why metacognition (1.2.1) and why PVTs (1.2.2)? What follows in Chapter 2 seeks to extend the rationale for the research questions stated in 1.3.1, exploring their context within relevant literature of the field. Chapter 2 will therefore conclude by stating the full rationale and context for each of the research questions. It is important to situate this study and PVTs as a research tool within the wider field of metacognition – PVTs are one research tool within a vast field. The findings of this study need to be grounded firmly within relevant debates of the field. With this in mind Chapter 2, after a brief introduction, is structured as follows:

- 2.1 - The Assessment of Metacognition in School-Aged Children: A Systematic Review.
- 2.2 – Defining Metacognition (including cognitive skills and the relationship with metacognition, metacognition and self-regulation, metacognition in practice and subdivisions of metacognition).
- 2.3 – Metacognitive development (with a particular focus on the development of metacognitive knowledge)
- 2.4 – Restating of the research questions from 1.3.1 with full rationale from the literature.

Chapter 2 - Metacognition: Assessment, Definition and Development

It is imperative to situate this study within a focussed and rigorous consideration of the assessment, defining and development of metacognition. The two linked bodies of literature that will facilitate this consideration are methods of assessing metacognition in school aged children and metacognitive development. What follows will consider where PVTs fit into the wider field, defining metacognition and the challenges that this poses and finally the development of metacognition (metacognitive knowledge in particular). This study makes contributions to the field(s) of both metacognition and existing research using PVTs (see also 1.2.2); it is imperative that this chapter clearly exemplifies these unique contributions.

The rationale for beginning with a systematic review stems from the focus of this study on assessing metacognition with PVTs; it is imperative to ground this measurement tool within the field and as such it was necessary to gain an overview of the field. Completing a systematic review was the most rigorous way of exploring the field in detail, whilst simultaneously providing a broad overview. The systematic review identified relevant literature from across the field, including: tools in addition to PVTs that have been used to assess metacognition (2.1), definitions of metacognition (2.2) and information about metacognitive development (2.3).

2.1. The Assessment of Metacognition in School-Aged Children: A Systematic Review[7]

A systematic review is a comprehensive method enabling researchers to explore what has been studied, how it has been studied and then to synthesise what has been found out. A systematic review has a defined and specific focus, with an explicit research question and time scale (Gough, Oliver, & Thomas, 2012). The focus of this review is on the tool or method stated by the authors as the measure or assessment of metacognition, as opposed to a more typical systematic review which focuses on the results or effects of a given metacognitive intervention or comparing the results of different interventions (Torgerson, 2003). This review presents an up to date synthesis of international and UK literature focussing on the assessment of metacognition in school-aged children between 1992 and 2012. The focus on school-aged children (4-16 years) is directly related to the age group in the sample for the empirical element of this thesis using PVTs. Defining the focus concept of this review (metacognition, and associated terminology) was explored in detail in 2.1.

Veenman's (2005) overview of assessing metacognitive skills provided a good introduction to a vast field, it was the only review of its kind at the time of publication. Nonetheless there is a need for a more systematic review of methods to assess metacognition. There is an abundance of research purporting to assess metacognition, but the different tools and methods described in the literature are not yet synthesised in a systematic way. The importance of this review centres on summarising a vast field, but also situating the empirical data collection in this study and therefore facilitating a grounded comparison and evaluation of the use of PVTs. This synthesis highlights the different tools and methods that have been used within a 20-year time frame to assess metacognition and facilitates an exploration of the potential links between:

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[7] Please note that this section (2.1) of this thesis is in press, to be published in *Review of Education*:

Gascoine, L., Higgins, S., & Wall, K. (In press). The Assessment of Metacognition in Children Aged 4-16 Years: A Systematic Review. *Review of Education*.

The article in press was established from this chapter directly, but it has been developed in line with reviewer feedback. The article therefore has some differences in the categorisation of tools and methods; there are also some differences in the included tools and the ways in which the findings are presented. For purposes of citation please cite the online version of the article (in press), the DOI is yet to be assigned.

- The types of tool or method used and the ages of the participants they are used with

- The tool or methods used and links between how metacognition and associated concepts are defined.

To effectively evaluate the utility of PVTs in exploring developmental trends in metacognitive knowledge it is essential to have an understanding of how other research in the field has approached this. This review provides theoretical and practical underpinning, informing the definition of metacognition that is subsequently applied in this study. An in-depth understanding of different assessments of metacognition on a broader scale facilitates a well-reasoned and balanced evaluation of PVTs as an emerging research tool.

2.1.1. Background and existing reviews.

Much of what has been published in terms of systematic reviews and meta-analyses concerning metacognition focuses on reviewing the impact(s) of pedagogic interventions (Dignath et al., 2008; Dignath & Büttner, 2008; Higgins et al., 2005). Although not the focus of this review, an understanding of these pedagogic interventions and how they are taught in schools is important. These links are key to appreciate the connections between what the desired outcomes of an intervention are, how the key concepts are defined, how the intervention is subsequently implemented and not least how the effects are or could be measured. The prevalence of pedagogic reviews, as opposed to reviews of methods like this one, supports the pragmatic and educationalist epistemology underlying this thesis.

Dignath and Büttner (2008) and Dignath et al. (2008) illustrated via meta-analysis the high number of intervention studies that have been conducted around metacognition and self-regulation. Initial background searches conducted before the final systematic searches for this review highlighted many studies including those highlighted in Dignath et al. (2008) that would need to be excluded. These studies focussed on teaching metacognition and/or self-regulation strategies (or interventions), as opposed to assessing or measuring metacognition. Dignath and Büttner (2008) based their analysis on Hattie, Biggs, and Purdie (1996) (strategy use, motivation and related affect, and academic performance). In their summary of main effects Dignath and Büttner (2008) explained that for secondary schools the effect sizes were higher if the theoretical background of the training programme focussed on metacognitive learning theories. This review differs

because the focus is on how metacognition is assessed with different tools and methods, as opposed to metacognition as an outcome.

Hattie et al. (1996) explored metacognitive teaching strategies and interventions, they conducted a meta-analysis relating to skills based interventions and potential improvements in student learning (including metacognitive awareness and autonomous learning). Hattie et al. (1996) focussed on the application of strategies and subsequent outcomes on an individual's learning, as opposed to measuring or assessing levels of metacognition:

> *Metacognitive interventions are those that focus on the self-management of learning, that is, on planning, implementing, and monitoring one's learning efforts, and on the conditional knowledge of when, where, why, and how to use particular tactics and strategies in their appropriate contexts. (p. 100)*

Similarly to the self-management skills based interventions focus above, Bangert-Drowns, Hurley, and Wilkinson (2004) conducted a meta-analysis regarding writing to learn and the associated metacognitive prompts that can have a positive impact on conventional measures of achievement.

One of the important developments in the UK in the last 20 years has been the advent and adoption of thinking skills approaches in schools. Thinking skills interventions are defined as "approaches or programmes which identify for learners translatable, mental processes and/or which require learners to plan, describe and evaluate their thinking and learning" (Higgins et al., 2005, p. 1). In an EPPI-review about the impact of the implementation of thinking skills approaches, Higgins et al. (2005) looked at the relative impact of thinking skills interventions, quantified the impact of thinking skills and compared thinking skills with other interventions. Metacognitive interventions were identified in the review as having a "relatively greater impact" (Higgins et al., 2005, p. 3). In contrast to the review in this thesis, the focus in Higgins et al. (2005) was on the impact of, rather than the assessment or measurement of metacognition. To summarise, existing reviews in the field of metacognition are primarily intervention focussed (e.g. metacognitive teaching interventions), looking at the impact of the pedagogic interventions on other factors including attainment.

Prior discussion of the methodology of this review, there is an important point to make regarding assessing metacognition and the links between defining it and assessing it. Hattie et al. (1996) noted a sense of ambiguity and a lack of exclusivity when studies define

complicated constructs like metacognition. It will be important in this review when completing data extraction to document how each included record or group of records using the same tool or method define the construct that they subsequently measure. It is important to have an awareness of the inevitable links between how the assessed construct is defined, the potential links between this and the subsequent assessment. There is evidence in existing research highlighting the importance of this link, indeed "how you test is what you get" (Desoete, 2008, p. 204). Therefore, the design and methods of this review need to incorporate for each included record, a consideration of the definition of the concept being measured within the study.

2.1.2. Research Question

This review focuses on methods to measure and/or assess metacognition in school age children. The research question solely focussed on this chapter is one of the subsidiary research questions stated in 1.3.1, it is essential in order to ground and evaluate the use of PVTs in this study:

How has metacognition been researched with school-aged children, and how do PVTs fit into this field of research?

More generally this review contributes by situating PVTs within the wider field, exploring how metacognitive development has been explored and the findings relating to this (2.3). The importance of situating PVTs was crucial in evaluating PVTs in this study and comparing them in critical evaluation with other tools.

2.1.3. Design and Methods

The process of conducting a systematic review is dynamic and comparable to the many changeable interpretations of the construct metacognition that will be explored in 2.2 and 2.3. Varied conceptualisations of metacognition necessitate a systematic and inclusive approach to examining how it has been assessed. Relating to the dynamism and fuzziness of metacognition the processes employed in this review were inductive, they responded to the needs of the review as it progressed. The methods employed were based on the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009). The PRISMA statement encompasses both meta-analysis and systematic reviewing. This review is not a meta-analysis, but the rigorous nature of the PRISMA statement helped to maintain quality and integrity especially during the search and screening processes (e.g. debating until agreement was reached on

records that reviewers disagreed about). Moher et al. (2009) emphasised the iterative nature of a systematic review, the necessity of acknowledging it as a dynamic and changeable process both (in the planning and execution stages).

The focus of this methodological review is the tool or method stated to be the measure or assessment of metacognition. This focus is reflected in the search strategies employed and in the grouping of information from the included records into groups based on similarities. In order to systematically compare and contrast the different methods, the quality appraisal of tools or methods included required a focus on the information given about reliability and validity. The replicability of a tool or method was also central; it would not have proved useful to include methods or tools in this review that were not replicable. Replicability was explored alongside reliability and validity; included tools and methods were required to have clear evidence of reliability and validity. In some cases, this was not proven and supported by statistics, but there was evidence that it had been considered in detail for tools that were in the earlier stages of development.

Maintaining the preciseness of the methodology of the systematic review was key, continuity in data extraction was particularly important. Existing methodological reviews are mainly focussed on the field of health and social care; these were examined to explore the possibilities for this review. For example, Brandstätter, Baumann, Borasio, and Fegg (2012) reviewed the meaning in 'life assessment instruments'. The focus was on the validity evidence given for each instrument included and the extent of their use in different studies. Similarly, Berne et al. (2013) looked at assessment instruments for measuring cyber bullying; they focussed on a coding scheme "to assess and value the information deemed relevant concerning the quality of the instruments" (p. 321). In this review the quality of the instruments will be intrinsically linked to their definition of the key construct (metacognition), the specifics of what the tool measures and the information about presented for each tool. The extent of use for the methods or tools included will also be important for grouping records, allowing an exploration of age related trends and progression or change in the tool.

The records included within this systematic review were quantitative and qualitative in design; the dynamic nature of metacognition lends itself to both approaches and mixed methods. This complexity required consideration in order to effectively synthesise data from multiple records that had very different approaches to quantifying and measuring the construct of metacognition. The traditional quantitative approach for systematic reviewing

or meta-analysis has undeniable value. However, "the pooling of effects" (Harden & Thomas, 2005, p. 258) does not necessarily lend itself to answering questions about how the people involved experience an intervention or indeed a measure, or in this case how appropriate they might be for different age groups. Harden and Thomas (2005) advocated a review process that looks beyond effectiveness and the inevitability within this, of embracing a wide range of diverse methods.

Dixon-Woods, Agarwal, Jones, Young, and Sutton (2005) highlighted the importance of erring on the side of caution in terms of excluding records on the grounds of their methodology; similar caution was exercised in this review and is described in detail in 2.1.5 (the screening processes). Dixon-Woods et al. (2005) made an interesting point about including records with different methods in one review and how this should be viewed as a different form of synthesis, as opposed to a different and new type of review. This review consciously did not exclude records based on their methodology, but the proviso at the beginning of the screening process was that across the included records there needed to be detailed methodological information that would enable replication. Replicability was considered alongside evidence of or the consideration of reliability and validity under the umbrella of quality appraisal (2.1.6).

After defining the research question and considering the intended parameters of the search, practice searches using key words and strings were completed in ERIC and BEI. Practice searches allowed refinement of the search strategy and aimed to ensure manageable numbers of records to be screened. Searches were completed for eight key databases: Australian Education Index (AEI), British Education Index (BEI), Education Resources Information Center (ERIC), First Search ECO, First Search Journal Articles, PsychArticles, PsychINFO and Web of Knowledge. Table 2 gives detailed information about the searches conducted and numbers of records found and retrieved. The search process employed, including the number of records included and excluded at each stage of the review process is illustrated in Figure 4. The final number of records included in the review was 153, a detailed breakdown of the numbers of records from each database included or excluded at each stage can be found in Table A (Appendix A).

Table 2: The search strings for each database, number of hits (n) pre and post-duplication

Database & provider		Search string	Limits applied	n	n - duplicates
Australian Education Index (AEI)	ProQuest	ab(metacognit* OR meta-cognit*) AND ab(measure OR assess* OR evaluate OR evaluat*) AND ab(student OR pupil OR school OR child OR children)	**Date:** After 1 January 1992	225	207
British Education Index (BEI)	ProQuest	ab((metacognit* OR meta-cognit*)) AND ab(measure) OR ab(assess*) OR ab(evaluate OR evaluat*) AND ab(student OR pupil OR school OR child OR children)	**Date:** After January 01 1992; **Language:** English; **Age group:** Adolescents (13-17), All children, Children (0-12 years), Infants (0-2), Pre-school children (2-4/5), Young children (0-8)	234	233
ERIC	ProQuest	ab(metacognit* OR meta-cognit*) AND ab(measure OR assess* OR evaluate OR evaluat*) AND ab(student OR pupil OR school OR child OR children)	**Date:** After January 01 1992; **Language:** English; **Education level:** Early childhood education, Elementary education, Elementary secondary education, Grade 1, Grade 10, Grade 11, Grade 12, Grade 2, Grade 3, Grade 4, Grade 5, Grade 6, Grade 7, Grade 8, Grade 9, High schools, Intermediate grades, Junior high schools, Kindergarten, Middle schools, Preschool education, Primary education, Secondary education	397	266
First Search	ArticleFirst	(kw: metacognit* OR kw: meta-cognit*) and (kw: measure OR kw: assess* OR kw: evaluate OR kw: evaluat*) and (kw: student OR kw: pupil OR kw: school OR kw: child OR kw: children)	**Date:** Yr 1992-2012	17	6
First Search Journal Articles	ECO	(kw: metacognit* OR kw: meta-cognit*) and (kw: measure OR kw: assess* OR kw: evaluate OR kw: evaluat*) and (kw: student OR kw: pupil OR kw: school OR kw: child OR kw: children)	**Date:** Yr 1992-2012	282	147
PsychArticles	Ebsco-host	AB (metacognit* OR meta-cognit*) AND AB (measure OR assess* OR evaluate OR evaluat*) AND AB (student OR pupil OR school OR child OR children)	**Year of publication:** from 1992 – 2012; **Age:** Childhood (Birth – 12 years); School age (6-12 Years); Adolescence (13-17 years)	17	0
PsycINFO	Ebsco-host	AB (metacognit* OR meta-cognit*) AND AB (measure OR assess* OR evaluate OR evaluat*) AND AB (student OR pupil OR school OR child OR children)	**Year of publication:** from 1992 – 2012; **Age:** Childhood (Birth – 12 years); School age (6-12 Years); Adolescence (13-17 years); Preschool age (2-5 years)	624	615
Web of Knowledge	Thomson Reuters	Topic=(metacognit* OR meta-cognit*) AND Topic=(measure OR assess* OR evaluate OR evaluat*) AND Topic=(student OR pupil OR school OR child OR children)	**Refined by:** Languages=(ENGLISH) Timespan=1992-01-01 - 2012-11-15. Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH. Lemmatization=On	925	615
			Total:	2721	2089

Figure 4: Flow diagram showing numbers of records throughout searching screening and data extraction, based on the PRISMA flow diagram (Moher et al., 2009)

2.1.4. Inclusion criteria

In order to complete the screening process in a systematic and transparent way, clear criteria for the inclusion of records from the beginning of the review process was essential. These criteria were clearly defined alongside careful consideration of the research question; they were based on the following main categories:

- The date of record
- What was being measured in the record
- The sample population in the record
- An empirical data set being present in the record
- The language in which the record was available

Table 3 illustrates how these categories were applied as inclusion and exclusion criteria in this review.

Table 3: Inclusion and exclusion criteria

Category	Rationale	Inclusion criteria	Exclusion criteria
Date	A systematic review specifies a time scale within which records are searched for	Records published between January 1992-November 2012	Records published outwith January 1992 and November 2012
What is being measured?	The focus of the review is metacognition and closely related and defined concepts	• Record specifies it is measuring metacognition or a closely related concept and there is a clear definition of what is being measured • Measured in the first language of the participants	• Metacognition or closely associated concept not being measured or the definition of metacognition is not clear or clearly linked to the measurement outcomes • Not measured in the first language of the participants
Sample population (age, setting, normally achieving)	The sample population must fall within the defined age group (4-16 years) and be normally or average achieving in mainstream education in order that there is a degree of homogeneity in the samples for the different included tools or methods	• Participants aged 4-16 years (at least 50%) • Mainstream school • Cross section of students (average achieving or cross section of abilities)	• Participants not 4-16 years • Not mainstream school setting • More than 50% of students identified as having additional needs or being gifted
Data set and methodology	The record needs to include an empirical data set to be included[8]	Empirical data needs to be collected and there must be a clear and replicable tool or method	No empirical data or the methodology is not clear or replicable
Language of the record	Time and financial constraints did not allow for records to be translated if they were not readily available in English[9]	Record readily available in English	Record not readily available in English

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[8] As previously explained, as the systematic review is an iterative process and in effect the processes are defined by outcomes along the way. Therefore, records that had been excluded early on as they did not contain an empirical dataset were added back in during data extraction. This happened if they were the first available record of a particular tool or method that other records used or referred to.
[9] Every reasonable effort was made to find out if a record was readily available in English, including making contact with authors.

2.1.5. The screening process

The screening process was lengthy, but rigour at this stage was important to maintain the integrity of the review process. Although an inductive process, responding to findings within the search and screening process, consistency was key and decisions made had to be applied consistently across all records. At times this meant going back a step or two in the screening process in order to move forward, but it was important for the reliability of this review to have this consistency.

The clarity of age groups applied in the analysis was key. Comparing ages across different countries, where grade numbers or year groups were given or not given, sometimes proved difficult. Some records recorded ages simply by stating year groups or grades, and in others average ages with decimal points were given. Where average ages were given, the first decimal point was considered and if this could be rounded up (> 0.5) or down (< 0.49) to within the specified age group of 4 -16 years the record was included. If a record included age groups that were outwith 4-16 years, but at least 50% of the sample population was within this age group then the record was included. Where possible the school grades of a different country (e.g. USA) were mapped onto the English system to record age groups for ease of comparison. For example, in the USA and Australia first graders are aged 6-7, this correlates with Year 2 in Key Stage 1 in England. A variety of online resources were used to make these comparisons, where necessary (and to confirm findings) contact was made with colleagues of the researcher who had particular knowledge of the education system in specific countries or regions.

The researcher alone completed the first stage screening, the title and abstract for each record were screened to see if they were on topic (i.e. about metacognition or a specified closely related concept like self-regulation) and that the sample was potentially in the correct age group (i.e. school aged, age 4-16 years). To calculate inter-rater reliability 20% of the 2089 original records were double-screened in the first stage screening by a member of the supervisory team, an inter-rater agreement of 98% was recorded. Records were imported into EndNote in order that they could easily be sorted and accurate records kept of three lists (included, excluded and unsure records). After initial screening, the list of records classified as 'unsure' were looked at again with a second input from the supervisory team. Agreement was reached in conjunction with the supervisory team as to whether the articles classified as unsure at this stage would be carried forward, or not, to the next stage of screening. Individual records were discussed until total agreement was reached, if there

was disagreement, records were included in order that they could be looked at in more detail in the second stage screening.

Second stage screening involved a more detailed full text screening; this focussed primarily on the methodology section of the records being screened, methodological information would be key in the next stage (data extraction). Based on the structure used by Dignath et al. (2008) the records in the second stage screening were coded for the following variables in order to include or exclude them at this stage:

- The full reference details – for ease of reference and accurate record keeping
- A definition of metacognition – was this present and clear?
- The sample characteristics – age group and educational setting
- Methodological information – was there clear information about the method or tool that has been used? Did it appear to be replicable from the information given?

Records were included, excluded or placed in an unsure category were monitored using the *smart groups* facility in EndNote, this also facilitated double screening where necessary. There was a distinct group of records classified as 'unsure' (n = 39) at this stage; these records were subsequently double screened by the supervision team. Records were discussed until all parties reached total agreement; differences in opinion were resolved through discussion.

The reasons why records were excluded was documented, the main reasons focussed on the broad categories shown in Table 4. An example of a record excluded because it only focussed on students with additional needs is Montague, Applegate, and Marquard (1993), this record looked explicitly at "72 students (aged 13.7–14.5 yrs) with learning disabilities" (p. 223). In terms of sample size or composition, Veenman, Elshout, and Meijer (1997) was excluded because although "the subject's metacognitive skilfulness and learning performances were assessed for each domain" (p. 187), the sample population comprised first year university psychology students as opposed to school aged students in the 4-16 years age group.

Table 4: Reasons for the exclusion of records at second stage screening

Reason for exclusion	Number of records excluded
Duplicates missed previously	11
Metacognition not main focus or measured	97
Not empirical data	34
Sample only SEN or Gifted and Talented students (mixed samples are included)	54
Record not available in English	31
Sample did not contain at least 50% of the participants within the correct age group (4-16)	64
The sample comprised participants metacognition was being measured in terms of second language learning (i.e. not the first language of the learner(s) in the sample population)	19
Total number of excluded records	**310**

Remembering the iterative nature of this review, of the 153 finally included records some had originally been excluded in the early screening. For example De Clercq, Desoete, and Roeyers (2000) was excluded due to lacking an empirical data set but it was re-added and used in the data extraction stage because it contained detailed methodological information for one of the included tools: The Evaluation and Prediction Assessment (EPA2000). Schraw and Dennison (1994) was excluded in early screening because the sample comprised university age students as opposed to school-aged, but it was used in the final data extraction because it was frequently cited as the first record giving detailed information about the Metacognitive Awareness Inventory (MAI) (Cantwell & Andrews, 2002; Kesici, Erdogan, & Ozteke, 2011; Sungur & Senler, 2009; Symons & Reynolds, 1999). Changes where previously excluded records were added back in have been reflected in alteration of the numbers given in Figure 4 and Appendix A (Table A). The figures given here reflect the final exclusions and inclusions, taking into account records added back in during the data extraction process.

2.1.6. Data Extraction and Quality Appraisal

Initial screening of the final included records made it clear that there were multiple records to data extract for certain tools or methods. For example, Think Aloud Protocol(s) (TAP(s)) were cited as a method used in 19 separate records, the Index of Reading Awareness (IRA) and the Motivated Strategies for Learning Questionnaire (MSLQ) were individually cited in 12 and 9 included records respectively. Therefore, rather than data extracting from each of the 153 included records they were explored in terms of the tool or method that they used. Similar tools were data extracted concurrently, the method or tool

that had been used was identified and data was extracted under the heading of the tool or method as opposed to individually for each of the included records. Some records only cited one tool or method; these records were data extracted individually. For example, Yildiz, Akpinar, Tatar, and Ergin (2009) is the only record to detail the Metacognition Scale.

Data extraction for each tool or method was performed using the same template and completed from the earliest available record (with detailed methodological information) for each tool or method. In some cases, this was a record that had been added to the total (n = 153) via citation searches, for example records that fell outside of the specified data range of 1 Jan 1992 – 15 November 2012. Jacobs and Paris (1987) was the first record detailing the Index of Reading Awareness (IRA). It was not picked up in the searches due to its date but was cited by other included records. The template for data extraction for the 87 tools or methods in the final data extraction is illustrated in Appendix A. The data extracted in this example is for the Inventory of Metacognitive Self-Regulation (IMSR) first referred to in the data extracted records by Howard, McGee, Shia, and Hong (2000b). Data was extracted under the following headings and themes:

- Method and type of instrument
- First full reference extracted
- Definition of metacognition
- Aim of the study
- Description of the tool or method
- Study design information including sample size, age range, average age and school setting
- Why metacognition is being studied (e.g. for another subject, internal testing i.e. only measuring metacognition or testing the tool
- The type of study (e.g. pre-test, post-test, longitudinal, experimental)
- Information given regarding reliability and validity.

Figure 4 showed that during the data extraction, and before quality appraisal, 32 records were excluded for reasons relating to the inclusion and exclusion criteria that had not been picked up in previous first and second stage screening. This later exclusion is reflective of the inclusive approach to screening adopted, if there was uncertainty across the reviewers a record was included for further exploration in the next stage.

The reliability, validity and replicability of the tools or methods in the included records were key. This focus was important given the methodological focus of this review, but it also provided a means of further cutting down the large number of included tools and methods to a smaller group with methodological rigour. Tools were excluded at the data extraction stage because they were not replicable (i.e. there was not sufficient published information to make replication possible), or if replication was possible but there was not sufficient information given or available regarding reliability and/or validity. To remain included, tools had to be replicable and have information about or show consideration of reliability, validity or both. Table 5 is based on an analysis of reliability and validity presented in Coffield, Moseley, Hall, and Ecclestone (2004). It presents each of the 87 tools and methods included after the final screening; it states whether or not they are replicable and highlights the different types of reliability and validity that they present. PVTs, used for the empirical data collection in this thesis, are tool number 60 in the table. Representations of reliability and validity have been divided into the eight main types presented most frequently within the included records:

- Reliability: Internal consistency, test-retest and inter-rater
- Validity: Construct, face, content, criterion and ecological

Some of the included records list ways of reporting reliability and validity data that are not reported in the above list, for example parallel forms reliability. Sperling, Howard, Miller, and Murphy (2002) focussed on testing two forms of the same tool in one experiment; the Junior Metacognitive Awareness Inventory (JrMAI), versions A and B. Other forms were also reported; no tools were excluded because they stated a form of reliability or validity that was not included in the table. These additional forms were in addition to the means of reliability and validity reported in Table 5.

Records were considered replicable if they replicated the tool or method in part or full, if other records that replicated the tool in part or full were referenced, or if there was partial replication of the specific tool or method (e.g. self-report questionnaire or observation framework). In the case of computer programmes or software, it was assumed that the clear physical presence of a piece of software or a computer programme inferred replicability with access to this. Tools or methods which did not fulfil the stated reliability, validity or replicability criterion were excluded at this stage and are shown as greyed out in the table (dark grey). Five methods or tools were excluded as shown in Table 5 (highlighted in grey):

- Child Assessment (Desoete, 2009): this tool was not replicable from the information available to me at the time, despite detailing internal consistency and test-retest reliability.

- Clinical Interview (Erbas & Okur, 2012): this tool was not replicable from the information available, nor was there reliability or validity information available.

- How I Study Questionnaire (Fortunato, Hecht, Tittle, & Alvarez, 1991)10: there was not sufficient reliability or validity data available despite this tool being replicable.

- Metacognitive skills and metacognitive development questionnaire (Rahman, Yasin, Ariffin, Hayati, & Yusoff, 2010): there was not enough information to replicate this questionnaire despite the record detailing internal consistency.

- Strategy card sort, individual interviews (Carr, Alexander, & Folds-Bennett, 1994): there was not any reliability or validity information available for this tool and it was not replicable from the information given.

This exclusion of the five tools above meant that the final number of included tools was 82. Although five methods or tools are listed above this only led to three records being excluded from the final total including citation search additions (156 – 3 = 153). Desoete (2009) also cited other tools or methods (including The Teacher Rating) so therefore had to remain included. Fortunato et al. (1991) had been added in as a citation search, so its exclusion was reflected in the numbers given Figure 4.

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[10] This record was added in via citation searching as it was referred to as the first record of the HISQ by another included record (Schwartz, Andersen, Hong, Howard, & McGee, 2004) Further investigation revealed that the tool in (Schwartz et al., 2004) was actually a combination of HISQ and the JrMAI and I was unable to locate the reliability and validity data for HISQ that is referred to.

Table 5: The reliability, validity & replicability for each of the data extracted tools or methods (n = 87)[11]

Tools or methods	Reliability			Validity					Replicable?
	Internal consistency	Test-retest	Inter-rater	Construct	Face	Content	Ecological	Criterion	
1. Bandura's Self Efficacy for Self-Regulated Learning Scale	✓	-	-	✓	-	-	-	-	✓
2. CA (Child Assessment)	✓	✓	-	-	-	-	-	-	x
3. CDR (Cognitive Developmental aRithmetics test)	✓	-	-	-	-	-	-	✓	✓
4. Classroom Coding System	✓	✓	✓	-	-	-	-	-	✓
5. Clinical Interview (Erbas and Okur, 2012)	-	-	-	-	-	-	-	-	x
6. Clinical Interview (Pappas, Ginsberg and Jiang, 2003)	-	-	✓	-	-	-	-	-	✓
7. Computer based measure of metacognitive skilfulness	✓	-	-	-	-	-	-	✓	✓
8. Concept maps	-	✓	✓	-	-	-	-	-	✓
9. Conditional knowledge	✓	✓	-	-	-	-	-	-	✓
10. Constructivist Internet based Learning Environment Survey (CILES)	✓	-	-	✓	-	-	-	-	✓
11. EPA2000 (Evaluation and Prediction Assessment)	✓	-	-	-	-	✓	-	✓	✓
12. Epistemic metacognition measure	-	-	✓	-	-	-	-	✓	✓
13. General Studies Metacognitive Orientation Scale (GSMOS)	✓	-	-	-	-	-	-	-	✓
14. Goal Orientation and Learning Strategies Survey (GOALS-S)	✓	-	-	✓	-	-	-	-	✓
15. How I Study Questionnaire (HISQ)	-	-	-	-	-	-	-	-	✓
16. Index of Metacognitive Awareness about Writing (IMAW)	✓	✓	-	✓	-	-	-	-	✓

[11] Where tools or methods have similar or the same names, primary citations are listed to aid clarity.

Tools or methods	Reliability			Validity					Replicable?
	Internal consistency	Test-retest	Inter-rater	Construct	Face	Content	Ecological	Criterion	
17. Index of Reading Awareness (IRA)	✓	✓	-	-	-	-	-	✓	✓
18. Index of Science Reading Awareness (ISRA)	✓	-	-	✓	-	✓	✓	✓	✓
19. Individual interview – strategy use and metacognition	-	✓	✓	-	-	-	-	-	✓
20. Integrated Learning Assessment	✓	-	-	-	-	-	-	-	✓
21. Interview about Metacognitive Awareness (IMA)	-	-	-	-	-	-	-	✓	✓
22. Interview from the Munich Longitudinal Study …	✓	✓	-	-	-	-	-	✓	✓
23. Inventory of Metacognitive Self-Regulation (IMSR)	✓	-	-	✓	✓	-	-	-	✓
24. Junior Metacognitive Awareness Inventory (JrMAI)	✓	-	-	✓	-	-	-	✓	✓
25. Knowledge and skills questionnaire	✓	-	-	✓	-	-	-	✓	✓
26. Learning strategies assessed by journal writing	✓	-	✓	-	-	-	-	-	✓
27. Learning Through Reading Questionnaire (LTRQ)	-	-	✓	✓	-	✓	-	-	✓
28. Metacognition Applied to Physical Activities Scale (MAPAS)	✓	-	-	✓	-	✓	-	-	✓
29. Metacognition of Nature of Science Scale (MONOS)	✓	✓	-	-	-	-	-	-	✓
30. Metacognition Scale	✓	-	-	✓	-	-	-	-	✓
31. Metacognitive Processes in Physical Education Questionnaire (MPIPEQ)	✓	-	-	✓	-	-	-	-	✓
32. Metacognitive Ability Self-report Questionnaire (MASQ)	✓	-	-	-	-	-	-	-	✓
33. Metacognitive Attribution Assessment (MAA)	✓	-	-	-	-	-	-	✓	✓
34. Metacognitive Awareness Inventory (MAI)	✓	-	-	✓	-	-	-	-	✓
35. Metacognitive Awareness of Reading Strategies Inventory (MARSI)	✓	-	-	✓	-	-	-	-	✓
36. Metacognitive experiences	-	✓	-	-	-	-	-	✓	✓
37. Metacognitive Interview (Lu, 1995)	✓	-	✓	-	-	-	-	-	✓
38. Metacognitive Interview (MCI) (Lefevre, 1995)	-	-	-	-	✓	✓	-	✓	✓

Tools or methods	Reliability			Validity					Replicable?
	Internal consistency	Test-retest	Inter-rater	Construct	Face	Content	Ecological	Criterion	
39. Metacognitive Knowledge in Mathematics Questionnaire (MKMQ)	-	-	-	✓	-	-	-	✓	✓
40. Metacognitive Knowledge Monitoring Assessment (KMA)	✓	-	-	✓	-	-	-	✓	✓
41. Metacognitive Knowledge Questionnaire	✓	-	-	✓	-	-	-	✓	✓
42. Metacognitive Orientation Learning Environment Scale – Science (MOLE-S)	✓	-	-	✓	-	-	-	-	✓
43. Metacognitive Questionnaire (Metallidou and Vlachou, 2010)	✓	✓	-	-	-	-	-	-	✓
44. Metacognitive Questionnaire (Okamoto & Kitao, 1992)	✓	-	-	-	-	-	-	-	✓
45. Metacognitive skills and Knowledge Assessment (MSA)	✓	-	-	-	-	-	-	✓	✓
46. Metacognitive skills and metacognitive development questionnaire	✓	-	-	-	-	-	-	-	x
47. Metacognitive Strategies (MSTRAT)	✓	-	-	-	-	-	-	✓	✓
48. Metacomprehension Strategy Index (MSI)	✓	-	-	-	-	-	-	✓	✓
49. Motivated Strategies for Learning Questionnaire (MSLQ)	✓	-	-	-	-	✓	-	-	✓
50. Multi method assessment of meta-cognitive behaviours	-	-	✓	-	-	-	-	-	✓
51. Multi-Method Interview (MMI)	✓	-	-	-	✓	-	-	-	✓
52. Observation (CASE@KS1)	-	-	✓	-	-	-	-	-	✓
53. Child 3-5)	✓	-	✓	-	-	-	✓	-	✓
54. C.Ind.Le	✓	-	✓	-	-	-	✓	-	✓
55. Original standardized test for metacognition	-	-	✓	-	-	-	-	-	✓
56. Paper and pencil assessment	✓	-	-	-	-	✓	-	-	✓
57. Private speech coding	-	-	✓	-	-	-	-	-	✓
58. Problem solving interview	-	✓	✓	-	-	-	-	-	✓
59. Prospective Assessment of Children (PAC)	✓	-	-	-	-	-	-	✓	✓
60. Pupil Views Templates (PVTs)	-	-	✓	-	-	-	-	-	✓

Tools or methods	Reliability			Validity					Replicable?
	Internal consistency	Test-retest	Inter-rater	Construct	Face	Content	Ecological	Criterion	
61. Questionnaire about Learning in Mathematics (QLM)	✓	-	-	-	-	-	-	✓	✓
62. Questionnaire about Learning Slovene Language (QLSL)	✓	-	-	✓	-	-	-	-	✓
63. Questionnaire about metacognitive beliefs	✓	-	-	✓	-	-	-	-	✓
64. Questionnaire based on Think Aloud	✓	-	-	-	-	-	-	-	✓
65. Rating Student Self-Regulated Learning Outcomes: A Teacher Scale	✓	-	-	✓	-	-	-	-	✓
66. Reading Strategy use scale (RSU scale)	✓	-	✓	✓	-	-	-	-	✓
67. Retrospective Assessment of Children (RAC)	✓	-	-	-	-	-	-	✓	✓
68. Retrospective Questionnaire Interview (RQI)	-	✓	-	-	-	-	-	-	✓
69. Self Regulated Learning Scale (SRL)	✓	-	-	✓	-	-	-	-	✓
70. Self report metacognitive learning strategies	✓	-	-	-	-	-	-	-	✓
71. Self-Assessment in Metacognitive Comprehension Strategies Reading Survey	-	✓	-	-	-	-	-	-	✓
72. Self-Directed Learning Instrument	✓	-	✓	✓	-	-	-	-	✓
73. Self-Efficacy and Metacognition Learning Inventory – Science (SEMLI-S)	✓	-	-	✓	-	-	-	-	✓
74. Self-efficacy for Learning Form (SELF)	✓	-	-	✓	-	-	-	✓	✓
75. Self-Regulated Learning Strategies Measurement Questionnaire	✓	-	-	-	-	-	-	-	✓
76. Self-report for cognitive and metacognitive learning strategies	✓	-	-	-	-	-	-	-	✓
77. State Metacognitive Inventory	✓	-	-	✓	-	-	-	-	✓
78. Strategy card sort, individual interviews	-	-	-	-	-	-	-	-	x
79. Strategy knowledge in the domain of Chemistry	-	-	✓	-	-	✓	-	-	✓
80. Swanson Metacognitive Questionnaire (SMQ)	✓	-	✓	-	-	-	-	-	✓
81. Task based interview	-	-	✓	-	-	-	-	-	✓

Tools or methods	Reliability			Validity					Replicable?
	Internal consistency	Test-retest	Inter-rater	Construct	Face	Content	Ecological	Criterion	
82. Teacher Rating (Sperling et al. 2002)	-	-	-	-	-	-	-	✓	✓
83. The Teacher Rating (Desoete, 2008)	✓	✓	✓	✓	-	-	-	✓	✓
84. Think About Reading Index (TARI)	-	-	-	✓	-	✓	-	-	✓
85. Think Aloud Protocol(s) (TAP/TAPs)	✓	-	✓	✓	-	-	-	-	✓
86. Worksamples Interview	-	✓	✓	-	-	-	-	-	✓
87. Würzburg Metamemory Test	✓	✓	-	-	-	-	-	✓	✓

2.1.7. Summary of results

The key findings from the results of this review included:

- The dominance of self-report measures (including questionnaires and surveys), described in more than 60% of the included records.

- An awareness of the literacy demands required for understanding and completing self-report measures. Related to this, the potential implications of using self-report to explore metacognition with younger students.

- Observation based methods have been reported within the included studies as only used with students aged 11 years and under.

- TAPs and PVTs are the two individual tools with the largest age ranges; they both have been used with (in the included records) 10 out of the 13 ages in (4- 16 years) (See Table B in Appendix A).

- The definition of metacognition given relates not only to the outcomes of a study but is also intrinsically linked to the tool or method and how it measures or assesses metacognition. "How you test is what you get" (Desoete, 2008, p. 204), but how you define metacognition is what you get and influences how you test.

- Information in included records regarding an additional focus (e.g. mathematics achievement) shows that the majority of these additional foci are based in core subjects like Maths, English and Science.

- Information regarding reliability and validity is not always given or accurate for different tools and methods captured in the searches of this review. That is not to discourage the development of new tools and methods, but rather to encourage a broad understanding of what exists in the field and the importance of being able to reliably validate tools and their findings. Tools or methods where at least one of the citations included adequate information about reliability were included, if replication was possible. Tools not fitting into this criterion were excluded at the data extraction stage.

- There is a range of opinions regarding evidence of metacognition and its development in the included records. Leutwyler (2009, p. 112) asserted that children aged as young as 3 years old show "the first roots of metacognition". Similarly Whitebread et al. (2010) concluded that using their observation based methods "enabled the clear identification of early metacognitive skills in young children" (p. 237) and Wall (2008) presented evidence of both metacognitive knowledge and

metacognitive skilfulness in children as young as 4 and 5 years old. Nonetheless it is made clear that the findings of these studies relating to age and metacognition (with younger children) are contrary to established belief in the literature. Established belief has asserted that metacognitive skills in particular do not emerge until much later than this at aged eight years or even beyond this (Bartsch et al., 2003; Kuhn, 1999b; Veenman et al., 2004).

- Definitions of metacognition can be linked to the type of tool or method and exploring the links (or lack of) between the definition of the concept being measured and what the tool actually seems to measure. This also links to whether a tool or method is thought to be an online or an offline method of assessing metacognition.

2.1.8. Results and discussion

Before presenting a synthesis of the findings of this review and discussing their relevance, it is imperative to understand the approach taken to synthesising such a large data set. The searches yielded a total of 2721 records that were potentially relevant. The final number of included records from these searches was 140, with a further 13 records added from citation searches, bringing the total number of included studies to 153. The presentation of the results in this section begins by listing the 82 included tools and methods. Synthesis of such a large data set was complex, a total of 82 tools and methods required consideration. It was useful to divide these tools or methods into groups according to their methodological similarities. For example, which were questionnaire based or based on the completion of a particular task or set of tasks? Categorisation of like with like facilitated the creation of a more manageable five categories. These broad categories are listed below:

- Questionnaires, surveys, self-report
- Task based methods and tests
- Observational methods and teacher ratings
- Interviews
- Multi-method

It was clear that these categories were not mutually exclusive and there were some tools that could fit into more than one category. For example PVTs could be described as a mediated interview due to their three way process of interaction between the student(s),

the researcher and the template itself (Wall, 2008), but they also centre on a task (the completion of the template) which is often completed with small groups of children so could also potentially be described as a type of focus group. The list below illustrates, in alphabetical order, how the 82 included tools and methods fit broadly into the categories above. The tools are listed in alphabetical order with the records from which data was extracted:

Questionnaires, surveys and self-report:

- Bandura's Self Efficacy for Self-Regulated Learning Scale (Gerlach, 2009; Pajares & Valiante, 1999; Zimmerman, Bandura, & Martinez-Pons, 1992)
- Cognitive Developmental aRithmetics test (CDR), (Desoete, 2009; Desoete & Roeyers, 2006a)
- Conditional knowledge measure (part of a larger questionnaire) (Wolters, 1996)
- Constructivist Internet based Learning Environment Survey (CILES), (Wen, Tsai, Lin, & Chuang, 2004)
- Evaluation and Prediction Assessment (EPA2000), (De Clercq et al., 2000; Desoete, 2007, 2009; Desoete & Roeyers, 2006; Desoete, Roeyers, & De Clercq, 2003)
- General Studies Metacognitive Orientation Scale (GSMOS), (Thomas & Au Kin Mee, 2005)
- Goal Orientation and Learning Strategies Survey (GOALS-S), (Dowson & McInerney, 2004)
- Index of Metacognitive Awareness about Writing (IMAW), (De Kruif, 2000)
- Index of Reading Awareness (IRA), (Bouffard, 1998; Bouffard & Vezeau, 1998; Jacobs & Paris, 1987; McBride-Chang & Chang, 1995; Meloth & Deering, 1992; Osborne, 1998; Pereira-Laird & Deane, 1997; Schmitt & Sha, 2009; Sperling et al., 2002; Swanson & Trahan, 1996; van Kraayenoord & Paris, 1996; van Kraayenoord & Schneider, 1999)
- Index of Science Reading Awareness (ISRA), (Craig & Yore, 1998; Holden, 1997; Yore, Craig, & Maguire, 1998)
- Integrated Learning Assessment (Silver, Hansen, Herman, Silk, & Greenleaf, 2011)
- Inventory of Metacognitive Self-Regulation (IMSR), (Howard, McGee, Hong, & Shia, 2000a; Howard et al., 2000b; Howard, McGee, Shia, & Hong, 2001; Parcel, 2005)
- Junior Metacognitive Awareness Inventory (JrMAI), (Ciascai & Lavinia, 2011; Huber, 2012; Kim & Pedersen, 2010; Lemberger & Clemens, 2012; Schwartz et al., 2004; Sperling et al., 2002; Sperling, Richmond, Ramsay, & Klapp, 2012)
- Knowledge and skills questionnaire (de Jager, Jansen, & Reezigt, 2005)
- Learning Through Reading Questionnaire (LTRQ), (Butler, Cartier, Schnellert, Gagnon, & Giammarino, 2011)
- Metacognition Applied to Physical Activities Scale (MAPAS), (Settanni, Magistro, & Rabaglietti, 2012)
- Metacognition of Nature of Science Scale (MONOS), (Peters, 2008; Peters & Kitsantas, 2010)
- Metacognition Scale (Yildiz et al., 2009)
- Metacognitive Processes in Physical Education Questionnaire (MPIPEQ), (Theodosiou, Mantis, & Papaioannou, 2008)
- Metacognitive ability self-report questionnaire (Panaoura & Panaoura, 2006; Panaoura & Philippou, 2003, 2007)

- Metacognitive Attribution Assessment (MAA), (Desoete, Roeyers, & Buysse, 2001)
- Metacognitive Awareness Inventory (MAI), (Cantwell & Andrews, 1998, 2002; Kesici et al., 2011; Schraw & Dennison, 1994; Sungur & Senler, 2009; Symons & Reynolds, 1999)
- Metacognitive Awareness of Reading Strategies Inventory (MARSI), (Boudreaux, 2008; Huber, 2012; Law, 2009; Mokhtari & Reichard, 2002; Morley, 2010)
- Metacognitive experiences (Dermitzaki, 2005; Dermitzaki & Efklides, 2001, 2003; Efklides & Tsiora, 2002)
- Metacognitive Knowledge in Mathematics Questionnaire (MKMQ), (Efklides & Vlachopoulos, 2012)
- Metacognitive Orientation Learning Environment Scale – Science (MOLE-S), (Peters, 2008; Peters & Kitsantas, 2010; Thomas, 2003, 2004)
- Metacognitive Questionnaire (Metallidou & Vlachou, 2010)
- Metacognitive Questionnaire (Okamoto & Kitao, 1992)
- Metacognitive Skills and Knowledge Assessment (MSA), (Desoete et al., 2001; Özsoy, 2011; Özsoy & Ataman, 2009)
- Metacognitive Strategies (MSTRAT), (Roeschl-Heils, Schneider, & van Kraayenoord, 2003)
- Metacomprehension Strategy Index (MSI), (Desautel, 2009; O'Hara, 2007; Pereira-Laird & Deane, 1997; Schmitt, 1990; Schmitt & Sha, 2009; Scott, 2008; Sperling et al., 2002; Tong, 2009; York, 2007)
- Motivated Strategies for Learning Questionnaire (MSLQ), (Kuyper et al., 2000; Law, Chan, & Sachs, 2008; Metallidou & Vlachou, 2010; Ommundsen, 2003; Pintrich & De Groot, 1990; Shih, 2005; Wolters, 1996; Yumusak, Sungur, & Cakiroglu, 2007; Zusho & Barnett, 2011)
- Paper and pencil assessment (Neuenhaus, Artelt, Lingel, & Schneider, 2011)
- Prospective Assessment of Children (PAC), (Desoete, 2007, 2008)
- Questionnaire about Learning in Mathematics (QLM), (Peklaj & Vodopivec, 1998)
- Questionnaire about Learning Slovene Language (QLSL), (Peklaj, 2001)
- Questionnaire about metacognitive beliefs (van der Zee, Hermans, & Aarnoutse, 2008; van der Zee, Hermans, & Aarnoutse, 2006)
- Questionnaire based on Think Aloud (Schellings, 2011)
- Reading Strategy use scale (RSU scale), (Pereira-Laird & Deane, 1997)
- Retrospective Assessment of Children (RAC), (Desoete, 2007, 2008)
- Self Regulated Learning Scale (SRL), (Prupas, 1995)
- Self report metacognitive learning strategies (Leutwyler, 2009)
- Self-Assessment in Metacognitive Comprehension Strategies Reading Survey (SAMS), (Pinto, 2009)
- Self-Efficacy and Metacognition Learning Inventory – Science (SEMLI-S), (Thomas, Anderson, & Nashon, 2008)
- Self-efficacy for Learning Form (SELF), (Peters, 2008; Peters & Kitsantas, 2010; Zimmerman & Kitsantas, 2005)
- Self-Regulated Learning Strategies Measurement Questionnaire (SRLSMQ), (Eom, 1999)
- Self-report for cognitive and metacognitive learning strategies (Wolters, 1999, 2004)
- State metacognitive inventory (Coffey, 2009; Heydenberk, 2002; Heydenberk & Heydenberk, 2005; O'Neil & Abedi, 1996; O'Neil Jr & Brown, 1998)
- Swanson Metacognitive Questionnaire (SMQ), (Sperling et al., 2012; Swanson, 1990, 1992)
- Think About Reading Index (TARI), (Schreiber, 2003)

- Würzburg Metamemory Test (Roeschl-Heils et al., 2003; van Kraayenoord & Schneider, 1999)

Observational methods and <u>teacher ratings</u>:

- Classroom coding system (Neitzel, 2004; Neitzel & Stright, 2003; Stright, Neitzel, Sears, & Hoke-Sinex, 2001)
- <u>Metacognitive Knowledge Questionnaire (teacher rating), (Metallidou & Vlachou, 2010)</u>
- Observation (CASE@KS1), (Larkin, 2006)
- <u>Observational tools for assessing metacognition and self-regulated learning: CHILD 3–5 (Whitebread et al., 2005; Whitebread et al., 2009)</u>
- Observational tools for assessing metacognition and self-regulated learning: C.Ind.Le (Whitebread et al., 2005; Whitebread et al., 2009)
- Private speech coding (Daugherty & Logan, 1996)
- <u>Rating Student Self-Regulated Learning Outcomes: A Teacher Scale (RSSRL), (Metallidou & Vlachou, 2010; Zimmerman & Martinez-Pons, 1988)</u>
- Self-Directed Learning Instrument (Dermitzaki, 2005; Hwang, 1999)
- <u>Teacher Rating (Sperling et al., 2002; Sperling et al., 2012)</u>
- <u>The Teacher Rating (Desoete, 2008, 2009)</u>
- Think Aloud Protocol(s) (TAP/TAPs), (Azevedo, Moos, Greene, Winters, & Crornley, 2008; Desoete, 2007, 2008, 2009; Desoete & Roeyers, 2006a; Jacobse & Harskamp, 2009, 2012; Mateos, Martín, Villalón, & Luna, 2008; Peters, 2008; Peters & Kitsantas, 2010; Throndsen, 2011; Tillema, van den Bergh, Rijlaarsdam, & Sanders, 2011; van der Stel & Veenman, 2008, 2010; van Kraayenoord & Schneider, 1999; Veenman et al., 2000; Veenman et al., 2005; Veenman & Spaans, 2005; Veenman et al., 2004)

Interviews:

- Clinical Interview (Pappas, Ginsburg, & Jiang, 2003; Pappas Schattman, 2006)
- Epistemic metacognition measure - retrospective interview, (Mason, Boldrin, & Ariasi, 2010)
- Individual interview - strategy use and metacognition (Throndsen, 2011)
- Interview about Metacognitive Awareness (IMA), (Schmitt & Sha, 2009)
- Interview from Munich Longitudinal Study on the Genesis of Individual Competencies (Lockl & Schneider, 2006)
- Metacognitive Interview (Lu, 1995)
- Metacognitive Interview (MCI), (Lefevre, 1995)
- Original standardized test for metacognition (Fritz, Howie, & Kleitman, 2010; Kreutzer, Leonard, & Flavell, 1975; Wang, 1993)
- Pupil Views Templates (mediated interview), (Erikson & Grant, 2007; Wall, 2008; Wall et al., 2005)
- Retrospective Questionnaire Interview (RQI), (Short, 2002)
- Worksamples Interview (van Kraayenoord & Paris, 1997)

Task based methods:

- Computer based measure of metacognitive skilfulness (Veenman et al., 2004)
- Concept maps (Ritchhart, Turner, & Hadar, 2009)

- Learning strategies assessed by journal writing (Glogger, Schwonke, Holzäpfel, Nückles, & Renkl, 2012)
- Metacognitive Knowledge Monitoring Assessment (KMA), (Osborne, 1998; Tobias & Everson, 1996)
- Problem solving interview (Carr & Jessup, 1995)
- Strategy knowledge in the domain of Chemistry (Scherer & Tiemann, 2012)
- Task based interview (Carr & Jessup, 1997)

Multi-method:

- Multi method assessment of meta-cognitive behaviours (Shamir, Mevarech, & Gida, 2009)
- Multi-Method Interview (MMI), (Wilson, 1999, 2001)

Accurately summarising and describing the results of a review that has 153 included records and 82 tools or methods, required effective use of synthesis tables to highlight patterns in data, with subsequent narrative synthesis adding to this. Tables and charts were particularly useful for looking at numerical data including age, and for quickly and efficiently looking at reliability and validity data. Narrative description was also important and is presented alongside summary tables and charts. Beginning with proportions of tools in the five categories from the list above, Figure 5 illustrates clearly the dominance of questionnaires, surveys and self-report based methods (comprising 62% of the total 82 tools). Tools classified as multi-method were the smallest of the five groups (3%), observational methods and teacher ratings, and interviews 13% each and task-based methods 9%.
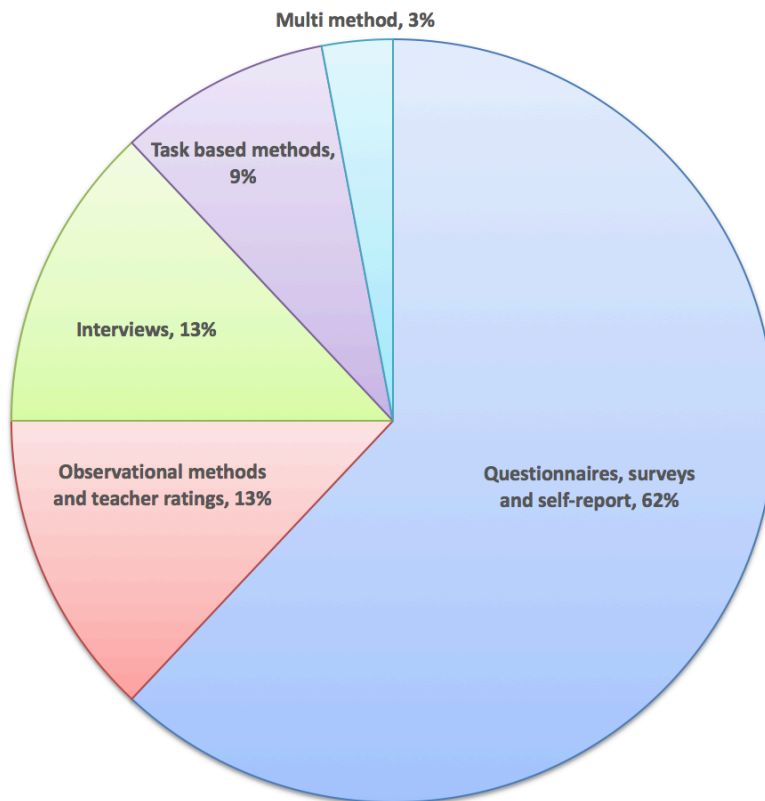
Figure 5: Chart illustrating the percentage of the total tools or methods in each of the five categories given (n = 82)

The dominance of self-report methods within the included tools lead to questions around why self-report measures were so dominant in the included records? It also facilitated consideration of what other types of tools were used less often and how age was related to this? Self-report measures are perceived as easy to use and as placing little in the way of time demands in terms of their application. Sperling et al. (2002) asserted that self-report inventories were the least problematic in terms of measuring metacognitive processing, but identified a gap in their lack of reported use with younger learners. Sperling et al. also reported that self-reports are useful on a large scale and for identifying learners that require intervention as well as being useful for theoretical research.

Considering the age groups that self-reports have been predominantly used with, it is important to consider the potential for high literacy demands that questionnaires, surveys and self-report measures may have. The nature of self-report implies a level of ability for the respondent in terms of literacy because they "rely upon a level of verbal understanding and fluency which cannot necessarily be assumed" (Whitebread et al., 2009, p. 65). If the

questions on a questionnaire are read aloud to a participant, at what point does a self-report questionnaire or survey then become an interview? The perceived literacy demands of some tools and methods imply that they will therefore be less suitable for participants in younger age groups. Younger participants would be more likely to require assistance in reading and/or understanding what is being asked of them to complete a self-report. This assertion about literacy demands is not just applicable to self-report measures. It could apply to other methods including those that are task based and inevitably require a level of understanding about the task. Interviews would also require an assumed level of understanding for the participant to know what is being asked of them.

Leutwyler (2009) identified "one-sided criticism" (p. 115) about the credibility of self-report measures; he affirmed the importance of recognizing the differences between which facets of metacognition different measures actually explore. Looking at two tools that have been used with contrasting ages of children exemplifies this point further. Bandura's Self-Efficacy for Self-Regulated Learning Scale (Zimmerman et al., 1992) and the Clinical Interview (Pappas et al., 2003) have been used in the included records with children aged 10-16 years and 4-6 years respectively. Pappas et al. (2003) explored metacognition in the context of mathematical problem solving for lower-SES[12] children and defined it as "particularly their awareness and expression of thinking" (p. 432). Alongside mistake recognition and adaptability Pappas et al. (2012) also related metacognition to language competence. Pappas et al. (2003) observed and video-recorded participants recording frequencies in line with the coding scheme applied and concluded that the three aspects of metacognition explored develop slowly during early childhood and are linked to language. In contrast, Bandura's Self-Efficacy for Self-Regulated Learning Scale was used to explore students' own perceptions of their perceived self-regulatory efficacy and how this influenced perceived self-efficacy for academic achievement in Zimmerman et al. (1992). In Zimmerman et al. (1992), with an older sample size, awareness of thinking was explored alongside student perceptions of how learning is regulated and the impact(s) that this may have on achievement. These links between the regulation of learning and achievement are complex, perhaps too complex for younger children, the complexity of this perhaps limited by the self-report nature of Bandura's Self-Efficacy for Self-Regulated Learning Scale.

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[12] SES referring to socio-economic status

This section has explored specific tools or methods in relation to the ages they have been used with and the potential impacts of this on the concept being measured, how this is defined and the suitability of different methods for different ages. Table 6 shows which categories of tools or methods have been used with different ages within 4 – 16 years. Table 6 is comprised from data in Table B (Appendix A). Table B (Appendix A) lists the ages each included tool or method (n = 82) has been used with across all of the 153 included records. For example, it shows that PVTs have been referenced in three included records and that they have been used with ten different ages (in years) across an age range of 4 – 13 years. Looking at Table 6 there are some points to note:

- The most commonly used category of tool or method (determined by percentage of instances of use in the included records) is shaded in grey.

- Records may have referred to more than one tool or method, then the age range for that record would be included for each tool or method that it applies to. Therefore, the number given for total number of records referenced (across all five categories) is 189 and not 153.

- The percentages given in the second column for each category are based on the number of times a tool is referenced in different records or clearly delineated separate studies within one paper, not the total number of tools or methods (n = 82).

Table 6: Categories of tools and methods used across different age groups

Type of tool	Number of records referenced	KEY STAGE & AGE in YEARS												
		EYFS		KS1		KS2				KS3			KS4		
		4	5	6	7	8	9	10	11	12	13	14	15	16
Self-report, surveys & questionnaires	127 (67%)	0%	0%	0%	33% (6)	61% (28)	73% (40)	71% (52)	74% (62)	74% (56)	76% (50)	79% (52)	80% (32)	87% (26)
Observation & teacher ratings	35 (19%)	44% (4)	54% (7)	50% (6)	22% (4)	20% (9)	13% (7)	14% (10)	10% (8)	16% (12)	14% (9)	11% (7)	13% (5)	3% (1)
Interviews	16 (8%)	44% (4)	38% (5)	42% (5)	33% (6)	13% (6)	11% (6)	11% (8)	11% (9)	5% (4)	8% (5)	5% (3)	0%	0%
Task based	8 (4%)	0%	0%	8% (1)	11% (2)	7% (3)	4% (2)	4% (3)	4% (3)	3% (2)	3% (2)	6% (4)	8% (3)	10% (3)
Multi-method	3 (2%)	11% (1)	8% (1)	0%	0%	0%	0%	0%	2% (2)	3% (2)	0%	0%	0%	0%
Total percentage for each age		2% (9)	2% (13)	2% (12)	3% (18)	8% (46)	9% (55)	12% (73)	14% (84)	13% (76)	11% (66)	11% (66)	7% (40)	5% (30)

Notes:

- EYFS = Early Years and Foundation Stage and also includes children aged 3 years old.
- Totals may not equal 100% due to rounding.

Looking at the categories in Table 6 alongside details of individual tools or methods in Table B (Appendix B) reveals some interesting patterns relating to age groups. Self-reports, questionnaires and surveys have only been used with students aged 7 years and over. This could be related to the perceived literacy demands that these measures likely have. In light of this, self-report measures would potentially prove more difficult to administer to younger children due to the necessity of reading the measure and its self-completion. In contrast, observational methods, interviews and multi-method tools have been used with participants as young as aged 4 years in the included records.

The only category of the five that has been used with students of every age represented in the Table 6 (4 – 16 years) is the category 'observation and teacher ratings'. Further clarification of this trend is required from the data in Table B (Appendix A). The category of observation and teacher rating was dominated by one particular method: Think Aloud Protocols (TAPs). Table B (Appendix A) shows that TAPs have been used with children aged 6 – 15 years. The number of included records referring to TAPs was 19 records and the total for the category was 35 records - TAPs accounted for more than half. Additionally, TAPs were only used with children aged 6 and over, the majority of participants in records using TAPs were over aged 8 years. The domination of TAPs in this category undoubtedly had a notable impact on the age range of the category overall.

TAPs was not the only tool to have been used with such a wide age range. PVTs have also been used across 10 of the ages included in Table B (Appendix A), their age range being 4-13 years. Interestingly Table B (Appendix A) exemplifies the much smaller number of records that PVTs (3 records) have achieved this age range with, compared to TAPs (19 records). Post-review publications using PVTs (Wall et al., 2012) have extended the age range of this tool further and would place it in all five age groups shown in Table 6, with a range of 4 – 15 years. This is an exciting finding for an emerging research tool like PVTs. The empirical data collection in this thesis further extends the age range by including children aged 4 – 16 years within one study.

Data presented in Table B (Appendix A - the data from which Table 6 was compiled) shows that it is clear that few tools, of the 82 included, were used across a wide age range. Each of the included tools and methods span no more than nine of the recorded ages (4 years to 16 years) apart from TAPs and PVTs. TAPs are described in the included literature as an online method, evidence of metacognition is derived from an instruction to 'think aloud' whilst engaging in an activity, e.g. problem solving. In Veenman et al. (2005) think aloud is

prompted whilst participants are solving maths problems individually; with a uniform prompt to think aloud added if participants fell silent. Veenman et al. (2005) asserted that thinking aloud does not hinder cognitive and metacognitive processes but merely slow them down. Returning to PVTs in comparison to TAPs, Wall (2008) explained that PVTs are a visual tool, comprising a template that forms part of a mediated interview, often completed as part of a focus group and sometimes in a whole class situation. PVTs comprise a picture of a learning situation (including a person or group of people) that has speech and thought bubble(s) in which the students write during and after discussion in the focus group. The learning situations range from working in a group or pair to using ICT (Wall et al., 2007). PVTs are inherently retrospective; the situations depicted facilitate student reflection on past experience.

The distinction between the perceived online nature of TAPs and the assumed reflective nature of PVTs is an interesting point to debate. It is interesting to note that PVTs are not explicitly described as either online or offline (or indeed prospective or retrospective). However, the evidence metacognition elicited using them is described as awareness (Wall, 2008; Wall et al., 2012). If TAPs do slow down cognitive and metacognitive processes does this disadvantage and therefore exclude the use of TAPs with younger students? The complexity of the demands on working memory (for the task being observed and completing the TAPs) may prove more challenging for younger students. The involvedness of being required to 'think aloud' whilst learning may therefore provide an explanation as to why TAPs were not been used with students under 6 years of age in the records included in the systematic review (2.1).

PVTs have methodological advantages in that they are completed in focus groups, perhaps mediating the pressure on individual students and recognising the social context of learning in school-aged children. PVTs are a visual tool; the picture representation of learning scenarios in PVTs may appeal to younger students. Observation based methods observing regular classroom activity (without TAPs) have similar advantages in terms of their use with younger students (e.g. Classroom Coding System, CASE@KS1 and C.Ind.Le) - the absence of additional demand(s) added by requesting that students externalise internal metacognitive and cognitive processes verbally whilst learning. It is important to consider if the slowing down associated with 'think aloud' could alter the trajectory that the learning episode being observed would have taken without this forced externalisation? Other observation methods included in this review did not place explicit demands (i.e. to 'think

aloud') on participants; rather they focussed on observing behaviour and/or listening to dialogue. For example, in contrast with the C.Ind.Le (Whitebread et al., 2005; Whitebread et al., 2009), TAPs have direct researcher input in the form of request to think aloud. Whereas for the C.Ind.Le (Whitebread et al., 2009), video was used to record children participating in "interesting and productive" (p. 70) activities, there was no researcher input in terms of requests to 'think aloud' as in TAPs. Observation was completed of regular classroom activity, in addition video was retrospectively analysed for evidence of metacognitive or self-regulatory events.

Although originally grouped with teacher ratings, observation based methods were explored separately due to significant methodological differences. The five teacher rating tools: CHILD 3–5 checklist; Teacher Rating; The Teacher Rating; RSSRL and MKQ were different in one key way to other specifically observation based methods. Both observation and teacher rating rely on third party (i.e. researcher or teacher but not the learner) to record evidence of metacognitive or self-regulatory activity. However, the included teacher ratings were checklists completed retrospectively and based on teacher experience as a whole, rather than reflection on a single learning episode or the observation of a particular task in the moment.

The CHILD 3-5 checklist (Whitebread et al., 2005; Whitebread et al., 2009) and Teacher Rating (Sperling et al., 2002; Sperling et al., 2012) involved teachers rating their students retrospectively on a scale of 1 – 6 for metacognition; the rating was assisted by examples student behaviours for each point on the scale. The Teacher Rating (Desoete, 2008) is a 20 item rating scale, described as a teacher questionnaire and again is not explicitly linked to a task. The RSSRL comprises a 12-item behaviour frequency 5-point scale is similarly not associated with observing behaviour in particular task. The ratings in the RSSRL are a more general reflection based on day-to-day classroom activity for the 'observed' students. The MKQ focuses on the "declarative, procedural, and conditional knowledge of the application of strategies" (Metallidou & Vlachou, 2010, p. 780); again a teacher rating that is based on retrospective and generalized reflection as opposed to a specific task.

The retrospective nature of the included teacher ratings and their associated reliance on the reflections of classroom teachers is distinct from other included observation based methods in addition to TAPs. The Classroom Coding System, CASE@KS1, C.Ind.Le, Private Speech Coding and Self Directed Learning Instrument are all observations focused on specific tasks. The observations in these examples are typically not completed by the regular

class teacher, but rather by researchers who in some instances are specially trained. Aside from Child 3-5 (Whitebread et al., 2009) the other teacher ratings are all used with children aged 7 or older. This may imply that assessing metacognition in children younger than this is more specialized or rather that there is a link between the methodology by which metacognition is assessed and the outcomes of this. To give an example from another category, Wall (2008) cited the use of PVTs in a national Learning 2 Learn project (Higgins et al., 2007). In this example, school staff used PVTs with children aged as young as 4 years to elicit pupil views and the data was analyzed by researchers for evidence of metacognition.

Considering why different tools have been used with different age ranges it is important to consider demands additional to those on working memory. Returning to the predominance of self-report measures and their use with students aged 7 years and over, it is important to consider if the literacy and reading demands of completing a self-report play a role. Questionnaires, surveys and self-report measures place potentially high demands upon the understanding of respondents. The nature of self-report implies a level of ability for the respondent in terms of literacy. If intervention is applied, for example the researcher or another non-participating individual reading out the questions and/or answer options, at what point does a self-report questionnaire or survey become an interview or mediated interview? Furthermore, if varying literacy levels across respondents imply varying levels of understanding of what a self-report measure is asking, does lack of understanding mean a lower 'score' and therefore less evidence of metacognition? If a student does not have the literacy level to understand and/or complete a self-report fully this does not necessarily mean that they are not being metacognitive in learning situations or that they do not have awareness of this.

A definition of metacognition relates not only to the outcomes of a study but is also intrinsically linked to the tool or method and how it measures or assesses metacognition. "How you test is what you get" (Desoete, 2008, p. 204), how you define metacognition is also what you get and, the planning and implementation of empirical research influences how you test. For example, if one method or tool has a limited age range or the literacy demands placed are too high for younger students to participate, findings will be moderated by this. Assertions about developmental trends in metacognition need to be considered alongside the tools or methods that have been used and the age range of the participants. With this in mind it is important to revisit one of the most commonly made distinctions

between tools and methods (whether they are described as online or offline), alongside a summary of differences in defining metacognition for some of the included records.

Defining metacognition in relation to the method

Defining metacognition and associated concepts is a complex task. Recognising that different groups of tools and indeed individual tools can refer to and define metacognition in very different ways is essential. Definitions of metacognition across the included records were varied. For example, two of the included self-report measures the MARSI and the MAI (both inventories) had similar definitions of metacognition based on the reflection on and monitoring of learning, including understanding of learning and an individual's control of their own learning. In contrast, records concerning TAPs largely defined metacognition in relation to the relevance of it as a predictor of learning. Drawing another similarity between PVTs and TAPs, research with TAPs often makes the same distinction between metacognitive knowledge and metacognitive skilfulness (see 2.2.3). This is likely related to the prevalence of Veenman and colleagues' work in the included records using TAPs in this review and the common thread of the distinction between metacognitive knowledge and skilfulness that Veenman and colleagues have defined (Veenman et al., 2005)[13].

The IRA was first described in 1987 by Jacobs and Paris (1987) this was 18 years before Wall et al. (2005) first developed and published research using PVTs. There are however links between the definitions of metacognition applied for the two different methods. The definition of metacognition given by Jacobs and Paris (1987, p. 258) divided metacognition into two broad categories ("self-appraisal of cognition" and "self-management of thinking"), there are clear similarities to the definition adopted in this thesis and in previous research using PVTs (Wall, 2008). The division here is metacognition, again in two categories but this time they are metacognitive knowledge and metacognitive skilfulness (Veenman et al., 2005).

It is beyond the scope of this review to explore in more detail the great variety of definitions of metacognitions in the included records. However, it is important to consider the impact of evidence from this review on the empirical data collection in this study. Going forward it is essential in Chapter 3 to present clear links between the literature explored in

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[13] Additional papers make this distinction and were listed in 2.2.3

Chapter 2 and the definition of metacognition operationalized to explore metacognitive knowledge using PVTs.

Online or offline?

Related to defining metacognition, is the position of a method or tool in terms of whether or not it is "administered either prospectively, concurrently, or retrospectively to performance on a learning or problem-solving task" (Desoete, 2009, p. 436). Examples of prospective tools in this review are the IMSR (Howard et al., 2000a), Metacognitive ability self-report questionnaire (Panaoura & Philippou, 2003), PAC (Desoete, 2007) and Metacognitive Awareness Inventory (Schraw & Dennison, 1994). Examples of included tools that asserted concurrence are TAPs (Veenman et al., 2004) and observation based methods including C.Ind.Le and the Classroom Coding System (Whitebread et al., 2009). Examples of retrospectively administered tools in this review included the RAC (Desoete, 2007), Questionnaire about Metacognitive Beliefs (van der Zee et al., 2006) and the IRA (van Kraayenoord & Paris, 1996). Related to this debate is the distinction between online and offline methods, what they measure and how, as well as the different tools or methods in each category and why they fit into it.

The online/offline debate was discussed at length by Saraç and KaraKelle (2012), they noted the interrelationships between the two. Saraç and KaraKelle's study did not however reveal a significant relationship between the online and offline methods that they investigated. The differences between online and offline methods necessitate further investigation of the literature. The interrelationships between online and offline are particularly important because literature frequently separates tools or methods as either online or offline. The usefulness of this distinction, how its subtle nuances may impact and not be acknowledged, leaves multiple unanswered questions and uncertainties. The following will explore in more detail the online/offline debate and in particular where think aloud, observation and PVTs fit into it.

Concurrent methods include TAPs; they are also commonly described as an online technique (Desoete, 2007; Mateos et al., 2008). However, as Mateos et al. (2008, p. 695) noted:

> *…while think-aloud protocols are considered one of the most effective tools we have for gaining access to the online cognitive processing of readers and writers, they have certain well-known limitations (e.g., Ericsson & Simon, 1993).*

Mateos et al. (2008) presented clear reasoning for additional debate. It could be argued that as soon as a researcher asks a participant to stop, think about and articulate out loud the processes behind their learning then they are actually being forced to be retrospective. This means that the previously presumed [on-line] "reflection-in-action" (Schön, 1983) becomes [offline] reflection-on-action, the action having occurred immediately before the reflection. Reflection 'in action' and its subsequent influence on learning via metacognitive processes could mean that TAPs are and can remain concurrent throughout the process, but this would depend on the tightness of the feedback loop between the activity, reflection and externalisation or recording of this reflection.

Azevedo et al. (2008, p. 51) defined TAPs to participants in a study as requiring them to "'think aloud' continuously while you use the hypermedia environment to learn about the circulatory system". Similarly, Veenman et al. (2005) instructed their participants to 'think-aloud' whilst they individually solved math problems. The nature of TAPs being online here poses two main questions:

- The individuality of what was being recorded or assessed – it is clear that it is one individual thinking aloud in both of the examples above but there are external prompts for this 'online' metacognition (a tutor to facilitate students' self-regulated learning in the first example and the experimenter using students to think aloud if they fell quiet in the second).
- How online is an online method if participants are thinking aloud? Does the action of stopping to think aloud not mean, that this is thinking about what has happened in terms of learning or perhaps looking forward to what will happen (likely based on past experience) as opposed to being strictly in the moment? Additionally, what are the potential demands placed on working memory, necessary to complete a task, by TAPs?

Working memory was defined by McNamara and Scott (2001, p. 10) as " a limited capacity, short-term cognitive system for processing and storing information", a shortfall of research exploring the links between working memory and strategy use was noted. Issues around working memory and strategy use are highly relevant to measures like TAPs, participants are asked to use their limited capacity working memory and declare their strategy use simultaneously. If a participant in TAPs has enough working memory to think aloud about what they are doing and declare it as they are doing it, then perhaps they are not fully concentrating on the task in hand or the task is not sufficiently challenging? Or alternatively,

are participants learning to think aloud as opposed to learning in and about the problem solving activity that they are engaged in?

Veenman et al. (2005) assessed think aloud by systematic observation and stated that previous research supports the assertion that "merely thinking aloud does not interfere with cognitive and metacognitive processes. Thinking aloud may only slow down those processes" (p. 200). The impact of slowing down this process and the unaccounted impact that this may have on learning and metacognition is an interesting point to consider. Similarly, interesting is the degree to which the required reflection for participants on their learning (made 'aloud') makes the metacognition captured by the assessment retrospective. There is strong opinion in the field that online measures are best suited to accurately assess metacognitive skilfulness and also repeated questioning of the authenticity of the 'online' description of think-aloud:

> *…it is now widely accepted that online measures (those that are collected concurrently with task completion) more fairly represent the metacognitive skills that are truly being used by participants than do offline measures (Veenman et al. 2006), and that the think-aloud methodology is obstructive in children (van Hout-Wolters et al. 2000; van Someren et al. 1994). (Bryce & Whitebread, 2012, p. 200)*

Whilst online measures of metacognition may be perceived as more reasonable in terms of accurately representing metacognitive skilfulness in the moment, this is not to say that offline measures do not also have a role in exploring metacognitive skills. Section 2.2.5 will explore the need for declarative metacognitive knowledge about procedural knowledge in order to access metacognitive skilfulness effectively. In effect, this declarative procedural knowledge (procedural is associated with metacognitive skilfulness in popular definitions – see 2.2.3) could be described as meta-metacognitive skilfulness, or metacognitive knowledge of metacognitive skilfulness. Thinking (being meta) about metacognitive skilfulness, could and would need to be accessed in conjunction with reflection on knowledge of how skills have been used in previous learning experiences. This knowledge may then influence skills in current or future learning.

TAPs and observational methods have some links in the ways in which they are operationalized (observation is part of the process in both cases: observing behaviour or observing think aloud) but there are key differences too. The difference with reference to working memory, between TAPs based observation (more often used with older students) and observation used with younger students from aged 3 years (Whitebread et al., 2005;

Whitebread et al., 2009) is that in the latter does not automatically depend on the prompted verbalisations of the participants. Despite a clear prevalence of observation as a means of accessing and recording metacognitive behaviour with younger children (Table 6), there is an intrinsic possibility of generalisation with this approach. The assumption that external observable behaviour reflects a common internal state, which is transferable in terms of being able to be observed across different participants in a study. Observation based methods may be online but how can a researcher be certain that what they are observing is metacognition when this is not always overtly seen or heard (Veenman, Van Hout-Wolters, & Afflerbach, 2006)?

Veenman et al. (2006) argued that metacognition could be observed in the self-instructions that students verbalise, but asserted "Metacognition, however, is not always explicitly heard or seen during task performance" (p. 6). This statement facilitates a consideration of what the difference is, theoretically and practically, between metacognition and observable behaviour that might be considered as being metacognitive. This argument raises questions around this statement in relation to later work where Veenman (2007) uses think aloud to analyse metacognitive activities: "All students were requested to think aloud while studying in the hypermedia environment" (p. 178). Even if a participant is thinking aloud within task completion, how can researchers be certain that there is not (additional) undeclared metacognition present – metacognition that may have been integral to task performance and subsequent outcome measures? This concern may be increased if participants are lacking in the verbal or oral skills to externalise their thought processes, therefore increasing the likelihood of undeclared metacognition. The concern is, of course, not unique to TAPs.

Despite critique around the approach of TAPs and other similar methods, the reliability of online observation based methods (including TAPs and their schedules) can and has been demonstrated. There are various methods of testing and reporting this, in the included records inter-rater or coder reliability is the most commonly referenced and is reported as high in studies including van der Stel & Veenman (2010). However, the question of how an observer can be sure that what they observe is what they think it is or code it as remains (i.e. the validity of it assigning a particular code). It is important to acknowledge that these questions could also be asked of methods that are not observation based. Many types of coding scheme or measure may have reliability across different coders within that study, but how is the validity of this ensured? If the inter-rater reliability is high, this tells us that

different raters are able to see and apply a coding scheme in the same way. Nonetheless, even with the demonstration of the reliability of coding, questions can remain about the validity of what is being coded and how it is coded. Whitebread et al. (2009) addressed this issue of validity in their observation-based study with reference to the naturalistic setting of data collection and the use of video to record a true account of events to code. Similarities can be drawn to this study (See Chapter 3 – Methodology and Study Design) where data was collected with PVTs in a naturalistic setting, using a familiar worksheet type format. The ecological validity of data collection with PVTs in this study is discussed in detail in 3.9.1.

Debate around benefits and drawbacks of the tools included within this review could be never-ending, awareness of these debates is important and much can be learned. Many questions like those raised in preceding sections could be asked of most of the tools, including PVTs. The purpose of this review was to raise methodological questions and learn from the debates in the answers for the purpose of study design (Chapter 3) and the expression of the empirical research in this study.

Additional foci of the included records

Measuring or assessing metacognition is as complicated as defining the concept itself, complexity is furthered when there is an additional study or subject focus (e.g. mathematics or reading). Table 7 shows the included groups of methods and their additional subject foci. Given the established links between metacognition and attainment (1.2.1), the core subjects of literacy, maths and science are predictably prominent.

Questionnaires, surveys and self-report measures were the largest category, unsurprisingly they also had the largest spread of additional subject foci. Despite this, a high number of questionnaires, surveys or self-report measures included did not have an additional subject focus (i.e. they focussed entirely on the concept being measured, for example metacognition). Observational methods, interviews and to a lesser extent, task based methods were also dominated by tools or methods that do not have an additional subject focus. There were only two tools included in the multi-method category; one focussed on maths and the other does not have an additional focus. The predomination of 'no additional focus' in the observation and teacher ratings category was likely due to the inclusion within this of teacher ratings completed retrospectively. Even in the task-based methods category the majority (over 50%) had no additional focus, indicating that the focus was on the concept being measured (i.e. metacognition, perhaps under the guise of problem

solving) rather than on a specific subject. Focussing in on the empirical data collection (Chapter 3), it is interesting to note that PVTs are very flexible in terms of having a subject focus or not; the focus could be very subject specific (e.g. ICT or an art lesson) or much more general (e.g. working in a pair). With this and other individual characteristics of PVTs in mind, what follows explores their uniqueness in more detail.

Table 7: The additional subject focus of included records

Method type	Questionnaires, surveys & self-report	Observational methods & teacher ratings	Interviews	Task-based methods & tests	Multi-method tools
Mathematics	22%	0%	9%	22%	50%
Literacy (first lang.)	20%	0%	18%	0%	0%
Science	6%	10%	0%	11%	0%
Computer/internet	4%	0%	0%	0%	0%
Physical education	4%	0%	0%	0%	0%
Religious education	2%	0%	0%	0%	0%
Language learning	2%	0%	0%	0%	0%
History	2%	0%	0%	0%	0%
Multiple subjects	10%	20%	0%	11%	0%
No additional focus	28%	70%	73%	56%	50%
Totals	51 tools	11 tools	11 tools	7 tools	2 tools

2.1.9. The unique characteristics of PVTs

The location of this review in a study that uses PVTs to collect data about metacognition requires comparison between PVTs and other methodologically similar tools. This comparison serves to highlight the unique characteristics of PVTs, thus justifying and rationalising the approach to exploring metacognition, with PVTs, adopted in this study. It is not within the scope of this thesis to compare PVTs to each of the 82 included tools or methods; rather tools for comparison will be selected based on perceived similarity in specific characteristics. Tools classified as self-report, interviews and visual methods all have similarities with PVTs. Reflecting on the design, administration and analysis of PVT data in previous research (Wall & Higgins, 2006; Wall, 2008; Wall et al., 2012) underscores three focus areas (with the key concepts underlined) to form the basis of comparison with other tools in this section.

Firstly, PVTs are a tool that has been used in schools (not laboratories) by both researchers and teachers to prompt pupil views on learning. Secondly, PVTs are a tool that is completed individually by each child. PVT completion is influenced by wider context because they are completed in a focus group setting (as a mediated interview) with discussion

actively encouraged. Thirdly and finally, the visual nature of PVTs is important. The picture at the centre of a PVT depicts one of any number of learning scenarios; this can be very specific (a maths lesson) or more general (working in a pair). Children can add to the PVT that they complete (adding to the picture as well as adding text), to some extent making the learning scenario flexible to the child's perceptions.

The three included records using PVTs (Wall, Higgins, & Smith, 2005; Erikson & Grant, 2007; Wall 2008) present as somewhat unique in that the research has reported that both researchers and teachers have used PVTs. PVTs have been implemented by both researchers and class teachers as part of large-scale research projects including the Learning to Learn Phase 3 evaluation (Wall, 2008), solely by researchers in the field (Wall et al., 2005) and by teacher researchers in schools (Erikson & Grant, 2007). In contrast, other included tools that have involved class teachers tended to focus on teachers rating a student on a scale (e.g. RSSRL, The Teacher Rating, Teacher Rating – see 2.1.8). For example, The Teacher Rating (Desoete, 2008, 2009) is:

> …a 20 item rating scale teacher-questionnaire on metacognitive prediction
> (seven items), planning (four items), monitoring (six items) and evaluation
> (three items) skills (e.g., the child never (1)/always (7) knows in advance
> whether an exercise will be easy or difficult). (Desoete, 2008, p. 195)

Desoete (2008) distinguished the Teacher Rating from other explicitly online methods used in the same study by saying of the Teacher Rating that direct interaction with participants in this process is not present, nor is the observed interaction of participants with a specific task. Examples of observed and recorded interaction in other included tools include the C.Ind.LE (Whitebread et al., 2009), CASE@KS1 (Larkin, 2006) and TAPs (Veenman & Spaans, 2005). PVTs are strictly speaking offline[14], or reflective on action, but data is gathered in an active and dynamic process that involves discussion and interaction both with the participants and between them. The interaction associated with PVT completion is reflective of the process of teaching. The Teacher Rating lends itself much less to this type of interaction, perhaps more reflective of testing and exams, rather than the collaboration and interaction associated with PVT completion.

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[14] The usefulness of the online/offline distinction, particularly in relation to using PVTs to look at metacognition with school-aged children was discussed in 2.1.8.

The process of PVT completion is not overly complicated and analysis can be mixed in method: " The form in which the data are produced (short one-word answers, phrases, and sentences) allows for qualitative and quantitative analysis" (Wall et al., 2005, p. 856). The mixed method nature of PVTs means that they are equally appropriate on different levels to:

- Provide an overview of student views about a particular topic and their learning
  and/or
- Provide detailed information about specific facets of metacognition that they can elicit.

Flexibility in the purpose and analysis of PVTs is not a common theme across the other included records. However, it is clear that some are more flexible than others – it is easy to visualise the flexibility of observational data collected using a coding scheme. The use of coding schemes and schedules in observation-based methods is not dissimilar to the approach taking in existing research using PVTs (Wall, 2008). Data collected via coding can be explored both qualitatively and quantitatively. Other approaches to assessing metacognition in the included records focus exclusively on quantitative analysis. For example, results and discussion reported in a study using the Metacognition Scale Yildiz et al. (2009) focussed on factor analysis and the quantitative measurement of metacognition. Interestingly, Yildiz et al. (2009) also asserted that interview and observation should be used to support the measurements of the Metacognition Scale qualitatively. The combination of mediated interview, focus group and the physical nature of the PVT in data collection with PVTs has similarities to the triangulation explored by Yildiz et al. (2009), but within one tool and data collection process.

PVTs are a mediated Interview; another example of an interview included in the review was the Clinical Interview (Pappas et al., 2003; Pappas Schattman, 2006). Like PVTs the Clinical Interview was conducted in schools and not in a laboratory environment that the word 'clinical' perhaps first suggests. In contrast to the familiarity of task and discussion-based completion of PVTs ("three- way interaction between the researcher, the pupils, and the template, stimulating talk about the learning context…" (Wall et al., 2005, pp. 853-854)), the Clinical Interview was completed as follows:

> *Each child was interviewed individually by one of nine different clinical interviewers…Clinical interviews typically lasted about thirty minutes. At the outset, children were made aware of the video camera and told that they*

> *were going to be asked some questions about numbers. Two adults were in*
> *the room with each child… (Pappas et al., 2003, pp. 434-435)*

Both PVTs and the Clinical Interview in the included records involved interaction between a researcher and children (the Clinical Interview individual children as opposed to groups in PVTs). Key differences between the application of PVTs and the Clinical Interview are clear: the ratio of adults to children present, the individual (in isolation from peers) completion of the clinical interview and the presence of a video camera to record the clinical interview.

The use of video alongside PVT completion, although beyond the scope of this study and with many ethical considerations necessary, is an interesting point to consider. What would video recorded conversation and interaction, recorded in a PVT focus group, tell us about metacognition in addition in addition to the written and visual record on the templates themselves? Recording focus group interaction in this way could elicit some of the social aspects of metacognition and learning as discussed in 2.1.8. The individual nature of the Clinical Interview would prohibit 'in the moment' elicitation of this within a peer group, but interaction with adults (i.e. teachers) is also inherent in children's learning activity within the classroom. The potential for interaction in the way information is collected about metacognition, given the social nature of learning, should be as important as the thinking about learning a tool intends to prompt.

The purpose of this review was partially derived from the methodological difficulties of assessing metacognition. If assessing metacognition were not fraught with contrast and conflicting opinion, this review would not have identified 82 tools or methods. The Multi-Method Interview (MMI) (Wilson, 2001) sought to address this difficulty directly by, like PVTs, having a multi-dimensional approach. PVTs could be described as an interview, a focus group or a self-report tool, they have visual and textual elements and can be analysed both qualitatively and quantitatively. Wilson (2001, p. 2) described their multi-method approach as follows:

> *The multi-method approach included: observation; a problem-based clinical*
> *interview (incorporating self-reporting and in some cases the think aloud*
> *technique); video and audio recordings. The most unique and revealing*
> *component of the clinical interview was the use especially designed*
> *metacognitive and cognitive action cards (see Appendix 1) to stimulate*
> *student responses about their thinking.*

In existing research, PVTs have not been used in conjunction with other methods like observation, but they do have a prompt (the template itself), which like in the MMI is used

to stimulate student response. PVTs are unique from the MMI in terms of this stimulation of student response in that they aim to stimulate interaction not only with the researcher and the task at hand but also with peers in a focus group setting and the prompt itself (the PVT that students record their responses on). The MMI was completed specifically in relation to a mathematics problem that participants were asked to solve, in the interview students were asked to sequence the prompt 'action' cards according to how they solved a particular math problem. The 'action' cards (split into awareness, action and regulation) of the MMI were not however specific to solving math problems and could, like PVTs, be used in relation to a variety of learning scenarios or more generally.

The cards used in the MMI (Wilson, 2001) comprised examples of cognitive behaviours or were blank – a semi-structured approach to prompting, the cards were tangibly there (as a PVT is, with its picture of a learning scenario) but some cards were blank (as are the speech and thought bubbles on a PVT). Visual prompts, meaning those that are physically there for participants to interact with (not only something that contains or has pictures), involve participants actively in a task. Even if the assessment of metacognition is not strictly online (i.e. retrospective in terms of thinking about a task that you have just completed or in the case of PVTs interacting in a group to discuss a learning scenario), visual prompts make research "a more 'active hands on'" affair for participants (Wilson, 2001, p. 7). Other included tools used computer software - EPA2000 (Desoete, 2009), the script engine was visual visual (pictures of traffic lights representing different possible student responses but the responses ere pre-defined and not flexible in the way that PVT responses are. Metacognition is not a passive process, it is active and PVTs are an active way to explore this in a naturalistic setting within a social context (peer group and/or class teacher, in school).

In light of multi-method research with visual elements, Wilson (2001, p. 10) raised concerns about self-reports: "The results raise doubts and questions about using students 'out of context' verbal reports without as data without corroborating evidence." PVTs being completed as mediated interviews (in focus or class groups) can mitigate this concern about self-report statements being isolated and 'out of context', the social context of learning addressed by the nature of data collection with PVTs. PVTs may be used in isolation (i.e. the only method or tool) but the method itself is undeniably not one-dimensional; involving discussion, a visual prompt, verbal prompts from the researcher and the template itself. PVTs are not administered as other self-report questionnaires might be, the MSLQ (Pintrich

& De Groot, 1990) required students to respond to items on a self-report questionnaire (including metacognitive strategy use) on a 7-point Likert scale (p. 34). In contrast PVTs, although comparable in that each individual student has their own template, have a focus group format requiring and encouraging discussion about their completion both before and during the process. The completion of PVTs in small or class groups is reflective of a more familiar classroom scenario. Considering the importance of context, not only of the school and individual participants but also the context of the assessment of metacognition, is crucial.

Section 2.2.1 explored the inextricable links between cognitive and metacognitive learning strategies and knowledge of this. Very few of the included tools from the systematic review have a broad base that is inclusive of this. More often, the focus is specific to a particular facet of metacognition and within a particular context (e.g. metacognitive skills in solving math problems). Very little explicit consideration of the cognitive skills underlying metacognition is present in the included tools and methods. Another self-report tool that does have this dual focus is a self-report measure of cognitive and metacognitive learning strategies (Wolters, 1999, 2004). The mean age of participating students in (Wolters, 2004) was 13.2 years (7th and 8th graders), considerably higher than the age range PVTs have been used with. The method described involves a self-report Likert-scale type survey comprising 89 items. Figure 6 shows an example of some of the 89 statements used and listed in the Appendix of Wolters (2004). Comparing this to a PVT (e.g. Figure 13) makes a clear argument for the accessibility of PVTs in terms of the ages that they can be used with, with a consideration of the verbal, oral and written skills of participants.

Appendix

Items Used to Assess Cognitive and Metacognitive Strategy Use

Cognitive Strategies

When I study for math, I read my notes, my homework, and the textbook over and over.

To learn the material for my math class, I rehearse the important material until I know it.

I spend my time memorizing key equations or facts when I study for math.

When I study for math I practice saying the material over and over to myself.

When doing work for math, I try to relate what I'm learning to what I already know.

When I study for math, I try to connect what I am learning with my own experiences.

I try to make all the different ideas fit together and make sense when I study for math.

I make up my own examples to help me understand the important concepts from math.

Metacognitive Strategies

Before starting a math assignment, I try to figure out the best way to do it.

Before I begin to study for math, I think about what I want to get done.

In math, I start my assignments without really planning out what I want to get done. (R)

For math assignments, I double check my work to make sure I am doing it right.

When I'm working on my math I stop once in a while and go over what I have been doing.

In math, I keep track of how much I understand the work, not just if I am getting the right answers.

I try to change the way I study for math to fit the type of material I am trying to learn.

I try to adapt how I do my math assignments to fit with what the teacher wants or expects.

If what I am working on for math is difficult to understand, I change the way I learn the material.

Figure 6: Example from the Appendix in Wolters (2004) from the self-report measure of cognitive and metacognitive learning strategies

Wolters (2004) described cognitive strategies as the "use of rehearsal and elaboration strategies when completing work" and metacognitive strategies as those reflecting "students' use of planning, monitoring, and regulatory strategies when completing work" (p. 240). In the Moseley model applied in previous research to explore cognitive skills using PVTs (e.g. Wall, 2008), rehearsal and elaboration strategies could be likened to the "experiencing, recognizing and recalling" or information gathering, combined with the "development of meaning" (including elaborating) associated with building understanding (Moseley et al., 2005a, p. 314). The unique contribution of the Moseley model, and PVTs here is the inclusion of a third element of the cognitive category – productive thinking. Productive thinking can clearly be linked to the metacognitive skills described by Wolters (2004). Moseley et al. (2005a) described productive thinking as inclusive of reasoning, an understanding of causal relationships, systematic enquiry, creative thinking and problem solving. Reasoning and the understanding of causal relationships are clearly linked to planning, monitoring and regulation. For example, decisions about planning based on prior learning experience around cognitive skills (like productive thinking), or the application of cognitive skills in the moment.

The size of the field (82 included tools or methods) made the task of extrapolating the unique characteristics of PVTs difficult, the number of other tools included meant that

there were often similarities. The uniqueness of PVTs summarized below in comparison to included tools is summarised below:

- PVTs have more flexibility as a research tool than other included tools:
  - They can be used by researchers and/or teachers to examine metacognition and pupil views on learning
  - PVTs can be linked to various themes or foci (e.g. specific academic subjects or particular ways of working like in a group or with computers).
- PVTs have a focus group approach to their completion with interaction, reflecting the social context of learning and subsequent metacognition.
- The visual basis of PVTs and bubble dialogue is unique; the ability of the participants to interpret, change and add to the research tool (template) based on discussion, prompts and individual participants understanding of the task is unique.
- The data gathered in PVTs can be analyzed both quantitatively and qualitatively.
- PVTs comprise a worksheet style sheet with a visual element (picture of the scenario or learner(s)); this is a familiar format for participating students. More familiar than self-reports with large numbers of statements, or 'clinical' one to one interviews where the ratio of adults to children is unbalanced and not reflective or regular classroom activity.
- PVTs have been used (despite only 3 studies included in the systematic review) across the same age range as TAPs (with 19 included studies). This wide age range across significantly fewer studies, combined with evidence of metacognition reported in children as young as 4 years old (Wall, 2008), signifies the potential of PVTs. This potential needs to be explored further and with a more systematic sample, this is the role and contribution of this thesis.

PVTs have several unique contributions to make to the study of metacognition. The use of PVTs with a wide age range and findings about metacognition within these studies need to be validated with further study including a more systematic sample. What follows condenses the contribution of this systematic review, both for this thesis and wider research in the field of metacognition.

2.1.10.   Conclusions

The rationale behind the completion of this review was twofold: firstly, it aimed to provide a solid theoretical background that would rationalise and facilitate the evaluation of the use of PVTs in a more systematic sample across the 4-16 years age group to explore metacognitive knowledge. Secondly, this review provides a rigorous synthesis of tools and methods to measure metacognition that does not currently exist in the field. The results of this systematic review are important not only in the context of this thesis, but also in the wider context of research in this field.

This synthesis of tools and methods used to measure metacognition in school-aged children is important for wider research on metacognition because there is not an equivalent review in this area. This review has raised important questions, particularly about the age groups that different methods of assessing metacognition are used with. There are wider debates in this field about the age at which metacognition develops, if this was not challengeable, then this review would not have found 13 tools or methods purporting to assess metacognition in participants aged 4 – 7 years. Nine studies detailing six tools or methods purported to assess metacognition or closely associated concepts in the youngest age group of 4-5 years. Bartsch et al. (2003) discussed the difficulties that younger children have in recognizing how and when knowledge is acquired and Kuhn (1999a) argued that metacognitive knowledge could be present at a much younger age than metacognitive skilfulness, which she stated does not develop until age 10-12 years. Evidence extracted in this review disagrees, Wall (2008) indicated that evidence of metacognitive knowledge and skilfulness, gathered using PVTs, appears at an earlier age than previously thought, in children as young as 4 and 5 years old. Similarly to Wall (2008), Leutwyler (2009, p. 112) makes reference to children aged three showing "the first roots of metacognition" and Whitebread et al. (2009) observed young children (aged 3) showing emergent metacognitive behaviours.

Although not the focus of this review, there is also evidence of how tools or methods have changed and been adapted, sometimes forming completely new tools. For example, Wolters (1996) describes a conditional knowledge questionnaire which is adapted from two other tools: the IRA and the MSLQ. Schmitt and Sha (2009) also make reference to the IRA when discussing the development of another tool: the IMA. There are interesting links between how metacognition is defined in relation to a tool or method and how this definition is intrinsically linked to what is being measured. It is important to remember this

when looking at what a particular tool or method purports to measure, thinking about whether or not they are actually measuring what has been defined.

This review is pivotal at this point in this study for several reasons. Firstly, this review has highlighted that PVTs are one of only two tools or methods that span four out of the five age groups. Additional research (Wall et al., 2012) published since the review searches were conducted, places PVTs in all five of the age groups, confirming the importance of the empirical data collection in this study that will provide a more systematic sample of data collected using PVTs with children aged 4-16 (encompassing all of the 5 age groups mentioned (EYFS – KS4)). This review is also important in terms of evaluating empirical data collection using PVTs, this review has facilitated an in-depth and broad understanding of how different tools and methods to assess metacognition have been used across different age groups.

2.2. Defining Metacognition

Chapter 1 introduced the complexity of debates around what metacognition is and how it is defined (1.2.1). These debates have developed significantly since Flavell (1976, p.232) defined metacognition as: "[referring] to one's own knowledge concerning one's own cognitive processes and products or anything related to them". Metacognition is something of a paradox, spanning a variety of disciplines including education, psychology and linguistics. There are many debates about what metacognition is, how it should be measured and how it develops. Despite the complexity and wide-reach of metacognition, it is vital that the pragmatic and educationalist epistemology of this thesis remains at the forefront. This section focuses on scrutinizing the complexity of metacognition with reference to this study and education practice. It seeks to acknowledge the often blurred or implicit link between metacognition and cognition, and furthermore the close relationship to self-regulation with metacognition.

The breadth of debate about metacognition can lead to confusion around the concept; it has a tendency to be either over-simplified or over-complicated. Metacognition can therefore be seen as a 'fuzzy' concept (Wellman, 1985), it is malleable and has been researched in many different ways with sometimes contrasting definitions. 'Fuzziness' further emphasises the need for pragmatism and transparency when defining and applying metacognition within, and for research. Hofer and Sinatra (2010, p. 117) proposed a "multiplistic perspective". *Multiplistic* does not imply that every definition of metacognition should be open to multiple interpretations, but rather that open-mindedness be maintained when considering them. Wilson (1999, para 9) noted that even Flavell himself did not have a detailed proposal for defining metacognition in the late 1980s, over a decade after he first introduced the term: "Flavell (1987) admitted that: 'none of us has yet come up with deeply insightful, detailed proposals about what metacognition is.' (1987: 28)." Reflecting on Flavell's assertion that deep insight was lacking with regards to what metacognition was defined as in the 1980s, what follows explores some relevant definitions of metacognition after Flavell (1976). This includes describing how metacognition is defined in existing research using PVTs.

Almost 30 years after Flavell, Efklides (2008) defined metacognition by referring back to Flavell's (1979) definition, but added that "metacognition is multifaceted", encompassing all of metacognitive experiences, metacognitive knowledge, the monitoring of cognition, metacognitive strategies and metacognitive skills (p. 278). The inclusion of multiple concepts

relating to metacognition in this definition underlines its complex and interlinked nature. Complexity is increased when terms including metacognition and self-regulation are used interchangeably and without appropriate consideration of their intersections and differences (Dinsmore, Alexander, & Loughlin, 2008; Hofer & Sinatra, 2010; Moseley et al., 2005a). Metacognition is a complicated concept, one of the clearest aspects of metacognition perhaps that fact that it is so multifarious. Metacognition has close relationships with related concepts including self-regulation, the links between aspects of this and metacognition are sometimes blurred. With this in mind, the following sections are divided into literature reviewed around cognitive skills and the relationship with metacognition (including the legacy of Piaget), the relationship between metacognition and self-regulation, metacognition in practice and components of 'multi-faceted' metacognition.

2.2.1. The complexity of interrelated cognition and metacognition

Cognition is essentially thinking, but also encompasses the process that this 'thinking' entails: "The mental action or process of acquiring knowledge and understanding through thought, experience, and the senses" (Cognition, 2015). Efklides (2011) referred back to Flavell (1979) in defining metacognition, making very clear the underlying cognition that is also a focus in this study. Efklides (2011) explained metacognition as both model and representation of cognition:

> *Metacognition is defined as cognition about cognition (Flavell, 1979) or a model of cognition (Nelson, 1996). It is a representation of cognition that is built on information coming from the monitoring function and that informs the control function, such as strategy use, when cognition fails for any reason. (Efklides, 2011, p. 6)*

Metacognition is a representation of cognition that is constructed from incoming information (monitoring, control, strategy use). The notion of 'representation' applied by Efklides (2011) suggested that it is difficult to extrapolate literature from the field discussing cognitive skills that is not manifestly linked to metacognition. Intersections between the two interlinked concepts (cognitive skills and metacognition) are clearly acknowledged in the ensuing sections of this chapter.

In order to understand metacognition, it is essential to contemplate the underlying cognition. Thinking about the relationship between the two highly interconnected concepts is vital. Cognition and cognitive development have been described in the literature under many guises including cognitive processes, cognitive skills and cognitive strategies. It is not

the purpose of this section to explore the breadth of cognition and cognitive development in all of its semblances. This would be too infinite of a task, with the inclusion of the systematic review in 2.1, this level of detail is not required to contextualise this study. The reasons for understanding the complexity of metacognition and appreciating the importance of cognitive skills to accomplish this understanding are twofold:

- Flavell's (1979, p. 906) definition of metacognition was "knowledge and cognition about cognitive phenomena". This definition clearly emphasised the importance of cognition as central in defining and therefore operationalizing metacognition.
- Previous research using PVTs (Wall, 2008; Wall et al., 2012) has explored metacognition alongside a significant component of cognitive skills based on the "integrated model for understanding thinking and learning" (Moseley et al., 2005a, p. 314).

It is important to begin this exploration at the beginning, remembering the influential theoretical contributions about cognitive development made by Jean Piaget (1896 – 1980). This section will draw explicit links to Piagetian theory. Piaget's legacy will be followed by an exploration of theoretical conceptualisations of learning that include explicit consideration of the cognition or cognitive skills alongside or with metacognition.

Piaget's Legacy

Whilst it is not the purpose of this sub-section to explore the integrated model from Moseley et al. (2005a) in great detail, it is pertinent to note at this point their acknowledgement of the major impact that psychology theorists like Piaget have had upon "educational theory and practice" (p. 185). Indeed, "For many, Piaget is the cognitive developmental psychologist of the twentieth century" (Moseley et al., 2005a, p. 189). Flavell (1996) also asserted that one does not have to look far for Piaget, in developmental psychology or cognitive development textbooks. Flavell (1996, p. 200) explained that:

> Piaget's assimilation-accommodation model of cognitive growth correctly
> emphasizes the active, constructive nature of the child. This model allows us
> to view cognitive development as a gradual, step-by-step process of
> structural acquisition and change, with each new mental structure growing
> out of its predecessor through the continuous operation of assimilation and
> accommodation.

Assimilation referring to new ideas being assimilated into existing knowledge and accommodation, the notion that adaption of existing schema occurs in order to

accommodate new information. Table 8 presents a summary of the stages of Piaget's theory and was informed by summaries from both Miller (2014, p. 652) and Moseley et al. (2005a, pp. 190 - 191).

Table 8: Piaget's Four Stages of Cognitive Development

Stage	Ages (approximate)	Description
Sensorimotor	0 – 2 years	• Egocentric stage, child cannot separate itself from its environment. • Understanding in terms of a child's own explicit actions on the world around them. • Concepts are "action-based" (Miller, 2014, p. 652). • "Their senses are largely unrelated to the actions that they perform on objects" (Moseley et al., 2005a, p. 190).
Preoperational	2 - 7 years	• Beginning use of symbols and language, symbols to represent (e.g. objects and events). • Egocentrism still presents limitations but symbols are "increasingly organised and logical, so that children can think about their causes" (Miller, 2014, p. 652). • Difficulties in terms of problem solving (limited communication, conversation and reasoning).
Concrete operational	7 – 11 years	• "Conversation, classification, seriation, and transitive reasoning are possible" (Moseley et al., 2005a, p. 191). • Flexible and abstract thinking, egocentricity declining (children can de-centre). • The flexible and abstract thinking cannot be applied to hypothetical situations, manipulation of object still required (hence concrete).
Formal operational	11 – 15 years	• Logical thinking about concrete objects and "hypothetical, or imaginary concepts and situations" (Moseley et al., 2005, p. 191). • The results of concrete operations are used to generate hypotheses. Described as the "*scientific method*" by Miller (2014, p. 652). • "It is now possible to thinking of possibilities and potentialities that have not been hitherto encountered" (Moseley et al., 2005, p. 191).

Miller (2014, p. 664) noted that Piaget's contributions have endured the test of time, guided current research and are still relevant today, in particular for exploring development:

> *Sequences, concurrences, organization, and the intertwining of qualitative and quantitative change can serve as guiding principles for analysing change and identifying mechanisms of development.*

Piaget's legacy is widely recognised across the field. In the title of his 1996 paper on the theme of "Piaget's Legacy" Flavell stated his objective as "to summarize what I believe to be Piaget's contributions to what we know about cognitive development and how we think about it" (p. 200). Fox and Riconscente (2008, p. 378) explained the Piagetian perspective as movement through developmental stages, requiring both awareness of and interaction with objects and with others in the environment. They also emphasised links between Piagetian theory and access to one's own cognition, this is reminiscent of Flavell's (1971) assertions about how we think about cognitive development. Thinking about cognition is metacognition (cognition about cognition), this further emphasises the necessity of understanding the cognitive skills that underlie metacognition.

Fisher (1980) studied skill theory, via Piagetian tasks or exploration of knowledge about the physical world and noted the complexity of cognition and popular measurement of knowledge. Fisher (1980) highlighted the complexity of cognition and references to it within developmental literature, emphasising a problem reported to have been recognised by Piaget himself. Fisher (1980) stated this problem as lacking consideration of the environment with the majority focus on the 'organism'. The context of learning is a notion central to the practice relevance of this study. Flavell did acknowledge the legacy of Piaget, but as Miller (2014) explained, in 1982 he was also aware of the need for a more refined analysis of "the possible nature of stages" (p. 654) with knowledge acquisition being extended in its processes and until the final point "cognitive items may not become concordant, tightly organized, and interrelated into a true stage" (p. 654). This neo-Piagetian perspective centred on the domain specificity or generality of cognition, with not all research supportive of the "broad conceptual structures that apply to all content areas" (Miller, 2004, p. 654) implied by Piaget's stage model. The focus of this study does not lie in the domain specificity or generality of cognition or metacognition, nevertheless it is important to acknowledge wider debates and their influence on theory including that derived from the legacy of Piaget.

Debates around the specificity or generality of metacognition are well established within the field (Halpern, 1998; Neuenhaus et al., 2011; van der Stel & Veenman, 2008; Veenman et al., 1997). Neuenhaus et al. (2011) stated the popularly held developmental

belief that metacognitive knowledge becomes more flexible and less tied to particular a particular domain with experience and practice, citing evidence from Borkowski, Chan, and Muthukrishna (2000) to support this. Perhaps encouraging a move away from numerically based stages, Miller (2014) noted that the neo-Piagetian perspective "offered theoretical models of stages defined in terms of the complexity of their information processing requirements rather than their logical structure" (p. 654). Complexity in the sense of information processing here, aligns with the non-linear approach to children's development discussed in 1.2.1.

The context of learning is an important point (both physical in terms of objects and social context). A link can be drawn to the work of Nelson and Narens (1990) in terms of context of 'objects' involved in learning – they defined cognitive processes as being split into two levels (object and meta level). The next section focusses on models, including Nelson and Narens (1990), that incorporate both cognition and metacognition explicitly.

Contemporaneous approaches to cognition and metacognition (or metacognition and cognition)

Regarding theories of cognitive development Goswami (2014, p. 641) was clear in asserting that "cognitive developmental psychology is rich in data, but relatively sparse in theories". The lack of theoretical clarity implied here necessitates an approach to exploring cognition that is driven by the specific requirements of this study, in order to ground and rationalise it. In light of the importance of contemplating cognitive skills, given Flavell's definition and previous analysis of PVTs, what follows focuses on approaches to theorizing learning and/or thinking that have included both cognition and metacognition concurrently. The four approaches explored in detail have been selected because they are conceptualisations of metacognition that include explicit consideration of cognition and/or cognitive skills:

- Nelson and Narens (1990) – Abstract principles of metacognition
- Efklides (2008) – Multifaceted and multilevel model of metacognition
- Moseley et al., (2005a) - Integrated model for understanding thinking and learning (the Moseley model)

- Segedy, Kinnebrew, and Biewas (2011) – Integrated cognitive and metacognitive model for learning in Betty's Brain

The link between metacognition and cognition may seem superficial and somewhat self-evident, but the four models listed illustrate the benefits of approaching metacognition and underlying cognitive skills simultaneously. Discussion of the Moseley model will include how this approach to metacognition and cognition has been used in previous research with PVTs including Wall (2008) and Wall et al., (2012).

Nelson and Narens' (1990) abstract approach

Nelson and Narens' (1990) conceptualisation of the abstract principles of metacognition (Figure 7) is the earliest approach of the four discussed in this section. Nelson and Narens' approach comprised three principles the first of which being that "cognitive processes are split into two or more specifically interrelated levels" – meta-level and object level (p. 125). Cognitive processing was described as the control of cognitive processes and the role that metacognitive monitoring plays in this. The second and third abstract principles of metacognition respectively, were described as focussing on the meta-level containing a dynamic model (mental stimulation) of the object level and the presence of two dominance relations (control and monitoring). Nelson and Narens' (1990) stated that in terms of 'control', the meta-level modifies the object level via a flow of information between the two. Informing this modification, 'monitoring' refers to how the meta-level is informed by the object level. Although not explicit, this infers that knowledge is required for monitoring. Without knowledge of the object, task and strategies the flow of information would be impeded. Given that both the 'meta' and 'object' levels are described as cognitive processes; it seems that the required 'knowledge' informing the modification is inextricably cognitive in its origins.

The abstract approach of Nelson and Narens is likely imposed by the complexity and wide ranging opinions about what metacognition is. Nelson & Narens (1990) explored their abstract approach under the guise of a theoretical framework for metamemory, the notion of metamemory not far removed from the themes explored in this study (i.e. the links between cognition and metacognition) because "Metamemory research has focussed mainly on the relations of metacognition with cognition" (Efklides, 2002, p. 21). Nelson & Narens

(1990) also drew links between metamemory and metacognitive knowledge. Flavell's (1979) work provides a link between metamemory and Flavell's conceptualisation of metacognitive knowledge.
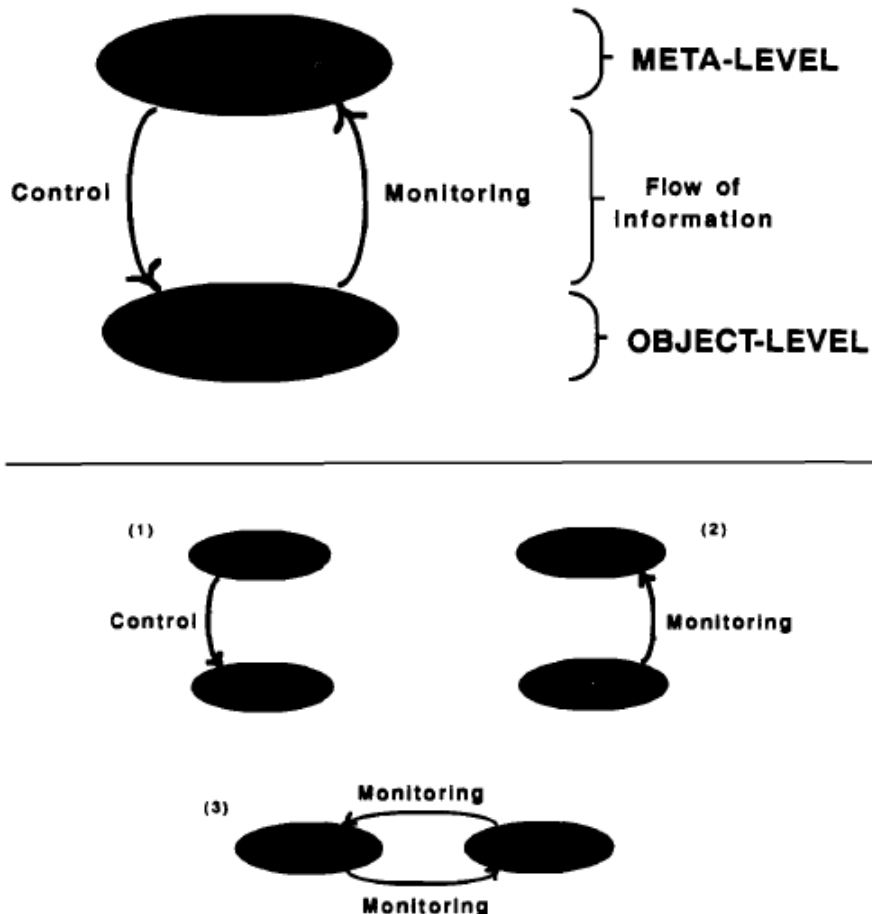
Figure 7: Three abstract principles of Metacognition, the two interrelated levels of cognitive processes (meta- and object-level). *Fig. 1* **from Nelson and Narens (1990, p. 125)**

Efklides (2011) asserted that Nelson (1996) described metacognition as a model of cognition. It is incredibly difficult to extrapolate metacognition from cognition and vice-versa, therefore making clear the value of approaching the concepts simultaneously. Nonetheless, questions can be asked of Nelson and Narens' (1990) abstract approach, for example the term object implies a relatively static concept as opposed to one that can be modified. However, we can also see in Figure 7 that there is a flow of information between the 'object' and 'meta' levels. Reflection to attain the knowledge to inform modification conceivably metacognitive but perhaps more accurately meta-affect. Knowledge about an object is not (and does not necessarily facilitate) cognition about cognition or rather

metacognition. Therefore, meta-affect, thinking (being meta-affective) about the affect of the object on learning, is likely a more accurate description.

Alongside their exploration of three abstract principles of metacognition, Nelson and Narens (1990) considered the importance of ease-of learning (EOL) judgements, judgements of learning (JOL) and feelings-of-knowing (FOK). In particular, whether these judgements and feelings were prospective or retrospective and the role(s) they were perceived to play in monitoring and controlling different aspects of memory. Control on its own does not yield information from the object level, monitoring is required for this (Nelson and Narens, 1990). Cognition or cognitive skills can be present and used by a learner without metacognition, for example the automaticity of cognitive skills to complete everyday tasks (e.g. reciting previously learned multiplication tables). However, metacognition cannot occur without the underlying cognition to be 'meta' about. The importance of cognition for and as an integral part of metacognition is implied by the associations between object, monitoring and control in the work of Nelson and Narens.

Efklides (2008): multi-level model

Efklides explained the influence of Nelson and Narens (Efklides, 2006, 2008), the importance of comprehending the significance of the object and meta level, which Nelson and Narens (1990) defined as cognitive processes. Efklides (2008, p. 278) also drew directly on the seminal work of Flavell (1979):

> *Flavell (1979) defined metacognition as cognition of cognition that serves two basic functions, namely, the monitoring and control of cognition. Nelson (1996; Nelson & Narens, 1994) defined metacognition as a model of cognition that functions at a meta level; metacognition represents the object level, that is, cognition.*

Efklides (2008) proposed a multifaceted and 'multi-level model of metacognition', exemplifying the links between different levels and between cognition and metacognition: "metacognition is usually conceived of as an individual and conscious process that serves the regulation of cognition" (p. 277). Efklides' multi-level model of metacognition (Figure 8) clearly illustrates cognition, alongside emotion, as the baseline for metacognition in the personal-awareness and social level. Efklides (2008) succinctly explained that metacognition and cognition are connected via monitoring and control functions. Figure 8 taken directly

from Efklides (2008) shows clearly how monitoring and control functions impact upon both cognition and emotion in Efklides' model. Figure 8 also shows that the monitoring of cognition directly influences cognition regulation and that the monitoring of emotion influences emotion regulation. Similarly, the control of cognition and emotion are influenced by cognition regulation and emotion regulation respectively, (represented by the dashed arrows as shown in the key).

Note: ME = metacognitive experiences; MK = metacognitive knowledge; MS = metacognitive skills; MJ = metacognitive judgments
◄··········· = Monitoring;   ◄- - - - - - = Control
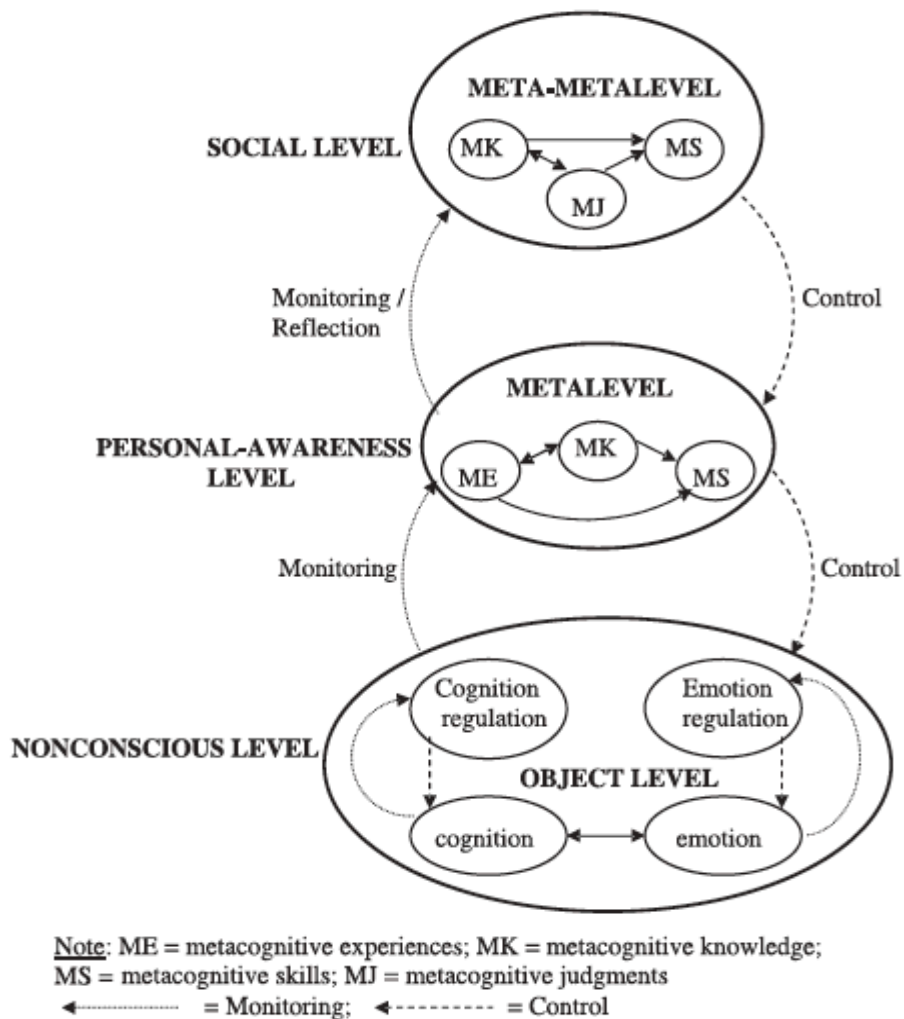
Figure 8: "The multifaceted and multi-level model of metacognition", *Figure 1* **from Efklides (2008, p. 283)**

The object level in Efklides' (2008) multi-level model was clearly influenced by the work of Nelson and Narens, which we know from the previous section, depicted cognitive processes as being on two levels (object and meta). Efklides' approach differs in that it also adds emotions at this level:

> *This tentative model posits that the object level (Nelson & Narens, 1994)*
> *comprises processes involved in cognition as well as in emotions/affect. It*
> *functions at a nonconscious level and involves two separate regulatory*
> *systems based on nonconscious monitoring and control processes. Products*
> *of each of the two regulatory systems, as well as of their interactions, along*
> *with perceptions of their behavioral outcomes, are represented at the*
> *personal-awareness level.*

> *(Efklides, 2008, p. 282)*

The object level is described, in Efklides' approach (Figure 9), as operating at a non-conscious level. Efklides (2008) noted that in the level above object (personal-awareness level), the products of cognition and emotion, their interactions and "perceptions of their behavioural outcomes are represented" (p. 282). Product in terms of personal-awareness level is taken to mean the product of self-regulatory systems (monitoring and control) on both cognition and emotion.

Returning to the relevance of cognition within the exploration of metacognition Efklides and Vlachopoulos (2012) developed this further, explaining that the two main functions of metacognition are monitoring and control. Monitoring is "manifested in the awareness people have of their cognition" (Efklides & Vlachopoulos, 2012, p. 227). Efklides (2011, p. 6) also presented a particularly clear explanation of these links, defining metacognition as follows:

> *It is a representation of cognition that is built on information coming from*
> *the monitoring function and that informs the control function, such as*
> *strategy use, when cognition fails for any reason.*

Defining the cognition in metacognition as a *representation* in this way, stemming from the work of Nelson and Narens, does however run the risk of overlooking cognition. Individual cognitive skills and/or their development potentially unobserved, whereas in contrast specific aspects of metacognition are considered in detail. Figure 8 illustrated that Efklides' model included various subdivisions of metacognition (labelled MK, ME, MS and MJ in the diagram). It is also not the purpose of this section to explore these subdivisions of metacognition that Efklides (2008) also presented (see 2.2.1), but rather to consider the operationalization of cognition with metacognition in this model. The two remaining approaches (Moseley et al., 2005a; Segedy et al., 2011) differ from Nelson and Narens (1990) and Efklides (2008) in that, with an eye to practice, they are explicit about the distinct aspects of cognition that they explore.

Moseley et al., (2005a) - Integrated model for understanding thinking and learning (the Moseley model)

Reflecting on the previously discussed legacy of Piaget and the focus on development in this study, it is important to note that prior to presenting their integrated framework (referred to as the Moseley model), Moseley et al. (2005a) discussed the Piagetian perspective on cognitive development. Moseley et al. (2005a) considered this alongside the works of other key theorists, including Perry, King and Kitchener, and Koplowitz. All of these having in common the "development of thinking through increasingly more complex phases or stages" (Moseley et al., 2005a, p. 186). The theme of moving through increasingly complex phases or stages is related to the assertion that metacognition requires the underlying and/or simultaneous development of cognitive skills and that it is difficult to separate these completely (see 2.2.1).

The Moseley model (Figure 9) comes from the aptly entitled book 'Frameworks for Thinking', with framework implying prospective application (with consideration) to different contexts. 'Framework' suggests a basis for exploring cognitive skills and metacognition, rather than a static definition. The integrated approach to cognitive skills and metacognition described by Moseley et al. (2005a) has the advantage of being resultant of a detailed and unique synthesis of 42 frameworks, models and taxonomies focussing on helping educators to "understand the processes and products of thinking and learning" (p. 1). Metacognition is clearly about learning, studying it without reference to practice would leave it ungrounded - as ungrounded as metacognition is without reference to underlying cognitive skills. The practice element of the Moseley model also fits well with the pragmatic and educationalist approach of this study.

Strategic and reflective thinking

Engagement with and the management of thinking/learning supported by value-grounded thinking (including critically reflective thinking)

Cognitive skills

Information-gathering	Building understanding	Productive thinking
Experiencing, recognising and recalling Comprehending messages and recorded information	Development of meaning (e.g. by elaborating, representing or sharing ideas) Working with patterns and rules Concept formation Organising ideas	Reasoning Understanding causal relationships Systematic enquiry Problem solving Creative thinking

Figure 9: The "integrated model for understanding thinking and learning" from Frameworks for Thinking, Figure 7.1 (Moseley et al., 2005a, p. 314)

The Moseley model as shown in Figure 9 makes clear the strong link between cognitive skills and metacognitive or self-regulatory activities (denoted as strategic and reflective thinking, for an explanation of this see 1.2.2). Moseley et al. (2005a) asserted that the reciprocal interaction between cognitive skills and strategic and reflective thinking, depicted by two-way arrows in their model, does not mean that this interaction always applies. Cognitive skills can be effected "in unplanned and unreflective ways" (Moseley et al., 2005a, p. 315) and that accounts of the process or processes cannot always be given, implying a degree of automaticity. Conversely, one cannot "operate at the level of strategic, value-grounded thinking without information gathering and other cognitive skills" (Moseley et al., 2005a, p. 315). The latter further re-affirming the necessity of underlying cognitive skills for metacognition.

The Moseley model presents cognitive skills as the foundation of metacognitive activity. Without underlying cognition and associated cognitive activity in learning, what is there to be 'meta' about (metacognition)? The link between cognitive skills and metacognition in the Moseley model (see Figure 9) differs from the approaches of both

Nelson & Narens (1990) and Efklides (2008) in the acknowledgement of specific cognitive skills and descriptors of them, as opposed to more general representations of cognition and its subsequent regulation. The cognitive skills featured in the Moseley model are:

1. Information Gathering
2. Building Understanding
3. Productive Thinking

The role of information gathering in the Moseley model is made clear in terms of its necessity to progress further and potentially initiate metacognition. Information gathering is described as to experience, recognise and recall learning and to comprehend messages or recorded information (e.g. about a new task or a task that is being reflected on). Information gathering is described as necessary in order to develop meaning and organise ideas (building understanding) or reason and understand causal relationships (productive thinking). Cognitive skills underlie metacognition; information gathering is presented in the Moseley model as a foundation that precedes the other cognitive skills and strategic and reflective thinking (metacognitive or self-regulatory activity).

Links can be drawn between specific facets of the Moseley model and the seminal work of Flavell. Flavell (1981, p. 273) reported that "Actions (strategies) refer to the cognitions or other behaviours that you carry out to attain these goals and subgoals", further explaining that examples of this are asking questions and recognising and responding to nonverbal cues. Behaviours to attain goals, described by Flavell, could include those described under the heading of information gathering (experiencing a situation to work out what is required), building understanding (organising ideas) in order to move forward to productive thinking (problem-solving). The development element of this is clear: the need to experience, recognise or recall the requirements of a situation, in order to organise one's ideas and potentially move forward to creative thinking and problem solving.

Moseley et al. (2005a) preceded their integrated model (see Figure 9) with a detailed exploration of different models of cognitive skills and cognition; their final integrated model drawing on several theories including that of Piaget. Moseley et al. (2005a) explicitly stated when introducing their integrated model (p. 312-313), that Bloom's Taxonomy (the revised version, Anderson and Krathwohl (2001)) was the starting point - the three categories of information gathering, building understanding and productive thinking are drawn directly from this. Krathwohl (2002) illustrated the original Blooms Taxonomy

alongside the revised version. This was an appropriate starting point for the Moseley model due to its clear focus on the cognitive domain, strong influence on many other models and formulations, and in its revised the relevance of it for practitioners.

The main differences between the original and revised taxonomy centre on the emphasis of two distinct dimensions (knowledge and cognitive processes) and the inclusion of metacognitive knowledge as an explicit category in the revised version. Krathwohl (2002) explained that the knowledge dimension in the revised taxonomy was related to the original category of knowledge and that the cognitive processes dimension encapsulates all six original classifications, with knowledge renamed as remember. The verbs used in the revised cognitive processes dimension (e.g. remember, understand, apply), as opposed to the nouns in the original taxonomy (e.g. knowledge, comprehension, application), are stated to be indicative of the practical relevance of the revised taxonomy. The basis of the Moseley model on this revised taxonomy, therefore further reinforces the relevance of it for the educationalist approach outlined in 1.1 and the importance of metacognition both in and for practice.

Remembering the inextricable link between metacognition and cognitive skills (2.2.1), this relationship is shown clearly in the revised Bloom's taxonomy. The addition of the category 'metacognitive knowledge' in the revised taxonomy, referring to knowledge of cognition in general but also "awareness and knowledge of one's own cognition" (Krathwohl, 2002, p. 214) is crucial. Knowledge and awareness of cognition (including one's own) is integral in learning, aiding in awareness of one's own metacognitive activity and the use of this knowledge to influence thinking and associated activity. Krathwohl (2002) listed three sub-categories of metacognitive knowledge in the revised taxonomy: strategic knowledge, knowledge about cognitive tasks and self-knowledge. Directly linked to this, the popularly defined subdivisions of metacognitive knowledge based on person, task and strategy are examined in 2.2.5.

The Moseley model has clearly defined roots in a variety of theory around learning and clear relevance for practitioners. It recognises the relevance of exploring cognition and metacognition simultaneously. The additional relevance of the Moseley model for this study, because it has been used in previous research with PVTs (Wall, 2008; Wall et al., 2012) will be considered in 2.2.3. Before exploring in more detail the importance of cognition and metacognition in practice, one final model is explored from the work of Segedy et al. (2011).

Segedy et al. (2011) – Integrated cognitive and metacognitive model for

learning in Betty's Brain

The final synchronous approach to metacognition and cognition explored in this section is an example drawn from a computer based learning environment called Betty's Brain. Segedy et al. (2011, p. 297) explained that Betty's Brain Learning Environment was used because it had been shown to "aid learners in developing cognitive and metacognitive strategies" to support science learning. The integrated cognitive and metacognitive model is based around the premise of scaffolding learning, thinking about how cognitive activities are used by students to "effectively and efficiently regulate their learning" (Segedy et al., 2011, p. 299). Figure 10 shows the circular fashion of the integrated model, two inner circles representing the basic actions (e.g. access resources, edit map) that are supported by the system as a whole. These basic actions are also supported by relevant cognitive activities including reading domain information, identifying causal relation(s) and organization to name a few. The outer circle in Figure 10 is the metacognitive layer, comprising four areas: goal setting and planning; knowledge construction; monitoring and help seeking. Metacognitive strategies are listed for each of the four areas, for example goal setting and planning: identifying, choosing and planning to achieve goals.

Links can be drawn between Segedy et al.'s (2011) representation of the relationship between cognition and metacognition and the Moseley model. Segedy et al., (2011) explained the links between cognition and metacognition via integration, which they explained as applying cognition and metacognition. One example from a table they presented (Table 2) (Segedy et al., 2011, p. 301) from the metacognitive area of monitoring was 'assessing understanding' (a metacognitive strategy/activity). The application of cognition and metacognition is described as "Check direct and indirect relations that involve recently added links against current understanding" (p. 301). The supporting cognitive activities described are as follows: "Check direct links by re-reading resources, and indirect relations by query, quiz, and explain activities" (Segedy et al., p. 301). The notion of relations illustrated in Figure 10, in particular indirect and causal, can be likened to the causal relationships described in the Moseley model under the heading of productive thinking. Furthermore, Segedy et al., (2011) and the Moseley model also have in common their detailed categorisation of cognition, with the explicit arrangement of cognition and metacognition as interlinked.

Segedy et al., (2011) concluded by asserting that Betty's Brain, the learning environment they used and developed their integrated model within, required continuing development. However, they maintained that what they presented was "a cognitive and metacognitive model for effective learning strategies in the Betty's Brain learning environment" (p. 304). Conclusions clearly focussed on on learning and how to do this effectively, like the Moseley model Segedy et al.'s integrated model also clear relevance for practice. Practice is a similarity between the Segedy et al., (2001) and Moseley models, but how the two are put into practice has clear differences. Segedy et al., (2011) focussed on computer based learning environments (in particular open ended learning environments) and Moseley et al. (2005a) the needs of practitioners in terms of understanding theory around cognition and metacognition that is based on a rigorous synthesis of research. What follows in 2.2.2 explores cognition and metacognition in practice further, before looking at literature that explores the similarly fuzzy distinctions between self-regulation and metacognition.
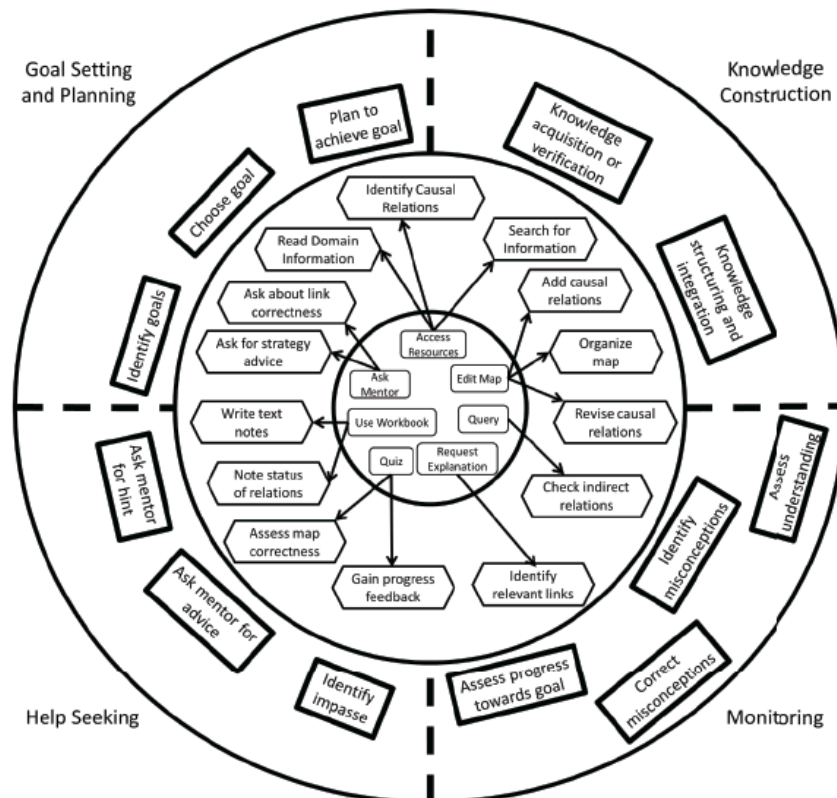
Figure 10: Integrated cognitive and metacognitive model for learning in Betty's Brain (Segedy et al., 2011, p. 230)

2.2.2. Cognition and metacognition in practice

Section 2.2.1 explored the complexity of the relationship between cognition and metacognition; the interrelatedness of this can be confusing so it was important to clarify this to ground and rationalise this study. Metacognition in this section is applied with reference to the value of acknowledging the practice contexts in which cognition and metacognition are explored. Section 2.2.3 will explore cognition and metacognition in research with PVTs in detail, this section will however make reference to the consideration of context evident in existing research that has used PVTs including Wall (2008) and Wall et al., (2012).

Cognitive skills in theory are important, but a consideration of their meaning in practice and how metacognition (and associated concepts) are defined in practice is of clear importance too. Of cognitive skills Kuhn and Dean (2004, p. 269) stated that:

> *The kinds of cognitive skills that educators think about as coming under the heading of critical thinking are amenable to empirical investigation.* [Therefore] *Teachers need a roadmap of what is developing and what needs to develop.* [And] *Researchers need to be examining forms of development that are unlikely to occur in the absence of appropriate educational environments. At the same time, educators need the developmental knowledge that will inform their efforts.*

In the paper that the citation above comes from, Kuhn and Dean (2004) focussed on conceptualising metacognition as a bridge: "A Bridge Between Cognitive Psychology and Education Practice" (Title). In terms of development, practitioners are interested in cognitive skills and metacognition, but more precisely what can be facilitated in educational environments that is learnt from cognitive psychology theory. The developmental knowledge that educators require to support their practice is explored further in 2.3, focussing on metacognitive development with emphasis on development deduced from the tools identified in 2.1 (systematic review).

Kuhn and Dean (2004) underlined the differences in the language that educators and researchers used to describe the same things. Thinking skills, used in practice to describe higher order thinking and metacognition, is the first example given. Reference is made to the research oriented goal of concepts being "precisely defined and measured" (Kuhn & Dean, 2004, p. 268). Schraw and Moshman (1995) made similar links suggesting that individuals, for a minimum of two reasons, extemporaneously construct metacognitive theories:

1. *Systemizing their growing repertoire of cognitive skills, strategies and metacognitive knowledge about these*

2. *Learning what it is to be an "effective, strategic learner" (p. 363).*

Schraw and Moshman (1995) also noted the social context of this extemporaneous process within learning; peer interaction and the projection of cognitive experiences onto others play an important role. Likewise, Zimmerman (1995) linked social context, cognition, metacognition and self-regulation, in particular the role of "social context on human reasoning and functioning" (p. 218). Reasoning and functioning may differ depending on where learning is taking place, why this is so and who else is there, but their importance remains.

Vygotsky is credited with making clear the links between practice and theory, whilst also noting the importance of interaction including the social context of cognition and metacognition. Vygotsky's model of cognitive development has been described as a precursor to metacognitive theory (Bråten, 1992; Bråten, 1991a, 1991b). Goswami (2014) noted Vygotsky's popular endorsement as being responsible for underscoring the importance of social context and culture for children's cognition, also the notion that language is central in cognitive development. The terminology and classifications inherent in the revised Bloom's Taxonomy (Krathwohl, 2002) clearly implied the importance of language skills. Similarly, the Moseley model (Figure 9) used terminology like recognising, recalling and comprehending. These words inferred a level of understanding in terms of language and being able to use it effectively in learning and when reflecting on learning. Similarities can be drawn between these Vygotskian notions and other theories or models, including Efklides (2008), which have clearly acknowledged the social context of learning and language.

Previous research using PVTs has been completed in focus groups, in school settings, clearly acknowledging the social context of learning and understanding the value of a naturalistic setting for research to consider this context. Whitebread et al. (2009) similarly argued the efficacy of conducting their (observation based) research in naturalistic settings. Preceding research with PVTs has given examples of how this social context of learning is elicited in data collection with PVTs: "It's good because we help each other to get more ideas. (Year 1 pupil)" (Wall, 2008, p. 29). The notion of receiving help to aid in learning is directly related to the Vygotskian notion of the Zone of Proximal Development (ZPD) and how interaction in learning can aid task proficiency and completion. Importantly this does not mean that direct assistance is necessary for learning and to move beyond the ZPD, more

usefully it can be interpreted as acknowledging the social context of learning. Whitebread et al. (2009) credited Vygotskian tradition as being from where the term self-regulation is derived. The complexity of the relationship between self-regulation and metacognition will be discussed in 2.2.4.

A practice, educationalist perspective on metacognition combined with the nature of teaching (practice), accentuates the importance of strategy (planning the use of, using strategies, evaluating strategy use). In the UK the teaching of higher order (metacognitive) strategies has increased in importance in recent years, notable examples include Thinking Skills (Higgins et al., 2005; Leat, 1999; Moseley, Elliott, Gregson, & Higgins, 2005b), Learning to Learn (Hall, Leat, Wall, Higgins, & Edwards, 2006; Higgins et al., 2007; Wall, 2008) and Learning How to Learn (Black, McCormick, James, & Pedder, 2006; James et al., 2006). In one example Leat (1999, p. 389) described how Thinking Skills programmes "make students think about thinking" (metacognition) and that through this, students can regulate their learning performance.

Echoing this increase in research around strategies for learning, research about additional funding including Pupil Premium (DfE, 2015) (for publicly funded schools in England) to raise the attainment of disadvantaged students has increased. This has facilitated the development of a toolkit of 34 different or approaches (Higgins et al., 2012). In the 2014 update of this toolkit, the impact of meta-cognition and self-regulation is described as "High impact for low cost, based on extensive evidence" (Higgins et al., 2014, "Approaches"). The definition given is as follows:

> *Meta-cognitive and self-regulation strategies (sometimes known as 'learning to learn' strategies) are teaching approaches which make learners think about learning more explicitly…Self-regulation refers to managing one's own motivation towards learning as well as the more cognitive aspects of thinking and reasoning. Overall these strategies involve being aware of one's strengths and weaknesses as a learner, such as by developing self-assessment skills, and being able to set and monitor goals. They also include having a repertoire of strategies to choose from or switch to during learning activities. (Higgins et al., 2014, "Meta-cognition and self-regulation", para. 1)*

Strategies are clearly important, entwined with teaching and thinking about learning explicitly. In 1.2.1 research demonstrating the links between metacognition and positive outcomes for students was summarised, thus making clear the relevance of metacognition for and in practice. Remembering the educationalist epistemology underlying this study, the

definitions applied in these examples are an appropriate place to begin in terms of linking metacognition to practice. Discussion below is derived from examples that have explicitly identified links between metacognition and positive student outcomes.

Akyol et al. (2010) presented a study of the links between cognitive and metacognitive strategy use with science achievement. Findings indicated that metacognitive self-regulation strategy use was a significant predictor for 7th grade students' achievement in science. Akyol et al., (2010, p. 2) stated that:

> *…metacognitive strategies are deeper processing strategies including planning, monitoring, and regulating that assist students in the control and regulation of the cognition (Pintrich, Smith, Garcia, & McKeachie, 1993).*

Similarly, Dignath et al. (2008) talked about metacognitive strategy use, defining this as strategies focussed on the regulation of learning (controlling, monitoring and regulating learning). They went on to explain that metacognitive knowledge (knowledge of cognition) is a facet of metacognition alongside the monitoring, control and regulation of one's own learning (metacognitive strategy use). They described metacognitive knowledge as knowledge of cognition: "the learners understanding of their own memory, their knowledge and their learning style" (p. 108). A third facet, metacognitive skills, was described as planning then monitoring during learning with rescheduling strategy use, finally followed by evaluation after learning. Prins et al. (2006) described metacognitive knowledge and skills, but not strategies specifically. Nonetheless this does not imply that they did not encapsulate strategy use within this: "self-regulatory activities actually being performed by a learner in order to structure the problem-solving process" (Prins et al., p. 375) is strikingly similar to the monitoring and strategy rescheduling described by Dignath et al. (2008).

Beginning with cognition, this section has explored the relevance of cognition and metacognition for practice. Examples of metacognition in practice have been cited from prior research that has explored metacognition through PVTs, a clear indicator that PVTs have value for exploring metacognition in both practice and research. In order to situate this study and its analysis within the field, what follows summarises the approach to cognition and metacognition in previous research with PVTs. Section 2.2.4 follows on, exploring how this maps onto relevant literature in the field and grounding the approach to the analysis of PVTs in this study that will be outlined in 3.7.

2.2.3. The approach to cognition and metacognition in PVT research

The findings of previous research using PVTs with regards to evidence of metacognition and therefore the relevance of this study were stated in 1.2.2. The approach to cognitive skills and metacognition applied in previous PVT research is based on the Moseley model. This model was described in 2.2.1 and illustrated in Figure 9, alongside a consideration of the importance of exploring specific and identified cognitive skills as well as metacognition. Consideration of the approach to cognition and metacognition in previous research with PVTs in this section, is based on two key papers: Wall (2008) and Wall et al. (2012) both of which used the Moseley model in their deductive analysis of PVT data. Table 1 presented a total of five papers that have used PVTs in research with children about their learning. Of these papers Wall (2008) and Wall et al. (2012) presented the most detailed methodological information about the deductive coding scheme based on the Moseley model. Thus Wall (2008) and Wall et al. (2012) are the two papers referenced in this section when previous research with PVTs is referenced.

Moseley et al. (2005a) stated that metacognition is an important feature in their integrated model alongside cognitive, affective and conative features of learning, noting that others have not always included metacognition explicitly in models with cognitive skills. In previous research using PVTs, evidence of cognitive skills (information gathering, building understanding and productive thinking) and strategic and reflective thinking (evidence of metacognitive and/or self regulatory activity) was coded first. The order of coding in PVT research (Wall, 2008; Wall et al., 2012) is representative of clear recognition in PVT research of the importance of considering cognition alongside metacognition. Moseley et al. (2005a, p. 314) made clear the links between cognitive skills and strategic and reflective thinking but also emphasised their differences:

> *Cognitive skills are procedures which can become automised and are not necessarily associated with effort or emotion. However, strategic and reflective thinking are always highly conscious and are often experienced as involving will and/or emotion as well as cognition.*

The main difference was described as the conscious nature of strategic and reflective thinking (the metacognitive/self-regulatory element of the model, see Figure 9), in comparison to the potential automaticity of cognitive skills. In comparison to the intentionality of strategy, the automaticity described here is reminiscent of the automaticity of skills described by Veenman et al. (2006). Veenman et al. (2006) highlighted the

"perennial issue of what constitutes a skill and what constitutes a strategy" (p. 6). Veenman et al., reasoned that the difference was automaticity and intentionality respectively – knowledge of strategies associated with intentionality and automaticity concomitant with skill and the feedback in the regulation of learning.

In the coding processes of previous research with PVTs (Wall, 2008; Wall et al., 2012), data coded as strategic and reflective thinking based on the Moseley model was subsequently reanalysed for evidence of metacognition (Wall, 2008). More specifically evidence of metacognitive knowledge or metacognitive skilfulness as defined by Veenman et al. (2005, p. 194):

> *[Metacognitive knowledge] refers to the declarative knowledge one has about the interplay between personal characteristics, task characteristics and the available strategies in a learning situation (Flavell, 1979). Metacognitive knowledge, however, does not automatically lead to appropriate execution of metacognitive skills.*

And

> *Metacognitive skills concern the procedural knowledge that pertains to the actual regulation of, and control over one's cognitive processes and learning activities (Brown, 1978; Brown & DeLoache, 1978; Flavell, 1992; Schraw & Moshman, 1995). They are occasionally referred to as executive skills (e.g., Kluwe, 1987). Task analysis, planning, monitoring, checking or evaluation, recapitulation, and reflection are behavioural manifestations of such skills that are (metacognitively) initiated during task performance.*

It is important to note that the above examples are not the only definitions of metacognitive knowledge and metacognitive skilfulness described by Veenman and colleagues, there are other examples (Veenman & Elshout, 1999; Veenman et al., 1997; Veenman & Spaans, 2005). However, in order to limit the complexity of the referencing in this thesis the Veenman et al. (2005) definitions will be referred to in relation to the distinction between metacognitive knowledge and metacognitive skilfulness from this point on.

In order to ground the methodological decisions that will be outlined in Chapter 3 (with respect to this study and the coding of PVT data) the usefulness of the metacognitive knowledge/metacognitive skilfulness distinction needs to be considered alongside wider debates. These debates include whether or not a method of assessing metacognition is online or offline (see 2.1.8). Many have argued that metacognitive skilfulness is something that can only be investigated using online methods, because it is in the moment and

pertaining to "the actual regulation of, and control over one's learning activities" (Veenman & Elshout, 1999, p. 510). Online referring to those methods that are used concurrently (not retrospectively or prospectively) – methods that are used within a task and therefore assess the metacognition elicited within that task. In some examples of methods described as online, observation schedules are applied (e.g. Whitebread et al., 2009) and in others participants are asked to think aloud whilst completing a task (e.g. Veenman & Spaans, 2005) .

Questions were raised about the true nature of being online with reference to specific tools and methods identified in 2.1 (Systematic Review) in 2.1.8. Critique of offline methods to assess metacognitive skilfulness focuses on the perceived inaccurate representations of metacognitive skilfulness that offline measures may elicit. Online measures being described as "…more fairly" [representative of metacognitive skills] (Bryce and Whitebread, 2012, p. 200). However, Saraç and KaraKelle (2012) explored the interrelationships between online and offline measures and concluded that using either online or offline measures alone was not the best approach, but rather to use a combination. This prompts a consideration of the efficacy of making the online/offline distinction in relation to metacognition - if the best approach to exploring metacognition is to use a combination the distinction becomes seemingly less important.

To ground the empirical data collection in this study, it is necessary to consider the online/offline distinction it in relation to PVTs and metacognitive skilfulness in existing literature. Existing studies (Wall, 2008; Wall & Higgins, 2006; Wall et al., 2012) do not delineate PVTs as explicitly online or offline, but they have presented evidence of awareness of metacognitive skilfulness. Archetypal definitions would designate PVTs as offline, because participants are asked to think about a learning scenario whilst completing a PVT (e.g. being taught with interactive whiteboards (Wall et al., 2005)), rather than actually doing the scenario in the moment (e.g. actually working with interactive whiteboards). Nonetheless, PVTs have been completed as part of focus group type interviews with small groups of pupils (Wall & Higgins, 2006). This discussion-based completion of PVTs potentially lies on the boundary between what is traditionally described as offline and online. There is a retrospective element but this reflectivity is moderated by active discussion about learning (mediated by a PVT and facilitated by a researcher) that is very much in the moment. PVTs have the potential to blur the traditionally asserted online/offline boundaries. This flexibility

of PVTs further supports the questions posed about the efficacy of the online/offline distinction.

In 2.2.6 the most appropriate approach to analysis of cognition and metacognition in PVT data in this study will be considered. An appropriate approach that will seek to acknowledge and employ the approach used in previous research with PVTs (Wall, 2008; Wall et al., 2012) whilst at the same time developing it further.

2.2.4. Metacognition and self-regulation

Metacognition and self-regulation are intrinsically linked, there is little doubt of this in the field. However, the fuzziness of existing definitions of metacognition and self-regulation leave it very much open to researcher interpretation in terms of how these links are portrayed. Despite many questions, there is no doubt that the question of which concept (metacognition or self-regulation) is superordinate of the other is central in the field (Veenman, 2007; Veenman et al., 2006) There is continued debate about where the definitions for these terms, if separated, intersect or are distinct. The issue of superiority (or not) for metacognition and self-regulation is often the 'elephant in the room', it is important to explicitly confront this debate to facilitate transparency within this research.

Confusion around defining metacognition and self-regulation, especially their intersections, is compounded by the fact both terms are often used interchangeably in the literature and without adequate or explicit consideration given to their relationship (Dinsmore et al., 2008; Hofer & Sinatra, 2010; Moseley et al., 2005a; Schunk, 2008). Careless use of terms without adequate consideration of the contexts in which they are being used can lead to misperception, especially if there are no clear accompanying explanations. Debate around what comes first and which term, if either, is dominant has spanned over two decades and it is widely recognised as remaining largely unresolved (Kistner et al., 2010; Robson, 2010; Veenman, 2007; Veenman et al., 2006).

Veenman et al. (2006) raised pertinent questions about this relationship between metacognition and self-regulation, presenting debate about whether self-regulation is subordinate to metacognition or whether self-regulation is actually superordinate to metacognition. In 2007 Veenman noted the content of more recent definitions of self-regulation and the inclusion of metacognitive knowledge and skills within this:

> *…more recently self-regulation is defined as a broader set of knowledge and skills, including domain-specific knowledge, cognitive skills, metacognitive knowledge and skills, and motivational processes (cf. Boekaerts et al. 2000; Schraw et al. 2002; Schunk and Zimmerman 1994)…Depending on the nature of the learning task the weight of self-regulatory components may vary. (Veenman, 2007, p. 2007)*

In this example metacognition (both knowledge and skills) is clearly placed as a part of self-regulation; one could therefore infer that self-regulation is the superordinate concept and metacognitive knowledge and metacognitive skilfulness as components parts of it. In another seemingly contrasting example, Veenman et al. (1997, pp. 187-188) described self-regulatory activities as representatives of metacognitive skilfulness, inferring that metacognition is overarching and that there is a direct link between definitions of metacognitive skilfulness and self-regulation:

> *The self-regulatory activities that constitute an effective working method comprise those that are mentioned in the literature as representatives of metacognitive skilfulness: reflecting on the nature of the problem, predicting the consequences of an action or event, planning and monitoring the ongoing activity, comprehension monitoring, checking the results of one's actions, testing for plausibility, and reflecting on one's learning performances (Brown, 1978; Flavell, 1979; Markman, 1985; Sternberg, 1990).*

In debating links between metacognition and self-regulation, Efklides (2006) highlighted that comparison can be drawn to the work of Nelson and Narens (1990) where metacognition was presented as a representation of cognition (object level). Could metacognitive skilfulness therefore be described as a representation of self-regulatory activities? A declarative representation (not in the actual task, more awareness of or meta-metacognitive skilfulness) of learners' awareness of how these self-regulatory activities have influenced learning?

Similarly to Veenman (2007), Pintrich and De Groot (1990) asserted that metacognitive strategies are something that is included within the overarching self-regulation of cognition, therefore suggesting that self-regulation is superordinate to metacognition. The summary below outlines the three components that Pintrich and de Groot (1990, p. 33) proposed as forming the self-regulation of cognition that they described:

I. *Metacognitive strategies for cognition (for planning, monitoring and modifying)*
II. *Management and control of effort on tasks*
III. *The cognitive strategies that students use to learn*

Boekaerts (1999) also proposed a model with self-regulation as the major construct of which the use of metacognitive knowledge and skills are a part of, but do not have the central role. Interestingly in Boekaerts' (1999) model, cognition is also acknowledged and central, in terms of learner's choices of cognitive strategies. Boekaerts (1999, p. 447) clearly acknowledged the importance cognitive strategies for and in self-regulated learning:

> *In the last decade it has become clear that one of the key issues in self-regulated learning is the students' ability to select, combine, and coordinate cognitive strategies in an effective way.*

In the same way that the complexity of metacognition requires a consideration of the cognition that one is being 'meta' about, so does the control of this cognition and metacognition in self-regulation.

Popularly regarded definitions of self-regulation, including Zimmerman's (1995) description have stated that self-regulation is more than metacognition (more than both knowledge and skill). This notion of 'more than metacognition' stems from self-regulation as involving "students' underlying sense of self-efficacy and personal agency" (Zimmerman, 1995, p. 220). Zimmerman asserted that self-efficacy and personal agency are present in addition to metacognition. It is important to acknowledge belief in the presence of this underlying self-efficacy and agency associated with self-regulation, but also to remember that it is not the focus of this study. Zimmerman (1995, p. 217) explained the necessity of self-regulation particularly clearly, but his definition also highlighted the necessity of having metacognitive knowledge and skill:

> *Unfortunately, it is one thing to possess metacognitive knowledge and skill but another thing to be able to self-regulate its use in the face of fatigue, stressors, or competing attractions. The aspect of SRL [Self-Regulated Learning] that plays a central role – namely, the capability to mobilize, direct, and sustain one's instructional efforts – has received relatively little attention in metacognitive accounts of academic self-directedness.*

Zimmerman's argument focussed on the necessary control and direction of metacognitive knowledge and skill, a role fulfilled via self-regulated learning, which is later described as "personal agency" (p. 218). In an earlier paper, Zimmerman and Martinez-Pons (1988, p. 284) made reference to social learning and noted the difference between knowledge about self-regulated learning strategies and actually using these strategies within "specific learning contexts". The presence of self-regulated learning strategies and awareness of them does not necessarily imply their appropriate use in learning contexts.

In 2000, Pintrich published his general framework for self-regulated learning. Moseley et al. (2005) explained that Pintrich's framework defined self-regulated learning as an active, learner centred process that is focussed on learners setting goals in their learning. This active process also involving the monitoring, regulation and control of cognition; the regulation element is further divided into four different domains (cognition, motivation and affect, behaviour and context). Considering that one of the domains for the regulation and control of cognition is cognition itself, surely this implies "cognition about cognition" (Flavell, 2000, p. 16) and therefore metacognition? One wonders as to what degree metacognitive knowledge impacts upon the regulation and control of cognition (self-regulated learning) and how this could be further explored? Efklides (2011) asserted that metacognition is a component of self-regulated learning, but as her debate moved on, questions were raised and she asserted the importance of metacognitive strategies (or skills) and metacognitive knowledge for "control of cognition" (p. 8). Similarly Schneider (2008) affirmed that in recent definitions of metacognition, elements including self-regulation skills have been added. If learners are not 'meta' about what they know (metacognitive knowledge) then how can they skilfully (metacognitive skilfulness) regulate learning experiences (self-regulation)?

In an early definition of self-regulation Brown (1987, p. 116) stated it to be part of an active learning process, more specifically as involving "continuous adjustments and fine-tuning of action by means of self-regulating processes…" Continuous adjustments in this sense, implying that self-regulation occurs in the moment. In Veenman (2007) the inclusion of metacognitive knowledge and skills within self-regulation infers that metacognition is necessary for this, and that there is an element of reflection (reflection on metacognitive knowledge). Dignath et al. (2008, p. 107) noted "metacognition enables reflection about one's own learning processes on the one hand, and use and regulation of strategic activities on the other hand". Reflection-in-action Schön (1983) provides a useful lens through which to examine this further, the concepts of knowing-in-action (practical knowledge that enables us to carry out tasks simultaneously) and reflecting-in-action (when an unexpected surprise presents in a task learners need to think on their feet) need to be considered. Schön (1983) asserted the importance of reflecting-in-action to avoid complacency in learning so as not to lead to "over-learning" (p. 7), thus enabling a learner to critically evaluate through reflection on their tacit understandings about a learning task. This avoidance of over-learning can be likened to self-regulatory monitoring and evaluation, which it seems, could also be tied into metacognitive skilfulness given the procedural knowledge described in definitions of both.

The perspective that self-regulation is the overarching concept may be popularly regarded in the literature, but this section has demonstrated that there are often clear links and references to the concept of metacognition, implying that this is the overarching or perhaps the enabling concept. For example, without metacognitive knowledge and being able to recall this, the notion of regulation in the moment would be somewhat stranded and less grounded. Stranded because it would not be based in experience, including reflection on this of how to move forwards in learning.

In 2008, Dinsmore et al. contemplated debate around defining metacognition and associated concepts in detail, their literature review focussed on the concepts of metacognition, self-regulation and self-regulated. Dinsmore et al. (2008, p. 393) focussed on the "core meaning" of the three seemingly related terms, and their convergences and divergences:

- Metacognition: "two distinct elements: knowledge about cognition (monitoring) and self-regulatory mechanisms that contain monitoring as a central focus" (p. 393). The inclusion of self-regulatory mechanisms here inferring an unmistakable overlap between the concepts of metacognition and self-regulation.
- Self-regulation: definition based on the work of Bandura (1986), concerning "the reciprocal determinism of the environment on the person, mediated through behaviour" (p. 393). Dinsmore et al. (2008) highlighted the difference between self-regulation and metacognition, with the former having a behaviour focus and the latter cognitive.
- Self-Regulated Learning: stemming from "focus on self-regulation in academic settings" and incorporating "aspects of both metacognition and self-regulation to shape its lens on learner monitoring" (p. 394).

Dinsmore et al. (2008) concluded that explicitly stating the differences between metacognition, self-regulation and self-regulated learning is inherently risky. They also affirmed that there is often a need to make inferences from the literature where details were lacking or underspecified. Clarity in definitions, or lack of, in terms of key concepts was an issue highlighted in the findings of the systematic review (2.1). Dinsmore et al., (2008) and Desoete (2008) (see 2.1.7) both strongly emphasised the importance of clear and transparent consideration of the conceptualisation and operationalization of metacognition (an associated concepts) and associated research outcomes. In addition to the intersections

between metacognitive knowledge, metacognitive skilfulness and self-regulation that have already been explored, 2.2.5 explores various additional and relevant subdivisions of metacognition.

2.2.5. Subdivisions of metacognition

Metacognition is commonly divided into two or more components (e.g. metacognitive knowledge and metacognitive skilfulness). Research often focusses on one specific component. It is not the purpose of this study to produce a full classification of metacognition (for a recent example of this see Tarricone (2011)). Rather, this section seeks to effectively situate the concepts central to this study within the wider context of research about metacognition. The research questions (1.3.1) identified that the concepts central to this study are cognition (research question II), which has been explored in 2.2.1 and metacognitive knowledge (the title of this study and research question III). It is important to situate metacognitive knowledge within the wider field of metacognition, acknowledging the complexity of links between metacognitive knowledge and other aspects of metacognition that have been defined within the field. Recognition of the complexity of interlinked concepts within metacognition to rationalise why (differently to previous studies using PVTs (Wall, 2008; Wall et al., 2012)) this study focuses on metacognitive knowledge is paramount.

Returning to the origins of metacognition, Flavell's (1979, p. 906) definition had four aspects: metacognitive knowledge, metacognitive experiences, goals (or tasks) and actions (or strategies). In addition, Flavell (1979) noted that cognitive monitoring and regulation was an emerging and a "promising new area of investigation" (p. 906). This emergent debate and the associated promise of a new focus, has since materialised as one of the longest running in the field - deliberation around the intersections of metacognition and self-regulation (as explored in 2.2.4). More recently than Flavell, Pintrich (2002, p. 219) divided metacognition into two main facets: knowledge of cognition and "the process involving the monitoring, control and regulation of cognition". Pintrich's (2002) later classification was based on prominent earlier work including that of Flavell (1979) and Brown, Bransford, Ferrara, and Campione (1982).

Seeking to visualise the connections between different facets of metacognition, Figure 11, illustrates some of the links between various conceptualisations of metacognition. The conceptualisation of metacognition applied in previous research with PVTs is at the top

and forms the basis of this visualisation. Metacognitive experiences is placed as overlapping with metacognitive skilfulness because of the similarity in that they are both perceived as something that is better accessed by online methods of exploring metacognition (Bryce & Whitebread, 2012; Veenman, Hesselink, Sleeuwaegen, Liem, & Van Haaren, 2014). What follows Figure 11 explores aspects of metacognition including metacognitive knowledge and metacognitive skilfulness (and their further subdivisions) in more detail. The notion of metacognitive experiences will be considered briefly in relation its seeming influence on both metacognitive knowledge and metacognitive skilfulness.

Cognitive skills

Strategic and Reflective Thinking

Metacognitive knowledge
"…declarative knowledge one has about the interplay between personal characteristics, task characteristics and the available strategies…" (Veenman et al., 2005, p. 194)

Metacognitive experiences
Metacognitive feelings (difficulty, satisfaction, knowing and confidence)
Metacognitive judgments or estimates (of effort, learning, estimate of time on task)
(Efklides, 2008)

Metacognitive skilfulness
"…the procedural knowledge that pertains to the actual regulation of, and control over one's cognitive processes and learning activities" (Veenman et al., 2005, p. 194)

Cognition & metacognition in previous research using PVTs (e.g. Wall (2008) and Wall et al. (2012)).

Metacognitive knowledge as knowledge of cognition

Flavell (1976): Interplay between knowledge of…

Person

How people deal (including self) deal with tasks in different

Task

"Task features and processing demands" (p. 227)

Strategy

"Strategies used in various tasks and contexts" (p. 227)

Detailed explanations for Person, Task & Strategy from Efklides and Vlachopoulos (2012)

Figure 11: Subdivisions of metacognition

Strategic metacognitive knowledge (Brown, 1978, Jacobs & Paris, 1987, Paris, Lipson & Wixon 1983; Schmitt & Sha, 2009): Declarative, procedural and conditional knowledge.

Metacognitive strategy knowledge (Efklides, 2008, p. 278): "knowledge of multiple strategies…the conditions for their use (i.e. when, why, and how a strategy should be used)"

Knowledge of strategies (Whitebread et al., 2009, p. 79): "explicit expression of one's own knowledge in relation to strategies used or performing a cognitive task, where a strategy is a cognitive or behavioural activity that is employed so as to enhance performance or achieve a goal"

Task analysis, planning, monitoring, checking and recapitulation (van der Stel & Veenman, 2008)

Prediction, planning, monitoring and evaluation (Desoete, 2008)

Aligns with the concepts of *Metacognitive Regulation* (Whitebread et al., 2009) – Planning, monitoring, control and evaluation

And

Metacognitive Learning Strategies (self-reported) (Leutwyler, 2009) – *planning, monitoring and evaluation.*

And links can be drawn to Strategic knowledge (Pintrich, 2002) – rehearsal, organization and elaboration Strategies and knowledge of metacognitive strategies.

Figure 11 clearly illustrates the complexity and overlap between differing conceptualisations of metacognition and the subdivisions within this. Veenman et al. (2006) explained that the most common distinction made between aspects of metacognition is metacognitive knowledge and metacognitive skilfulness; this distinction has been applied in previous research using PVTs (Wall, 2008; Wall et al., 2012) (see also 2.2.3). Developing the distinction between metacognitive knowledge and metacognitive skilfulness further, Veenman et al. (2006) introduced the notion of metacognitive awareness and declarative knowledge as one that encompasses conditional knowledge (what to do, when to do it), they also discussed how this can form part of metacognitive skills. Veenman et al. (2006) asserted that metacognitive knowledge does not necessarily automatically lead to metacognitive skilfulness, metacognitive knowledge about learning processes can be correct but it may also be incorrect. One example given by Veenman et al. (2006) proposed that even if a student thought that they had adequately prepared for an exam, that they might not have. Inaccurate knowledge of self (and one's own learning) is where metacognitive knowledge differs from metacognitive skilfulness, this assertion is central to the online/offline debate.

Metacognitive skilfulness is different to metacognitive knowledge because it has an intrinsic "feedback mechanism" (Veenman et al., 2006, p. 5), feedback here to affirm metacognitive knowledge or make new metacognitive knowledge, where metacognitive skilfulness has failed. The feedback used to describe metacognitive skilfulness by Veenman et al. (2006) is not dissimilar to the reciprocity and mediation of self-regulation described by Dinsmore et al. (2008). The complexity of these links requires a discussion focussing on specific perceived components of metacognition. Figure 11 illustrated how both metacognitive knowledge and metacognitive skilfulness have been subdivided in the literature. What follows explores these subdivisions, focussing on the concepts of metacognitive knowledge and metacognitive skilfulness, exploring the differences and intersections between them.

Reflecting on Flavell's (1979) division, metacognition is popularly presented as comprising three phenomena metacognitive knowledge, metacognitive experiences and metacognitive skills (or metacognitive skilfulness) (Desautel, 2009; Efklides, 2008; Efklides & Vlachopoulos, 2012; Veenman & Elshout, 1999). Efklides (2008) and Efklides and Vlachopoulos (2012) presented distinctions between these facets particularly clearly and

explored their interactions. Efklides (2008) defined the three components of metacognition
as follows:

- Metacognitive knowledge: "declarative knowledge stored in memory and comprises
  models of cognitive processes, such as language, memory and so forth" (p. 278). It is
  also described as involving knowledge of person, task, strategy and goals. Efklides
  and Vlachopoulos (2012) further condensed this to knowledge of person, task and
  strategy.

- Metacognitive experiences: "what the person is aware of and what he or she feels
  when coming across a task and processing the information related to it (Efklides,
  2001, 2006)" (p. 279). Efklides and Vlachopoulos (2012) further described
  metacognitive experiences as including metacognitive feelings (of difficulty,
  satisfaction, knowing, confidence) and judgments or estimates (e.g. estimate of
  effort, judgement of learning).

- Metacognitive skills: "the deliberate use of strategies (i.e. procedural knowledge) in
  order to control cognition…executive control…related to metacognitive regulation;
  that is both monitoring and control." (p. 280). Efklides and Vlachopoulos (2012)
  referenced the definition of metacognitive skilfulness given by Veenman and Elshout
  (1999) and referred to "procedural knowledge manifested in peoples behaviour" (p.
  228).

Efklides (2008) explained things differently to Veenman et al. (2006) describing
metacognitive skilfulness as deliberate use of strategies. The notion of deliberate use is
important, in comparison to Veenman et al.'s (2006) association between automaticity and
skill (and the intentionality of strategy). The potential for overlap here, is why this section is
imperative in rationalising the approach in this study. Exploring metacognitive knowledge
and metacognitive skilfulness in turn but also exploring the potential for overlap between
these concepts. Reflecting Efklides' (2008) division of metacognition into three facets, it is
important to acknowledge the importance of metacognitive experiences but greater focus
will be placed on metacognitive skilfulness and metacognitive knowledge given their
relevance to previous studies using PVTs because of their inclusion in the coding process
(Wall, 2008; Wall et al. 2012). What follows begins with a brief exploration of metacognitive
experiences highlighting link to debate around metacognitive knowledge and metacognitive
skilfulness that will follow.

Efklides has been at the forefront of research in metacognitive experiences since the early 2000's. Efklides (2002) stated that metacognitive experiences are online metacognition comprising "ideas, feelings, judgments and metacognitive knowledge evoked during problem solving […] metacognitions available in working memory" (p. 20). Importantly, and referring back to the online/offline debate (2.1.8), working memory implies that metacognitive experiences are accessed using online methods. Openly online, Whitebread et al. (2009) in their C.Ind.Le coded for "Emotional and motivational regulation" (p. 80), the "[expression] of positive or negative emotional experience of a task" (p. 80). The positive or negative experiences described here are not dissimilar to feelings of difficulty or familiarity that are generally described as metacognitive experiences in examples including those given by Efklides (2008).

Efklides (2002) described metacognitive experiences explicitly as "online" (p. 20). However, Efklides and Vlachopoulos (2012) explained how they assessed metacognitive experiences immediately prospectively or retrospectively to the given task. Efklides (2006) referred to the "fuzziness in the conceptualization" of metacognition (p. 4). Importantly differences were posited between specific elements of metacognitive experiences; feelings and judgments/estimates separated from "online task-specific knowledge" (p. 4), online task specific knowledge including task features and procedures employed. The pro or retrospective application in Efklides & Vlachopoulos (2012) of a measure of metacognitive experiences is not then strictly 'online', participants either have yet to complete the task or have already completed it. More precisely this elicitation of metacognitive experiences could therefore be described as awareness of metacognitive experiences before and/or after a task. Self-reports of metacognitive experiences have been used (Efklides, 2008), indicating that there is potentially a contradiction here, self-reports likely to be classified as offline. It is beyond the scope of this study, but perhaps this use of self-report to access metacognitive experiences is actually eliciting declarative awareness of it (offline, after the event, upon reflection on past learning experiences). Offline measures cannot explore the affect (in a task) of metacognitive experiences. Instead, offline measures facilitate reflection on how knowledge of metacognitive experiences has affected learning (via reflection on them) and how knowledge has been created as a result of particular metacognitive experiences. With this notion of knowledge in mind what follows explores subdivisions of metacognitive knowledge.

The roots of conceptualising metacognitive knowledge and the division into person, task and strategy are popularly regarded as being initiated by Flavell (1976) (Neuenhaus et al., 2011). Neuenhaus et al. (2011) described the person variable in terms of self and others; task in terms of knowledge of task demands and strategy in terms of knowledge of strategies. It is necessary to explore component parts of metacognitive knowledge beyond distinctions of the metacognitive knowledge of person, task, strategy and other comparable divisions (Brown, 1978; Flavell, 1976; Flavell & Wellman, 1977; Jacobs & Paris, 1987; Pintrich, 2002; Schmitt & Sha, 2009; Veenman et al., 2005; Veenman & Spaans, 2005; Whitebread et al., 2009). While the differences between metacognitive knowledge of person and task, with metacognitive skilfulness are relatively clear, further clarification around types of strategy knowledge is required to make clear the differences and intersections between metacognitive knowledge and metacognitive skilfulness.

Neuenhaus et al. (2011, p. 165) explained that Paris, Lipson, and Wixson (1983) and Brown (1978) subdivided metacognitive knowledge about strategy into declarative, procedural and conditional knowledge as follows:

> In accordance with the three metacognitive knowledge dimensions proposed by Anne Brown (1978), they differentiated between declarative strategy knowledge, referring to knowledge on "what" measures can be taken to solve a task, procedural strategy knowledge on "how" to realize these measures, and conditional strategy knowledge regarding the circumstances of a strategies effectiveness ("when" to apply a strategy).

These further distinctions are where the distinguishing between metacognitive knowledge and some aspects of metacognitive skilfulness becomes more difficult. The 'action' associated with procedural metacognitive knowledge of strategy inevitably links it to the feedback and behavioural aspects of metacognitive skilfulness. Similarly to Neuenhaus et al. (2011), Schmitt and Sha (2009) presented metacognition (in reading specifically) as comprising two facets: knowledge and regulation. Referring to Paris, Lipson and Wixson (1983), Schmitt & Sha (2009, p. 255) described the three aspects of metacognitive knowledge as illustrated in Figure 12. Conditional knowledge draws links to knowing (when and why) and characteristics of the self, as well as task relevant strategies. It would seem that as Neuenhaus et al. (2011) explained, the metacognitive knowledge of strategy in terms of conditional knowledge and the circumstances of a strategies effectiveness are definitely linked to the self, but different to the metacognitive knowledge of person. To know when

and why (conditional) is clearly relevant to metacognitive knowledge of person, but also it cannot be separated from metacognitive knowledge of strategy.

META-COGNITION in READING

KNOWLEDGE

DECLARATIVE
Knowing About
- Self
- Task
- Strategies

PROCEDURAL
Knowing How
- Strategies

CONDITIONAL
Knowing When and Why
- Self-Characteristics
- Task-Relevant Strategies

REGULATION

PROBLEM SOLVING
Using strategies for problem solving on the run, all points of difficulty and after noticing error but not able to accurately correct

SELF-MONITORING
Checking on meaning, structure, visual and phonological information sources and noticing breakdown on any source and/or dissonance between them

SELF-CORRECTING
Revising as error by achieving meaning and/or bringing consonance to mismatches of information sources

Figure 12 "Meta-cognition in reading: knowledge and control" from Schmitt & Sha (2009, p. 255)

Returning to debate around procedural knowledge and the overlap with the procedural 'doing' that is associated with metacognitive skilfulness, it is clear that knowing how to perform a strategy does not mean that it will be performed or indeed performed correctly. Nonetheless, knowledge of how to perform a strategy and reflection on it can feed into metacognitive skilfulness and 'online' task completion. The same can be applied to conditional knowledge of strategies; past learning experiences can inform of the appropriateness of when and why to use a strategy at a specific time. Pintrich (2002) divided strategic knowledge or metacognitive knowledge of strategy into different types of strategies. This further sub-division of metacognitive knowledge of strategy was based on the work of Weinstein & Mayer (1986): rehearsal (e.g. repeating words over and over to remember), elaboration (e.g. mnemonics for memory, summarising, paraphrasing…) and organisational (e.g. outlining, concept mapping, note taking). The notion of awareness and

Pintrich's (2002) assertions around the metacognitive knowledge of strategies as strategic knowledge combined with Schmitt & Sha's (2009) emphasis on 'awareness', postulates a dynamic and multi-faceted conceptualisation of metacognition.

Figure 11 illustrated how metacognitive skilfulness or metacognitive skills are popularly subdivided into planning, monitoring, control and evaluation and widely reported as measured online as opposed to offline (Whitebread et al., 2009; Veenman et al., 2005). Schraw (1998) described metacognition differently, splitting metacognition into knowledge of cognition and regulation of cognition. The notion of the regulation of cognition here emphasises the complexity of the terminology in this field and inevitable overlap between metacognition and self-regulation (2.2.4). Schraw (1998) described the regulation of cognition or regulatory skill as being further subdivided (based on Jacobs and Paris, 1987) into three essential skills, namely planning, monitoring and evaluation. Describing cognitive processing and metacognitive skills as a part of self-regulated learning, Boekaerts (1999, p. 449) described metacognitive skills as "orienting, planning, executing, monitoring, evaluating and correcting (Brown, 1987; Weinstein & Mayer, 1986)". Although there are differences in conceptualisations of the components that make up metacognitive skilfulness and/or metacognitive skills it is clear that there is also a lot of similarity in the varied definitions.

Veenman and colleagues have explored metacognitive skilfulness using TAPs, a method reported as online. Examples of TAPs include Prins et al. (2006), van der Stel and Veenman (2010) and Veenman et al. (2005). In the most recent example listed, van der Stel and Veenman (2010) divided metacognitive skilfulness into four sub-categories: orientation, planning and systematic orderliness, evaluation and elaboration. Table 1 in van der Stel and Veenman (2010, p. 221) exemplified evaluation as including monitoring, whereas in other conceptualisations monitoring and evaluation are explicitly separated. Despite the majority view that metacognitive skilfulness and the associated metacognitive strategies (planning, monitoring, control, evaluation) are best assessed 'online' there is some evidence in the literature to support metacognitive knowledge of these metacognitive strategies. Pintrich (2002, p. 220) noted "students can have knowledge of various meta-cognitive strategies that will be useful to them in planning, monitoring, and regulating their learning and thinking". Consequently, there is an argument for the offline assessment of metacognitive knowledge of metacognitive strategies that would normally be encompassed within online approaches to metacognitive skilfulness.

Questions can be posed with regards to overlap between metacognitive skilfulness and metacognitive knowledge of strategies. For example: what is the difference between the procedural knowledge described as part of strategy knowledge within metacognitive knowledge, and the procedural knowledge that is also described under the heading of metacognitive skilfulness (Veenman et al., 2005)? Given the online/offline debate, the most discernible answer seems to centre on the following: in terms of offline metacognitive knowledge of strategies, procedural knowledge centres on an awareness of the process of thinking and knowing how to do something. Whereas for online metacognitive skilfulness, procedural knowledge would be demonstrated by actually doing something and therefore providing evidence of knowing how to do it within an (online) task. Procedural knowledge in a task (online) as opposed to knowledge of how to use a strategy in a task (offline). Offline metacognitive knowledge of procedural knowledge of strategies (and reflection on it) would logically being required for the procedural knowledge to then be reflected on and used 'online' and within a task. Explaining metacognitive reflection, Dignath and Büttner (2008) referred to the regulation of strategy use: they described declarative, procedural and conditional knowledge under the heading of metacognitive knowledge of strategy. With all reflection there is an element of uncertainty around accurate recall and the subsequent findings of 'offline' measures relying on reflection, 2.1.8 outlined that online methods also have problems. Ultimately, there are benefits and drawbacks for both online and offline approaches.

Focussing on debate regarding the overlap of metacognitive knowledge of strategy and metacognitive skilfulness, it is important to consider the impact of this for research with PVTs. One example of PVT data from Wall et al., (2012, p. 8) coded as metacognitive skilfulness was: "If people are stuck on a work, asking the teacher or a friend to help you". If metacognitive skilfulness is exclusively online, reflecting on the Veenman et al. (2006) distinction that skills are automatic and strategies intentional, the evidence gathered using PVTs might be described as metacognitive knowledge of strategies. The strategy being asking a teacher or a friend to help, the element of knowing when to do this ('If people are stuck on work') therefore making it conditional knowledge as there is clear awareness of knowing when a strategy is appropriate.

Returning to Pintrich's (2002) suggestion that students can demonstrate knowledge of metacognitive strategies[15] (strategies that would prove useful in the planning, monitoring and regulating learning) the example from Wall et al., (2012) demonstrates awareness of knowledge of metacognitive strategies that would be useful for monitoring learning. It could be inferred that knowing to ask for help is evidence of monitoring cognition according to Pintrich's (2002) conceptualisation of this. Whitebread et al. (2009, p. 72) described metacognitive regulation as the "cognitive processes taking place during ongoing activities i.e. planning, monitoring, control and evaluation", their study focussed on assessing metacognition and self-regulated learning in young children. Despite overlap, there are key differences between knowledge of cognition (metacognitive knowledge), regulation of cognition (metacognitive skilfulness) and self-regulation. Zimmerman (1995) asserted that possessing metacognitive knowledge and metacognitive skilfulness is different to self-regulation within the demands of a task, additionally having metacognitive knowledge does not mean that metacognitive skilfulness will be executed appropriately in a task.

Reflecting on the notion of metacognitive knowledge of strategy, alongside both findings of previous research using PVTs and Efklides' (2008) *Multifaceted and Multilevel Model of Metacognition* (see Figure 8) questions can be raised with regards to representations of metacognitive knowledge and metacognitive skilfulness. The second personal-awareness or metalevel of Efklides' (2008) model explicitly included metacognitive experiences, metacognitive knowledge and metacognitive skilfulness. Efklides (2008) described this level as integrating "the person's explicit representation of the situation and of its demands with the action/behaviour ensued is accomplished" (p. 282). The final and uppermost, meta-meta level described also as the social level included metacognitive knowledge, metacognitive skilfulness and the metacognitive judgments aspect of metacognitive experiences. Defined as judgments because:

> This level comprises only metacognitive judgments about the one's and others' ME, MK and MS[16]; it is informed by self-awareness at the personal level, as well as by information received from the ongoing interaction with others. Monitoring at this level is explicit and can take the form of reflection.

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[15] Pintrich (2002) emphasized that knowledge of metacognitive strategies was of course different to the actual use of metacognitive strategies

[16] ME = metacognitive experiences, MK = metacognitive knowledge and MS = metacognitive skills

It leads to a socially-shared and negotiated representation of the person-in-context. (Efklides, 2008, p. 283)

This is where metacognition becomes complicated in data gathered using PVTs. Popular opinion in relevant research has asserted that metacognitive skills are only able to be assessed via online methods (Bryce & Whitebread, 2012; Veenman et al., 2014). It is interesting to consider whether, or not, Pintrich's (2002) knowledge of metacognitive strategies would fit here? In this consideration, it is important to remember that knowledge of metacognitive strategies refers to knowledge of use as opposed to actual (in the moment) use of strategies including the planning, monitoring and regulating of learning.

Section 2.2.3 described the previous approach to analysis of evidence of metacognition (and cognitive skills) applied in research with PVTs, which included evidence of metacognitive skilfulness as described by Veenman et al. (2005). PVTs are completed in a social situation (mediated, focus group interview), so it could be said the metacognitive skilfulness elicited in PVT data is in the form of the metacognitive judgment as described by Efklides in her 2008 model. Therefore, PVTs elicit meta-metacognitive skilfulness (judgments of metacognitive skilfulness in the context represented in the PVT, based on metacognitive knowledge of metacognitive strategies (Pintrich, 2002)). Declarative procedural knowledge (meta-metacognitive skilfulness) is required to access metacognitive skilfulness in the moment effectively. In Efklides' (2008) model the meta-metalevel is linked to and feeds back to the metalevel, it is depicted to control it, with the metalevel informing the meta-metalevel via monitoring/reflection (p. 283). Interaction between all three levels (object, meta and meta-meta) in Efklides' (2008) model and the control and monitoring implying that "the deliberate use of strategies…to control cognition" (p. 280) is online and task-specific, but also makes use of metacognitive knowledge.

Metacognitive knowledge of metacognitive skilfulness or meta-metacognitive skilfulness seems more confusing than it actually is, a common problem for terminology in this field. Online metacognitive skilfulness can be recorded or assessed within task completion. However, there is nothing to say that within this task completion a learner is not recalling and using metacognitive knowledge of metacognitive skilfulness and that they are not reflecting on a previous learning task to recall this. The notion of meta-metacognitive skilfulness is an interesting one that requires further exploration within the field. This further exploration is beyond the scope of this thesis, rather an idea for further research that will be revisited in 5.3.

Thus far this chapter has presented a systematic review of methods with which metacognition has been explored with school aged children and explored the complexity of defining metacognition. The importance of defining metacognition for this study and subsequent analysis of metacognition in PVT data collected in this study will be revisited in Chapter 3 (Methodology & Study Design). What follows in 2.3 is reflective of the title of this thesis and explores developmental trends in metacognition, drawing on evidence from the systematic review (2.1) and wider literature in the field.

2.3. Metacognitive Development

Developmental perspectives on metacognition are about looking for patterns, investigating changes in line with other developmental trajectories (e.g. age). Cross and Paris (1988) stressed the important role that metacognition plays in more general learning and development. This linking of metacognition with other learning and development is important; it begins to contest prevalent assertions in the literature that younger children are not capable of being metacognitive. Veenman and Spaans (2005) highlighted the association between metacognitive development and other development including age and intellectual development. The monotonic development hypothesis focussed on how there is "a continuous growth of metacognitive skilfulness with age, alongside intellectual growth" Veenman and Spaans (2005, p. 162). The notion of intellectual growth is important here, research has demonstrated positive links between metacognitive awareness and positive outcomes for students (1.2.1).

Early in published literature clear links were made between metacognition and age. Writing just one year after Flavell (1976) Brown and Smiley (1977) stated that:

> It is thought that with increasing age and experience the child becomes more
> and more aware of himself as an active agent in knowing (Bransford, Nitsch,
> & Franks, 1977; Brown, 1975, 1977a) and gradually achieves an increasingly
> realistic picture of his abilities and limitations as a problem solver. (Brown &
> Smiley, 1977, p. 1)

The notion of metacognition developing, with age and experience, was reiterated by Kuhn (2000) who noted the usefulness of placing metacognition within a developmental framework. Kuhn (2000, p. 178) stated "metacognition develops. It does not appear abruptly from nowhere as an epiphenomenon in relation to first-order cognition." The notion that metacognition emerges in early life and becomes more powerful and effective (during an extended developmental course) is suggestive of the presence of emergent (early) metacognition. Kuhn (2000) argued that conscious control of this early metacognition develops gradually.

Reflecting on the systematic review (2.1), it is interesting to consider if the increasing development of the conscious control of metacognition (Kuhn, 2000) is related to the ability of children to externalise metacognition? The systematic review raised questions about the ability of children to engage with and respond to various assessments of metacognition. For example, the predominance of the age group 7-16 years for self-report

measures, raised questions around understanding the requirements of and complying with a self-report measure (for children younger than aged 7 years). With this in mind, 2.3.1 begins with an exploration of findings around metacognitive development derived from evidence presented in the systematic review (2.1). The findings of 2.3.1 will guide the structure of subsequent sub-sections and form the basis of reasserting the relevance of PVTs within the field and rationalising why they were chosen for this study. It is not the purpose of this section to revisit all of the included records of 2.1; examples have been selected to illustrate specific points around the importance of exploring metacognition through a developmental lens.

2.3.1. Lessons from the findings of the systematic review

The findings of the systematic review (2.1) indicated the importance of considering concurrently how metacognition is assessed, the definition applied, with whom the method was used (e.g. age group) and the consequent outcomes. Inextricable links between these key considerations are further exemplified when considering developmental trends in metacognition. If a specific method has not been reported as used with or detected a particular element of metacognition for a particular age of participant, this does not necessarily mean that it was not present but perhaps that it was being assessed in an inappropriate way or not assessed. For example, a measure could be incongruous with (or not focussed on) particular element(s) of metacognition, or not appropriate for a particular age group. Exploration in 2.1 of how different tools have been used with different age groups looked at this debate about the suitability of different methods for different age groups in detail.

Section 2.1 included discussion around how methodological limitations may have reduced the age range that specific tools and groups of tools were used with in the included records (2.1.7). If a method required the participating child to read a series of statements and assess where they placed themselves on a Likert scale, this would have required participants to both read and understand the measure. Examples of this from the included records with the age ranges they were used with are: EPA2000 (De Clercq, Desoete & Roeyers, 2000) (7-10 years), the MKMQ (Efklides & Vlachopoulos, 2012) (11-15 years), the Jr. MAI (Sperling et al., 2002) (8-16 years) and the Self-report for cognitive and metacognitive learning strategies (Wolters, 1999, 2004) (12-16 years). The necessity of reading, including the associated understanding, for some measures would preclude some younger children

from engaging with such measures to their fullest extent. In the examples given above, the youngest age stated was 7 years old. This preclusion of children younger than 7 years of age would consequently limit the age range for which conclusions could be drawn about the development of metacognition. The age group associated with these tools would therefore impede or prevent exploration of emergent metacognition, the age group is a direct result of the method and how this type of self-report would be less accessible for younger children.

Based upon the evidence of the systematic review (2.1), the focus of self-report measures on children aged 7 upwards suggests that it is more difficult to explore metacognition using self-report methods with children under 7 years of age. Some of the tools listed in 2.1 cross boundaries between different types of tools (e.g. they could be described as more than one type of tool – e.g. interview, self-report). PVTs are a mediated interview, but also involve the completion of a template (the visual aspect of PVTs) by the individual participants so could in this way be seen to have a self-report element. Table B (Appendix A) showed that PVTs have been used with children as young as 4 years of age. Another tool that crosses the boundaries of the classifications of included tools applied in 2.1 is concept maps (Ritchhart et al., 2009). Concept maps were classified as task based, but because the content of these in Ritchhart et al. (2009) was then analysed for evidence of 'strategic' responses this could be perceived as self-report evidence. Ritchhart et al. (2009) described strategic responses as inclusive of metacognition, self-regulation and motivation strategies. Like many of the self-report tools included in 2.1, concept maps were used only with children aged 8 – 16 years, the youngest participant 4 years older than the youngest in PVT research. Assertions about the development of metacognition need to be considered within the context of the type of method assessing metacognition, how metacognition is subsequently defined and relevance of different tools for different ages.

To further exemplify this point, one can refer to the exploration of the development of metacognitive skills in Veenman et al. (2005, p. 197):

> *Although metacognitive awareness and knowledge may arise at an earlier age (Istomina, 1975; Kluwe, 1987; Kuhn, 1999b), the development of metacognitive skills sets in at the age of 10–12 years (Berk, 2003; Campione, Brown, & Ferrara, 1982; Flavell & Wellman, 1977; Kuhn, 1999b).*

The sample of students that had their metacognitive skilfulness assessed (via systematic observation of TAPs whilst solving math problems) in Veenman et al. (2005) were 12-13

years of age. The focus of the study was the relationship between intellectual and metacognitive skills. The point being that Veenman et al. (2005) explored metacognitive skills and stated, that they do not develop until 10-12 years. There is a contradiction here, because sample in the study was aged 12 – 13 years and stated to be at an early stage of metacognitive skill development. Veenman et al. (2005) rightly did not make assertions about the development of metacognitive skilfulness from their data, instead drawing links between metacognition intellectual skills. It is easy to see the complexity of metacognitive development arising from issues around different tools used to explore metacognition and the ages that they have been used with. It can be difficult to extrapolate findings about the development of metacognition. Metacognitive development is often referred to without it being a focus of, or matching with the age range, of the study in which it is discussed. With this complexity in mind, the usefulness of the systematic review (2.1) was integral in providing an overview of the field. In particular, an overview of the age groups that different tools and methods have been used with.

Analysis of the records included in the systematic review (Appendix A) showed that the majority of the individual tools were used with small age ranges. Looking at Table B (Appendix A), only two tools identified in 2.1 (PVTs and TAPs) were used with as many as ten of the referenced ages (4 – 16 years), other tools included had a tendency to focus on much narrower age groups. For example, the Epistemic Metacognition Measure (Mason et al., 2010) and the Self-Assessment in Metacognitive Comprehension Strategies Reading Survey (Pinto, 2009) were only used with children aged 12 and 13 years in the included records. Narrow age ranges like this create difficulties in drawing generalizable conclusions about metacognitive development. Table B (Appendix A) demonstrated that the distribution of tool use across different ages is largely adjacent; the included tools have been used with specific age ranges rather than spread intermittently across the entire range of 4 – 16 years (e.g. tools have not been used with 4-5 year olds and then also with 15-16 year olds). For example, the Classroom Coding System (Stright et al., 2001) has been used with children aged 4 – 6 and 8 - 9 years in the included records – there is only a gap of one year within the range that this tool has been used with. These closely defined age ranges provide a snapshot of the development of metacognition in a particular age group. The information required to make more generalizable deductions across a wider age range is complex and there are few tools in the field currently that endeavour to do this.

One of the greatest challenges in the field centres on the methodological considerations necessary for research around metacognition with different aged children. This challenge is significant for this study when considering why only two tools (PVTs and TAPs) have been used with 10 out of the 14 ages specified in the review. Questions were raised in the systematic review (2.1.8) about demands on participants, in addition to the demands of assessing metacognition (assumed levels of understanding, reading ability, verbal ability). It is important to consider what these related demands tell us about metacognition and how the development of it can be assessed with children of different ages. What follows draws links between metacognitive development and other factors that may influence this, beginning with the links between metacognitive development and literacy or reading ability. Evidence from the systematic review will be signposted as such, but it is not appropriate to separate this from wider themes and evidence in wider literature at this point.

2.3.2. The development of metacognition and literacy

Links can be drawn between the development of literacy abilities (literacy in this sense encompassing reading and writing) and being able to externalise (and therefore make measurable) metacognition (see 2.1). This link between literacy, reading ability, understanding and metacognition was explicit in several examples from the systematic review including Bouffard (1998) and Lockl and Schneider (2006). Metacognitive development does not occur in isolation; the context of its development and measurement must be considered alongside other educational developments including literacy skills. It is important to consider what the development of literacy tells us about the development of metacognition (including its assessment) and also what the development of metacognition tells us about the development of literacy. Linked to literacy here is the notion that vocabulary also plays a role, in particular to externalise (via speech or written work) metacognition as some of the tools listed in 2.1 required. Literature around the development of metacognitive vocabulary will also be considered in this section.

Links between the development of metacognition (metacognitive knowledge in particular) and literacy was prevalent in several records included in the systematic review (2.1). Examples included the Index of Metacognitive Awareness about Writing (IMAW) (De Kruif, 2000); the Index of Reading Awareness (IRA) (Bouffard, 1998; Bouffard & Vezeau, 1998; Jacobs & Paris, 1987; McBride-Chang & Chang, 1995; Meloth & Deering, 1992;

Osborne, 1998; Pereira-Laird & Deane, 1997; Schmitt & Sha, 2009; Sperling et al., 2002; van Kraayenoord & Schneider, 1999); the Index of Science Reading Awareness (ISRA) (Craig & Yore, 1998; Holden, 1997; Yore et al., 1998) and the Metacognitive Awareness of Reading Strategies Inventory (MARSI) (Boudreaux, 2008; Huber, 2012; Law, 2009; Mokhtari & Reichard, 2002; Morley, 2010). Section 2.1.8 drew comparison between PVTs and several other included tools in the results of the systematic review. The link between metacognition and reading in research using the IRA, alongside the similarity in definitions of metacognition applied to the IRA (Jacobs & Paris, 1987) and PVTs (Wall, 2008), makes the it an appropriate starting point.

The IRA was one of the most widely referred to included tools in the systematic review, with a total of 12 records reporting using it. Bouffard (1998) used the IRA to explore links between reading development and the self-system (including cognitive and metacognitive development in reading, described as metacognitive knowledge of reading). The participants of the study were in 4th Grade with a mean age of 10 years. Bouffard (1998) discussed questions around the validity of the IRA to explore developmental trends, describing it as an "adequate" measure of metacognition in reading (p. 69). The notion of adequacy here further exemplifies the complexity of metacognitive development, the necessity of considering the strengths and weaknesses of particular tools to explore metacognition with different age groups. Results reported by Bouffard (1998) indicated "moderate relations between the self-system and cognitive and metacognitive development in reading were observed across time" (p. 70). Nevertheless, Bouffard (1998) reported "a clear developmental trend in scores for the IRA" (p. 70). Difficulties in assessing metacognitive development and the notion of the adequacy of the IRA further emphasizes the complexity of metacognition.

Although Bouffard's (1998) study only included children aged 10 - 12 years, the age range of the IRA in all of the included records was 6 years (participants from 8 – 14 years, see Table 11). A single study can only draw conclusions regarding metacognitive development for the age range that it includes, but if a tool is used across age ranges in different records links can be drawn and assumptions made. It is important to recognize that assertions made about the development of metacognition, from several records using the same tool, need to take into account methodological differences in tool application that may have impacted. In the case of the IRA, deductions could be possibly be made about metacognitive development and reading (over a wider age range) by looking at the findings

from multiple studies covering different age ranges. However, it would be important to consider the following:

- Slight variations in definitions of metacognition across different records included in the systematic review that used the IRA. For example, Bouffard (1998, p. 62) talks of "how a student develops metacognition and engages in self-regulation" describing the "self-system" as a route to cognitive and metacognitive development. Van Kraayenoord & Schneider (1999, p. 306) also used the IRA (to explore reading achievement and knowledge of reading and memory); they applied the familiar definition of metacognition around the duality of metacognition as "knowledge and control of cognition". The specific nuances of each definition would need to be considered alongside evidence pertaining to the development of metacognition.

- Different age ranges used by the different included records – in the van Kraayenoord & Schneider (1999) example the age range of participants is 9 – 10 years, for Bouffard (1998) a single age of 10 years. In contrast, Meloth & Deering (1992) have participants of third grade age (USA, 8-9 years). If methodological alterations were made to implement a tool like the IRA or any of the others included in 2.1, these differences would need to be explored and accounted for.

The focus of Meloth & Deering (1992) was not the development of metacognition; rather the IRA was used to explore the effect of cooperative learning on peer discussion, reading comprehension and metacognition. The notion of peer discussion exemplifies another link to PVT methodology in the sense that PVT data is collected as part of a mediated group interview (within a focus group) that involves dialogue amongst participants. Focusing on a similar age group (third and fourth grade students) to that reported in Meloth & Deering (1992), Van Kraayenoord & Schnieder (1999) used the IRA to examine reading achievement and metacognitive knowledge. Van Kraayenoord & Schnieder (1999) used the IRA alongside other tools including teacher evaluations and the Würzburg Metamemory Test (Roeschl-Heils et al., 2003; van Kraayenoord & Schneider, 1999). Conclusions stated that there were correlations in the findings across the different measures, thus serving to validate the findings of each of the measures they used via triangulation of the evidence. With regards to findings and the development of metacognition:

> *Our study also found that, in contrast to students in Grade 3, Grade 4*
> *students had better word decoding skills, performed better on the tests of*
> *metacognitive knowledge about reading and memory, and were judged by*
> *their teachers to be better readers. These findings are in line with those of*
> *other researchers who have noted developmental differences in reading*
> *performance (Adams, 1990) and in metacognitive knowledge (Myers & Paris,*
> *1978; Schneider & Pressley, 1997; Weinert, 1986).*
> *(Van Kraayenoord & Schneider, 1999, p. 318)*

The developmental standpoint above is clear. However, it is important to remember the small age range of one year in this study and the implications of this for drawing inferences about the development of metacognition beyond the age range of the included sample.

Together with records explicitly using the IRA to explore metacognitive knowledge of reading (e.g. Bouffard, 1998), the systematic review also listed records that explicitly stated that the tool (e.g. the Index of Metacognitive Awareness or IMA) was developed from the IRA (or from the IRA and another tool). The IMA was reported by Schmitt and Sha (2009, p. 258); they acknowledged the difficulties of the sensitivity of metacognition assessment methods to different age groups. The recognition of this methodological sensitivity no doubt related to the reasoning behind the development of the IMA from the two other tools. Schmitt and Sha (2009) used the MSI and two types of reading activities to measure Meta-cognitive self-control alongside the IMA, recognizing the complexity of metacognition and triangulating evidence from the IMA with other tools. Schmitt and Sha (2009) reported evidence of a relationship between age (school grade) on the two measures of metacognitive knowledge that they included (the IMA and the MSI, the IMA being partially based on the IRA). In estimates of effect sizes (partial eta squared – η^2) the effect sizes for grade differences were greater for metacognitive knowledge than they were for metacognitive control. Schmitt and Sha (2009) interpreted this as meaning that metacognitive control develops at a lower rate than metacognitive knowledge.

Evidence gathered using the IRA implies links between metacognition and literacy (or reading) both conceptually and methodologically speaking. In completing the IRA learners are required to rate themselves with regards to activities that they engage in whilst reading. Participants are required to read the rating scales and there is an assumption that they will be understood. It is important to consider what the intended participants in a study are likely to understand about the content of a measure, and how it is presented and applied. Part of this likely (or not) understanding is undoubtedly related to the vocabulary and understanding of vocabulary of the participants. Flavell (1999) noted the importance of

acknowledging and studying the links between metacognition and language and communication.

It is interesting to consider the vocabulary used when exploring metacognition with tools like PVTs or observation methods including the C.Ind.Le (Whitebread et al., 2009) where coding is applied to participant written text or transcripts of dialogue. Considering the links between the development of vocabulary and metacognition may prove a valuable insight in terms of eliciting metacognition to explore development with different age groups. Miscione, Marvin, O'Brien, and Greenberg (1978) explored understanding of the words 'know' and 'guess' with children aged 3-7 years. They suggested an understanding of development based in the development of comprehension, asserting that this development of comprehension is limited by a child's cognitive capacity. It seems that the development of cognitive skills and metacognition alongside metacognitive vocabulary works in multiple ways – cognition, metacognition and vocabulary are all influential of each other and therefore have the capacity to limit the development of the others.

Peskin and Astington (2004) explored the notion that there is a conceivable link between the exposure of children to metacognitive language and increased "understanding of mental states…" (p. 253). Evidence presented pertained to increasing competence with metacognitive language as children get older and move through school. Peskin and Astington (2004, p. 254) noted that "attention has turned to the role of explicit metacognitive terms in fostering a representational understanding of the mind", they went on to discuss and refer to definitions of the "mental verbs" (e.g. know and think) that form the basis of this metacognition and language link. The link between metacognition and language is however far from simple. Peskin and Astington (2004) concluded that metacognitive terms and their referencing of abstract entities is both "intriguing and puzzling" (p. 264). Results showed that narrative of metacognitive terms alone did not increase conceptual understanding, but only the use of metacognitive terms. The link between usage of metacognitive terms and exposure is something that needs to be addressed within the field. Tools like PVTs that encourage dialogue about learning have the potential to increase all three of exposure to, the acquisition of and contextual understanding of metacognitive vocabulary.

The importance of language acquisition and particular types of verbs relating to metacognition has been described as a prerequisite for the development of metacognition:

> *Another important precondition for the development of metacognition is language acquisition, in particular, the acquisition of what Miscione, Marvin, O'Brien, and Greenburg (1978) labeled mental verbs.'' Although Kreutzer et al. (1975) provided evidence that the youngest participants in their study (i.e., kindergarten children) could properly apply mental verbs, it has proven more difficult to determine preschoolers' knowledge of this specific vocabulary. (Lockl & Schneider, 2006, p. 17)*

Lockl and Schneider (2006) deduced that without language acquisition, in particular the development of 'mental verbs', the development of metacognition would be impeded. The Kreutzer et al. (1975) study that Lockl and Schneider referred to stated that children of kindergarten age can remember common mnemonic expressions. However, they acknowledged that the methodology of the Kreutzer et al. (1975) study could have impacted on the outcomes in terms of how the mnemonic expressions were approached (via a series of questions relating to pictures of objects). In an interview like this, the use of key words, classified as metacognitive vocabulary, like 'learn' could have compensated for potential lack of understanding associated with the metacognitive language development of the participants. This reiterates a key point from 2.1, namely the notion that how complicated concepts like metacognition are tested has an impact on the outcomes and therefore potential subsequent inferences about the development of metacognition. That is not to say the approach to the mnemonic expressions in the Kreutzer et al. (1975) study was flawed, rather that the links between definition, method, operationalisation and outcomes must be considered fully. The systematic review (2.1) presented a detailed debate about these links with reference to tools including PVTs, TAPs and observation-based methods. In all of these examples there is an unavoidable intersection with metacognitive vocabulary. It is important to consider how the outcome of a particular measure may be affected by the extent of the development of the metacognitive vocabulary of the participants.

Evidence presented in this section aligns with the findings of research in which metacognition has been explored with children as young as 3 and 4 years old, including the work of Leutwyler (2009), Wall (2008) and Whitebread et al. (2009). Peskin and Astington (2004) explained that in the literature there is evidence to support that by aged 4 years children can " comprehend "mental verbs" such as know and think." (p. 254). Metacognition is a complicated concept; the development of it and interlinked concepts including literacy makes for an interwoven field where it is often difficult to extract the relevant information. Aside from methodological comparisons in relations to conclusions about the development

of metacognition, 2.1 also summarised the ages of participants with which different individual tools had been used in the included records.

Earlier in discussion around the IRA reference was made to the potential impact that the age range of a sample can have upon the conclusions that can subsequently be drawn about metacognitive development (2.3.2). A single tool exploring the development of metacognition with a large age range in a single sample or study was not a common finding in the systematic review. Incorporating all of the records that reported their use, PVTs and TAPs were the two tools identified as having the widest age ranges. In the included records, PVTs had a higher age range for a single study than any study citing TAPs. In Wall (2008) there is a gap of one-year group (Year 3), but even Reception through to Year 2 is an age range of 3 years (4 – 7 years). The whole sample in Wall (2008) includes children up to the age of 11 years (Year 6) with the exception of only Year 3 (7-8 years). None of the records citing TAPs in 2.1 have been used with such a wide range of ages in a single study. Discussion around metacognition and the relationship with pupil age in Wall (2008) is justified and supported by the wide age range of the sample.

In 2.1.9 explicit links were drawn between PVTs and other included tools where specific methodological comparisons were made. The methodological comparisons were wide ranging given the multifarious methodological profile of PVTs. PVTs are a visual tool, they are a mediated interview (which takes place in focus group format) and are self-report in that each individual participant completes their own PVT. Table 9 revisits some of the tools named in the comparison of 2.1.9 to investigate the findings that they reported about metacognitive development. The category and rationale are listed with the tool to make the methodological comparisons to PVTs clear. There are clear indications of how (methodologically speaking) the development of metacognition has been explored in a range of different methods. Evidence from Table 9 implies that PVTs encompass a wide range of methodological features that have been shown to be conducive to the study of metacognitive development (through their use in other methods as well as in existing PVT research). For example, the accounting of PVTs for social aspects of learning (including interaction) and the use of PVTs to explore metacognition in children as young as 4 years of age.

The evidence presented in Table 9 compared the findings of selected tools included in the systematic review, relating to metacognitive development, with those reported in research using PVTs (Wall, 2008; Wall et al., 2012). Table 9 also exemplifies that the tools

included in 2.1 focused on different aspects of metacognition, these different aspects were explored in 2.2.5. Section 2.3.3 focuses on evidence in the literature (including that identified in 2.1) about how different aspects of metacognition develop at different rates.

Table 9: Revisiting comparisons to PVTs from 2.1.9 with a focus on metacognitive development

Tool	Category & Rationale	Comparison to PVT methodology made in 2.1.9	Findings relating to metacognitive development	PVT comparison (MC development)
CASE@KS1 (Larkin, 2006)	Observation	Interaction with peers during the data collection process	Metacognitive (MC) development is supported by social interactions & the role of the teacher in this process	PVTs are completed in a focus group setting (social interaction). Therefore, appropriate to investigate MC development as they facilitate social interaction in discussion about learning
C.Ind.Le (Whitebread et al., 2009)	Observation	Interaction with peers during the data collection process	Verbal and non-verbal evidence of MC in 3-5 years' age group. This is contrary to established belief about the ages at which MC develops	Interaction during data collection (observation). Interaction is also present in data collection with PVTs. Research using PVTs (Wall, 2008) has also presented evidence of MC in children as young as 4 years old
Clinical Interview (Pappas et al., 2003; Pappas Schattman, 2006)	Interview	Conducted in schools and not in a laboratory environment. But individual children in Clinical Interview, not focus groups as with PVTs	The development of metacognition is slow during the two years (4-5 years) in the study	Research using PVTs (Wall, 2008) has presented evidence of MC in children as young as 4 years old. Perhaps the social aspects of metacognition encompassed in the PVT methodology make a difference with regards to eliciting it
EPA2000 (De Clercq et al., 2000; Desoete, 2007, 2009; Desoete & Roeyers, 2006; Desoete et al., 2003)	Task based methods (with a computer based visual aid/prompt)	The visual prompts provided by the computer software	Metacognition needs to be taught explicitly in order to develop. The focus of these studies is not however explicitly the development of metacognition	Link to practice also exists in PVT research
MMI (Wilson, 1999, 2001)	Interview (non-traditional)	Multi-dimensional approach (not a traditional interview with interviewee and researcher)	The focus of these studies is not explicitly the development of metacognition	The advantages of self-reporting to examine thinking processes (in comparison to non-self-report). The advantages of a multi-dimensional approach
RSSRL (Metallidou & Vlachou, 2010)	Teacher rating scale	Potential (PVTs) or actual (RSSRL) involvement of the classroom teacher in data collection	Results were presented relating to teachers' ratings of student ability rather than the age related development of metacognition	-
Self-report for cognitive and metacognitive learning strategies (Wolters, 1999, 2004)	Self-report	Dual focus on cognitive and metacognitive learning strategies. Comparison made to the Moseley, Baumfield et al. (2005) model used in PVT research	The focus of these studies is not explicitly the development of metacognition	-

2.3.3. Differentially developing elements of metacognition

Considerable debate around the development of metacognition focuses on understanding how different facets of metacognition develop at different rates, with knowledge often claimed to develop before skills (including control and associated concepts). What follows explores evidence from the literature around the development of the three main concepts identified in 2.2.5: metacognitive knowledge, metacognitive skilfulness and metacognitive experiences. It was acknowledged in 2.2.5 that evidence of metacognitive skilfulness in research using PVTs (where data is collected retrospectively but in a dynamic focus group setting via a mediated interview) is perhaps more accurately described as meta-metacognitive skilfulness or metacognitive knowledge of metacognitive skills. However, it remains important to consider evidence from the literature about the development of metacognitive skills to fully explore evidence of developmental trends in metacognitive knowledge (including of metacognitive knowledge of skills) in this study.

Moshman (2008) noted that research on metacognition has a tendency to focus on metacognition with adult and older children participants. This narrow focus places clear constraints on theory around the development of metacognition if younger children are excluded. Bartsch et al. (2003) asserted that young children are not capable of metacognition, but emphasised the importance of the first 5 or 6 years of a child's life in terms of their "conception of knowledge acquisition". Indeed, Flavell (1979) himself noted the probable lack of monitoring of one's own memory for young children. Disagreement pertaining to the differential development of various elements of metacognition is primarily focussed on metacognitive knowledge and metacognitive skilfulness. Reflecting on the records included in the systematic review (2.1), it is fair to say that this argument is commonly referenced in studies that focus on the development of metacognitive skilfulness including Veenman and Spaans (2005). Veenman and Spaans (2005) presented a standpoint on the differential development of individual elements of metacognition as follows:

- Metacognitive knowledge (preceded by metacognitive awareness[17] at 4 – 6 years) develops gradually in the years thereafter awareness (i.e. 6 years onwards)

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[17] Awareness in terms of having an inclination that something was wrong.

- Metacognitive skills "not expected to set in before the age of 11-12 years" (p. 163).

Referring back to 2.2.5 and the other prominent subdivision of metacognition – metacognitive experiences, there do not appear to be prominent assertions in the literature about the age at which this develops. Efklides and Vlachopoulos (2012) reported exploring metacognitive experiences with older students aged 11 - 15 years.

In contradiction to Veenman and Spaans (2005) research included in the systematic review presented evidence of metacognitive skilfulness for children aged as young as 4 years old (Wall, 2008; Whitebread et al., 2009)[18]. Wall and Whitebread et al. both acknowledged their findings were in contrast to the established belief that metacognitive skilfulness does not emerge until aged eight years or beyond (Bartsch et al., 2003; Kuhn, 1999b). Kuhn (1999a) argued that metacognitive knowledge developed at 3-5 years, but in a paper published in the same year that metacognitive skilfulness does not develop until 10-12 years (Kuhn, 1999b). Schraw and Moshman (1995) stated that children can theorize about their own cognition at 4 years old. It is interesting to note that both Wall (2008) and Whitebread et al. (2009) used tools or methods (PVTs and the C.Ind.Le respectively) that have many unique characteristics across the records included in the systematic review. Given that both Wall (2008) and Whitebread et al. (2009) have identified evidence of metacognitive skills in young children this further exemplifies the conclusion drawn in 2.1 regarding how you test and what you subsequently get (Desoete, 2008). Perhaps the methods of assessment and tools used in evidence that has claimed metacognitive skills do not develop until much later, ought to be considered further in terms of why different methods have different findings.

The notion of metacognition (or not) and younger children stems from the work of Flavell, in particular Flavell's (1971) assertion that younger children lack the skills for future recall. Future recall in this sense is closely linked to the definition of metacognitive skilfulness presented in 2.2.5 (Veenman et al., 2005). Veenman and colleagues have explored metacognitive skilfulness in numerous studies and examples are listed in 2.2.3. In recent work van der Stel and Veenman (2014) listed research questions including where metacognition comes from, when it first emerges and how it develops from there? In this study (van der Stel & Veenman, 2014) the participants were in their first year of secondary

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[18] The youngest participants in Whitebread et al. (2009) were 3 years old.

school in the Netherlands. Van der Stel and Veenman (2014) acknowledged that children aged less than 8 years are not lacking completely in metacognitive skills, this inference was made with reference to other research that sampled younger children (Whitebread et al., 2009). Cross-referencing methodologically different work with different age groups in order to explore the development of metacognition does however have potential pitfalls (primarily related to methodological differences). Nonetheless, if these differences are fully considered and acknowledged they can be useful. For example, one tool used with older children may be able to be adapted (with an idea from a tool used with younger children) to make it more appropriate for use with a wider age range.

Despite the closeness of the distribution of ages in the records included in the systematic review for individual tools or methods (Table B – Appendix A), several included tools and methods have been used across primary school (Reception up to KS2/age 4 - 11 years) and secondary school (KS3 – 4/aged 11-16 years). Examples spanning both primary and secondary aged students include PVTs, Concept Maps, the JrMAI, Metacognitive Experiences, TAPs and the MCI. Thinking about metacognitive development it seems appropriate to investigate the assumption that developmental trends, including assertions about developmental trends relating to specific tools or methods, are best explored within a wide age range. Pin pointing papers (included in the systematic review) that make explicit statements about metacognition and its development alongside those tools that have been used with a wide age range, is an appropriate starting point for this.

Concept maps were only used in one included record of the systematic review (Ritchhart et al., 2009), with the intention of uncovering students' metacognition. They were however used with a wide age range of 8 – 16 years (spanning both primary and secondary school stages). Importantly, the application of concept maps to explore metacognition in this example was completed as part of regular classroom activity in a pre and post-test scenario. A naturalistic and non-standardized approach was adopted, with no control group and instead a pre-post comparison for one group. Similarly to PVTs, the concept maps were open to interpretation by the students, the prompt given being "What is going on inside your head?" (p. 150). This flexibility is in contrast to the less flexible self-report lists included where responses are often recorded on a Likert scale. Given the methodological similarities that can be drawn to PVTs, it is interesting to compare the findings of Ritchhart et al. (2009) with Wall (2008) in terms of the development of metacognition.

The results presented by Ritchhart et al. (2009) show the 'meta' responses across the age groups included in that study (Grades 3-4, 5-7 and 7-11, Australia) appear to be less in quantity and perhaps develop more slowly. Ritchhart et al. (2009, p. 153) described 'meta' responses as those that…

> …spoke to a greater awareness of the nature of thinking. Rather than specifying an action, these comments focused on epistemology, the nature of understanding, and conceptualizations of building knowledge. This Meta type of response included comments such as: "There is always more to learn," "You can't ever fully understand something," and "Remembering helps to develop creativity."

In comparison to the broad definition of metacognitive knowledge presented in 2.2.3, there are similarities. The definition above is about building knowledge, the definition in 2.2.3 emphasising declarative knowledge, but recalling that this does not automatically lead to the "appropriate executing of metacognitive skills" (Veenman et al., 2005, p. 194). Awareness of metacognitive knowledge and the skilful implementation of metacognitive knowledge as metacognitive skilfulness is different, but there is crossover and this must be acknowledged (see 2.2.4 and 2.2.5). Fuzziness in the delineation of separately described aspects of metacognition implies that there is potential uncertainty with regards to making definite assertions about their development.

Debate around the development of metacognitive skilfulness is much more prevalent that debate about metacognitive knowledge, one of the key contributions this study makes is focussing on the development of metacognitive knowledge. Several records included in the systematic review (2.1) focussed explicitly on metacognitive knowledge (IRA, Knowledge and Skills Questionnaire, MKMQ, Metacognitive Knowledge Questionnaire and the KMA[19]). Of metacognitive knowledge Garner and Alexander (1989, p. 144) stated:

> It is not so much that young children have no knowledge of their cognitions, but rather that their knowledge is limited as compared to that of older children. This is not surprising. As Flavell (1985) noted, like other knowledge, metacognitive knowledge is abstracted from years of experience in the "domain" of thinking. [Young children] are particularly inexperienced in the deliberate learning situations that occur regularly in school.

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[19] See 2.1.7 for a full list of references for these tools.

Even in the early days of the 1980s after Flavell's conceptualisation of metacognition in the 1970s, there was acknowledgement that younger children do have limited knowledge of metacognitive knowledge as opposed to no knowledge of cognition. This distinction is not dissimilar to the claim presented earlier relating to notion that sometimes the focus ought to be altered; deliberation of how knowledge of cognitions is elicited and how age should be considered is necessary (2.2.1).

The assertion that metacognitive knowledge does not automatically lead to metacognitive skilfulness (Veenman et al., 2005) is comparable to the assertion made in 2.2.1 that cognition does not always lead to metacognition. Efklides & Vlachopoulos (2012) drew a conceptually similar and interesting comparison in a study where the focus was on metacognitive knowledge of mathematics and assessed by the MKMQ. Examination of links between metacognitive knowledge of self, task and strategy revealed evidence supporting the claim that with age and experience metacognitive knowledge becomes part of self-concept and that metacognitive knowledge of self has the potential to predict performance. Like metacognitive skilfulness, performance is not a certainty with metacognitive knowledge. However, it is conceivable that the accurate prediction of performance may increase with age and experience in relation to metacognitive knowledge. The prominence of achievement and performance concerning metacognitive knowledge is related to the link between metacognition and positive outcomes for students (1.2.1), hence the multitude of studies identified in 2.1 to measure or assess metacognition. One of these studies, Neuenhaus et al. (2011) reported on the metacognitive knowledge of 5th graders in Germany and the relationship of this to school achievement. The approach in the study was a Paper and Pencil Assessment. The importance of the age appropriateness of tools to measure or assess metacognitive knowledge is emphasised in that a new tool was developed specifically for the fifth graders in the Neuenhaus et al. (2011) study. The importance of considering age further exemplifies the point made in 2.1.8 regarding "how you test is what you get" (Desoete, 2008, p. 204). If a measure is not appropriate for a particular age group (e.g. because the associated literacy demands of it are too high) then the elements it seeks to measure may not be elicited.

Prior to concluding this section, it is important to directly address the question of what existing research using PVTs concludes about metacognitive knowledge. The main point to raise here is that research with PVTs has presented evidence of metacognitive knowledge in children as young as 4 years old (Wall, 2008; Wall et al., 2012). Wall (2008) noted that there

was "some support for the fact that metacognition develops and increases as pupils get older or become more experienced learners" (p. 32). This step towards confirming the utility of PVTs to explore developmental trends in metacognitive knowledge formed the rationale behind the conceptualisation of this thesis. Wall et al. (2012) furthered understanding using PVTs to explore the age related development of metacognitive knowledge (and metacognitive skilfulness). This thesis is the only PVT sample this far to include the entire school age range of 4 – 16 years, a sample that has been systematically selected and stratified based on year group and gender.

This section has presented narrative analysis of themes and trends in the literature relating to developmental trends in metacognition. The methodological difficulties of exploring developmental trends in metacognition, in a diverse and growing field, have been highlighted. Links between metacognitive development and other aspects of child development including the development of literacy (broadly speaking this included reading and vocabulary) have been explored in detail. Exploration of the literature has directed attention to the notion that different aspects of metacognition (as explored in 2.2.5) may develop at different rates. Before moving onto Chapter 3 (methodology and study design) and insomuch as the evidence presented in this literature review, it is important to revisit the research questions. What follows restates the research questions giving rationale and justification for their inclusion based on the literature that has been reviewed in this chapter.

2.4. Restating the Research Questions

Restating the research questions serves to summarise the findings of the literature reviewed in this chapter (2.1 – 2.3) and link forward to the next chapter (methodology and study design). The research questions as introduced in 1.3.1 are restated below, with full rationale from the literature. The main research question is:

In a systematic sample of PVTs collected across school-aged children, what associations apparent in pupil comments about their learning that are classified as metacognitive?

This question is derived from evaluation of existing research using PVTs and the ideas for further research identified within this. In terms of patterns in pupil comments about their learning on PVTs, prior research (Wall, 2008, Wall et al., 2012) has shown evidence of developmental trends in metacognition. Evidence from the systematic review (2.1.9) sets out the unique characteristics of PVTs in the field and underlines the significance of the

unique characteristics to contribute to the field. The unique characteristics of PVTs were explored in Chapter 2 in relation to the wide-ranging age groups PVTs have been used with, the approach to analysis in previous research and evidence about the development of metacognition in previous research using PVTs. In 2.3 the development of metacognition was explored in relation to literacy and metacognitive vocabulary, as well as considering the development of metacognitive knowledge in particular.

Previous PVT research was limited by sample size and sampling techniques (related directly to the funded projects that the PVTs were sampled within). The introduction (1.2.2) outlined the need for additional research using PVTs, with a more systematic sample of the entire school-age range. This relates directly to the survey aim (1.3) of this study, using the same PVT across a systematic sample of school-aged children. This approach to sampling has not been adopted in previous research using PVTs (see Table 1). In this study the approach to metacognition and subsequent focus on metacognitive knowledge that will be outlined in the framework for analysis in Chapter 3 (Table 12) stems from an exploration in the literature of subdivisions of metacognition (metacognitive knowledge and metacognitive skilfulness) and components of metacognitive knowledge within this (2.2.5). Four subsidiary research questions support the main question stated above. They are restated below alongside the rationale for their inclusion in this study:

I.   **How do PVTs fit into the field of metacognition research with school-aged children?**

This question was the single most important factor in the inclusion of a systematic review (2.1) as part of this literature review chapter. The systematic review showed that PVTs have unique characteristics (2.1.9) and evidence from Table B (Appendix A) illustrated the uniqueness of PVTs in terms of there only being one other method included in the review (TAPs) that had been used with a large age range like PVTs.

i.   **In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as cognitive skills (Moseley et al., 2005a)?**

The approach to cognitive skills in previous research using PVTs (Wall, 2008; Wall et al., 2012) is maintained in this study after an exploration of the complexity of the relationship between cognition and metacognition (2.2.1). The Moseley model was considered the most

appropriate approach based on its rigorous synthesis alongside an eye for practice. The Moseley model succinctly demonstrated the complex interrelationships between cognition and metacognition and at the same time specified and defined particular cognitive skills. The complex nature of metacognition negated an approach in this study that considered the interrelatedness of cognitive skills and metacognition. Previous research using PVTs and the Moseley model (Wall, 2008; Wall et al., 2012) has shown the coding to be manageable with relatively large sample sizes and to have demonstrated reliability.

II.   **In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as metacognitive knowledge?**

Evidence from the literature (2.2.5) showed that metacognition can be explored beyond the duality of metacognitive knowledge and skilfulness (Veenman et al., 2005); existing research using PVTs does not do this. Requiring a specific and manageable focus, this study will therefore approach metacognition via a deeper qualitative analysis of comments classified as metacognitive knowledge in PVT data. The components of metacognitive knowledge that will be explored in PVT data in more detail were discussed in detail in 2.2.5; they will be explored alongside cognitive skills based on the Moseley model as in previous research with PVTs (Wall, 2008; Wall et al., 2012). Metacognitive knowledge will be explored in terms of metacognitive knowledge as declarative knowledge of person, task and strategy, with metacognitive knowledge of strategy further divided into procedural and conditional knowledge. Metacognitive knowledge of strategy will also be explored in terms of the type of strategy (based on Weinstein & Mayer, 1986) as cited by Pintrich (2002) – rehearsal, organisation and elaboration.

III.   **What are the advantages and disadvantages of PVTs as a tool to collect data across a systematic sample of school-aged children?**

To date, PVTs have not been used with a systematic sample encompassing the entire school age range of 4 – 16 years. However, PVTs have shown evidence of developmental trends in metacognition (1.2.2); in order to support these trends a more systematic approach to sampling is required. The systematic review highlighted the unique characteristics of PVTs (2.1.9), therefore warranting PVTs as a tool justified for further study. Further study of the development of metacognitive knowledge using PVTs requires consideration of their advantages and disadvantages in all respects, as well as ideas for study beyond this thesis. For example, to explore the notion of metacognitive knowledge of

metacognitive skilfulness or meta-metacognitive skilfulness is beyond the scope of this study, but is an idea for future research that stems from an exploration of the advantages and disadvantages of PVTs. Consideration of the advantages and disadvantages of PVTs will include a consideration of the efficacy of the deductive coding scheme applied in this study, compared to the coding scheme applied in previous research using PVTs (Wall, 2008; Wall et al., 2012)

2.5. Summary

This chapter has taken a systematic and rigorous approach to exploring metacognition in terms of its measurement, definition and development. The systematic review (2.1) facilitated an organised exploration of the field that allowed a full appreciation of different measures of (or tools to measure) metacognition and the depth and complexity of the field. Included within this depth and complexity was a deeper exploration of how metacognition is defined and how it is purported to develop. Having restated the research questions and given full rationales for their inclusion (based on the findings of this chapter) what follows in Chapter 3 presents the methodology and research design for this study. The research design and methodology is resolutely embedded in the findings from the literature presented in this chapter. Integral to this is retaining Desoete's (2008) mantra regarding the links between how something is explored and the outcomes of the exploration. Transparency in the ensuing research design and methodology will enable the demonstration of clear links between how metacognition is defined in this study (PVTs, the framework of analysis), how it is operationalized (using PVTs) and the outcomes of it (findings relating to metacognitive knowledge).

Chapter 3 - Methodology and Research Design

The purpose of this study is to explore developmental trends in metacognitive knowledge in school-aged children using Pupil Views Templates (PVTs). This chapter seeks to explain how the research design of this study will be focussed to accommodate the complexity of metacognition and answer the research questions posed in 1.3.1. An active and careful consideration of the research questions is imperative in order that study design is appropriate and effective for the subject in mind. The "direction and the scope of the questions may be critical to designing an effective study" (Agee, 2009, p. 434). Newby (2010) agreed with this question driven approach to study design, stating that the research approach should be built from research questions. It was therefore appropriate that Chapter 2 closed by revisiting the main and subsidiary research questions and explained their rationale with evidence from relevant literature (2.4).

Building on the findings of 2.1, this chapter will critically evaluate some of the key findings in Chapter 2 that are linked to methodological decisions adopted in this study based on these findings. The influence of the pilot study (3.4) is also important with regards to these methodological decisions. This chapter includes detailed discussion around the research design and subsequent justification of the methods and study design for this study. Detail of methods and research design will include discussion around reliability and validity and an examination of the ethical considerations necessary for this research.

3.1. The Field of Study

This section should be considered alongside the systematic review (2.1); here the methodological benefits of using PVTs to explore metacognitive knowledge with school-aged children will be further developed. The underlining of these methodological benefits is accompanied by discussion around some of the methodological challenges that the field of metacognition that were explored in 2.1. More specifically this section considers how these challenges were addressed in this study.

The choice of PVTs to collect data about metacognition is directly related to existing research using PVTs (Wall & Higgins, 2006; Wall, 2008; Wall et al., 2012). The findings of 2.1 showed that PVTs were one of only two tools (PVTs and TAPs) identified in the systematic review to have been used with an age range of 9 years; thus making their versatility and utility across different age groups clear (see Appendix A, Table B). After the systematic

review (2.1) was completed, additional research published using PVTs (Wall et al., 2012) furthered the relevance of PVTs by showing that they had now been used with the an age range of children aged 4 – 15 years. If the review was updated systematically, it is likely that new records would alter (albeit most probably only slightly) the age ranges for other included tools. It is important to note that the date range for the systematic review was 1992 – 2012; the researchers' knowledge of subsequent PVT research is directly related to their use in this study. The age ranges for other tools and methods identified in 2.1 have not been explored in additionally published research (post-2012).

Literacy demands were underlined in 2.1 as a key factor to consider in the utility of different methods to assess metacognition across the age range of 4-16 years. For example, the importance of considering the potential shortcomings self-report measures including the IRA (Jacobs & Paris, 1987), MAI (Schraw & Dennison, 1994) and the LTRQ (Butler et al., 2011). Self-report measures theoretically place demands on the reading, literacy abilities and understanding of respondents. If a tool or method is truly self-report and stands alone (i.e. without additional support from the researcher or the teacher of the students completing it), how can the researcher be sure that the level of understanding required to complete is definitely present? It could be assumed that an interview therefore may be a more appropriate approach given this consideration, however Jacobs and Paris (1987) argued that the IRA (a self-report) has advantages over interview. They claimed that interview might lead to bias due to interpretation issues. It seems that the potential for interpretation challenges is two-fold: the participants' interpretation (and understanding) of a self-report tool or method and also for interviews the interpretation of the interviewer. In terms of bias, a scored self-report measure where scores for different participants can be added up is less open to interpretation than perhaps an interview would be.

The methodological challenges of interpretation and understanding raised an important question: at what point a self-report tool would become an interview if help was required with its completion? Considering the age range of this study (4-16 years), this question was pertinent when using self-report with younger participants who may require assistance via reading aloud or scribing. Additionally, interviews and task-based methods also have the potential to place demands upon the reading ability (and associated understanding) of respondents. The literacy demands of self-report, interviews and task based methods may therefore all lead to results that have the potential to not be truly representative. An unrecorded (or unaccounted for) lack of understanding and/or reading

ability could lead to guess work by participants. It is important to acknowledge that although PVTs are completed in focus groups with discussion, they are designed to be self-report (individual participants complete the templates themselves, see Wall, 2008; Wall et al., 2012).

With the preceding evaluation of literacy demands in mind, PVTs could therefore also be critiqued as other self-report methods have been in terms of demands upon literacy ability and understanding. However, the discussion associated with the completion of PVTs (1.2.2) does hold the potential (via peer support and dialogue) to mediate for differences in the literacy abilities and limit the potential for research bias via researcher intervention even when some students require assistance in PVT completion by way of scribing. When comparing PVTs to other methods identified in the systematic review, scribing in a PVT focus group session seemed more ecologically valid than it may be in other data collection situations (e.g. an interview). The data collection in this study took place in schools, as part of the school day. The participants had all participated in group-work with their peers before (this was established in conversation prior to data collection with my school contacts). The group work component of PVT completion requires a consideration of the influence of this context and peer influence alongside discussion of the results.

Group dynamics and peer influence were not however the only important potential influences on PVT completion to consider. Additional findings of the systematic review encompassed consideration of the subject focus of the included 82 tools and methods (2.1.8, Table 7). Many of the tools identified in the systematic review were explicitly subject specific, examples included the Index of Metacognitive Awareness about Writing, Metacognitive Knowledge in Mathematics Questionnaire, Metacognition of Nature of Science Scale. The findings of the systematic review showed that these subject specific tools were largely in the category of questionnaires and self-report measures. PVTs are advantageous in that they are versatile and may or may not be subject specific. PVTs have been used to gather pupil views on very specific matters including using interactive whiteboards in the classroom (Higgins et al., 2005; Wall et al., 2005), but have also been used more generally on themes that apply to multiple subjects (for example group work and paired work (Wall et al., 2007)). The flexibility of PVTs fits well with the notion that metacognition infers thinking about learning and subsequent consideration of the transfer of skills across different learning situations. Metacognition is not subject specific, open-ended tools like PVTs allow for fluidity in respondents' responses.

The open-endedness of PVTs also lends itself to use with a wide range of ages, as shown in Table B (Appendix A). Exploring developmental trends in metacognition in school-aged children has methodological challenges centring on the use of a data collection tool that can facilitate responses inclusively and consistently from children aged 4 to 16 years old. There are few tools within the field that have been used with students at the lower end of the age range in the systematic review. PVTs are one of the tools that have been used with this age group, other tools in this age group are all either interview or observation based. Observation does play a role in data collection with PVTs, but it is not the main focus in terms of data collection and analysis. Observation played an important role in developing the data collection protocol for this study (3.6.2); observations made during the pilot study (3.4) explored the feasibility of logistics of data collection and the necessary procedures within a busy school environment.

The reliability and validity of this study will be discussed in detail in 3.9, however it is important to reference ecological validity firmly within the context of other research in the field. Bronfenbrenner (1976, p. 7) proposed that "An experiment is ecologically valid when it is conducted in settings that occur in the culture or subculture for other than research purposes". The 'group work' format of a PVT focus group session is likely to be more familiar to the participants when compared to other tools. For example in the Clinical Interview (Pappas et al., 2003) participants are interviewed and videotaped with two adults in the room. The familiarity of the focus group, worksheet format of the PVT sessions was discussed with the participating schools beforehand; this confirmed that this style of activity was common in these schools and not unfamiliar for the participants. Staff working at the school, as opposed to a researcher, would customarily conduct group work; therefore, it will be important to consider potential impact of the researcher on the findings. However, the teaching experience of the researcher and discussions with the participating schools informed a confidence that it was not uncommon for students to work in small groups with visitors external to the schools.

The systematic review (2.1) has proved to be influential and something of a reflexive tool forcing reflection in the moment on the research design and methodology of this study. It facilitated an active consideration the literacy demands, activity familiarity and ecological validity of PVTs. What follows in 3.2 maps existing research using PVTs considering how this has directly influenced the research design and methodology of this study, therefore underscoring the contribution that this study seeks to make in PVT research.

3.2. An Overview of Research using Pupil Views Templates

The purpose of this section is twofold, both to reaffirm the contribution of this study to existing research using PVTs and to characterise the influence of this existing research on the study design and methodology of this study.

Sampling in existing PVT research has been largely opportune, associated with large-scale national projects (e.g. Learning to Learn) and mainly comprised of one or two age groups of children as opposed to multiple age groups using PVTs in one single study (see Table 1). For example, in Higgins et al. (2007) PVTs were used as part of the *Learning to Learn Phase 3 Evaluation* with participants of primary school age, all but one (Year 3) of the year groups of a typical seven year-group primary school in the UK were included in the sample. The numbers of templates for each year group were uneven ranging from 6 templates in Reception to 57 in Year 5. The primary focus in Wall et al. (2005) was pupil views of interactive whiteboards, PVTs were used to explore the initiation of metacognitive talk but the sample only included students in Years 5 and 6. More recently published research using PVTS (Wall et al., 2012), encompassed both primary and secondary school, with participants aged 4 to 15 years old. This more recent research was part of the *Learning to Learn Phase 4 Evaluation* (Wall et al., 2010). Table 10 is comparable to Table 1 and summarises the main findings of existing research using PVTs. The latter two records in the table (Wall, 2008; Wall et al., 2012) used the Moseley model, which forms the basis for the analysis in this study.

Table 10: Key findings in existing research using PVTs

Record	Age Range	Aim(s) & Points to Note	Key Findings
Wall et al. (2005)	10 - 11 years	To explore pupil voice, beyond attitudes and beliefs (about teaching), focussing on the process of learning (metacognition)	• Centres on metacognitive processes • The under exploration of pupils' views of their own learning and the importance of this for metacognition and self-regulation • The importance of pupils' views about metacognition for teachers
Wall et al. (2006) (See also Higgins et al. (2004))	7 – 10 years	The use of PVTs in an evaluation (of the Digital Portfolio Project). To explore pupils views of the research and learning process	• Pupil perceptions of their metacognition are under explored in research • The value of asking pupils about how they learn • The usefulness of multimedia to facilitate children's talk about their own learning • The essentiality of further research to further development and understanding
Erikson and Grant (2007)	10 - 13 years	To evaluate the use of IWBs as a medium for teaching and learning Metacognition as self-appraisal and self-management of cognition	• PVTs as a medium to facilitate children's discussion of their own learning and their individual learning styles • Year 5 (aged 10 – 11 years) students less able to articulate their metacognition
Wall (2008)	4 – 11 years	PVT data collected as part of the L2L (Phase 3) evaluation. Templates used by individual teachers in different ways Data analysis using a pre-determined structure (Moseley model)	Cognitive skills: • General increase in comments classified as cognitive skills with age • An increase in comments relating to building understanding from Year 6 • An age related trend for productive thinking (increasing with age) Metacognition: • Comments relating to both metacognitive knowledge and metacognitive skilfulness apparent across the year groups • Evidence of declarative metacognitive knowledge and metacognitive skilfulness at a much younger age than previously thought
Wall et al. (2012) (See also Wall et al. (2010))	4 – 15 years	Focus on visual methods in mixed methods research Part of L2L (Phase 4) evaluation	• Articulations of metacognitive skilfulness at a younger age than previously thought (as young as 4 years old) • The deductive approach and its statistical analysis to make observations and new generalisations • Drop off of both metacognitive knowledge and metacognitive skilfulness in ages 12-15 years.

Table 10 clearly shows that existing PVT research has presented evidence of declarative knowledge of metacognition (including both metacognitive knowledge and metacognitive skilfulness) in school-aged children. However, this evidence of metacognitive development must be considered in light of the sample composition of these studies in terms of age and size (see also Table 1). The largely smaller age ranges in the sampling for existing PVT research, combined with the lack of reported stratification in the sampling, means that they are likely not certain to be representative of the populations that they represent. For example, it is not clear in the samples the numbers of students of each gender and the spread of this in the year groups sampled. In order to thoroughly explore the developmental trends in metacognition that have been identified, a more systematic sample is required. This thesis aims to collect a more systematic sample and will encompass all age groups that comprise compulsory schooling in the UK, the sampling stratified by both gender and age (school year group). The same PVT design will be used to collect data across the entire age range of 4-16 years; this is an aspect of PVT implementation that has not been explicitly explored in the existing research.

In keeping with previous research using PVTs, the importance of transparency and replicability in the method of using PVTs to explore metacognition with school-aged children is key. The transparency of the mixed method approach, particularly to analysis with a pre-determined approach, is key. What follows in 3.2 underscores the importance of research design, with a focus on both the advantages and challenges of a mixed method approach and in particular the significance of pragmatism in this educationally rooted study of metacognition.

3.3. Summary of Research Design

"A research design provides a framework for the collection and analysis of data" (Bryman, 2008, p. 31)

Boeije (2010, p. 20) specified that "[an] open and flexible approach should not lead to a non-committal attitude in which everything goes". A commitment to a research plan that clearly links key factors pertaining to the research (e.g. existing research literature, research questions, sampling, data collection and analysis) is essential. Choosing the correct research design and approach is vital. This study centred on a design that facilitated an exploration of the population (school aged children), at one point in time, to see if there was evidence of developmental trends in metacognitive knowledge in data gathered using PVTs.

This study employed a non-experimental fixed design (Robson, 2011); exploring the relationship between two or more variables at a given point in time (e.g. the relationship between age group and evidence of various cognitive skills or aspects of metacognitive knowledge). A cross-sectional survey design (Hall, 2008) provided a snapshot of metacognitive knowledge in the population comprising the sample (school aged children, 4-16 years). This approach (including the data collection tool, process and analysis) was based on the methodology and findings of previous studies that have used PVTs to collect data around cognitive skills and metacognition (see Table 10). The data in this type of study design is collected at a single point in time. The sampling across three different schools in this research negated that this single 'point in time' stretched over a period of just over six weeks.

In order to maximise the rigour of a research design, data collection and analysis, Bryman (2008, p. 31) advocated a focus on three main criteria: "reliability, replication and validity". In this respect, lessons were learnt from the findings of the systematic review prior to data collection for this study – "how you test is what you get" (Desoete, 2008, p. 204). It was imperative to demonstrate an explicit and transparent consideration of reliability and validity of this study, ensuring clear explanations of all of the processes involved and allowing for future replication of the methodology. The validity of PVTs, in terms of their uniqueness within the field as a method to explore metacognition with school-aged children, was grounded and rationalised by the findings of the systematic review (see 2.1 and 2.1.9).

Critique of qualitative research has often focussed on difficulties encountered in generalising findings, with this (generalising) perceived as more pertinent to quantitative research. Firestone (1993) proposed three arguments for generalising qualitative data: "sample-to-population extrapolation, analytic generalization, and case-to-case transfer" (p. 16). Sample-to-population extrapolation is key for this research, which will seek to generalise the findings in this study with regards to age groups (including school year groups) in the English education system. Onwuegbuzie and Leech (2007) noted the arguments about qualitative research and the relative lesser importance of sample size (compared to quantitative research). However, they also noted that in most qualitative studies at least one generalization is usually made. Generalisation denotes assumptions that can be inferred from a data set, with a specified sample, about the wider population. Generalisation is using those in the study to make generalisations about others who may fit into for example the same age group. The quota sampling in this study is based on having

the same numbers of students in the sample, with equally split males and females, for each year group (Reception – Year 11). If the sampling in this study was not organised in this way there would be a higher chance that the population in the sample would not be comparable to the norms of the wider population (school-aged children in England), in terms of numbers of males and females in the sample.

The rationale for the proposed study design is clearly embedded in both the findings of the systematic review (2.1) and the methodology and findings of existing research into pupil views of learning (and metacognition) using PVTs (Table 10). This study is a pragmatic and mixed method approach to exploring developmental trends in metacognitive knowledge with school-aged children, the design is non-experimental with a fixed design. A cross-sectional survey design with quota sampling allowed for the stratification of the sample of school-aged children (4-16 years) by both gender and age group. A pilot study was conducted in order to plan the logistics of data collection and test the practicalities of the method for the purpose of this study.

3.4. Pilot Study

Pilot studies are a "crucial element of a good study design. Conducting a pilot study does not guarantee success in the main study, but it does increase the likelihood" (van Teijlingen & Hundley, 2001, para 2). A pilot study was conducted in July 2012 in two schools, one primary and one secondary. The schools were not related in terms of their geographical location, but both were Catholic schools. The pilot study had a total of 67 participants, from Reception through to Year 10. Year 11 had left school (post-GCSE examinations) at the time of data collection in the pilot. The pilot trialled two PVT designs, one focussed on group work and the other on paired work, neither of the designs were associated with a specific lesson or subject. Figure 1 illustrated an example of a PVT completed about group work in the pilot study, in contrast Figure 13 shows a PVT completed by a female Year 5 student (aged 10) about paired work. Table 11 illustrates the group sizes for each year group within the pilot study and relevant extracts from the researcher's field notes. Extracts relating particularly to group dynamics, the size of the group and the template that was used with that group proved particularly relevant in confirming the final data collection protocol applied in this study (3.6.2).
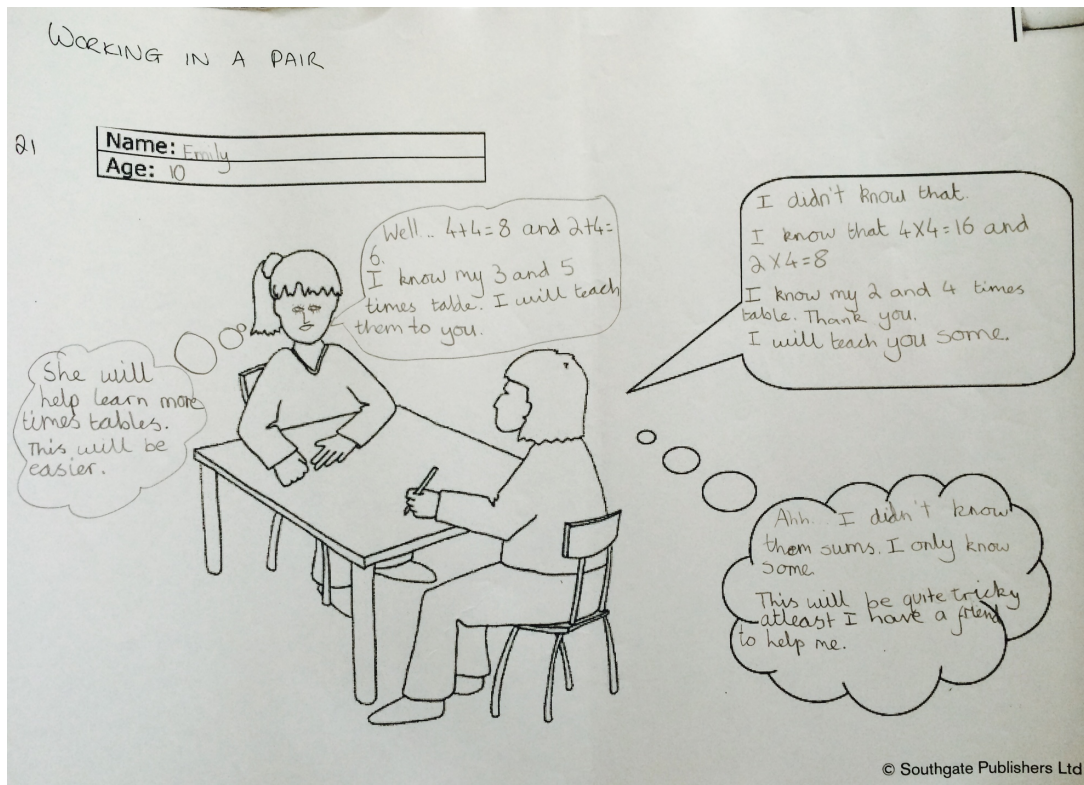
Figure 13: A PVT completed in the pilot study about working in a pair

Table 11: Group sizes, gender splits and templates used in the pilot study alongside relevant field notes

Year Group	Total templates completed	Which template?	Group sizes (Male: Female ratios)	Relevant field notes extracts
Reception	6	Group	3 (1:2) 3 (2:1)	Used spare paper to allow students who requested assistance to copy (I wrote what they said and they copied to template as they said things and/or requested this help). Four bubbles on this template, difficult to keep up and keep conversation on track. Scribed for students who requested, directly onto templates. This seemed to take longer for the second group compared to the first
Year 1	3	Pair	3 (1:2)	A very chatty group, I had to keep steering the group back to the task
Year 2	3	Group	3 (2:1)	The students were completing the templates at very different rates in this group, once they had said they were finished it proved difficult to keep them involved with the task and discussions
Year 3	3	Pair	3 (1:2)	The students asked if they could add more bubbles – I thought this would be the case, I think if the final template has 2 bubbles (1 speech, 1 thought) students will add their own if they wish to include extra
Year 4	3	Group	3 (1:2)	This group was very keen to write, they seemed to have a good understanding of what was being asked and conversation was more constant
Year 5	3	Pair	3 (2:1)	Conversation mainly at the beginning but did continue at a lesser level for the remainder of the activity
Year 6	3	Group	3 (1:2)	Lots of discussion, a little off task at times but back on task with minimal encouragement and requests to refocus on the template
Year 7	6	Pair	3 (1:2) 3 (2:1)	Discussion focussed at the start of the activity, less discussion when completing the templates…Very enthusiastic discussion at the start – need to think about how to best harness this and keep it on task. It was harder to keep conversation going in this group
Year 8	13	Group Pair	9 (6:3) 4 (2:2)	Conversation lacking a bit in this group, it is difficult to begin and maintain conversation with this group even with all of the prompt questions. Discussion mainly focussed on the beginning of the activity, tailed off as students filled in templates but all group members seemed active in the discussion. Need to think about the clarity of my instructions to students at the beginning of the activity and throughout to keep conversation going
Year 9	18	Pair	3 (3:0) 3 (0:3) 9 (4:5)	Discussion focussed on the start of the activity. Discussion mostly focussed on the start of the activity. Lots of conversation in this group, all of the way through
Year 10	6	Group	6 (3:3)	Appeared very interested in the research and why I was doing it. Asked lots of questions. Reasonable amount of discussion within the group

The pilot study did not include a full analysis of the data collected based on previous research using PVTs including the Moseley model (Wall, 2008; Wall et al. 2012). The pilot study was exploratory and focussed on logistics and feasibility. Key considerations included which PVT (or PVTs) to use, how big the groups of students should be (also therefore influencing the final total sample size) and calculating approximately how long the data collection process would take to complete. Previous experience (Gascoine, 2011; Wall, Higgins, Hall, & Gascoine, 2011) meant that the researcher was familiar with the coding framework used to analyse PVTs. This prior experience meant that the logistics of data collection took priority in the pilot study as opposed to data analysis and coding. It was important to recognise that the logistical issues that would not only concern the researcher, but also the participating schools and how the research could be fitted in to the pre-existing structures of the school day. What follows explores some of the key questions asked and rationalises the answers based on the findings of the pilot.

- **Should the template have a subject focus?**

  No subject focus: Both of the templates used in the pilot study were not related to specific subjects, the pilot study showed that not giving a specific subject for pupils to focus their template on was not detrimental in terms of them being able to actively participate in the process of PVT completion. Worries that students would potentially find it hard to visualise the activity given in the template if a subject was not also given did not come to fruition. The researcher also considered that if a subject was specified that this may have potentially very different meanings for students at different stages of schooling (e.g. the differences and similarities between what is termed Literacy and/or English across different schools).

- **What should the group size and gender split be?**

  Groups of 4 would be used in primary school and groups of 8 in secondary school, with an even gender split: Groups of 4 and 8 students allowed for an even gender split in both smaller groups of 4 and larger groups of 8 students. The pilot study showed that it was easier to work with smaller groups of students (e.g. 4) in primary schools and that it was not difficult to accommodate larger groups (e.g. 8) in a secondary school environment. The pilot study also indicated that groups that had an even gender split tended to have a more equal and sustained involvement of all members of the group in the conversation. A gender split within

the groups was important; this was representative of the fact that all the
participating schools were mixed sex.

- **How many speech and thought bubbles should there be on the template?**

  One of each, the students could add extra if required: The researcher had concerns
  that students would feel limited if there was only one speech and one thought
  bubble on the template. In the pilot two templates were used, one had two of each
  (speech and thought bubbles) and the other had one of each. The researcher
  explained to the students in the pilot that they could add extra speech or thought
  bubbles if required, students did do this in the PVTs gathered in the pilot study. The
  decision for the final template to have one of each (speech and thought bubble)
  was based on this and the notion that some students may feel intimidated if they
  perceive having two of each (speech and thought bubble) as space that they are
  obliged to fill with text.

- **What should the time frame for data collection in the main study be?**

  20 minutes per group allowing for 5 minutes either way: The focus groups with
  PVTs took approximately 20-25 minutes to complete in the pilot regardless of the
  age of the students (the smaller groups with younger students seemed to
  accommodate additional time spent scribing). The extra five minutes would
  accommodate secondary school students potentially travelling further from
  different classrooms to the location of the data collection.

- **Which biographical and other information should be collected about the
  participants?**

  ***Year group, age, gender and which subject the student was 'thinking about' when
  they completed their template:*** Year group and gender were simple pieces of
  information to record; children of all ages were able to manage this (some with
  prompting to complete it) in the pilot study. It was decided to also ask for age in
  years in the main study, children frequently recorded this information on their
  templates in the pilot study and it would allow the calculation of a mean age for
  each year group. In the pilot study, students frequently mentioned which lesson
  (e.g. maths) they were thinking about when they completed their templates so the

decision was taken to add a question relating to this to the back of the final PVT where students were recording their biographical information.

3.5. Sampling

As with other research (Table 1) conducted using PVTs the sample in this study comprised school-aged children (4-16 years). The incorporation of both primary and secondary aged students required an approach to sampling that considered:

- The composition of classes in the participating schools and generally across the school-aged population in England (e.g. mixed gender schools and classes)
- The number of schools in the sample
- The minimum sample for each year group (Reception – Year 11) that would be appropriate both logistically for the collection of the data and for the statistical analysis of trends in the data (to conform to minimum cell sizes required in quantitative analysis)
- The size of the focus groups and how this would accommodate both the total sample size per year group and the even gender split advocated

What follows describes the importance of considering sampling in terms of generalisations that can be made from research evidence and more specifically the sample size, sampling frame and group sizes (and duration) to facilitate this.

Reflecting on discussion around sample to population extrapolation earlier in this section, Firestone (1993) also noted that a random sample would increase the confidence of inferences made in terms of sample to population extrapolation. The sampling employed was not truly random; research and teaching experience informed the decision that it would have proved more difficult to engage schools in this small-scale study if cooperation with random sampling was also required. However, the researcher did not play a role in selecting the participants for this study so there was a degree of randomness in that responsibility for the selection process was passed over to the schools. A selection criterion given to the schools was based on: year group, gender, ability and willingness to participate. The school contact selected the participants based on the criteria above, mixed ability referring to the requirement for the groups of participants selected to be of mixed abilities in the eyes of the teaching staff.

The sampling approach applied was non-probability and more specifically quota sampling. The non-probability element comes from the fact that the main focus was that the quota was met, as opposed to how it was chosen. Quota sampling is when the "Researcher identifies desired characteristics and quotas of sample members to be included in the study" (Onwuegbuzie & Collins, 2007, p. 287). Year group and gender provided strata from which the population was sampled in this study. For a small-scale survey such as this it would have been difficult to stipulate precise sampling procedures for the schools to follow and this may have made it more difficult to recruit and maintain schools in this project. This approach to sampling meant that the sampling in this study was more systematic than in previous research using PVTs (see Table 1). The sample comprised children from each year group (Reception – Year 11) and planned to sample equal numbers of males and females. The sampling frame comprised a pyramid of three schools selected from within one geographical area.

Robson (2011, p. 274) explained that non-probability sampling is when it is not "possible to specify the probability that any person…will be included in the sample". He also noted that non-probability sampling is often used in small-scale surveys, like this study. Quota sampling is often used in commercial research and aims to "produce a sample that reflects a population in terms of relative proportions of people in different categories" (Bryman, 2008, p. 185). The population targeted in this research was that of school aged children, therefore it was decided that an approach selecting even numbers of students in each year group of compulsory schooling would be the most appropriate. As explained by the findings of the pilot study (3.4), it was decided that the sample in this research should be stratified by year group and/or key stage and also by gender, with even numbers of males and females in each group.

3.5.1. Sample size.

An appropriate sample size was key, it was imperative to collect enough data to appropriately identify and generalise trends in the data and perform statistical testing. It was also essential that the sample size was realistic in terms of logistics, the research collected the data alone and it may have proven more difficult to recruit participating schools if the sample size was too large. Robson (2011) noted that the larger the sample then the lower the likelihood of error in generalisation. Error is an important consideration when considering the higher likelihood of bias associated with non-random sampling

(Mangal & Mangal, 2013). Borg and Gall (1979) are commonly cited with regard to sample size and they stated that around 100 observations for the major subgroupings in a survey (primary school and secondary school in this case) and 20-50 for each minor subgrouping (each year group in this case) are appropriate. Similarly to the 20-50 cases per subgrouping mentioned above, Cohen, Manion, and Morrison (2007) suggested a minimum of thirty cases per variable; using the criterion of year group in this research, this would mean 30 templates per year group (360 in total). With these suggestions regarding the sizes of major and minor sub-groupings in mind, it was decided that 32 would be an appropriate number of templates to aim to complete with each year group in the study. Early decision-making led to the conclusion that 30 would be an adequate number, however the pilot study (3.4) influenced a change to 32 in order ensure that all of the groupings had an even gender split. Groups of 32 students would allow groups of both 8 students (secondary) and 4 (primary), whereas groups of 30 would not.

3.5.2. The sampling frame

A 'pyramid' sampling frame was applied to gain as complete a representation as possible of the school community within the geographical area that this study was located. Secondary schools have more than one feeder primary school so to be representative it was necessary to recruit two primary schools. The secondary school was recruited first with initial contact made via a colleague. The recruitment of a willing secondary school facilitated the approach to recruitment of the primary schools in a more focussed way. The secondary school recruited was a large academy converter mixed secondary school and had four main feeder primary schools (two of which also academy converters). The Department for Education (DfE, 2014c) stated that academies are:

> …publicly funded independent schools that are not managed by a local
> authority. They can set pay and conditions for their staff and also change the
> length of their terms. Academies don't have to follow the national
> curriculum (para. 1).

Following the recruitment of a secondary school, all four of this school's feeder primary schools were contacted by email and followed up by telephone. Correspondence was addressed to the head teachers of the primary schools (see Appendix B for copies of this, including the participant information sheet). The two participating primary schools were not academy converters, they were the first to respond to requests for participants and after

initial discussions with their head teachers both were willing to take part. Figure 14 illustrates the pyramid of schools and outlines key biographical information.

Secondary school: A mixed secondary school academy converter with approximately 1200 pupils on roll.

Feeder primary 1: A mixed primary school with approximately 260 pupils on roll.

Feeder primary 2: A mixed primary school with approximately 320 pupils on roll. This school has higher than average numbers of pupils for whom English is a second language.

Secondary school

Feeder primary 1

Feeder primary 2

Figure 14: Pyramid sampling frame with key information about the participating schools

3.5.3. Group size and timings

In conjunction with decisions made about the sample size for this study, the size of the focus groups was an additional key decision. The decision to have groups of eight participants in the secondary school sample and groups of four participants in the primary school sample was based on the findings of the pilot study, the proposed sample size and grounded in existing research that has explored the use of focus groups with children.

PVTs are designed to be part of a mediated interview conducted in small groups (Wall & Higgins, 2006). The aim of this study was that all participants would feel comfortable to participate in the discussion. O'Reilly, Ronzoni, and Dogra (2013) discussed group sizes in relation to conducting focus groups, they advocated that typically eight to ten children was appropriate and stated that groups of three to four would also be suitable. The pilot study confirmed that smaller groups allowed scribing with the younger children to be an achievable task. In groups of larger than four scribing would likely have become too difficult to manage within an appropriate time frame for the researcher. Additionally, the pilot study indicated that larger groups facilitated more productive and engaging focus groups with the older students. Heary and Hennessy (2002) noted that four to five participants would be

appropriate number, aiming to ensure at least three 'talkers' per group. The minimum group number in this study was four participants (in the primary school). Another important consideration was how long each focus group would take; the pilot study suggested that 20-25 minutes with all age groups was appropriate. A duration of 20-25 minutes per focus group, fits with findings of research exploring methodological issues in conducting focus groups with children. For example, Morgan, Gibbs, Maxwell, and Britten (2002) looked at methodological issues of conducting focus groups with participants aged 7-11 years and advocated sessions of 20 minutes.

Having considered the design of previous research using PVTs and the influences of this, the pilot study (3.4) and relevant literature about sampling and focus groups, what follows states explicitly how data was collected in the main study.

3.6. Data Collection

With previous sections having focussed on sampling and logistical issues that required consideration in the pilot study, the focus in this outlines the detailed planning and processes involved in the final data collection. In addition to presenting the PVT used, a detailed itemisation of how the PVTs were administered in each setting (primary and secondary school) will be described, rationalising the differences in data collection protocol for different age groups.

3.6.1. The final PVT for data collection

The final PVT used in this study is shown in Figure 15. It does not specify a particular scenario (e.g. Working in a pair) nor a specific subject, it has been adapted from a template that does (Wall et al., 2007). The decision to not collect data relating to a specific subject related to the idea that this could potentially bias a school's decision on whether they might take part or not. A specific subject focus could potentially influence the student responses if they did or did not favour the chosen subject. Core subjects in the National Curriculum including Maths, English and Science do span from KS1 up to KS4, but could potentially represent different things do different age groups. For example, English as a subject in secondary school will incorporate aspects of the subject known as Literacy in many primary schools, literacy is more often than not taught as a distinct subject in primary schools. Figure 15 also illustrates the reverse side of the PVT, asking participants to record the following information after they had completed their template:

- Gender

- Age

- Year Group

- What kind of lesson were you thinking about when you completed your template?

It was explained to participants that this extra information on the reverse of the PVT was to explore patterns in the data and would not be used to identify individual participants, even if data was shared anonymously with the participating schools. Administrative information was also recorded on the back of the template that included the date, which school the participant attended (anonymised as A, B or C), the group size and the gender split of the group.

Think about a lesson when you learnt something new...

© Southgate Publishers Ltd

Male / female (Please circle)

Age: _____

Year Group: _____

What kind of lesson were you thinking about when you completed your template?

FOR ADMINISTRATIVE USE ONLY

Date: _____

School: A / B / C (for purposes of sharing data back with the school)

Group size: _____

Gender split:_____

Additional notes: _____

_____

Figure 15: The PVT that was used in the data collection for this study

3.6.2. The data collection process and protocol

The data analysed in this study was collected between 23 April 2013 and 7 June 2013. Data needed to be collected at times convenient for the participating schools and students, it was therefore collected over a number of days within each school. Data was collected in both morning and afternoon sessions, often from more than one school in a single day. During the data collection process maintaining continuity and minimising the potential impacts of uncontrolled variables was key, in order to do this a detailed protocol for data collection was employed and adhered to rigorously. The sequence of proceedings in each focus group was completed in the same order with the role of the researcher made clear and remaining the same. Alterations in the protocol for different ages were explicit and applied consistently throughout the data collection.

Data collection always began with a verbal request from the researcher for the participants to participate in the research, it was explained to the students that participation was voluntary (and informed – the information sheet and a verbal explanation of the research based on this). Participants were informed that they were free to withdraw at any time and/or to not complete any part of the template that they did not want to, ("not do this" was used alongside the word "withdraw" to aid understanding, particularly with the younger primary aged participants). Another explicit difference in the data collection protocol relating to age was the offer to scribe for the younger students in Reception and KS1, this offer was made to all students in these age groups. The researcher offered to scribe onto the templates for Reception and KS1. Some students requested that their contributions were written on scrap paper so they could copy onto their templates, there was no reason to deny this at the time of data collection as long as this was subsequently consistent with all groups. The nature of research with children and within education settings requires a degree of flexibility and responsiveness to challenges in the moment. Consistency throughout the data collection in response to challenges and questions in the data collection process was key.

After explaining and requesting permissions and consent with the participants, the researcher summarised why the research was being conducted. The explanation given was as follows:

> *My name is Louise I am from Durham University. I am doing some research about what happens when you learn new things and how you think about*

your thinking. This means I am interested in learning about what happens when you learn new things and how you think about your learning.

It was explained to the participants that they each had a PVT and this was their own to complete. The process of using the PVTs as their record of the discussion was also outlined:

The template is yours to complete but I would like you to talk about it in your group first. I would like you to think about a time when you learnt something new and talk about this in your group.

At this point students were left to discuss the prompt question. When from the initial prompt were coming to a natural end, the prompt relating to the completion of the PVT was introduced:

Think about a lesson where you learnt something new, imagine these 2 students were there…what were they saying, what were they thinking?

After this prompt, participants began completing their individual templates. When conversation lessened, the following additional prompts were introduced:

- *If the two students in the picture/template were in your classroom when you learnt something new, what would they be saying and what would they be thinking?*
- *What do you talk about when you are learning something new?*
- *What do you think about when you are learning something new?*
- *Who might help you when you learn something new? What do they say?*

The prompts given were not subject specific; the researcher did not want to discriminate between different subjects, confusion may have arisen from differences in subject areas studied or the names by which they are referred to across different the age groups. There was also a consideration of not wanting to discriminate against students who may struggle in particular subjects.

The researcher did not move around the room whilst the PVT focus groups were taking place. Unless scribing for younger students the researcher aimed to remain external to the discussion whilst actively monitoring and interjecting with additional prompts as detailed above when necessary. The externality was directly related to minimising any potential researcher bias but did mean that the researcher was left with some questions about the data collection process that will likely remain unanswered. For example, two students did not complete the templates (no text on the template side of their paper) but

did attend the session. It was unclear whether or not these students actively chose not to complete the template because they did not want to participate, or perhaps because they did not understand what was being asked of them. Alternatively, these students may not have felt comfortable participating in the focus group. The researcher did request that the school contacts selected willing participants, but perhaps there were exceptions in this school-based selection process.

3.7. Coding

Coding in this study was deductive (as in previous research using PVTs (Wall, 2008; Wall et al., 2012); due predominantly to the scale of the sample it was deemed the most appropriate and manageable approach. There were two elements to the coding process; firstly the same coding scheme used in previous work was used based on a predetermined framework (which was in turn based on the Moseley Model[20]) the rationale for which was explored in detail in 2.2. Secondly, codes arising from a more detailed exploration of metacognitive knowledge were applied thus reacting to some of the criticisms of the distinction between metacognitive knowledge and metacognitive skilfulness (outlined in 2.2.5). The full coding scheme applied, with its two elements, is presented in Table 12.

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[20] See section 2.2 and Figure 9 for detailed information about the Moseley model.

Table 12: The deductive scheme used to code the PVT data with definitions and examples from the PVT data

Category		Description	Example(s) from PVT data	Links to theory/research
Cognitive Skills Moseley et al., (2005a)	**Information gathering**	"Experiencing, recognising and recalling Comprehending messages and recorded information" (Moseley et al. 2005a, p. 314)	"I learnt about how the Tudors lived…" "I was learning maths today and I learnt how to do dividing sums and how to do remainders."	Moseley, Baumfield et al. (2005) 'Integrated model for understanding thinking and learning' Previous analysis of PVT data (Wall, 2008; Wall et al., 2012)
	Building understanding	"Development of meaning (e.g. by elaborating, representing or sharing ideas) Working with patterns and rules Concept formation Organising ideas" (Moseley et al. 2005a, p. 314)	"There is a pattern here. Miss said that you add the first number and the second" "I've learnt how to do short multiplication so this should be easy to learn."	
	Productive thinking	"Reasoning Understanding causal relationships Systematic enquiry Problem-solving Creative Thinking" (Moseley et al. 2005a, p. 314)	"I wonder what notes I will get from the rainforest. How am I going to remember them?" "This information could be handy one day it could help me on a test or something"	
Strategic and reflective thinking[21]		"…the comments represented an awareness of the process of learning. It needed a reflective or strategic element to the statement; that this comment represented thinking about learning." (Wall, 2008, p. 28)	"Factor numbers aren't very easy you get very confused with them. Let's go ask the teacher" "…thinking about it helps me to remember to spell my name"	Moseley, Baumfield et al. (2005) 'Integrated model for understanding thinking and learning' Previous analysis of PVT data (Wall, 2008; Wall et al., 2012)

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[21] The two-way arrow is taken from the Moseley et al.'s (2005a) 'Integrated model for understanding thinking and learning', it represents interaction between cognitive skills and strategic and reflective thinking but this interaction does not always apply (see p. 94 and also Moseley et al., 2005a, p. 315)

Comments classified as 'strategic and reflective' then analysed for evidence of Metacognitive Knowledge (metacognitive knowledge), which is divided into metacognitive knowledge of person, task and strategy. Metacognitive knowledge is taken to mean "declarative knowledge stored in memory" (Efklides, 2008)			
Metacognitive Knowledge	**Metacognitive knowledge of Persons[22]**	Declarative knowledge of person's characteristics that are relevant to the task) Knowledge of self and others (strengths, weaknesses, ability, motivational beliefs). Including knowing who to ask for help.	"I know how to do this but I am still struggling a bit." "She is getting the hang of it we should celebrate."	**Person, task and strategy:** Flavell (1976); Flavell & Wellman (1977); Brown (1978); Jacobs & Paris (1987); Veenman et al., (2005), Efklides (2008); Pintrich (2002), Schmitt & Sha (2009); Whitebread et al. (2009)
	Metacognitive knowledge of Tasks	Declarative knowledge of the characteristics of the task. Long-term memory, responses demonstrate knowledge of components of the task. Also, comparisons made and judgements about difficulty.	"So all I need to remember is my mental maths and all the things I have learnt in the past lessons." "Why doesn't it follow the patterns of normal 'ir' verbs? How can we remember the endings?"	Schmitt and Sha (2009): From Paris, Lipson & Wixon (1983) three types of metacognitive knowledge – • Declarative knowledge (about characteristics of person, task and strategy)
	Metacognitive knowledge of Strategies	Declarative knowledge of characteristics of strategies relevant to the task	**Rehearsal** **Procedural** – "If I close my eyes it makes me look back in my brain and think about it." **Conditional** – "I learned how to speak Chinese, I'm going to have a conversation in Chinese with my friend	• Procedural knowledge - awareness of "knowing how to perform the strategies" (p. 255)

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[22] Metacognitive knowledge of person – Metacognitive knowledge of strategy - In the example of asking for help, it would become strategy knowledge when there is evidence of knowing why it is appropriate to ask for help and when (e.g. "I have been trying to do this for ten minutes so I'm going to ask the teacher now" = procedural) and/or why strategies are effective (e.g. "I'm stuck, I know that my friend can do this so I will ask her to show me how to do it with an example" = conditional).

		GENERAL CATEGORIES of LEARNING STRATEGIES (Weinstein & Mayer, 1986), see also Pintrich (2002): **Rehearsal** – e.g. repeating words to remember them, reading through work to revise **Organisation** – Strategies to make connections e.g. note taking, concept mapping. **Elaboration** – deeper processing e.g. mnemonics, summarizing, paraphrasing.	so I remember." **Organisation** **Procedural** – "They would talk about what they learnt and try to repeat what was said and if it was wrong, write and give feedback to each other." **Conditional** – "Wow I never knew that before, that could be useful in the exam. I better remember that, I'll make a mind map" **Elaboration** **Procedural** – "I learnt them by using sentences. Because it's used like this. Big elephants can add up sums easily. People like this: People eat orange peel like elephants. And said: Sally Anne is dancing." **Conditional** – "Both talking about the work asking each other topical questions and clarifying understanding with one another before completing questions."	• Conditional knowledge awareness of "knowing when it is a good idea to use a specific strategy and why it is helpful at that point" (p. 255) As with Schmitt & Sha (2009, p. 255): 'Awareness of' in PVTs because the measure is also offline. Pintrich (2002) described metacognitive knowledge of strategies as strategic knowledge. Organisation and elaboration strategies thought to result in deeper learning and suitable for more complex concepts than rehearsal strategies would be.

It is important to note that the codes in the section of this coding framework based on Moseley et al. (2005a) were not exclusive; text could be coded as more than one of the six codes outlined in Figure 9. In relation to this non-exclusivity, Moseley et al. (2005a, pp. 313-315) noted that information gathering is a prerequisite for the other cognitive skills and that the strategic and reflective thinking (the metacognitive/self-regulatory aspect of their model). Nonetheless, information gathering being a condition of building understanding, predictive thinking and/or strategic and reflective thinking does not necessarily mean that it will be present in all of the text coded as this. This is not to say the recall and comprehending of messages did not happen just that this aspect of the learning episode detailed in the PVT is not explicit in every section of coded text.

It is integral to revisit the reasoning behind the adoption of this framework (outlined in Chapter 2) and consider any potential challenges that may arise from it. Considering potential challenges is particularly important given the differences between the framework presented in Table 12 (focussing on metacognitive knowledge) and the framework adopted in previous research with PVTs with respect to the distinction between metacognitive knowledge and metacognitive skilfulness. With previous research in mind (Wall, 2008; Wall et al., 2012) a comparative analysis is presented in Appendix D. The unit of analysis for this comparison was number of words and the coding framework applied the same as the framework presented in both Wall (2008) and Wall et al. (2012).

Alongside analysis from the deductive coding framework, this study also includes a more exhaustive analysis of metacognitive knowledge. This analysis included what Pintrich (2002) described as knowledge of metacognitive learning strategies[23] (planning, monitoring and evaluation). The metacognitive learning strategies described by Pintrich (2002) cross over with popular definitions of metacognitive skilfulness, including the definition applied in previous research using PVTs. The definition of metacognitive skilfulness referenced in this respect by Wall et al. (2012) is that given by Veenman et al. (2005). Veenman et al. (2005) described metacognitive skilfulness as encompassing planning, monitoring and evaluation alongside other factors including task analysis, recapitulation and reflection. It is not the purpose of this section to revisit the online/offline debate in the field of assessing metacognition (2.1.8), it is however important to acknowledge that within the field there are

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[23] Knowledge of strategies as opposed to the actual use of (Pintrich, 2002)

differing opinions. Research including that of Pintrich (2002), Efklides (2008) and Wall (2008) has posited that there is space in the field to consider the legitimacy of measures labelled as 'offline' to explore what are commonly described as 'online' aspects of metacognition. These 'online' aspects including metacognitive experiences and aspects of metacognitive skilfulness including planning, monitoring and evaluation that are popularly described metacognitive skills or metacognitive skilfulness. Indeed, Efklides' (2008) model suggested that there is a meta-meta level and that one aspect of this is metacognitive skilfulness, thus 'meta-metacognitive skilfulness'.

With these debates in mind, it will be important in Chapter 4 (Results and Discussion) under the fourth subsidiary research question (What are the advantages and disadvantages of PVTs as a tool to collect data across a systematic sample of school-aged children?) to evaluate the coding framework applied in this study (Table 12). In this analysis and evaluation, it will be important to make a comparison with previous research using PVTs (Wall, 2008; Wall et al., 2012) and consider what may be the advantages and disadvantages of each of the approaches to coding. For example, this includes a consideration of the exclusion of metacognitive skilfulness in the deductive coding scheme for this study but the inclusion of Pintrich's (2002) similar notion of knowledge of metacognitive strategies (planning, monitoring and evaluation). Within this a consideration of the notion of metacognitive knowledge of strategy (as described in Table 12) and the potential crossover between this, Pintrich's planning, monitoring and evaluation, and popular definitions of metacognitive skilfulness. With an evaluation of the utility of PVTs to both collect and analyse data in mind what follows presents the framework for analysis (Table 12)) and goes on to explore the remainder of the coding process and its reliability as a whole, followed by a plan for the data analysis.

3.7.1. Additional coding information.

In addition to the coding scheme illustrated in Table 12, the following supplementary codes were added, therefore maximising the potential range of comparisons that could be made in the data analysis for this study and in any future analysis:

- Text written in a speech bubble
- Text written in a thought bubble
- Speech and thought bubble read together
- Picture drawn in speech bubble (no text)

- Picture drawn in thought bubble (no text)

- Text written in an extra speech bubble

- Text written in an extra thought bubble

Third on the list above is 'speech and thought bubble read together'; an initial look at the data before coding indicated that there were some examples of PVTs where the thread of what the student had written was clearly continuous and comprised one conversation of the same idea across the speech and thought bubble. Two examples of this are given in Figure 16. Example 1 is a PVT completed by a female, aged 5 from a Reception class (this example is also a PVT that was scribed by myself) and example 2 is a male student, aged 12 from a Year 7 class. It was decided at this stage in the coding process that the text across speech and thought bubbles in cases like these should be coded as one; otherwise examples of cognitive skills and metacognition within individual PVTs may be have been missed and not accurately coded and represented. In 'example 1' if the thought and speech bubble were coded as separate entities "1, 2, 3, 4 counting up to 100" would have been coded as information gathering rather than building understanding, strategic and reflective and then metacognitive knowledge as it was when read together with "because the teacher was helping us".

Example 1 (female, aged 5):
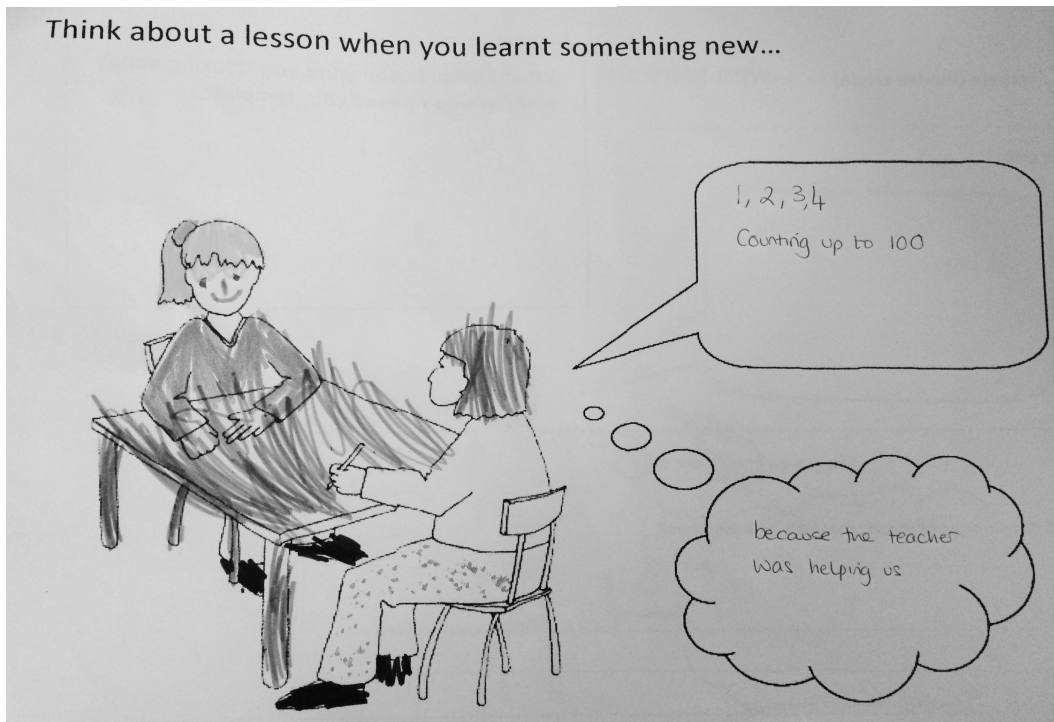
Example 2 (male, aged 12):
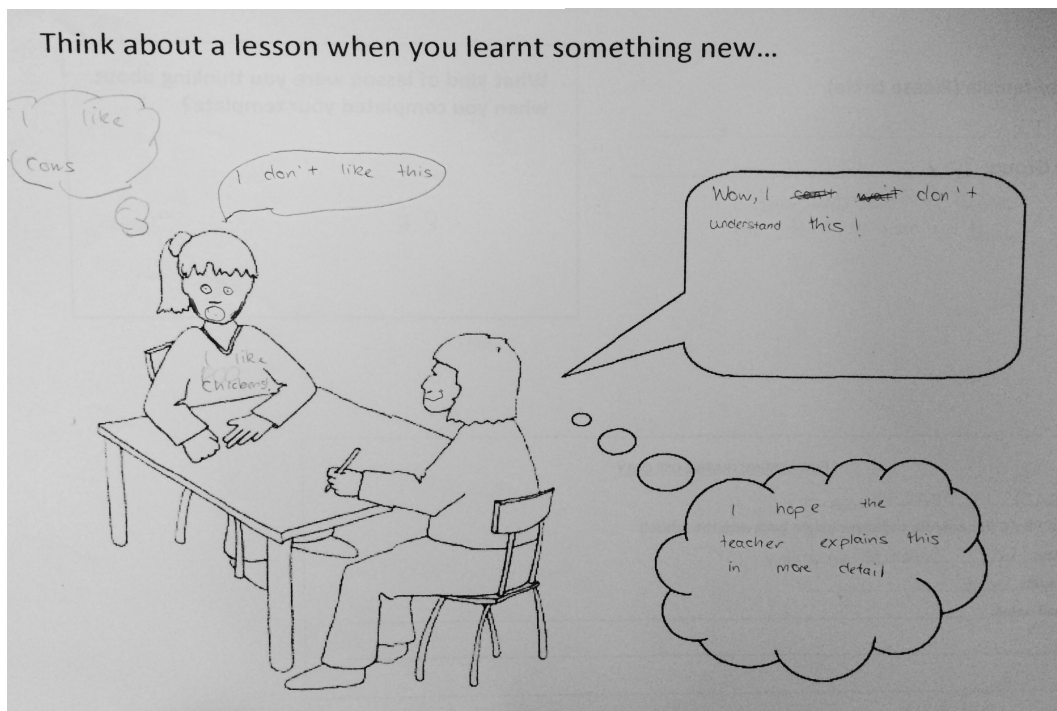
Figure 16: Examples of PVT text coded as continuous across both the speech and thought bubble

3.7.2. The coding process and reliability

The data from each PVT was transcribed over a period of two weeks, with each transcription saved as an individual text file in order that it could easily be uploaded to the qualitative analysis software NVivo 10 (2012). This also facilitated matching up individual text files (one per PVT) with the biographical information of the participant to whom they belonged. The biographical information of the participants was imported into NVivo as a classification sheet from Microsoft Excel. The coding process undertaken by the researcher reflected the order of the coding framework detailed in Table 12. The additional and comparative analysis presented in Appendix D was based directly on Wall (2008) and Wall et al. (2012). Once biographical information had been matched, speech bubbles and thought bubbles were coded alongside the other information listed on p. 173. Then cognitive skills and strategic and reflective thinking were coded simultaneously. Finally, text coded as strategic and reflective thinking (therefore showing evidence of metacognitive/self-regulatory activity) was re-visited and coded for evidence of metacognitive knowledge of person, task and strategy (including the sub-categories within strategy). Data was coded over a total of three weeks and following measures were put in place in order to facilitate increased rigour and reliability during the coding process itself:

- Working with colleagues who were involved with another project where PVTs formed part of the data set and PVTs were being coded using the same coding scheme (Dorsett et al., 2014) – we discussed and debated multiple examples of coding PVTs from the Mind the Gap project over three meetings.
- Contact via email with colleagues from the other project during the coding process for the PVTs in this study, if there was a particular text unit I was unsure of I emailed colleagues for input.

Previous research using PVTs has good inter-rater reliability, Wall (2008) and Wall et al. (2012) both record percentages of 82%. When all of the 374 templates in this sample had been coded, the inter-rater reliability was checked for a random sample of c. 10% of the total number of templates (n=38). A colleague double coded the 38 templates. The inter-rater reliability was 80% (Kappa – 0.32).

3.7.3. The unit of analysis

The data in the text files was coded by text unit, as in previous research using PVTs (Wall, 2008) where a text unit referred to a unit of text in a student's response that makes sense. A unit of text that makes sense could be one word or a sentence or more. For example, "$E = mc^2$" was coded as one unit of text, as was "I kind of understand but we have moved on too quick. So I don't have a chance to consolidate my learning." It was not the aim of the PVTs to be strict about grammatical sense, but to explore 'sense' in terms of the meaning of what had been written. Meadows and Dodendorf (1999) noted the importance of carefully choosing the unit of analysis and being consistent with its application, warning that if units of analysis are too large they may become cumbersome. The nature of the PVTs and the time limited focus group meant that the participating students did not have time or space to write large paragraphs, more often than not a text unit was a maximum of two sentences.

The construction of meaning is an important point for consideration in terms of the coding in this study, given the role of the coder in establishing these units of text that 'make sense'. Lemke (1998) explained the importance of recognising that the students' individual text does not become data until it is transposed it from the original activity to the activity of analysing it for research purposes. In this transposition from original activity to data it is impossible to avoid the data then also becoming about the researcher. What a student completing a PVT might define as a text unit may be different to how the researcher has interpreted the PVT data in the coding and analysis process for this study. Lemke (1998) advocated the preservation of the data in its original form, avoiding the temptation to clean up the data and risk losing potentially important features.

The quantitative statistical analysis of data presented in Chapter 4 comprises analysis at the level of text unit. However, comparatively and in line with analysis in previous research using PVTs (Wall, 2008; Wall et al., 2008) Appendix D contains analysis where the unit of coding was text unit, but the unit of analysis was number of words. Importantly, the unit of analysis in the statistical testing made very little difference (in terms of both results and significance) to the outcomes in both cases.

3.7.4. Dependent and independent variables

The independent variable in this study that will be referred to in the analysis plan (3.7.5) is age. More specifically this refers to both year group (based on the year groupings in English schools: Reception – Year 11) and age group (based on Key Stages in English schools but combining Reception with KS1). The reasoning behind two approaches to defining age in this study was twofold:

I.   To meet the minimum cell sizes required for quantitative analysis in SPSS larger age groups were required. The groupings based on Key Stage were as follows: Reception and KS1, KS2, KS3 and KS4.

II. To facilitate a more fine-grained approach to analysis (both quantitative and qualitative). The cell sizes would have been too small for robust statistical analysis in SPSS using the year groups as the age groups (e.g. Reception, Year 1, Year 2…), but this was not to say that information at this level would not prove valuable.

Both age groupings (Year Group and those based on Key Stage) were used in the qualitative analysis, this meant that supporting evidence could be drawn out but that at the same time a more fine-grained approach to analysis implemented. The charts presented in Chapter 4 will show the subtle differences in dependent variables for the age groups (by year group) that were not visible when groups based on key stage were used. The dependent variables in this study are presented in Table 12: information gathering, building understanding, productive thinking, strategic and reflective metacognitive knowledge of person, metacognitive knowledge of task and metacognitive knowledge of strategy (and the sub-categories). Strategic and reflective thinking was not included in the quantitative statistical analysis, rather as in previous research using PVTs this was a step in the coding process and subsequently recoded as more specific aspects of metacognition (metacognitive knowledge of person, task and strategy in this study). Strategic and reflective thinking was recoded for evidence of metacognitive knowledge and metacognitive skilfulness in previous research using PVTs (Wall, 2008).

3.8. Mixed method data analysis.

Analysing qualitative data quantitatively as well as qualitatively in this type of mixed method approach to analysis is not free of deliberation and nor, as was argued earlier, is it a catch-all solution to the complexities of social research. As early as the 1980s there was

debate about the "omnipresence of qualitative data" in social, behavioural and biological sciences (Young, 1981, p. 357). Mays and Pope (1995) discussed rigour and qualitative research in the field of medicine; they took an approach that involved combining "a qualitative analysis with some quantitative summary of the results" (p. 112). The combination approach described by Mays and Pope (1995) is similar to the approach adopted in this study, however, the analysis in this study does not prioritise qualitative analysis and then provide a quantitative summary. The quantitative data is presented first purely for ease of presentation and access to the data; the results are then addressed (presented and discussed) in relation the research questions with neither quantitative nor qualitative evidence being privileged. The size of the data set in this study (n = 374) negated a pragmatic approach where for each of the aspect of the analysis, the evidence (both qualitative and quantitative) was viewed holistically and simultaneously. This is not to say that quantitative trends identified were not further evidenced with qualitative data, but nor is it to say that all of the trends identified in the data stemmed from the quantitative analysis.

The holistic and pragmatic approach to data analysis described above fits well with arguments about mixed methods research that focus on the usefulness of the knowledge that research can create. For example, Feilzer (2009) noted the strive for integration in mixed method research and how pragmatism can be a research paradigm applied to facilitate this. Hanson (2008) questioned the usefulness of the qualitative/quantitative division wondering if it was more of a convention than anything else? Interestingly and of relevance to this research, given the explicit focus on the links between test and outcome (Desoete, 2008), Hanson (2008, p. 107) also argued that the validity of a method is defined by "the relationship between theory and method". This idea of matching up theory and method was reflected in the inclusion and exclusion criteria of the systematic review (inclusion required a clear description of the concept being measured, see 2.1.4).

The proposed analysis in this study incorporated both qualitative and quantitative elements in a mixed methods approach. The coding scheme was qualitative and deductive by nature but the data was analysed using mixed methods. Quantitative analysis of trends relating to aspects of the qualitatively applied coding scheme was accomplished via the cross tabulation of different aspects of the coding scheme and age group. The qualitative analysis was effective in providing a means of zooming in, looking in more detail at the text on the PVTs. This closer look explored the data inductively, both looking for trends and

supporting trends identified in the quantitative analysis. Pragmatism aside, it is clearer to present the planned quantitative and qualitative analysis in this study separately below. This itself is not un-problematic given the debates outlined above and there are methods used in this study, including word clouds (3.8.2), that most definitely cross the boundaries in terms of qualitative and quantitative data emerging from a quantitative research tool (Feilzer, 2009).

3.8.1. Statistical analysis based on Wall (2008) and Wall et al. (2012)

After detailed consideration, reading, consulting previous analysis of PVT data (Wall, 2008; Wall et al., 2012) and seeking advice from statistical experts; the researcher took a pragmatic approach to analysis that included both parametric and non-parametric statistical analysis completed in SPSS. What follows outlines the approach to statistical analysis in terms of both comparisons to previous analysis and the differences and contribution of the analysis that will be presented in 4.2. The statistical analysis adopted in this study comprised a series of one-way analyses of variance (ANOVA) with post-hoc testing to explore relationships between age group and the individual dependent variables. Field (2013, p. 870) defined ANOVA as:

> *[testing] the overall fit of a linear model. In experimental research this linear model tends to be defined in terms of group means, and the resulting ANOVA is therefore an overall test of whether group means differ.*

The statistical analysis in 4.2 therefore explores whether group means for the four age groups (Reception and KS1, KS2, KS3 and KS4) differ across the four dependent variables included in the statistical analysis (information gathering, building understanding, productive thinking and metacognitive knowledge).

The statistical analysis in 4.2 is based on, but does not exclusively replicate the analysis of PVTs in previous research (Wall, 2008; Wall et al., 2012). The analysis in 4.2 does include four of the dependent variables included in previous analysis, namely the three cognitive skills from the Moseley model and metacognitive knowledge. This means that comparison is still possible. The analysis in 4.2 is different to previous analysis in two key ways:

1) The unit of analysis if number of text units as opposed to number of words – text units refer to units of text that make sense and not the number of words within this unit of sense.

2) The dependent variable metacognitive skilfulness that was included in previous analysis (Wall, 2008; Wall et al. 2012) was not included – Chapter 2 explored the usefulness of the online/offline distinction in relation to metacognition, in particular metacognitive skilfulness. Established belief argues that metacognitive skilfulness is best explored 'online' and PVTs are 'offline'. It is beyond the scope of this study to explore the overlap between metacognitive knowledge of strategy and metacognitive skilfulness in detail, therefore the analysis focuses on metacognitive knowledge.

On reflection of the key differences presented above, a comparative analysis including metacognitive skilfulness is included in Appendix D. This comparative analysis replicates the analysis, in terms of both dependent variables and unit of analysis, which was presented in previous research (Wall, 2008; Wall et al. 2012). Although not a main focus or research question, this comparative analysis is useful both to examine the utility of the coding applied (Table 12) in comparison to previous research and the differences (or similarities) in statistical analysis as related to the unit of analysis applied. The comparative analysis in Appendix D and discussion and comparison with the findings presented in 4.2, serves to assist in evaluation of the analysis applied to this sample of PVT data. It also helps to problematize the limitations in metacognition research that can present from the online/offline distinction in relation to metacognitive knowledge and metacognitive skilfulness.

Although the comparative statistical analysis presented in Appendix D facilitates evaluation on more than one level, the differences in the analysis presented in 4.2 and existing analysis (Wall, 2008; Wall et al., 2012) do compromise the survey aim (1.2.2) to some extent. The survey aim is not upheld in 4.2 in relation to the unit of analysis and the exclusion of the dependent variable metacognitive skilfulness. This compromise is partially reconciled by the progress that these differences facilitate in debate around the usefulness of the online/offline distinction in relation to data collection tools including PVTs. The inclusion of a more fine-grained consideration of sub-categories of metacognitive knowledge (person, task and strategy) facilitates consideration of the overlap between metacognitive knowledge of strategy and aspects of metacognitive skilfulness. However, despite the

development of the analysis of metacognitive knowledge the minimum cell sizes required for accurate and robust statistical testing excluded these sub-divisions from the statistical analysis. Statistical analysis in 4.2 therefore includes only the overarching category of metacognitive knowledge. The approach to analysis of metacognitive knowledge of person, task and strategy is rather a combination of descriptive statistical exploration of the percentage of text units and qualitative analysis (3.8.2) of the sophistication of pupil comments about their learning.

The parametric statistical analysis in 4.2 was supported by a secondary non-parametric data analysis comprising Kruskal-Wallis H test (plus post-hoc testing) (4.2.2). It was important to acknowledge and explore the challenges that statistical analysis of the data presented, but also to recognise that to the researchers' knowledge, and that of the 'experts' consulted, there were no 'perfect' statistical tests for this data. The mixed method analysis is important in this sense, to explore the data from as many angles as possible. One might conclude then that if the same type of trends were emerging despite the challenges of the data set it would seem appropriate that the results of this study could be confidently discussed based on a practical, multi-dimensional analysis that included both parametric and non-parametric testing.

Cross-tabulated data exported from NVivo was used as the basis for both parametric and non-parametric statistical analysis, the cross tabulations were completed to explore trends in the dependent variables across different age groups. Initially, this involved producing charts to summarise the data visually and identify key trends that would require further investigation to see if they were statistically significant or not. The charts produced provided a useful means of identifying potential developmental trends in the PVT data, which were then further explored using statistical analysis in SPSS. The statistical testing conducted required that the number of participants in each group (described as cell size) were as even as possible. The evenness of the cell sizes contributes to the robustness of statistical testing and therefore had an impact on decisions about how to group the different age groups of participants. It was important that age groupings were related to age groupings in schools, but also that they were fairly even in numbers for the application of statistical analysis. The lower numbers of participants in KS4 listed below deviated from this assumption slightly, however based on the continuing need to be pragmatic and acknowledge that this research was conducted in the 'real' world of the participating schools, the following age groups were decided on:

- Reception and KS1 (n = 96)

- KS2 (n = 128)

- KS3 (n = 96)

- KS4 (n = 54)

It was not appropriate to combine KS3 and KS4 therefore achieving one category to represent all the year groups in secondary school, especially given there were separate age groups within the primary school. Furthermore, initial exploratory data analysis revealed differences in some trends between KS3 and KS4 that would have been lost in the final analysis if they were combined.

Normality testing preceded the statistical analysis, this included a visual exploration the data to examine its distribution and assist with the selection of appropriate tests and procedures. Figure 17 illustrates the non-normal distribution of the data, however for the conditions explored separately across the dependent variables (e.g. age group) the distribution within and between dependent variables was similar. The distribution of the data in this study was assessed by visual inspection of histograms. Examples from building understanding are shown in Figure 17; the histograms show that the four different age groups all spiked at zero and that they also all had long tails. Each of these features pulls the mean in opposite directions so we might consider that this would even things out. We can see from the 'normal' lines also plotted on the histograms that the deviations from normality in terms of the distribution of the data are fairly similar. Histograms for the remaining dependent variables are located in Appendix C.
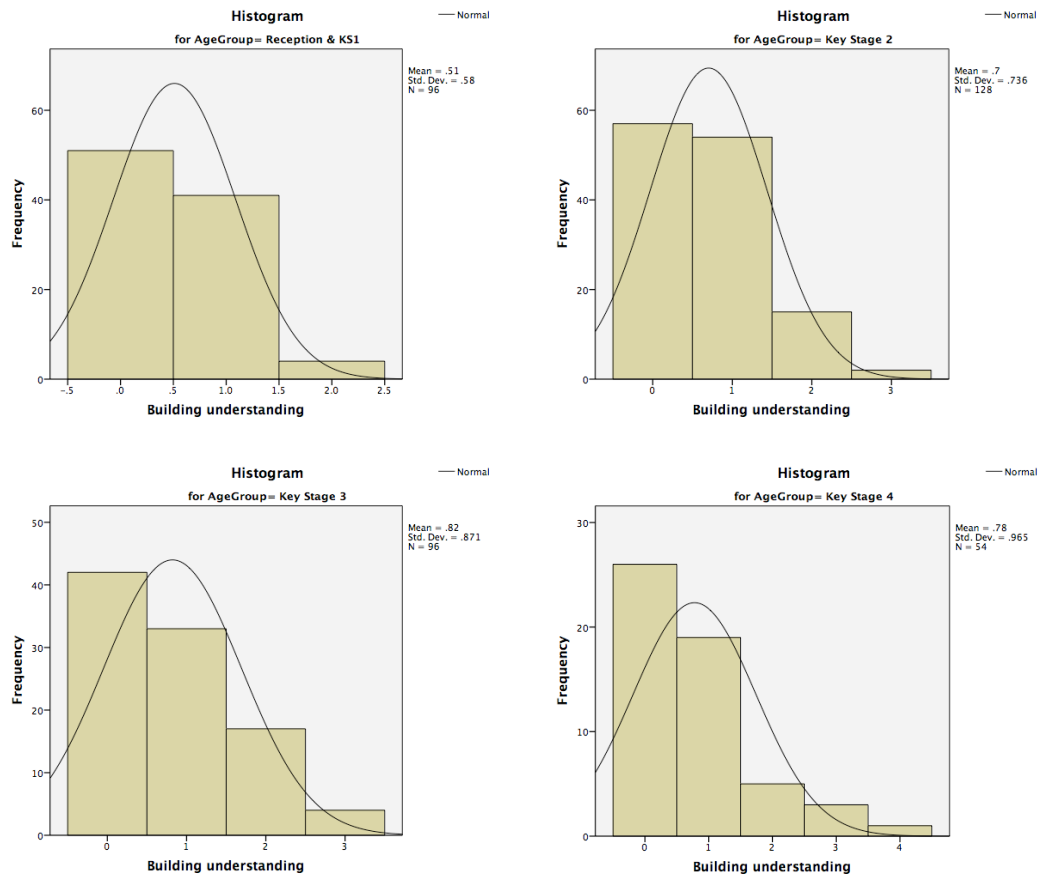
Figure 17: Similarity in the non-normal distribution of building understanding across the four age groups

Despite assurances about a pragmatic approach and the non-normality of the data set, there was extensive discussion about the PVT data with relevant statistics experts around the number of zeros in the data set. Conversation centred on whether or not the potential problems, in particular relating to the lack of normal distribution in the data, could be overcome by excluding these zeros from the data analysis. From the beginning of these discussions the researcher was uneasy about the prospect of not including the zeros, if a particular student's PVT had a '0' for information gathering, this was not to say that they could not do this. Indeed, there are examples of participants from all age groups, from Reception to Year 11, that show zeros for information gathering. The PVT completion was not a test to see if each student could demonstrate awareness of each of the cognitive skills and facets of metacognition in the deductive coding framework. Importantly these had not been shared with the participating students. In addition, the zeros themselves can be considered meaningful in PVT data; they could potentially highlight general trends in increases and/or decreases or pauses in the dependent variables. To satisfy curiosity about

the zeros in this data the researcher used SPSS to select all of the cases (individual case = 1 student) where there were no zeros and this left less than 50 templates from the original 374, this was a clearly unworkable sample with less than 10 templates in each year group.

Popular statistics textbooks including Field (2013) and statistical experts consulted by the researcher, suggested that transformations can be applied to data in order to correct deviations from a normal distribution. Due to the number of zeros in this data set a square root transformation was applied to all of the dependent variables to see if this would make a difference to the normality of the data (the differences between the means and medians, and the outcomes of statistical testing for normality). The square root transformation did alter the level of difference between the means and the medians (this became marginally smaller as shown in Table 13). However, the square root transformation did not make a big difference in respect of normality. Tabachnick and Fidell (2013) noted that it is essential to check that the variable is normally distributed after transformation; in this case normality was not achieved prior to the transformation or after. Ultimately the data was analysed in its raw state, there was no difference in terms of test significance for the analysis of variance when the transformation was applied compared to when it was not applied.

Table 13: Means and medians for each of the dependent variables (non-transformed and transformed)

Dependent Variable	Age Group	Non transformed dependent variable			Transformed dependent variable (SQRT transformation)		
		Mean	Median	Difference	Mean	Median	Difference
Information Gathering (IG)	**R&KS1**	1.22	1.00	.22	.95	1.00	.05
	KS2	1.22	1.00	.22	.92	1.00	.08
	KS3	1.67	1.00	.67	1.13	1.00	.13
	KS4	1.96	2.00	.04	1.09	1.41	.32
Building Understanding (BU)	**R&KS1**	.51	.00	.51	.49	.00	.49
	KS2	.70	1.00	.30	.61	1.00	.61
	KS3	.82	1.00	.18	.67	1.00	.67
	KS4	.78	1.00	.22	.62	1.00	.48
Productive Thinking (PT)	**R&KS1**	.19	.00	.19	.18	.00	.18
	KS2	.37	.00	.37	.34	.00	.34
	KS3	.48	.00	.48	.40	.00	.40
	KS4	.81	1.00	.19	.63	1.00	.47
Metacognitive Knowledge (MK)	**R&KS1**	.35	.00	.35	.32	.00	.32
	KS2	.66	.00	.66	.55	.00	.55
	KS3	1.01	.00	1.01	.68	.00	.68
	KS4	1.46	1.00	.46	.93	1.00	.07
Total	**-**	-	-	6.07	-	-	5.84

Statistical testing was completed in the knowledge similarity in the non-normality of the data by visual inspection (Figure 17). There is widespread debate in the literature about

the robustness, or not, of parametric testing for data that is not normally distributed (Brace,
Kemp, & Snelgar, 2012; Finch, 2005; Schmider, Ziegler, Danay, Beyer, & Bühner, 2010). The
researcher consulted colleagues and read widely to conclude that because of the reasons
listed below that the parametric tests (ANOVA) would be fairly robust to the deviations from
normality identified in the data set:

- The distribution, although not normal, was similar across different
  conditions for the different dependent variables.
- The sample size of n = 374 was relatively large
- The observations were independent
  and
- The sample had a degree of randomness (the researcher did not choose the
  participants; they were selected largely on the day as willing participants by
  their class teacher below).

Indeed in recent literature, Schmider et al. (2010) noted that for ANOVA popular advice
recommends a sample size of no less than 25 for each condition "to circumvent possible
negative influences of violations of normality assumptions…", in this study the lowest
sample in terms of age group, is KS4 (n= 96). In addition, the secondary non-parametric
analysis would further bolster the robustness of the approach to quantitative analysis in this
study. Although the data in this study is not without challenges, this section has
demonstrated that the most appropriate and robust approach is parametric analysis
supported by non-parametric analysis.

Although not always advised, due to the fact it is thought to be less powerful (Finch,
2005), the parametric approach presented here was supported by a non-parametric
approach. Non-parametric testing is not as assumption free as is sometimes thought, there
are arguments both for and against the view that non-parametric tests are less powerful and
therefore a more 'robust' parametric test would be a better approach (Field, 2013). The
Kruskal-Wallis H test applied in this study looked at the relationship between age group and
the individual dependent variables. Significant results were followed up with individual
Mann-Whitney U tests. Looking at the parametric and non-parametric pairwise
comparisons, showing which age groups have significantly different scores, the results are
comparable (4.2.3). There were more significant pairwise comparisons for the parametric
analysis, but this is to be expected if upholding the belief that the power of non-parametric
testing is not as great.

3.8.2. Qualitative data analysis

Qualitative data analysis in this study centred on using examples from the PVT data to support quantitative trends identified, but more importantly to illustrate exploratory qualitative findings. Qualitative data analysis was not restricted by sample sizes, therefore analysis was conducted at year group level, as well as the age groups used in the quantitative analysis. Given the focus of this research on developmental trends in metacognitive knowledge, the qualitative findings are presented in such a way as to highlight the development, or not, of a particular aspect of the coding scheme with age. The different ways in which the qualitative data analysis has been presented, in addition to giving excerpts in the narrative, are outlined below.

Developmental trends explored in this study are more clearly organised by way of diagrams as opposed to multiple excerpts presented in the narrative. To this end, in order to clearly explore qualitative trends and validate quantitative findings relating to developmental trends, excerpts from PVTs will be presented in ladder form. Ladders for particular cognitive skills and aspects of metacognition will illustrate changes and development from the youngest age group (Reception class) to the oldest (Year 11). Another innovative aspect of this study is its use of word clouds to support data analysis and also to analyse data in its own right. What follows will explain in more detail the position and application of word clouds in the current literature and how they have been applied in this study.

Word clouds are a "fast and visually rich way to enable researchers to have some basic understanding of the data at hand" (McNaught & Lam, 2010, p. 630). They crossover between qualitative and quantitative, therefore fitting in well with the mixed methods approach in this study. Word clouds are a quantitative method because they systematically interrogate and order words according to their frequency; the frequency of each particular word is directly related to the size of the typeface used in the word cloud. However, the word cloud itself is primarily explored in a qualitative way by looking at the 'cloud' produced and unpicking key trends in the frequency of the different words included. In the analysis of the empirical data in this study both the word cloud and the preceding word frequency data will be used for purposes of analysis and discussion. Word clouds are somewhat experimental in research to date and have not been studied nor applied to their full potential.

Qualitative analysis using word clouds can be used to support and validate trends already identified in previous analysis (McNaught & Lam, 2010; Peskin & Astington, 2004), but they may also highlight additional themes and trends in the data. In light of this, Cidell (2010) noted that word clouds, also referred to as content or tag clouds, can be used as a form of exploratory qualitative analysis. In this thesis word clouds provide a useful exploratory technique to summarise and explore trends in the types of vocabulary used to describe learning by students in different year groups.

NVivo was used to produce word frequency counts that were presented as the top 20 most frequently used words for each year group. Word frequency counts and their associated word clouds were then explored in relation to literature about metacognitive vocabulary and the development of this (Miscione et al., 1978) (see 2.3.2). Word cloud analysis then applied at year group level to explore trends in the vocabulary used by students of different ages in smaller age groups than Key Stage based age groups; the focus is on age groups and trends within these as opposed to individual participants. Word clouds can be analysed in their own right, but can also be used as a means of synthesising the other quantitative and qualitative analysis. Significant trends identified in the quantitative data analysis of this study will be further explored using qualitative analysis that will include word clouds. In addition, word clouds may identify trends that are then followed up with quantitative analysis.

The mixed method approach and the use of methods like word clouds that blur traditional quantitative and qualitative boundaries, requires an in-depth consideration of reliability and validity. The methodological discussion that follows will include consideration of the reliability measures applied in this study and will summarise a consideration of ecological validity within this study.

3.9. Reliability, Validity, Ethical Considerations & Limitations

Bryman (2008) noted the central importance of three main criteria in social research: reliability, replication and validity. Reliability is intrinsically linked to replicability in that "it is concerned with the question of whether or not the results of a study are repeatable" (p. 31). This notion of a study being repeatable then links to its validity, which is primarily concerned with the integrity of the conclusions that are drawn from the research. In qualitative research like this, it is key to have a detailed data collection protocol. In this study the protocol detailed in 3.6.2 was followed throughout the data collection in all three of the

participating schools. Alterations to this protocol (e.g. those based on a consideration of age) were applied consistently for all participants of that age in all of the participating schools. This control over as many variables as possible is essential when using a qualitative data collection tool, so that the replicability of the tool and reliability and validity of the findings can be as robust as possible. The link between theory and method is perceived by some as validity and one of the most important considerations in choosing a method (Hanson, 2008). Construct validity, or the validity of the measurement, is clearly related to replicability. If different studies have used the same research tool to measure or assess the same concepts (e.g. PVTs to explore cognitive skills and metacognition) and they are stable in the trends described reliability between different raters, this is a good indication that the measurement is valid, reliable and replicable.

3.9.1. Ecological validity.

Ecological validity has not been discussed at length in previous research using PVTs, but the familiar worksheet format of PVTs has been discussed (Wall & Higgins, 2006). Having reflected at length on the use of PVTs as a data collection tool, their potential to facilitate ecological validity was important to this study. Ecological validity is defined by Bryman (2008, p. 33) as a criterion that is "concerned with the question of whether social scientific findings are applicable to people's every day, natural social settings". Findings clearly have to begin with planning and research design and therefore choice of research tool. The researchers' experiences as a teacher and discussions with the participating schools confirmed that PVTs are a research tool not dissimilar to regular classroom activities. With these ideas in mind, prior to data collection staff from participating schools looked at the templates and the researcher explained how they would be implemented for this research. The authenticity of PVTs, in terms of being a classroom-based activity, was also discussed. The consulted staff thought that PVTs would be an authentic activity in their schools. PVTs are a familiar worksheet format, they are not an out of the ordinary type of classroom activity (worksheet combined with group discussion). Even though the PVT focus groups in this research involved participants working in small groups outside of the classroom, this was not thought by the teaching staff consulted to be too out of the ordinary.

3.9.2. Ethical Considerations

Ethical considerations are of key importance when conducting research with children and young people and in schools. What follows will discuss the following areas key in the ethical considerations of this study:

- Agreement, consent and gatekeeping
- The individual's choice to participate
- The ownership of the data
- The anonymity of the data collected

Importantly, previous research using PVTs (Wall, 2008; Wall & Higgins, 2006) places the origins of the gathering pupil perspective and views of learning, firmly within Article 12 of the UN Convention of the Rights of the Child (United Nations Convention on the Rights of the Child, 1989). This research was granted ethical approval from the School of Education Ethics Committee in May 2012; no changes were required to the planned study when approval was granted.

Bazeley (2013) noted the importance of seeking and maintaining clear agreements with the stakeholders in qualitative research, in this case the students were of course the main stakeholders. Participating students in the three schools were in the care of the head teachers and other senior staff (gatekeepers of access to the school). In terms of consent, clearly explaining the aims of the research and how it would be conducted were essential components in early discussions with all of the participating schools. Anonymity of all students was assured from the beginning. With regard to gaining consent from children and young people in schools, The British Psychological Society's (BPS) Code of Human Research Ethics stated that:

> *…where the research procedures are judged by a senior member of staff or other appropriate professional within the institution to fall within the range of usual curriculum or other institutional activities, and where a risk assessment has identified no significant risks, consent from the participants and the granting of approval and access from a senior member of school staff legally responsible for such approval can be considered sufficient.*

> *(BPS, 2010, p. 17)*

Robson (2011) made an important point about the ethics of gatekeeping that has been clearly considered within this research: even when permissions are granted from a

gatekeeper "it is important to remember that the informed consent of individual children and young people must still be sought" (p. 213). The data collection protocol (3.6.2) explained how staff in each school were asked to select participants, participants who after having had the research explained to them wanted to participate. At the beginning of each PVT session in the schools, the research project was explained to the students using age appropriate language and students were given the opportunity to decline participation and/or withdraw at any point. It was explained to students that they did not have to complete any parts of the PVT that they did not wish to. The process followed in this research to gain consent, fits with the BERA (2011) assertion that children should be aided to give fully informed consent and that "Researchers must take the steps necessary to ensure that all participants in the research understand the process in which they are to be engaged, including why their participation is necessary, how it will be used and how and to whom it will be reported (p. 5)."

In terms of ethics, it was important to acknowledge and problematize the ownership of each individual participant's PVT. The physical nature of the research tool and data is one aspect contributing to the complexity of education research and the associated ethical considerations necessary where pupils are involved in research in schools (Baumfield, Hall, & Wall, 2008). There is a point to be made here about power relations, potential imbalances and the ownership of the physical research data. There were inevitable power imbalances given that the researcher was an adult conducting research with children. One of the aims of the development of PVTs centres on seeking to mitigate these inevitable power relations, the PVT mitigating in dialogue between teacher (or researcher) and pupil where the power relations are usually unequal (Wall et al., 2012). Shaw, Brady, and Davey (2011, p. 15) noted that it is important to acknowledge, "the natural power imbalance between adult (researcher) and child (participant), and the effect that this is likely to have on the data collected". With this in mind, the wide variety of content of the PVT data does seem to show that participants completed their PVTs in a fairly relaxed setting. The researcher made it clear from the outset that they were not a teacher (in the participating school) and asked the children to be as honest as they felt they could in their responses. Some of the responses on individual PVTs named specific staff members, students and lessons from which it can be inferred that students were confident that their responses were indeed to be treated anonymously.

Included in the explanation of the research at the beginning of each focus group, it was explained that the researcher would like to take away the individual PVTs to help with the research. The researcher explained that only anonymous data would be used in the research and that feedback to the schools would also be anonymous. Baumfield et al. (2008) emphasised the importance of closing the feedback loop in terms of research being ethically good, in this study although students did not keep their individual PVTs, it was explained to them and their teachers that the findings of the study would be fed back via the school throughout the analysis process. Each student was asked to give me their PVT at the end of each session and no students appeared outwardly unwilling to do this. The ecological validity of PVTs was discussed in3.9.1, in terms of the similarity of PVTs with other common classroom worksheet type activities which are 'handed in' at the end of a lesson this is not dissimilar. The researcher acknowledged that the notion of work not being returned to students may be more normalised perhaps for older students who are accustomed to sitting exams or indeed those who have participated in research before, indeed it may have been easier for the older students to comprehend the reasons that the researcher gave for wanting to take away their completed PVTs. Returning PVTs to individual students at the time of the research was not possible for several reasons including time pressure and lack of copying facilities for the researcher to use in the participating schools. The researcher also had concerns that if copied, the potential lessened quality of the copied PVTs may increase the difficulty of transcription.

Transparency was key here in terms of ethical considerations; the researcher was open and honest with the student participants and schools throughout the process. During explanations regarding taking away the completed PVTs, the notion that it was each individual student's choice to participate was reemphasised. Looking back at research notes made in the field, there was not a point during the data collection where a student appeared to be begrudgingly participating in the activity. Of course this is the opinion of the researcher, it must be considered in discussion about and reflection on the data collection. Two students in the sample did not write anything on their PVTs, although it is not possible to know for certain why this happened it might have indicated a choice taken by these students not to participate.

Preserving the anonymity of the participants in this study was not only important for ethical reasons but it also eased the process of recruiting schools, schools seemed more willing to participate when they knew identifiable data and information about their pupils

would not be collected (e.g. date of birth was not collected). The anonymity of the data meant that the head teachers of the respective schools were agreeable for the students to participate, if they wished to, without having to seek individual parent or guardian permission for each participating student. A copy of the consent form signed by a representative from all three schools is available in Appendix B.

3.9.3. Limitations of the methodology & research design

Acknowledging the limitations of a study is an important point to consider, even before presenting the results, discussion and conclusions. An awareness of limitations in the methodology and research design is key in their consideration in relation to the results and subsequent conclusions. For this study, key limitations included:

- **TIME CONSTRAINTS**: the time constraints of one researcher being responsible for collecting, transcribing and coding all of the data. Despite the high inter-rater reliability in this study, the fidelity of the data collection process itself was not assured in that it was not observed and agreed.

- **SAMPLING**: the difficulties of maintaining a strict sampling process in the participating schools. There were some issues with children not attending the focus groups in the secondary school; logistically this was difficult as the participating children were often coming from different areas within the school. The 'travel time' to the focus group was not an issue in the primary school data collection. Setting the minimum number of participants at 30 and conducting extra focus groups allowed the researcher to minimise (as far as possible) deviation from the proposed sample size of 32 per year group.

- **CONTEXT (including teachers)**: the influence of teachers and/or the lessons that children had been excused from to participate in the focus groups. The lesson the child was in immediately before may have influenced their completion of the PVT. Additionally, the influence of the teachers (although not present at the focus groups) was important. For example, in the primary school one class teacher may have used more metacognitive, language about thinking and learning than another. It was not possible to accommodate this in the study design but it should be considered in the subsequent chapters.

- **RESEARCH TOOL**: this study seeks to build upon and develop existing research using PVTs; the more systematic sample is the primary way in which this study contributes. PVTs have been used with a wide age range but they have not been completed systematically across a wide age range, using one template. This may have presented problems in terms of age appropriateness and the need to scribe for some of the younger children, as scribing likely increased the researchers' involvement with some children (and the potential associated bias).

3.10. Summary

Undoubtedly the analysis and discussion of the PVT data in Chapter 4 will underline further limitations; these will be discussed in detail in 4.4. Having discussed in detail the research design and methodology of this research (alongside reliability, validity, ethical considerations and potential limitations) the next chapter will present the results of this study with discussion focussed on the research questions identified in 1.3.1. The mixed method approach adopted in this study is reflected in the structure of this chapter; the statistical analysis will be presented first, to aid clarity where the quantitative analysis is concerned, this will be followed by an exploration of the evidence (both qualitative and quantitative) to address each research question in turn and also discuss the significance of the results presented.

Chapter 4 - Results and Discussion

The results and discussion have been purposefully positioned alongside each other, within this one chapter. This decision facilitates a strategic exploration of the data gathered in this study alongside the research questions identified in 1.3.1. This chapter is presented in this way to make clear the close connections between both the quantitative and qualitative results in this mixed method approach; and the implications discussed in relation to the results. The discussion is required alongside the presentation of results in order to clearly understand the implications of the results presented. The structure of this chapter is as follows:

- A summary of the data set analysed, including biographical details of the sample
- Presentation of the statistical analysis based on Wall (2008) and Wall et al. (2012). The location of this analysis (parametric and non-parametric) at the beginning of this chapter facilitates ease of reference for the subsequent presentation and discussion of the results around each research question
- Presentation and discussion of the results for each subsidiary research question identified in 1.3.1 – this will present a mixed method approach to the presentation and discussion of results. Quantitative and qualitative results will be presented and discussed alongside each other
- A discussion of the results of this study in relation to the overarching research question. This will include the presentation and discussion of results in relation to word frequency trends in the PVT data, linking to the exploration of the links metacognition and literacy (including metacognitive vocabulary) in 2.3.2 and initiated in the systematic review (2.1). The exploration of metacognitive vocabulary in PVT data is one of the original contributions that this study makes
- A discussion of the limitations of the methods used in this study in relation to the results presented and a discussion of what can be learnt from this
- In light of discussion around the limitations of this study, a discussion of what has been learnt about research with PVTs and wider research in the field of metacognition

The latter discussion around the contribution and limitations of this study provides a clear link to Chapter 5 (Conclusions), which includes a concise consideration of the implications of this study alongside ideas for development and further research.

4.1. Summary of the Data Set Analysed

In order to envision the scale of the data collected in this study it is important to present it in relation to the biographical data of the participants. Data from 374 PVTs was analysed, within these 374 templates there were 931 units of text to analyse (10386 words in total). Table 14 illustrates how these text units and numbers of words were distributed across the sample. Table 14 illustrates that the participants in this study were 374 students of compulsory school age; the sample comprised 188 males and 186 females. The youngest student to participate was 4 years old and the oldest 16 years old. It is important to note at this point that the research set out to have 32 templates per year group equally divided by gender, this would have given a total sample size of 384 (192 males and 192 females). Two PVT examples per year group are located in Appendix C.

This research was conducted whilst complying with the requirements of the schools, in particular with regards to timetabling the PVT focus groups. Schools are busy and at times changeable in terms of demands placed on the time of both staff and students. It is not always possible when researching in the field to control all variables strictly including focus group sizes; there is an inherent element of flexibility required. As such the target of 32 templates per year group was not achieved for every year group, Years 9, 10 and 11 fell below this target of 32. Difficulties in reaching the target for some year groups in the secondary school stemmed from difficulties around logistics associated with data collection in a large secondary school. Discussion on the day(s) of data collection informed the knowledge that some of the selected students were not present in school or in a particular lesson on the day of data collection. In the example of Year 11 it was unfortunate that the scheduling of the data collection was close to the time of GCSE exams. It was not possible for the school to schedule data collection with this year group before this time therefore the sample was lower than expected.

Given the logistics of data collection discussed above, especially in the secondary school, the decision was made that if the numbers of participants for an individual year group fell below 30 students, an additional group would be created. It was not possible to do this for the Year 11 sample due to their having left school. It was the aim to make the participant numbers as close to 32 per year group as possible and at least above 30 students. Despite deviations from expected numbers and from the planned even gender split in each focus, Year 10 and Year 11 were the only year groups that did not have even numbers of males and females in their total samples. Acknowledging departure from the

planned sample size and being explicit about the reasons for this as well as precisely
showing the actual sample size, contributes to the transparency of this study. This explicit
recognition of limitation in terms of sampling also goes some way to responding to critique
of existing education research around the reporting sample sizes and the impact that this
can have on presenting the results and drawing conclusions (Tooley & Darby, 1998).

Table 14: Biographical details of participants & summary of data set

Key Stage (age range)	Year Group	Age (years)	Mean age (years)	Participants			Total number of text units	Total number of words
				Total	Male	Female		
Reception	Reception	4-5	4.8	32	16	16	52	411
Key Stage 1	Year 1	5-6	5.7	32	16	16	65	427
	Year 2	6-7	6.7*	32	16	16	67	507
Key Stage 2	Year 3	7-8	7.8	32	16	16	61	577
	Year 4	8-9	8.7	32	16	16	64	857
	Year 5	9-10	9.9	32	16	16	81	937
	Year 6	10-11	10.6	32	16	16	74	910
Key Stage 3	Year 7	11-12	11.7	34	17	17	115	1249
	Year 8	12-13	12.6	32	16	16	80	1090
	Year 9	13-14	13.8	30	15	15	89	1076
Key Stage 4	Year 10	14-15	14.5	31	16	15	95	1245
	Year 11	15-16	15.7*	23	12	11	88	1100
TOTAL	-	-	-	**374**	**188**	**186**	**931**	**10386**

Note: * In the Year 2 and Year 11 samples one participant in each did not record their age in years, they had recorded their year group so this did not have a big impact upon the approach to analysis in terms of age groupings.

Although the purpose of Table 14 is to summarise, it does indicate some tendencies with
regards to the unit of analysis and how this may link to age. Table 14 shows that the number
of 'text units' per year group peaks at the beginning of KS3 for Year 7, but also that in the
secondary school (Key Stage 3 and Key Stage 4) the number of words is fairly constant and
the range is only 173 words. The peak in Year 7 cannot be explained, but some of this may
be attributable to the enthusiasm of a year group who are perhaps still quite excited about
being in a new school. The secondary school in this study (see Figure 14) was very large
compared to its feeder primary schools; this implied a potentially big change in terms of
school environment for many of the Year 7 students.

4.2. Statistical Analysis Based on Wall (2008) and Wall et al. (2012)

As outlined in 3.8.1, the statistical analysis element of this study is prompted by previous
research using PVTs (Wall, 2008; Wall et al., 2012). The analysis in this section has
dependent variables in common with previous analysis (information gathering, building

understanding, productive thinking and metacognitive knowledge), but it does not include metacognitive skilfulness. In addition, the unit of analysis used in this analysis, is units of text (making sense) as opposed to number of words (see 3.7.3). The analysis presented in this section can be considered alongside an additional analysis included in Appendix D, which is closer to previous research using PVTs including the metacognitive knowledge/skilfulness distinction. Appendix D includes a comparison of the results presented here and those replicated based on previous research, this helps to achieve the survey aim of this study as well as to more directly build on the established PVT research field. However, in this section the critiques of metacognitive skilfulness as a concept will be upheld and the focus will be on metacognitive knowledge. This will establish a base for the more fine-grained mixed method analysis needed to answer the research questions presented in 1.3.1.

The statistical analysis presented in this section comprises:

- Parametric testing: One-Way Analysis of Variance (One-way ANOVA) of the dependent variables (cognitive skills based on the Moseley model and metacognitive knowledge). The ANOVA's were followed up with post-hoc testing (Games-Howell).
- Non-parametric testing: The Kruskal-Wallis H Test was used in addition to the one-way ANOVAs due to the non-normality of the data (3.8), post-hoc testing for this test was the Mann-Whitney U Test.

4.2.1. Parametric data analysis

The parametric data analysis presented in this is presented with reference to APA conventions (Nicol & Pexman, 2010). The parametric data analysis (a series of one-way ANOVAs) aimed to explore potential relationships between the five dependent variables (Information Gathering, Building Understanding, Productive Thinking and Metacognitive Knowledge) and the independent variable of age group based on Key Stage groupings in the English education system (see 3.5.3). The parametric data analysis presented in this section is directly pertaining to the following subsidiary research questions from 1.3.1:

iii. In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as cognitive skills (Moseley et al., 2005a)?

iv. In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as metacognitive knowledge?

The results presented in this section will be combined with additional evidence and discussion of the results in relation to each of the subsidiary research questions in sections 4.3.1 to 4.3.4.

A modified version of ANOVA (Welch's-F Ratio) was required in the analysis that follows, because the assumption of homogeneity of variances was violated for all five dependent variables (as assessed by Levene's Tests of Homogeneity of Variance, $p = < .05$ in all cases) thus the variances were heterogeneous. Welch's-F Ratio (F) provides a more robust test of the equality of means. In the one-way ANOVAs, Omega squared (ω^2) was used to calculate the effect size rather than eta-squared (η^2). Eta-squared is based on sums of squares from the sample, with no adjustment for estimating the effect size in the population as there is in omega squared (Field, 2013). The results of the one-way ANOVA and follow up for each of the dependent variables will be presented in turn after the summary tables. Table 15 presents each of the dependent variables (cognitive and metacognitive) and details the mean and standard deviation for each age group contained within the independent variable (Age group). Table 16 gives the results of the one-way ANOVAs (including the calculation of effect size) and Table 17 presents the post-hoc testing.

Table 15: Means and Standard Deviations for Four Age-Groups and Four Dependent Variables

Dependent Variable	Age Group							
	Reception & KS1		KS2		KS3		KS4	
	M	SD	M	SD	M	SD	M	SD
Information Gathering	1.22	.91	1.22	1.03	1.67	1.53	1.96	2.11
Building Understanding	.51	.58	.70	.74	.82	.87	.78	.97
Productive Thinking	.19	.42	.37	.59	.78	.08	.81	1.05
Metacognitive Knowledge	.35	.60	.66	.82	1.01	1.36	1.46	1.67

Table 16: One-Way Analysis of Variance for the Effects of Age Group on Four Dependent Variables

Variable & source		SS	MS	Welch's F Ratio			
				F	df	p	ω^2
Information gathering	Between	30.665	1.22				
	Within	673.54	1.82				
	Total	704.21		4.075	3, 159	.008	0.04
Building understanding	Between	5.22	1.74				
	Within	222.03	.60				
	Total	227.25		3.621	3, 165	.014	0.02
Productive thinking	Between	14.29	4.76				
	Within	176.47	.48				
	Total	190.76		8.749	3, 159	<.001	0.07
Metacognitive knowledge	Between	49.64	16.55				
	Within	441.25	1.19				
	Total	490.89		13.063	3, 154	<.001	0.09

Notes:
The formula used to calculate ω^2 is as follows:

$$\omega^2 = \frac{SS_M - (df_m)MS_R}{SS_T + MS_R}$$

Where SS_M = between-group effect, MS_R = the within-subject effect, SS_T is the total amount of variance in the data and df_m is degrees of freedom for the effect (Field, 2013).
.01 = small effect, .06 = medium effect, .14 = large effect (Kirk, 1996) as cited by Field (2013).

Table 17: Results of post-hoc testing for one-way ANOVAS (Games-Howell) showing significant interactions between specified age groups

Dependent variable	Pairwise comparison	Mean difference (I – J)	SE	*p*	95% confidence interval		*d*
					Lower bound	Upper bound	
Information gathering	R&KS1 – KS2	.000	.130	1.000	-.34	.34	-
	R&KS1 – KS3	.448	.182	.070	-.92	.02	-
	R&KS1 – KS4	.744	.302	.075	-1.54	.05	-
	KS2 – KS3	.448	.181	.068	-.92	.02	-
	KS2 – KS4	.744	.301	.074	-1.54	.05	-
	KS3 – KS4	.296	.327	.802	-1.15	.56	-
Building understanding	R&KS1 – KS2	.193	.088	.129	-.42	.03	-
	R&KS1 – KS3	.313	.107	.020	-.59	-.04	.40
	R&KS1 – KS4	.267	.144	.256	-.65	.11	-
	KS2 – KS3	.120	.110	.697	-.41	.17	-
	KS2 – KS4	.075	.147	.957	-.46	.31	-
	KS3 – KS4	.045	.159	.992	-.37	.46	-
Productive thinking	R&KS1 – KS2	.180	.067	.040	-.35	-.01	.26
	R&KS1 – KS3	.292	.090	.008	-.53	-.06	.42
	R&KS1 – KS4	.627	.149	.000	-1.02	-.23	.90
	KS2 – KS3	.112	.095	.642	-.36	.13	-
	KS2 – KS4	.448	.152	.022	-.85	-.05	.65
	KS3 – KS4	.336	.163	.176	-.76	.09	-
Metacognitive knowledge	R&KS1 – KS2	.302	.095	.009	-.55	-.06	.28
	R&KS1 – KS3	.656	.151	.000	-1.05	-.26	.60
	R&KS1 – KS4	1.109	.235	.000	-1.73	-.49	1.02
	KS2 – KS3	.354	.156	.111	-.05	.05	-
	KS2 – KS4	.807	.238	.006	-1.44	-.18	.74
	KS3 – KS4	.452	.266	.329	-1.15	.24	-

Notes:

$$d = \frac{mean\ difference\ (i-j)}{\sqrt{MS_w}}$$

Where MS_w is the within groups mean square value (within groups SD), a pooled estimate as there is more than one mean in pairwise comparisons.
The significant pairwise comparisons (p = < .05) are highlighted in grey.
Cohen (1969) effect sizes: small = 0.2, medium = 0.5, large = 0.8

Analysis of the data in Tables 16-17 for each of the dependent variables is as follows, beginning with Information Gathering. A one-way ANOVA was conducted to explore the impact of age group on levels of four dependent variables (Information Gathering, Building Understanding, Productive Thinking and Metacognitive Knowledge) as recorded on PVTs:

- There was a statistically significant difference ($p < .05$) in information gathering for the four different age groups: $F_{(3, 159)}$[24] = 4.075, $p = < .001$. Despite this significance, using omega squared, age group only accounted for approximately 4% of the difference in information gathering. Post-hoc comparisons using Games-Howell showed that mean information gathering was not significantly different between any of the pairwise comparisons calculated.

- There was a statistically significant difference ($p < .05$) in building understanding for the four different age groups: $F_{(3, 165)}$ = 3.621, $p = .014$. Despite this significance, using omega squared, age group only accounted for approximately 2% of the difference in building understanding. Post-hoc comparisons using Games-Howell showed that mean building understanding was significantly different only in one comparison: R&KS1 (M = .51, SD = .58) was significantly different from KS3 (M = .82, SD = .87).

- There was a statistically significant difference ($p < .05$) in productive thinking for the four different age groups: $F_{(3, 159)}$ = 8.749, $p = < .001$. Despite this significance, using omega squared, age group only accounted for approximately 7% of the difference in productive thinking. Post-hoc comparisons using Games-Howell showed that mean productive thinking was significantly different only in the following comparisons:

    – R&KS1 (M = .19, SD = .42) was significantly different from KS2 (M = .37, SD = .59)

    – R&KS1 (M = 119, SD = .42) was significantly different from KS3 (M = .78, SD = .08)

    – R&KS1 (M = 119, SD = .42) was significantly different from KS4 (M = .81, SD = 1.05)

    – KS2 (M = .37, SD = .59) was significantly different from KS4 (M = .81, SD = 1.05)

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[24] See *Robust Tests of Equality of Means i*n Appendix C for the SPSS output that corresponds to this

- There was a statistically significant difference (p <.05) in metacognitive knowledge for the four different age groups: $F_{(3,154)}$ = 13.063, p = < .001. Despite this significance, using omega squared, age group only accounted for approximately 9% of the difference in metacognitive knowledge. Post-hoc comparisons using Games-Howell showed that mean metacognitive knowledge was significantly different only in the following comparisons:

  – R&KS1 (M = .35, SD = .60) was significantly different from KS2 (M = .66, SD = .82)

  – R&KS1 (M = .35, SD = .60) was significantly different from KS3 (M = 1.01, SD = 1.36)

  – R&KS1 (M = .35, SD = .60) was significantly different from KS4 (M = 1.46, SD = 1.67)

  – KS2 (M = .66, SD = .82) was significantly different from KS4 (M = 1.46, SD = 1.67)

4.2.2. Non-parametric data analysis

As explained in 3.8.1, non-parametric data analysis was also conducted in order to maximise the robustness of the analysis of the data in this study. Maximisation of the robustness was important given the non-normality of the data. What follows presents the results of a series of Kruskal-Wallis H Tests for each dependent variable: Information Gathering, Building Understanding, Productive Thinking and Metacognitive Knowledge. Significant results for the Mann-Whitney U Test (Table 18) were followed up with post-hoc tests including pairwise comparisons and then a Mann Whitney U test for significant results identified in the post-hoc testing (Table 19). In each example below, the number of cases per age group remains the same throughout and is as follows for the four age groups:

- Reception and KS1 (n = 96)
- KS2 (n = 128)
- KS3 (n = 96)
- KS4 (n = 54)

The Kruskal-Wallis H test was used to explore the following hypotheses:

- H_0 = the mean ranks for each of the dependent variables are the same across the four age groups.

- H_A = the mean ranks for each of the dependent variables are not the same across the four age groups.

Table 18 shows that the null hypothesis (H_0) can be rejected for productive thinking and metacognitive knowledge (significance accepted at the $p = < .05$ level). The results of the Kruskal-Wallis H Test for information gathering and building understanding indicated that the mean ranks were the same across the four age groups, H_0 therefore being retained.

Table 18: Null hypotheses for the independent-Samples Kruskal Wallis H Test

Null hypothesis (referring to mean ranks)	Retain or reject?	$\chi^2(3)$	df	Sig.	n
The distribution of information gathering is the same across categories of 'Age group'	Retain	6.42	3	.093	374
The distribution of building understanding is the same across categories of 'Age group'	Retain	5.67	3	.129	374
The distribution of productive thinking is the same across categories of 'Age group'	Reject	22.74	3	< .001	374
The distribution of metacognitive knowledge is the same across categories of 'Age group'	Reject	28.28	3	< .001	374

Table 19: Results of the Kruskal-Wallis H Test post-hoc analysis & Mann-Whitney U Test

Dependent variable	Age group comparisons	N	Kruskal-Wallis H Test Post-Hoc Analysis (Pairwise comparisons) Difference between mean ranks	Adjusted p value	Mann - Whitney U Test U	z	p	r
Productive thinking	R&KS1 – KS2	224	25.9	.177				
	R&KS1 – KS3	192	34.04	.045	3778.000	-2.815	.005	.20
	R&KS1 – KS4	150	70.48	<.001	1626.000	-4.703	<.001	.38
	KS2 – KS3	224	8.34	1.000				
	KS2 – KS4	182	44.58	.011	2615.000	-3.026	.002	.22
	KS3– KS4	150	36.44	.091				
Metacognitive knowledge	R&KS1 – KS2	224	35.16	.047	4904.000	-2.968	.003	0.20
	R&KS1 – KS3	192	50.67	.002	3417.000	-3.543	<.001	.26
	R&KS1 – KS4	150	84.43	<.001	1449.000	-5.036	<.001	.41
	KS2 – KS3	224	15.51	1.000				
	KS2 – KS4	182	49.27	.012	2487.000	-3.217	.001	.24
	KS3 – KS4	150	33.76	.256				

Notes:

- Significance accepted at .05 level for Kruskal-Wallis H test (adjusted p values are presented)
- Mann-Whitney U tests only conducted where significance was found in the post-hoc analysis for the Kruskal-Wallis H test. Significance accepted at .05 level
- Approximate effect size (r) calculated by: $r = \frac{z}{\sqrt{n}}$

The results of the non-parametric data analysis are outlined below, with the box plots and pairwise comparisons from the SPSS output located in Appendix C:

- Distributions of Information Gathering scores were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of Information Gathering were not statistically significantly different between groups, $\chi^2(3)$ = 6.421, p = .093.

- Distributions of Building Understanding were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of Building Understanding were not statistically significantly different between groups, $\chi^2(3)$ = 5.670, p = .129.

- A Kruskal-Wallis H test was run to determine if there were differences in Productive Thinking between four age groups. Distributions of Productive Thinking were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of Productive Thinking were statistically significantly different between groups, $\chi^2(3)$ = 22.740, p = < .001. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons, adjusted p values are presented. Post hoc analysis revealed statistically significant differences in Productive Thinking between the following comparisons:

  - Reception & KS1 (mean rank = 159.72) and KS3 (mean rank = 193.76) (p = .045),

  - Reception & KS1 (mean rank = 159.72) and KS4 (mean rank = 230.20) (p = < .001)

  - KS2 (mean rank =185.62) and KS4 (mean rank = 230.20) (p = .011)

Following the statistically significant differences in mean ranks for three age group combinations as highlighted by the Kruskal-Wallis H Test, a Mann-Whitney U test was run as a follow up to confirm the differences in productive thinking between R&KS1 and KS3, R&KS1 and KS4 and KS2 and KS4. The results were as follows:

  - Distributions of productive thinking for R&KS1 and KS3 were not similar, as assessed by visual inspection. Productive thinking for KS3 (mean rank = 105.15) was statistically significantly higher than for R&KS1 (mean rank = 85.85), U = 3778.000, z = -2.815, p = .005.

- Distributions of productive thinking for R&KS1 and KS4 were not similar, as assessed by visual inspection. Productive thinking for KS4 (mean rank = 93.38) was statistically significantly higher than for R&KS1 (mean rank = 65.44), U = 1626.500, z = -4.703, p = < .001.

- Distributions of productive thinking for KS2 and KS4 were not similar, as assessed by visual inspection. Productive thinking for KS4 (mean rank = 107.07) was statistically significantly higher than for KS2 (mean rank = 84.93), U = 2615.000, z = -3.026, p = .002.

- A Kruskal-Wallis H test was run to determine if there were differences in metacognitive knowledge between four age groups. Distributions of metacognitive knowledge were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of metacognitive knowledge were statistically significantly different between groups, $\chi^2(3)$ = 28.278, p = < .001. Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons and adjusted p values are presented. Post-hoc analysis revealed statistically significant differences in metacognitive knowledge between the following comparisons:

    - R & KS1 (mean rank = 150.27) and KS2 (mean rank = 185.43) (p = .047)

    - R & KS1 (mean rank = 150.27) and KS3 (mean rank = 200.94) (p = .002)

    - R & KS1 (mean rank = 150.27) and KS4 (p = < .001)

    - KS2 (mean rank = 179.50) and KS4 (mean rank = 234.70) (p = .012),

Following the statistically significant difference in mean ranks between three age group combinations highlighted by the Kruskal-Wallis H Test, a Mann-Whitney U test was run as a follow up to confirm the differences in metacognitive knowledge between R&KS1 and KS3, R&KS1 and KS4 and KS2 and KS4. The results were as follows:

    - Distributions of metacognitive knowledge for R&KS1 and KS2 were not similar, as assessed by visual inspection. Metacognitive knowledge for KS2 (mean rank = 122.19) was statistically

significantly higher than for R&KS1 (mean rank = 99.58), U = 4904.000, z = -2.968, p = .003.

– Distributions of metacognitive knowledge for R&KS1 and KS3 were not similar, as assessed by visual inspection. Metacognitive knowledge for KS3 (mean rank = 108.91) was statistically significantly higher than for R&KS1 (mean rank = 84.09), U = 3417.000, z = -3.543, p = < .001.

– Distributions of metacognitive knowledge for R&KS1 and KS4 were not similar, as assessed by visual inspection. Metacognitive knowledge for KS4 (mean rank = 96.67) was statistically significantly higher than for R&KS1 (mean rank = 63.59), U = 1449.000, z = -5.036, p = < .001.

– Distributions of metacognitive knowledge for KS2 and KS4 were not similar, as assessed by visual inspection. Metacognitive knowledge for KS4 (mean rank = 109.44) was statistically significantly higher than for KS2 (mean rank = 83.93), U = 2487.000, z = -3.217, p = .001.

4.2.3. Comparative summary of parametric and non-parametric analysis

The reasoning for conducting both parametric and non-parametric analysis of this data was justified in 3.8, to further this justification it is important to compare the results of both types of analysis. What follows presents a comparative summary of the parametric and non-parametric analysis of the data, in both cases this comprises a summary comparison of the testing (ANOVA and Kruskal-Wallis H Test, including pairwise comparisons) followed by the post-hoc testing (Games Howell and Mann-Whitney U Test).

The results of the one-way ANOVAs and the Kruskal-Wallis H Tests are comparable to some extent; the results for productive thinking and metacognitive knowledge are significant in both cases. In the parametric data analysis, the one way ANOVAs showed that variance for the effects of age group on all four dependent variables (information gathering, building understanding, productive thinking and metacognitive knowledge) was significant in all cases. It is however interesting to note that the omega squared (ω^2) values for productive thinking and metacognitive knowledge are highest (.07 and .09 respectively, both a medium

effect, see Table 16). These higher values for productive thinking and metacognitive knowledge in the parametric data analysis are comparative with the rejection of the null hypotheses (the distribution of productive thinking/metacognitive knowledge is the same across categories of 'age group') for both productive thinking and metacognitive knowledge (p = <.001) in the non-parametric analysis (Table 18).

In terms of post-hoc testing and pairwise comparisons between age groups[25], the parametric testing (Table 17) for building understanding showed only one significant pairwise comparison between R&KS1 and KS3 (d = .40). For productive thinking the significant pairwise comparisons in the parametric post-hoc analysis (Table 17) were R&KS1 and KS2 (d = .26); R&KS1 and KS3 (d = .42); R&KS1 and KS4 (d = .90) and KS2 and KS4 (d = .65). The underlined comparisons were also significant in the non-parametric post-hoc analysis (Table 19). For metacognitive knowledge the significant pairwise comparisons in the parametric post-hoc analysis (Table 17) were R&KS1 and KS2 (d = .28); R&KS1 and KS3 (d = .60); R&KS1 and KS4 (d = .1.02) and KS2 and KS4 (d = .74). The underlined comparisons were also significant in the non-parametric post-hoc analysis (Table 19).

Discussion above has clearly demonstrated a degree of similarity between the results of parametric and non-parametric analysis completed. The similarity in results between parametric and non-parametric testing was greatest for the dependent variables of productive thinking and metacognitive knowledge. The parametric testing did show significant results for all four of the dependent variables in the analysis. The only dependent variable in the parametric analysis that did not show significant pairwise comparisons in the post-hoc testing (parametric) was information gathering. Given discussion in 3.8 and 4.2.1 around the robustness of parametric testing and the steps taken in the quantitative analysis process to further increase the vigour, the quantitative analysis referred to in subsequent sections will be the parametric analysis from 4.2.1. The pragmatic approach to mixed method analysis applied aimed to explicitly not prioritise the value of quantitative statistical analysis over more qualitative approaches. Both have been utilised to good effect, allowing the presentation of results and their discussion to sit side by side and for links between research questions to be effectively drawn and exemplified. With this in mind, what follows

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[25] R&KS1, KS2, KS3 and KS4

in 4.3 addresses each of the research questions presented in 1.3.1 in turn, with full presentation of relevant and analysis and associated discussion.

4.3. Presentation & Discussion of Findings in Relation to the Research Questions

The research questions first stated in 1.3.1 form the basis of this section, each question will be addressed individually with the findings presented and discussed simultaneously in order to make clear their relevance and contribution. This section will conclude by addressing the overarching and main research question, highlighting how evidence presented in relation to the four subsidiary questions cumulatively responds to this main question:

> *In a systematic sample of PVTs collected across school-aged children, what associations are apparent in pupil comments about their learning that are classified as metacognitive?*

The four subsidiary research questions were carefully considered in relation to relevant literature in Chapter 2 and full rationale given in the closing paragraphs of the literature review (2.4). The first of these four questions was explored in detail in 2.1 (the systematic review), including discussion of the results and conclusions in relation to this study so it will be briefly summarised in this penultimate chapter. Each section will present results relevant to the research question highlighted above, as well as the specific sub-questions, and the implications for wider research in metacognition.

4.3.1. How has metacognition been researched with school-aged children, and how do PVTs fit into this field of research?

The relevance of this first subsidiary research question was rooted in the grounding of this study within the field of metacognition research. In particular, the rationale for the systematic review was based in the comparison of PVTs to other tools that have been used to explore metacognition with school-aged children. Exploring the similarities and differences between PVTs and other methods facilitated quantifiable and systematic evidence to validate of the use of PVTs to explore metacognition. In addition to underlining the unique characteristics and advantages of using PVTs to explore metacognition with school-aged children, the systematic review also underscored the inherent complexity of metacognition. Understanding the complexity of metacognition proved key in this study and

served to further increase the researcher's mindfulness of the importance of transparency in method and study design.

The findings of the systematic review were presented in full in 2.1.8, with the conclusions stated in 2.1.10. It is not the purpose of this section to repeat the findings and conclusions, but rather to summarise them. Of additional relevance is the contribution that the response to this question makes in answering the overarching research question (1.3.1) and how it links to the remaining three subsidiary research questions. Section 2.1 systematically explored the study of metacognition with school-aged children in materials published between 1992 and 2012, a total of 82 tools or methods were included (extracted from 149 distinct papers or sources). Methodologically transparent and thorough, it is not unreasonable to assume that the results of this review could summarily answer the question of how metacognition has been researched with school-aged children.

The complexity of the findings of 2.1 indicated the vastness of the field. Charts and summary tables were used to present the findings of the systematic review clearly and in a manner that facilitated ease of comparison between methods (or groups of methods). The discussion and conclusion focussed on findings including the categorisation of different tools and methods based on their similarities, the age ranges that different tools and methods had been used with and the academic subjects that they were or were not associated with. The latter part of the first subsidiary research question centres on where PVTs fit into the field of research (metacognition assessed in school-aged children) that 2.1 investigated. PVTs were one of only two tools or methods identified in the systematic review to have been used (in the included literature) with an age range of 9 years (the other method identified in this respect was TAPs). Debate around the utility and challenges of TAPs in relation to online and offline methods was presented in 2.1.8 and also raised methodological questions that were relevant to the use of PVTs in this study. The results of the systematic review presented in 2.1 and their interpretation were integral to this study in four main areas. Reflecting on the summary of results presented in 2.1.7 what follows reaffirms the fundamental findings of the systematic review (underlined) alongside discussion an exemplification of what was learned from them in this study (and potential limitations):

The literacy demands required for understanding and completing self-report measures, alongside the connected potential implications for using self-report to assess younger students. The notion of self-report measures relying on an assumed level of understanding for the participants was actively considered in this study,

alongside the potential limitations of data collection in this study. Continuity of the application of the methods in the data collection process for this study, including scribing for those students who required this, facilitated a reasonable assumption of the understanding of the participants and their ability to access and participate in the data collection. PVTs were also completed as part of a mediated group interview (or focus group), this social context serving to enhance the ecological validity of the data collection. In the data set for this study two participants did not complete their PVTs, only the reverse side of the sheet with biographical information on – this could be due to limitations of the method linked to an assumed level of understanding and mediation of this by way of the focus group.

TAPs and PVTs were the two individual tools with the largest age ranges identified in 2.1; they both had been used with (in the included records) 10 out of the 13 ages in (4- 16 years) (See Table B in Appendix A). This study further expanded the breadth of PVT research in terms of the age groups used with because the sample (3.5) was systematic and planned for stratification to enable equal numbers of participants (with an even gender split) across the different school year groups in this age range. The findings in this study also support the findings of previous research using PVTs in relation to both cognitive skills and metacognition in terms of the utility of PVTs to elicit this in children aged as young as 4 years old.

"How you test is what you get" (Desoete, 2008, p. 204), but also how metacognition is defined is how you test and what you get. The findings of 2.1 indicated that the definition of metacognition given in a study relates not only to its outcomes, but is also intrinsically linked to the tool or method and how it measures or assesses metacognition. Reflecting further on this, 2.1 concluded that how metacognition is defined is also what you get and further influences how you test. In terms of the 'test' another key debate centred on the online/offline debate (2.1.8) with regards to the different tools and methods identified. This debate is also relevant to 4.3.3 and will be discussed in relation to analysis of evidence of metacognitive skills in the PVT data of this study. The complexity of the multidimensional links between concept, definition, test and outcomes was a key finding of 2.1, the necessity therefore in this study for transparency across these links was key.

The presence or development of metacognition in younger children. Some of the included records in 2.1 confirmed established belief in the field that metacognition

does not develop until 8 years of age or beyond this (see 1.2.1). The systematic review presented findings to contradict this, Table 6 showed that metacognition had been elicited using the included tools, in the included records, with children in the age range of 4 – 7 years as well as 8 years and beyond. As 1.2.1 introduced, this is not new information in the field but the findings of 2.1 presented a systematic summary of the ages (between 4 and 16 years) that metacognition had been recorded as being elicited in, in the included records. The information added to the field, from the systematic review, supports the previously marginal view that metacognition or emerging metacognition is recordable or observable in children as young as 4 years old.

To summarise, PVTs are a multidimensional tool, they fit into and contribute to the field in a number of key ways. These contributions are related not only to the design and methodology associated with PVTs, but also their contemporaneous findings with regard to the development of metacognition in school-aged children. The systematic review (2.1) showed that metacognition has been researched with school-aged children in a multitude of different ways. These different approaches have clear differences (e.g. distinct methods may explore distinct aspects of metacognition) but also clear intersections (e.g. the grouping of tools into methodologies that are alike or have similarities: self-report, observation based […] as in 2.1.8). Self-report methods were dominant in the field, as shown by the results presented in 2.1.8; PVTs could be classified as self-report in that they involve individual participants completing individual templates. However, in 2.1 PVTs were listed as being in the category of interviews. The nature of how data is collected using PVTs, in focus groups (essentially a group interview mediated by the PVT template itself), meant that they fitted more accurately into this category than being solely self-report. The flexibility of PVTs in this sense is one of the contributions that they make to the field – their use across different age groups and their potential to be adaptable and to cross the boundaries of classifications listed in 2.1.8.

The findings of 2.1 go some way to answering the bigger question of how metacognition has been researched with school-aged children, this facilitated a careful consideration of where PVTs fit into this field and the rationalisation of their use in this study (including the underlining of their unique characteristics, 2.1.9). It is also important at this point to return to the first and overarching research question posed in 1.3.1, the findings of 2.1 were integral in expediting a suitable response to this. The overarching research

question considers associations in pupil comments about their learning that are classified as metacognitive. The findings of 2.1 enabled a broad approach to both defining and operationalizing metacognition in this study, without the systematic approach to studying the wider field the conceptualisation of metacognition in this study would have had many potential limitations. These limitations were subsequently partially negated by the broad and thorough approach to defining metacognition derived from the systematic reviewing process. Section 2.1 provided a broad and rigorous basis on which to rationalise the use of PVTs and explore their contribution to metacognition research within this study.

4.3.2. In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as cognitive skills (Moseley, Baumfield et al., 2005)?

The importance of a consideration of cognitive skills when studying metacognition was underlined in 2.2.1, the relevance of the Moseley model and its inclusion of cognitive skills (information gathering, building understanding and productive thinking) forming the basis of the framework of analysis used in this study (3.7). The three other models of metacognition explored in 2.2.1 also included cognitive skills, presenting them as inherent to and inextricable from metacognition itself. Figure 18 illustrates that the PVT data in this presents evidence that does suggest developmental trends in students' awareness of cognitive skills, in particular for productive thinking. Productive thinking appears to increase (from Reception and KS1 to KS4) and information gathering to decrease with age (from Reception and KS1 to KS3). There is a slight increase in building understanding from Reception and KS1 to KS3, but then a decrease in KS4. Information gathering, which remains relatively constant across the age groups in Figure 19 was described by Moseley et al., (2005a, p. 315) as a prerequisite for "either building understanding or productive thinking".

The statistical analysis from 4.2 supports the trends illustrated in Figure 18, the statistical significance has been annotated onto Figure 18 accordingly, with full details given in Table 16 and Table 17 (4.2.1). The statistical analysis showed evidence of significance for all three of the dependent variables concerned with cognitive skills – it suggested that the independent variable of age group did have an impact on the cognitive skill dependent variables. Remembering the challenges of this non-normal data set, alongside the reasoning behind the mixed method approach to analysis in this study (the potentially limited value of

data based on frequency counts), what follows examines the PVT data in detail to explore

patterns in comments classified as cognitive skills.

F (3, 159) = 4.075, p = < .001
ω^2 = .04

F (3, 165) = 3.621, p = .014
ω^2 = .02

F (3,159) = 8.749, p = < .001
ω^2 = .07

INFORMATION GATHERING:

Significant difference across the four age groups but no significant pairwise comparisons.

BUILDING UNDERSTANDING:

Significant difference across the four age groups but only one significant pairwise comparison in post-hoc testing (R& KS1 – KS3).

PRODUCTIVE THINKING:

Significant differences across the four age groups. Four significant pairwise comparisons: R&KS1 – KS2; R&KS1 – KS3; R&KS1 – KS4 and KS2 – KS4.

Figure 18: The percentage of text units per age group coded as cognitive skills and the results on the one-way ANOVAs

Information gathering was defined by Moseley et al. (2005a, p. 314) as "Experiencing, recognising and recalling. Comprehending messages and recorded information". Information gathering and building understanding remained relatively constant in the proportion of text units per age group, both with a range of less than 10% across the four age groups. Moseley et al. (2005a) noted the critical difference between cognitive skills and strategic and reflective thinking, stating that cognitive skills are procedural and become automatic, but that strategic and reflective thinking (metacognitive and/or self-regulatory processes) are highly conscious. This automaticity is reflective of the relatively constant presence of information gathering across the age groups and year groups (Figure 20). Text coded as information included statements recalling the context of various learning situations that were recorded on the PVTs, for example:

> *They're so cute The yolks have been on them and they're all wet (Reception & KS1)*

> *I've learnt all about how the Victorians live now! (KS2)*

In these examples of information gathering from the primary school data, the contextual information given concerns the content of the lessons. Building understanding described in the Moseley model as involving the development of meaning, working with patterns and rules, forming concepts and organising ideas. Information gathering is necessary for this (and productive thinking) so there is also evidence of contextual and content information, alongside evidence of the development associated with building understanding:

> *One day my friend dug out a bulb, they grow you have to leave them so they grow. (Reception & KS1)*

> *I've learnt all about how the Victorians live now! I understand a lot more about them now I understand how all the children had to work and it helps me a lot! (KS2)*

> *It's strange because if you have two different letters and numbers they are like 2a and 2b if you add them. But when you times or divide them they are AB or something. It's weird because they don't go together but they also do. (KS3)*

> *Happy. They can do the work and therefore are proud; they're also able to go onto explain the subject/topic further. (KS4)*

It is interesting to note the decrease in building understanding for both KS3 and KS4 shown in Figure 18, yet there are differences apparent between the age groups within the

examples given above. The findings of the statistical analysis (4.2.1) did support a link between the age groups and all of the dependent variables including building understanding. In the example from Reception & KS1 we can see development, alongside content information. There is evidence of emerging understanding about the 'rules' of the process (growing plants from bulbs) that is being reflected upon. In the example from KS2 the development of meaning is apparent in additional detail. The KS2 excerpt incorporates the context of the subject (Victorians), but also explains a more detailed understanding and links this to new knowledge ('I understand how all the children had to work') and the extent to which it helps. In the KS3 example there is detailed information pertaining to the patterns and rules of the mathematical concept that is being described. In the KS4 example there is evidence of forming concepts and organising ideas, additionally this has been linked to a feeling ('Happy') and foresight to future learning ('they can go on to').

Returning to the conceptualisation of children's development as non-linear first introduced in 1.2.1 (Hofer & Sinatra, 2010; Kuhn, 2000), it is important to consider comparison of the statistical representation of the development of information gathering and building understanding with the qualitatively explored examples presented and discussed above. The findings presented in Figure 18 could be potentially misleading if looked at in isolation from the statistical analysis presented in 4.2.1, but also if looked at in isolation from the qualitative analysis above. The data for both information gathering and building understanding in the chart of Figure 18 does not singularly provide evidence of the relationships between these variables and age (including significant pairwise comparisons for building understanding) that were detailed in 4.2.1. This furthers the significance of the holistic and mixed method approach to analysis undertaken in this study, in order to fully appreciate the evidence of both cognitive skills and metacognition that can be concluded from the data.

In contrast to the other cognitive skills, Figure 18 shows that for R&KS1 (4-7 years) productive thinking accounts for only 10% of the total text units on the templates completed by this age group, this figure increases to 24% for KS4 (14-16 years). Text coded as productive thinking showed evidence reasoning, problem solving and creative thinking. Evidence from the PVTs of text coded as productive thinking largely focused on problems encountered in the given learning scenario and a student or students exploring solutions in order to move on or reach a resolution. Figure 18 showed clear differences (across the age groups) in the presence of information gathering, building understanding and productive

thinking. Information gathering and building understanding seem less linear (than productive thinking), but as qualitative analysis exemplified there is still evidence of development when comparing across age groups. It is important to reflect on the nature of productive thinking, comparing Figure 18 and Figure 20, the similarity of the upward trends across the four age groups facilitates questions around whether or not productive thinking relates more closely to metacognitive knowledge or indeed the metacognitive/self-regulatory element of the Moseley model which shows a similar trend. A closer link between productive thinking and evidence of metacognition makes sense. Although the Moseley model places the three cognitive skills side by side information gathering is a pre-requisite for the others and there is clear indication of increasing complexity from building understanding to productive thinking – meaning is developed and ideas organised before there is reasoning and understanding of causal relationships.

In line with the mixed method approach to this analysis it was important to see how the trends in productive thinking shown in Figure 18 mapped onto qualitative evidence and vice-versa. Figure 19 uses a ladder to demonstrate, at a year group level, how PVT data shows development in productive thinking. Productive thinking was defined by Moseley et al. (2005a) being concerned with higher order thinking to facilitate a deeper understanding. One excerpt of text per year group coded as productive thinking was selected to demonstrate how data gathered using PVTs could illustrate a developmental trend in this particular cognitive skill. Figure 19 demonstrates that students as young as 4-5 years old (Reception class) demonstrated thinking about transferring their learning. The example given refers to work the students had done in class relating to sharing things and being kind to each other, in this case the student has shown evidence of thinking about how they could potentially use this skill (sharing) on different occasions ("everyday"). This demonstration of forward thinking in terms of skill use indicates an understanding of causal relationships in terms of how skills could be applied in different situations. As early as Year 1 (5-6 years old) evidence from PVTs shows that students begin to acknowledge the importance of help seeking behaviour in order to assist with their learning, in particular asking questions.

Word frequency analysis looked at the potential influence of exam years in school in the text that students of these year groups, primarily Year 10 and Year 11, recorded on the PVTs. Evidence of a link to exams can again be seen in some of the text coded as productive thinking by students in these year groups, for example the excerpt from Year 11 in Figure 19 refers to the use of written notes for revision. The notion of looking back on previous work

for current or future learning or transferring learning is also present in excerpts from younger class groups shown in Figure 19 - the Reception excerpt details how the students are thinking about how they could share everyday (looking back at field notes to contextualise this I remember that these particular students had been learning about sharing things in the classroom). The Year 4 excerpt (8-9 years), very creatively explains an awareness of inwardly reflecting on prior learning and the process of recalling memories that are in their brain to think about the task or topic at hand. From Reception to Year 4 we have moved from productive thinking that could be considered largely recall, to what seems an awareness of a very active thought process where a student can look back on prior learning and apply it to current learning.

> *Oh dear…I can't do that question. Actually I could look back at the example I have written and that will help me. It will also help with my homework and revision. I'm really starting to like algebra. Sometimes teachers can help but it's nice to have friends helping too. (Female, Year 7, aged 12 years)*

The excerpt above makes clear reference to several aspects of the definition of metacognition given and the deductive coding scheme applied (Chapter 4 and Section 3.7). These are the context (a math lesson about algebra with specific people present) but also productive (knowing who can help, note the association of feelings with productivity here – nice when friends help) and metacognitively skilful. We can see that this student has awareness of thinking about how they can apply and transfer their knowledge (for revision and homework). These clear links between the coding scheme outlined in 3.7 and the results discussed above, show that the concept(s) explored are clearly linked to the outcomes (what the participants wrote on the PVTs). These links further support the presence of construct validity and PVTs being able to demonstrate this.

KS4	**Year 11**	I will ask the teacher to explain it to me, and then I will write it down in my book so I can revise from it.
	Year 10	Can you help with this and how to improve it? I think it is right, but I need you to check it for me.
KS3	**Year 9**	They would talk about what they learnt and try to repeat what was said and if it was wrong, write and give feedback to each other.
	Year 8	This information could be handy one day it could help me on a test or something
	Year 7	I might write that down as an example, before I forget. I can always look back at that if I need help.
KS2	**Year 6**	This lesson is a bit tricky isn't it I don't really get it! How about you? Okay I will. (Puts hand up).
	Year 5	Factor numbers aren't very easy you get very confused with them! Lets go ask the teacher.
	Year 4	If I close my eyes it makes me look back in my brain and think about it.
	Year 3	I wonder what notes I will get from the rainforest. How am I going to remember them?
Reception and KS1	**Year 2**	It helps me remember when I practice adding up numbers and times.
	Year 1	How do you spell it out? Spelling out so you can read the word.
	Reception	They are thinking about how they could share everyday

Figure 19: Productive Thinking Ladder

The analysis and discussion of cognitive skills in this section affirms the importance of a pragmatic approach to mixed method data analysis. The trends identified quantitatively do not always match up with those identified using a qualitative approach. The non-normality and uniqueness of the data analysed negated an approach that considered both sides of the debate to appreciate the richness of the PVT data fully. Evidence pertaining to cognitive skills has highlighted two main issues:

- The differences between the quantitative data presented in Figure 19 and the statistical analysis (4.2.1)
- An awareness of the trends and development in cognitive skills identified via qualitative exploration that are **not clear** for **all** of the individual cognitive skills in Figure 19. Importantly the quantitative statistical analysis presented in 4.2 does show evidence of developmental trends (via significant pairwise comparisons in post-hoc testing) for both building understanding and productive thinking but not for information gathering

The findings of this section have required multiple types of analysis to be explored and discussed simultaneously from different perspectives on the data. A consideration of this simultaneity is key in exploring the wider concept of metacognitive knowledge in 4.3.3.

4.3.3. In a systematic sample of PVTs collected across school-aged children what patterns are apparent in comments classified as metacognitive knowledge?

The systematic sample of PVTs in this study and the approach to analysing for evidence of metacognitive knowledge are the key differences between this study and previous research with PVTs that used a deductive coding scheme based on the Moseley model (Wall, 2008; Wall et al., 2012). The approach to analysis of PVTs for examining metacognitive knowledge in this study was multidimensional and comprised the following:

- Analysis and discussion based on the dependent variable of metacognitive knowledge – the results of this analysis were presented in 4.2.1 alongside analysis of three other dependent variables (information gathering, building understanding and productive thinking)
- Mixed method analysis based on sub-categories of metacognitive knowledge as stated in the deductive coding framework (Table 12):

- ▪ Metacognitive knowledge of person
- ▪ Metacognitive knowledge of task
- ▪ Metacognitive knowledge of strategy

- A closer exploration of metacognitive knowledge of strategy with additional sub-categories in relation to the type of strategy used based on Weinstein & Mayer's (1986) general learning strategies (as cited in Pintrich (2002)): rehearsal, organisation and elaboration

and

A further examination of metacognitive knowledge of strategy based on classification outlined by Paris, Lipson & Wixson (1983) in relation to whether metacognitive knowledge of strategy was declarative (knowledge about strategies), procedural (knowing how to perform strategies) or conditional (knowing when to use a strategy and why it is helpful at that particular point)

- An exploration of metacognitive knowledge in relation to metacognitive vocabulary based on literature that was explored in 2.3.2

- A consideration of debate around the 'offline' assessment of aspects of metacognition (planning, monitoring and evaluation) commonly described under the 'online' umbrella of metacognitive skills and evidence of these aspects of metacognition in the PVT data of this study. This debate is reflective of the literature explored in 2.1 and 2.2

General trends in metacognitive knowledge

Thinking in general terms about metacognitive knowledge it is necessary to return to the definition of metacognitive knowledge applied in previous PVT research (Veenman et al., 2005) with its focus on declarative knowledge and the interplay of this declarative knowledge of person, task and strategy characteristics. Therefore, the definition of metacognitive knowledge given in previous research using PVTs (Wall, 2008) did include metacognitive knowledge of person, task and strategy but the analysis did not explore these three facets individually. Wall et al. (2012) developed the analysis of PVTs further with a combination of a deductive and inductive approach. The inductive approach detailed in Wall

et al. (2012) included 'tools for learning' where links can be drawn to the conceptualisation of metacognitive knowledge of strategy and 'social aspects of learning' which are to some extent comparable to metacognitive knowledge of person.

This section focuses on general trends in metacognitive knowledge as whole. Subsequent sections focus on trends in metacognitive knowledge of person, task and strategy individually. The PVT data in Wall (2008) showed an increase of metacognitive knowledge across age groups, this study aligns with that finding. Figure 20 illustrates a clear age related trend in evidence of metacognitive knowledge in the PVT data collected in this study; this is comparable to findings presented by Wall (2008)[26]. In the Moseley model, strategic and reflective thinking was described as being indicative of metacognitive and/or self-regulatory activities, Figure 20 illustrates a similar upward trend across the age groups in strategic and reflective thinking as compared to metacognitive knowledge. The similarity in the patterns presented for metacognitive knowledge and strategic and reflective thinking further supported the relevance of the Moseley model in both this study and the wider field. Figure 20 presents evidence of parallels and integration between the definition of metacognition from the Moseley model (strategic and reflective thinking) with other definitions of metacognition applied within the same study (metacognitive knowledge).

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[26] Wall (2008) – Figure 7, p. 30
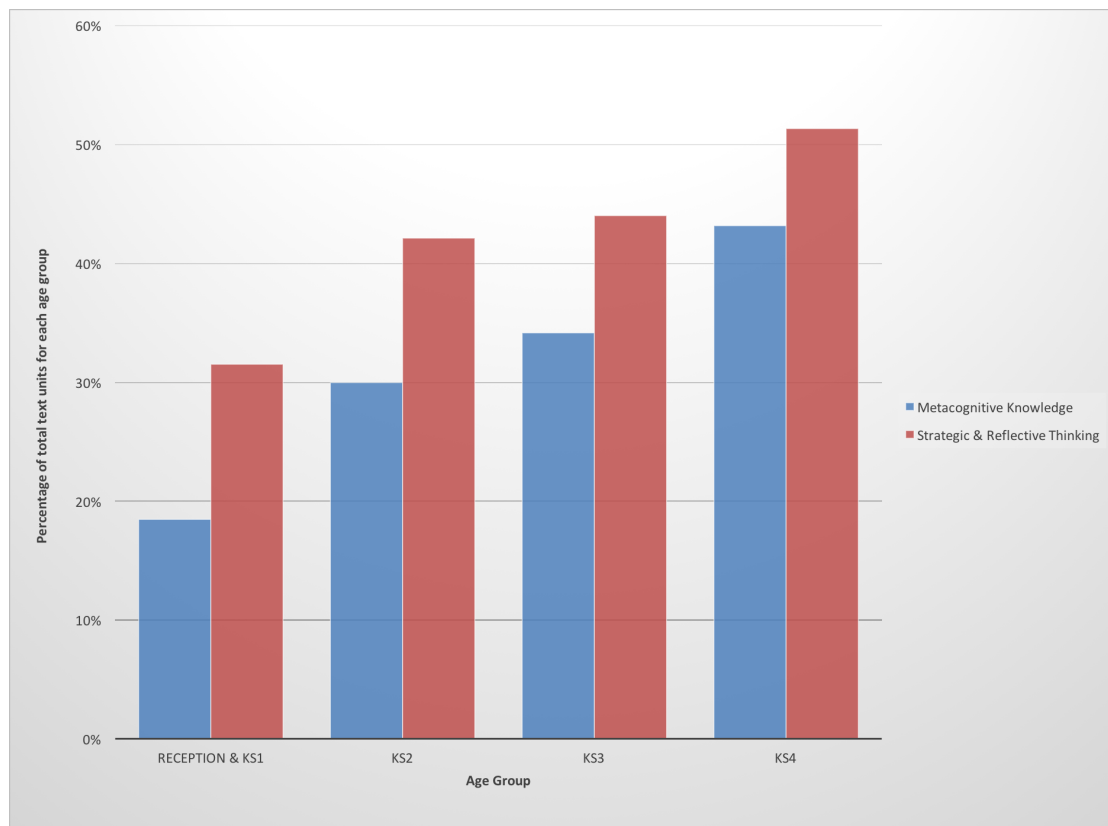
Figure 20: Percentage of text units for each age group coded as metacognitive knowledge and 'strategic and reflective thinking'

The one way ANOVA for metacognitive knowledge presented in 4.2.1 showed that there was a statistically significant difference ($p = < .05$) for metacognitive knowledge across the four age groups: $F (3, 154) = 13.063$, $p = <.001$. The effect size calculation (omega squared) revealed that age group accounted for only 9% of the difference but there were four significant pairwise comparisons (between the age groups) out of a possible six. Interestingly the analysis by text unit in this chapter is analogous with the comparative analysis presented in Appendix D and increases the effect size by 2%. A very small difference in effect size tempered by the matching significant pairwise comparisons. It is more difficult to compare the parametric analysis in this study with that presented by Wall et al. (2012) because the analysis conducted comprises a two-way MANOVA and the measure of effect size for the dependent variables differs. It can be noted that the significance of different levels of metacognitive knowledge across age groups was significant ($p = < .001$) in both analyses.

The finding in the statistical analysis that age group accounted for only 9% of the differences across metacognitive knowledge is perhaps where the accuracy of this data set is limited by its non-normality. As discussed in 3.8.1 the approach taken to analysis in this

study was carefully considered in relation to the robustness of the testing undertaken and the non-normality of the data set. The uniformity of the non-normality of the data set was a deciding factor (see Figure 17) in the approach taken. The analysis did indicate that there was a difference across age groups for metacognitive knowledge; it is possible that the effect size for this significance (see Table 16) has been affected by the non-normality of the data. This does not discount the finding, but rather increases the importance of the mixed method approach to analysis adopted in this study. Figure 21 further exemplifies the age related trend identified in the parametric analysis (4.2.1) by focussing on year group as opposed to age group. Looking at these narrower (2 year[27]) age groupings facilitates a closer look at what happened with levels of metacognitive knowledge across the year groups. It is interesting to note that although there are peaks and dips in metacognitive knowledge across the year groups, the general trend of increasing metacognitive knowledge with age (year group) is still apparent.
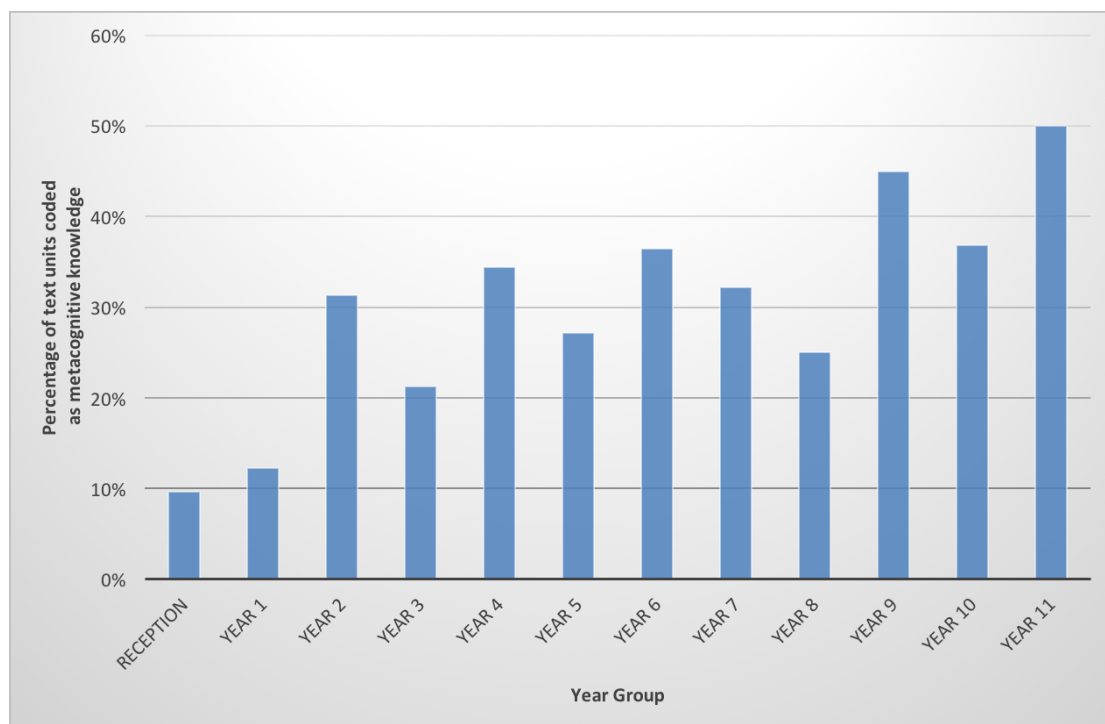
Figure 21: Percentage of text units per year group coded as metacognitive knowledge

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[27] Reception: 4-5 years; Year 1: 5-6 years, Year 2: 6-7 years […]

A trend that can be seen in the analysis of metacognitive knowledge presented in Wall (2008) appears to be replicated in Figure 21. Although the Wall (2008) analysis only included Reception – Year 6 there was a dip in metacognitive knowledge in Year 5, a similar decrease can be seen in Figure 21. Wall (2008, p. 29) suggested "This could be due to teacher affect, although the numbers of analysed templates within this particular year group should have produced representative statistics." In this study the number of templates completed by Year 5 students (see Table 14) was in line with the proposed number per year group (32) and there were no striking differences between Year 5 and other year groups in KS2 in terms of number text units or words on the total sample of 32 templates for Year 5. Wall's (2008) statement about representative statistics cannot be similarly applied to the data in this study - Table 1 showed that the PVT data in Wall (2008) was collected across 7 schools. The number of primary schools in this study was 2 with 3 schools in total (including the secondary school), this likely suggests that differences across different year groups in this study could be resultant of individual teacher affect. Perhaps some teachers in the sampled schools used more metacognitive language or approaches in their teaching, this was not accounted for but must be acknowledged.

The number of schools in this study, linked to teacher effect, is one of the limitations of the sampling. In order to clarify the significance of trends in metacognitive knowledge for different year groups (Figure 21) a systematic sample is necessary, as in this study, but across a wider range and number of schools. It is however important to remember the importance of the value of a non-linear approach to children's development (Hofer & Sinatra, 2010; Kuhn, 2000). With this in mind it is not possible to be certain about what has influenced the PVT data in this study, it is possible to hypothesise possible reasons for some of the effects shown.

Comparable to the decline in metacognitive knowledge for Year 5 there are other rises (e.g. Year 2, Year 6) and declines (Year 8, Year 10) in metacognitive knowledge. Teacher effect is not the only potential variable that should be considered in relation to variation of metacognitive knowledge across the different year groups. For example, the decrease in metacognitive knowledge from Year 6 (primary school) to Year 7 (secondary school) could be due to a number of factors: school effect, the challenges of adjusting to a new and much bigger school or indeed teacher effect. In the transition from primary to secondary school students move from being largely taught by one or two teachers to having potentially a different teacher for every subject. The social context (2.1.8) of learning may have also

played a role in that students in primary school are mainly taught together in a class group, in the transition to secondary school these learning and social groups are often dispersed as students are allocated to different class groups across much larger year groups.

Reflecting beyond the comparison between this study and previous analysis of metacognitive knowledge in PVTs (Wall, 2008), it is important to consider how the findings of this study relate to wider trends reported in the field. As discussed in 1.2.1, established belief is that metacognition does not develop until 8 years of age or beyond. The findings of this study therefore support the findings of Wall (2008), Leutwyler (2008), Whitebread et al. (2009) and others, in the claim that metacognition can be evidenced in children as young as 3 -5 years old. Part of the C.Ind.Le Coding Scheme in Whitebread et al. (2009) focussed on metacognitive knowledge, in particular metacognitive knowledge of person, task and strategy. Comparable classifications of metacognitive knowledge were applied to the data in this study (Table 12). What follows further develops the approach to analysis of metacognitive knowledge in previous studies using PVTs (Wall, 2008; Wall et al. 2012) by focussing on evidence of metacognitive knowledge of person, task and strategy.

Metacognitive knowledge of person, task and strategy

The approach to analysis of PVT data in this study explored metacognitive knowledge of person, task and strategy in addition to the broader approach to the analysis of metacognitive knowledge applied based on the Veenman et al. (2005) definition presented in Wall (2008) and Wall et al. (2012). As outlined in Table 12, the definitions and conceptualisation of metacognitive knowledge of person, task and strategy in this study are based on a broad range of work within the field including Flavell (1976); Flavell & Wellman (1977); Brown (1978); Jacobs & Paris (1987); Veenman et al., (2005), Efklides (2008); Pintrich (2002), Schmitt & Sha (2009) and Whitebread et al. (2009). Despite the breadth of work that theorises metacognitive knowledge as person, task and strategy there is little analysis in the field of the differences across different age groups or ranges. The value of frequency counts in this respect is limited, as Whitebread et al. (2009) indicated, but the exploration of such trends graphically and qualitatively simultaneously as presented below in a mixed method approach offers some insight.

It is useful to begin this exploration of metacognitive knowledge of person, task and strategy in the data by looking at general trends in the percentage of text units per age group coded as each. Figure 22 illustrates an upward trend in metacognitive knowledge of

person across the age groups, with a gradual increase from 8% (Reception & KS1) to 22%

(KS4) of the total text units per age group. For task there seems to be a marked increase

from Reception & KS1 (4%) to KS2 (9%) but this then appears to level out with both KS3 and

KS4 data both recording 10% in the PVT data. For metacognitive knowledge of strategy there

is little difference between Reception & KS1 (7%) and KS2 (6%), but a fall in KS3 (4%)

followed by an increase to 11% in KS4. Interestingly, metacognitive knowledge of strategy

shows a much less linear pattern across the percentages charted in Figure 23. Figure 23

illustrates trends in metacognitive knowledge of person, task and strategy at the level of

year group (smaller age ranges than the age groups based on Key Stage that were used in

the statistical analysis (4.2). The trends across individual year groups for metacognitive

knowledge of person and task generally show an increase with year groups, although there

are peaks and troughs within this. The trend shown in Figure 23 for metacognitive

knowledge of strategy is less linear. There is a marked decrease between year 6 and year 9

with an increase from year 10 – year 11. Teacher effects, the transition from primary to

secondary school and exam demands are all potential reasons for this pattern. The

qualitative analysis that follows explores this context of learning in more detail.
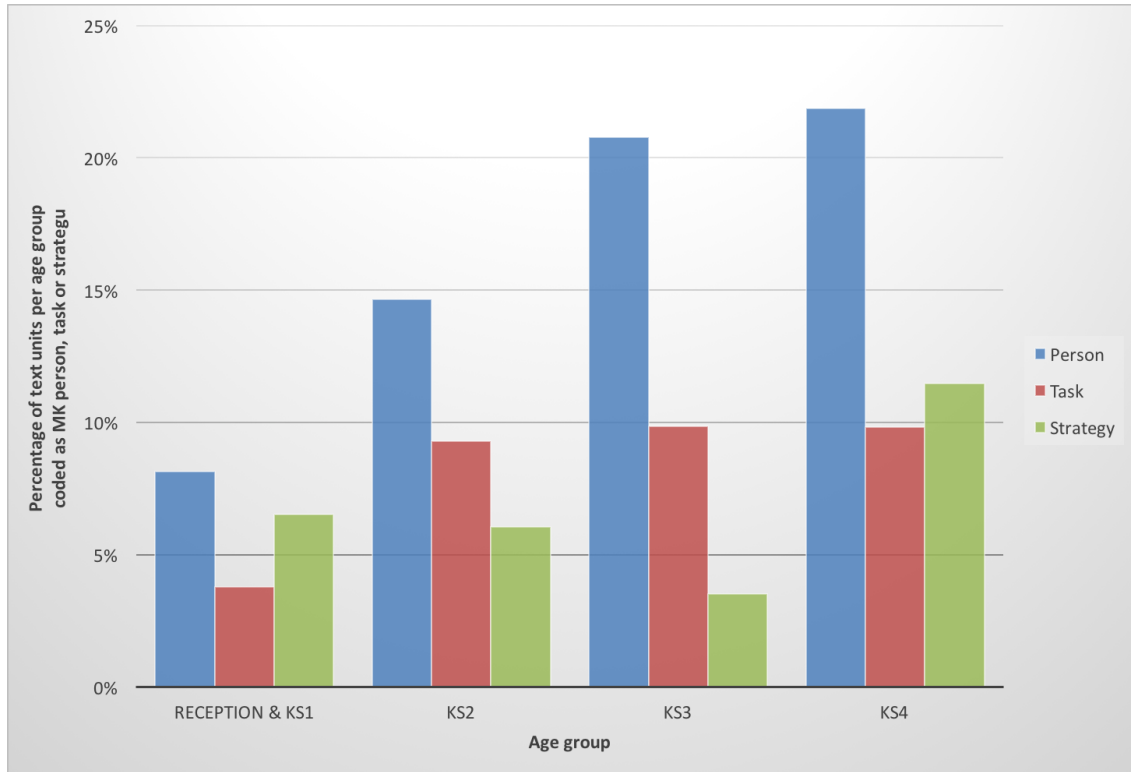
Figure 22: Percentage of text units in the four age groups coded as metacognitive knowledge of person, task and strategy

	Reception	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Person	2%	8%	13%	8%	17%	11%	22%	20%	13%	29%	21%	23%
Task	4%	2%	6%	10%	11%	7%	9%	7%	10%	13%	8%	11%
Strategy	4%	3%	12%	3%	6%	9%	5%	5%	3%	2%	7%	16%
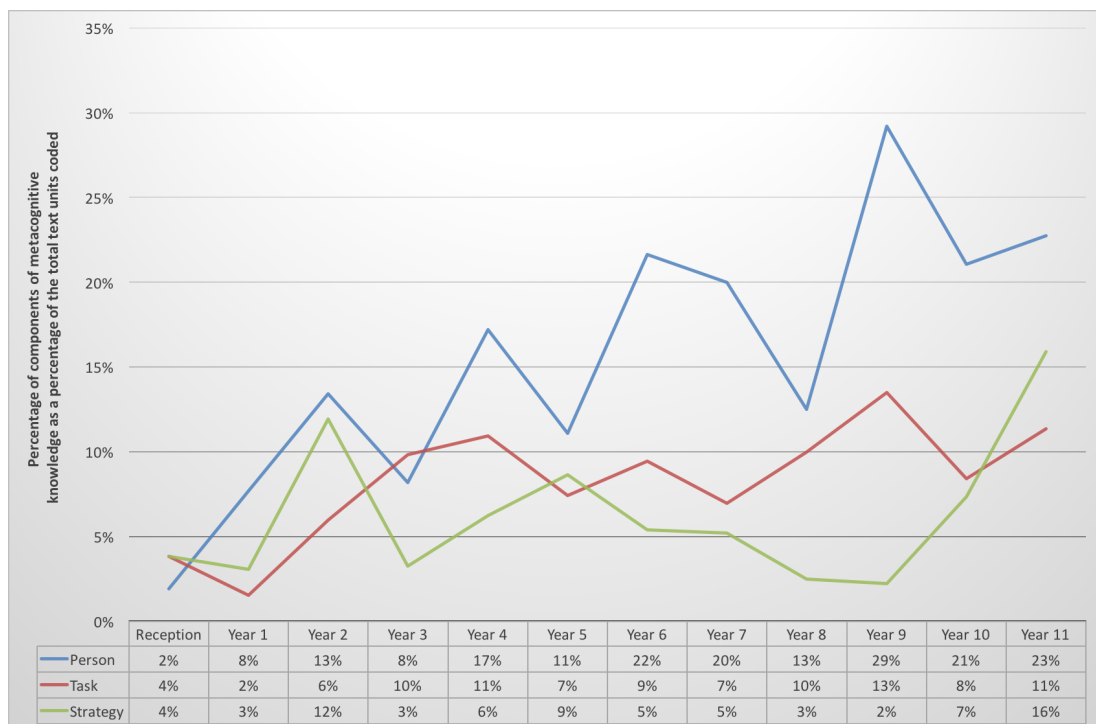
Figure 23: Percentage of text units coded as metacognitive knowledge of person, task and strategy in the twelve year groups

It is interesting to explore the intersections of metacognitive knowledge of person, task and strategy for the different year groups (Figure 23). For example, in Reception the focus seems to be on task and strategy, but there is a marked increase in metacognitive knowledge of person from Reception to Year 2. A link can be drawn here to Piaget's stages of development (Table 8) where in Stage 2 (2-7 years) egocentrism still presents limitations. In light of Piaget's stages and the notion of egocentrism, it is difficult to account for the increase of metacognitive knowledge of person by Year 1 (5-6) by more than double the level recorded for Reception (4-5 years) from 2% to 8%, there is a further increase to 13% by Year 2 (6-7 years). In the examples that follow, differences in the focus of metacognitive knowledge of person can be seen – in the excerpts from Reception and KS1 there is a focus on the teacher helping the individual student. In contrast by KS2 there is increased evidence of different people involved in learning, peer groups and friends as well as teachers. Due to minimum cell size requirements, the statistical analysis presented in 4.2 was not conducted at the level of metacognitive knowledge of person, task and strategy, rather it focussed more generally on metacognitive knowledge as a whole. It is therefore imperative to explore these trends in more detail with a qualitative approach beginning with metacognitive knowledge of person.

The definition of metacognitive knowledge of person given in Table 12 focussed on declarative knowledge of a person's characteristics that are relevant to a task. This broad umbrella of metacognitive knowledge of person included knowledge of strengths, weaknesses, ability and motivation, as well as knowing whom to ask for help. Across the different age groups, metacognitive knowledge of person in the PVT data focussed on a variety of people including both the self and others (e.g. teachers, friends, peer group). Word clouds created in NVivo for text coded as metacognitive knowledge of person across each age group (Figure 24) suggested subtle differences with regard to who the metacognitive knowledge of person is referring to in the PVT data. For example, the word teacher features more prominently in Reception and KS1, and KS2, the frequency of 'teacher' decreases in KS3 and then rises again in KS4.

In Figure 24 it is interesting to note the increasing and decreasing frequency of words including 'understand' across the four age groups, its dominance becoming more central in the KS4 word cloud. The examples below show that by KS4 the word 'understand' is used within the context of explanation, as opposed to the simpler statements including

'understanding' which refer to the presence or lack of understanding. In 'Reception and KS1' there is a clear focus on the help of the teacher to aid understanding, for example:

> *1, 2, 3, 4 Counting up to 100 because the teacher was helping us*

> *My teacher helps me learn new things. I ask my teacher questions.*

> *My teacher tells me new things and gives me help.*

In KS2 the focus appears to shift to a more general approach to help seeking, but there are still several examples where the teacher's help is at the fore.

> *I didn't think I was able to do it but with everybody's support I got over my fears.*

> *I still can't find it I will ask someone else*

> *She will never answer. I'll ask the teacher.*

> *I understand how all the children had to work and it helps me a lot!*

> *Maybe I should ask the teacher to explain more because I need to know a bit more about it.*

In the latter example (10-year-old female, Year 5) there is clear evidence of development in terms of how this example not only identifies the person who is the source of help, but also demonstrates acknowledgment of ability and weaknesses. In KS3 the focus seems be less on metacognitive knowledge of person 'other' but more on 'self' and the acknowledgement of ability, weakness and to some extent acknowledging progress and the motivation that ensues. For example:

> *How hard is this I don't understand a single thing about this subject.*

> *I can't believe I struggled before on an easy thing.*

> *I'm starting to understand algebra now.*

> *I can't believe this is so easy and I was struggling at first. I can't believe I didn't know what to do.*

The latter example was written by a 12-year-old female in Year 7 and alludes to both acknowledgment of a struggle and subsequently finding the difficult task easy. In another

example from the same student there is recognition of the different sources of help in terms of people:

> *I'm really starting to like algebra. Sometimes teachers can help but it's nice to have friends helping too.*

The example above is presented in comparison to the earlier examples from Reception and KS1 that were firmly focussed on the help that the teacher can provide. In examples from KS4 there is a sense of the development of metacognitive knowledge of person to also include explicit consideration of specific aspects of learning, including the consolidation of it:

> *I kind of understand but we have moved on too quick. So I don't have a chance to consolidate my learning*

In the example above there is evidence of knowledge about ability but also an indication of considering the value (for this person) of this knowledge in the future – the notion of the consolidation of learning suggesting a consideration of the necessity of this knowledge in the future. This could also conceivably be described as declarative evidence of awareness of the monitoring of learning when it occurred at the point in time on which the child is reflecting – monitoring and realising that the learning has moved on too quickly to allow for consolidation of learning.

Figure 24: Word clouds of metacognitive knowledge of person across the four age groups

Having explored the general trends in metacognitive knowledge of person it is important to also explore metacognitive knowledge of task in the PVT data before moving on to focus in finer detail on metacognitive knowledge of strategy and the various sub-categories that were outlined in Table 12. Metacognitive knowledge task was defined as declarative knowledge of the characteristics of a task, included within this were:

- Long-term memory
- Responses demonstrating knowledge of task components, and
- Judgments about difficulty

The key difference between judgments about difficult in this sense and the declarative metacognitive knowledge of person concerning weaknesses and ability lay in the specificity of task characteristics as opposed to the more general declarations classified as metacognitive knowledge of person (e.g. 'This is easy' or 'This is hard'). Both Figure 22 and Figure 23 showed much less distinct increases or decreases in the percentage of metacognitive knowledge of task recorded across both age and year groups. The most noticeable change is the increase from 4% of the total Reception & KS1 text units to 9% of the total text units for KS2. Remembering to interpret findings based on frequency counts with caution, it is necessary to explore these trends more closely.

The increase in frequency of metacognitive knowledge of task from Reception & KS1 to KS2 may be related to the novelty of more learning tasks for the younger students. For example: '*I don't know what to write. This is hard because it's new work*' (Year 2, 6-year-old male) shows evidence of metacognitive knowledge of task in that there is knowledge that writing is necessary for the task, there is a comparison (the task is 'new) and there is a judgment about the difficulty of the task. By KS2 the metacognitive knowledge of task has developed and there is evidence of a more sophisticated metacognitive knowledge of task:

> *I've learnt how to do short multiplication so this should be easy to learn.*

> *I remember this because the first line has five the second has seven and the third has 8.*

In both of the examples above the knowledge of the task itself, on which the comparison is made, is more complex. In the Year 2 example the task was judged on the basis that it was 'new', in the KS2 examples above reference is made to specific details of the task, aspects of which are named. In the first example prior learning is stated, the latter part of the sentence

implies a link being made to the current task and in the second example the recollection of specific facets of the task is detailed.

Evidence of metacognitive knowledge of task in KS3 and KS4 does seem to increase in complexity. Figure 23 shows a marked increase of 9% from Year 7 to Year 9 indicating that within KS3 there is evidence of the development of metacognitive knowledge of task. Examples from the KS3 PVT data illustrate this point:

> *Finding the nth term is hard at first, but it gets easier. You take a sequence:*
> *e.g. 2 – 3 = -1 (Year 7)*

> *"Dear oh dear" How don't I understand we have spent 4 lessons on it and I*
> *still don't know what happens when cold and warm fronts meet. (Year 8)*

> *Why are we learning this? I want to find out more about this. I wonder if we*
> *will need this in the future? (Year 9)*

Referring back to the definition of metacognitive knowledge of task given in Table 12, some differences can be seen across the three year groups in KS3. The example from Year 7 indicates clear task analysis, there is evidence of characteristics of the task and what is required for it to go from being 'hard' to 'easy' and evidence of long-term memory of how to complete the task. In the Year 8 example there is clear acknowledgement of the task (knowing what happens when warm and cold fronts meet) and evidence of time based comparison related to a judgement of difficulty. The introduction of the idea of 'future' in the Year 9 excerpt furthers the complexity of the metacognitive knowledge of task, because there is a consideration of taking stock of current learning (task) and thinking about how what is learnt from this may be transferred and applied in the future. Looking at KS4, although Figure 23 showed a decrease to 21% for Year 10 then a small increase to 23% or metacognitive knowledge of task for Year 11, there is definitely evidence of this transfer of learning. The KS4 PVT data also showed evidence of direct reference to where knowledge about a particular task came from. The latter example below indicates awareness around the transfer of learning:

> *Trying to extend their new knowledge to understand why other things occur*
> *or applying it to real life situations.*

> *I learnt this last physics lesson when another student used it as their answer.*

Evidence in the PVT data for KS4 (despite the trends identified in Figure 24 and Figure 25) of the transfer of learning and specifying the origin of task knowledge (from longer term memory further) supports the necessity of detailed qualitative analysis of the PVT data. Frequency counts and statistical analysis are not sufficient on their own to appreciate the richness of the data about metacognitive knowledge of task in full.

The mixed method approach to analysis of metacognitive knowledge of task has facilitated the exploration of trends in the data that sit at a deeper level than frequency counts. The assumption of minimum cell sizes for statistical analysis would not have allowed statistical analysis of this more fine-grained data. Interpretation of the trends for metacognitive knowledge of task centres on the notion of the complexity and transferability of the knowledge conveyed in the metacognitive knowledge of task. There appears to be an association between the complexity of metacognitive knowledge of task and age; complexity increases when metacognitive knowledge of task moves from knowledge about the task as a whole to specific knowledge and judgements about exact and defined aspects of the task. This may suggest a link between age and the process of task analysis; does the process of task analysis become more apparent and/or easier with age? Evidence of task analysis (and segmentation of tasks) becomes more apparent and more detailed with age in the PVT data. In the Reception and KS1 example above the whole task is described hard because it is '*new work*'. In examples from the older children in the sample there is evidence of the task being broken down into more specific facets (e.g. '*Finding the nth term is hard*').

The more detailed analysis of metacognitive knowledge of task in this study is limited by the sample size and composition, the sample comprising only three schools in total. Therefore, teacher effect was not likely to have been mediated, as it may have been if there were more schools in the sample. The close analysis of metacognitive knowledge of task in this study is relatively distinctive, there is evidence of other research analysing metacognitive knowledge of task at this level (e.g. Whitebread et al., 2009) but the field at this stage is not large. The approach to the deductive analysis of cognitive skills and metacognition outlined in Table 12 included metacognitive knowledge of strategy and several sub-categories for this. What follows presents the results of the analysis in relation to this aspect of the deductive coding scheme and discusses their meaning and contribution.

Focusing on metacognitive knowledge of strategy.

The complexity of the analysis of metacognitive knowledge in this study becomes more complex at this point; Table 12 illustrated the sub-division of metacognitive knowledge of strategy into that which was declarative (about strategy), procedural (knowing how to perform strategies) and conditional (knowing when and why to use a strategy at a specific point). Text coded as metacognitive knowledge of strategy was also analysed for evidence of Weinstein & Mayer's (1986) General Categories of Learning:

- Rehearsal (e.g. repeating words to remember them, going through work to revise)
- Organisation (strategies to make connections, e.g. note taking, concept maps)
- Elaboration (strategies that involve deeper processing e.g. mnemonics, summary, paraphrasing)

These additional classifications for metacognitive knowledge of strategy were new in terms of previous analysis of PVT data (Wall, 2008; Wall et al. 2012), but also more detailed than the analysis of metacognitive knowledge of strategy in the field, e.g. Whitebread et al. (2009, p. 79) where knowledge of strategies was explored within a wider definition:

> *A verbalization demonstrating the explicit expression of one's own knowledge in relation to strategies used or performing a cognitive task, where a strategy is a cognitive or behavioral activity that is employed so as to enhance performance or achieve a goal.*

The sub-categories of metacognitive knowledge of strategy employed in this analysis facilitated a closer examination of specific aspects of metacognitive knowledge of strategy, the types of learning strategies employed and the type of knowledge (declarative, procedural or conditional).

Considering first the types of learning strategies that were evidenced in the PVT data, Figure 25 indicates some potential trends to consider in more detail:

- The decrease, with age, in the use of rehearsal learning strategies across the four age groups
- The increase, with age, in the use of learning strategies classified as elaboration across the four age groups

- The increase and decrease in the use of learning strategies classified as organisation across the four age groups

Rehearsal was the first and least complex strategy in Weinstein and Mayer's (1986) *General Categories of Learning Strategies*, it decreased from 67% in Reception and KS1 to just 20% in KS3. This decrease in the use of strategies classified as rehearsal, combined with the increase in use of strategies classified as elaboration implies an increase, with age, in the complexity of learning strategies that were evident in the PVT data of this sample. Looking at examples of text coded as metacognitive knowledge of strategy (the broad category as opposed to the sub-categories) this trend in complexity becomes clear:

> *It helps me remember when I practice adding up numbers and times.*
> *(Female, aged 7 – Reception & KS1) -* **REHEARAL**

> *I learned how to speak Chinese, I'm going to have a conversation in Chinese*
> *with my friend so I remember. (Female, aged 10 – KS2) -* **REHEARSAL**

> *Oh dear! It has come up again in a homework…actually all I need to do is*
> *look at when I wrote my notes in my book. They will help me answer it if I*
> *keep reading it over and over again. (Female, aged 12 – KS3) -* **REHEARSAL**

The complexity of the strategies used in the examples above shows clear increase from the first example taken from the youngest age group (Reception & KS1) to the latter example from KS3. The KS3 example although detailing a simpler 'rehearsal strategy' (looking back at notes, making notes would have implied organisation but the action in this example is looking back at notes) makes a clear connection between prior learning and learning in the moment which in this example is homework.
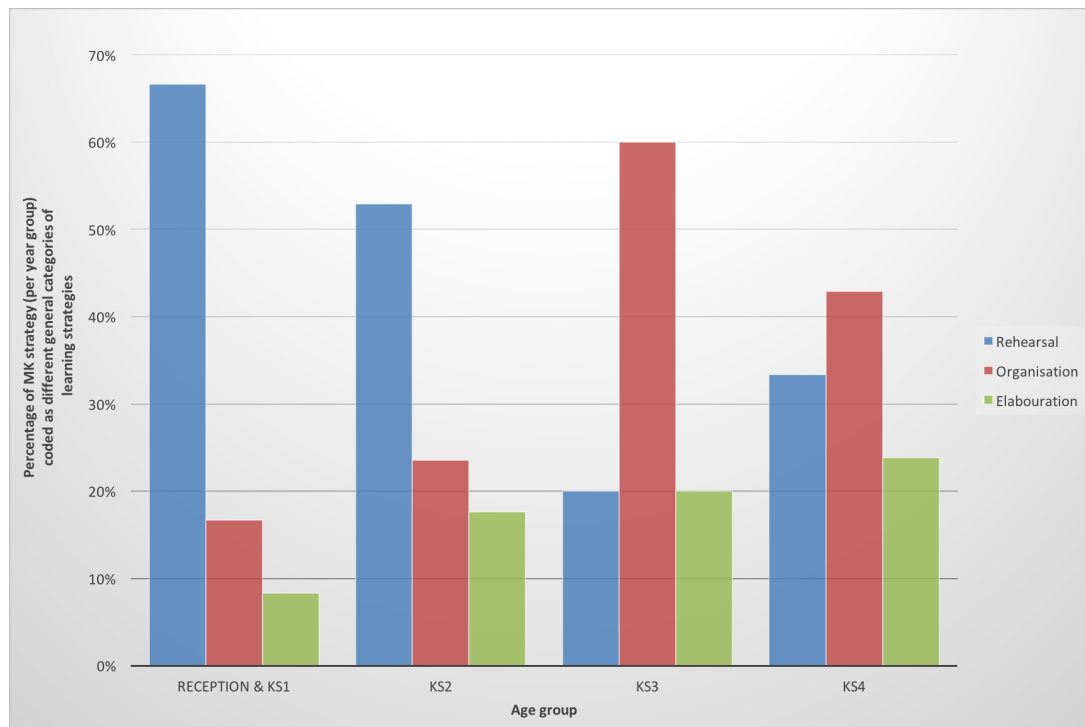
Figure 25: Percentage of text units coded as metacognitive knowledge of strategy coded as one of three general learning strategies (Weinstein & Mayer, 1986) (see also Pintrich (2002)

Elaboration, as defined by Weinstein and Mayer (1986), refers to a learning strategy that employs deeper processing and summarizing (e.g. the talking and clarifying understanding in the KS4 example above). The complexity of this is likely to increase in age as students move through school, increasing and building upon their 'toolkits' of learning strategies. However, there was evidence in the PVTs in this study of elaboration in students of the younger age groups:

> *This is a lot easy! Because we are making rhymes for long words (Female, aged 7, Year 2, Reception & KS1).*

> *I learnt them by using sentences. Because it's used like this. Big elephants can add up sums easily. People like this: People eat orange peel like elephants. And said: Sally Anne is dancing. (Male, aged 9, Year 4, KS2)*

> *I've learned about how tricks can help you in your 9 times tables. If you want to find the answer to: 8x9, you'll have to do 7x10=70 and then you add the number bond to 9. 70 + 2 – 72. 7 + 2 = 9. 9 x tables. (Male, aged 10, Year 5, KS2)*

Therefore, although the pattern in Figure 25 alludes to an increasing complexity of strategies with age there is still evidence of complex strategies in the youngest age groups of this

sample (Reception & KS1 and KS2). The presence of complex strategies like elaboration supports the significant presence of metacognitive knowledge for the younger age groups in the quantitative statistical data analysis that was presented in 4.2.1. In turn, this further evidences the findings of previous research about the development of metacognition (including research using PVTs) contrary to establish belief that it does not develop until beyond 8 years. The systematic review (2.1) showed that tools used within the age group comprising children in the Reception and KS1 age group (4 – 7 years) were the smallest group – perhaps this is the reasoning behind this established belief? Exploring metacognition with younger children (aged 7 or 8 and below) is an emerging area of research. It seems that at present this emergent body of research is not large enough to change established belief although it definitely appears to challenge it. The evidence from PVT data presented in this study serves to further validate the use of PVTs to explore evidence of metacognition in younger children and also adds to the wider field in this respect.

Weinstein and Mayer (1986) defined organisation as strategies that showed evidence of making connections, this included taking notes and strategies like concept mapping. Figure 25 shows an increase in evidence of organisation strategies in the PVT data from Reception & KS1 to KS3 and then a decrease between KS3 and KS4. This decrease at KS4 coincides with an increase in evidence of rehearsal strategies for this age group. Remembering the gradual increase in evidence of elaboration strategies across the four age groups it is interesting to consider why at KS4 evidence of rehearsal strategies increased and organisation decreased. Students in KS4 are in the two years of secondary school education where public examinations (GCSEs) very much become the focus as the endpoint or goal of secondary schooling. The researcher's personal experience as a teacher and observations in the secondary school for the sample in this study confirmed a focus on examinations in KS4. There is evidence in the PVT data of a focus on examinations and revision in the KS4 PVT data:

> *Asking the teacher for new/higher level knowledge or clarification on which points would receive marks on exam papers.*

> *I use mind maps to revise but it's not working*

> *Thinking of how to apply this/ways to remember it e.g. mnemonics/ways to revise it.*

There is also evidence in the PVT data of an awareness of revision and exams in examples from KS3:

> *Actually I could look back at the example I have written and that will help me. It will also help with my homework and revision.*

In this example there is an element of planning and evaluation. The notion that "It will also help with my homework and revision" implies a sense of forward thinking and planning in the idea of "homework and revision" - the example that has been written, will be useful in the future as well as its usefulness at that moment.

Earlier discussion considered the importance of reflecting upon the impact of teacher effect in the results of this study. The data in this study (e.g. the above consideration of the influence of public examinations) also requires a consideration of other contextual issues including the focus in English schools on the preparation and 'rehearsal' of students for public examinations. Procedural knowledge defined in Table 12 as "knowing how to perform the strategies" (Schmitt and Sha, 2009, p. 225, from Paris, Lipson & Wixson, 1982). The frequency data for declarative, procedural and conditional metacognitive knowledge of strategy in Figure 26 shows a decrease from Reception & KS1 to KS2, but this increases again in KS3 and KS4. It is important to consider whether this increase in procedural metacognitive knowledge of strategy in secondary school is related to the procedure of passing public examinations and the awareness of secondary school students of the importance of this. There was evidence in the PVT data of both the pressures of secondary school and the predominance of focus on forthcoming examinations:

> *Ok, that just went straight over the top of my head. I used to get this. I used to be at the top of the class and now I'm not. I don't want to be in the middle, I want to be at the top. How selfish, but oh well, there's too much pressure to being in the middle all the time. (Female, aged 14, Year 10)*

> *That will help me so much in GCSE exams. (Male, aged 15, Year 10)*

> *Asking the teacher for new/higher level knowledge or clarification on which points would receive marks on exam papers. (Female, aged 16, Year 11)*

Conditional metacognitive knowledge of strategy, the latter and more complex of declarative, procedural and conditional, refers to knowing when to apply a strategy and why it is appropriate to do it at this time. Like elaboration it appears that evidence of text units coded as conditional metacognitive knowledge of strategy in the PVT data increases with

age – this however is limited to an increase from KS2 – KS3. The decrease in KS4 theoretically linked to an increased focus on public examinations as discussed above.

Exploring the increase in conditional metacognitive knowledge of strategy from KS2 – KS3 leads to a consideration of the complexity of conditional knowledge in relation to knowledge of the transfer of learning (reflection on it) or the suggestion of it as part of a strategy. In the example below from KS2 there is evidence of when and why to use a strategy, in relation to specific information about a specific task:

> *I've learned about how tricks can help you in your 9 times tables. If you want to find the answer to: 8x9, you'll have to do 7x10=70 and then you add the number bond to 9. 70 + 2 – 72. 7 + 2 = 9. 9 x tables.*

The above excerpt indicates conditional strategy use in terms of 'when' by the specificity of wanting to find the answer to a specific calculation and knowing that specific strategy or 'trick' can help. The notion of knowing 'why' is also tied into this, knowing that the 'trick' is useful at that time and for that particular problem. In the example below (KS3), increased involvedness of the conditional metacognitive knowledge of strategy is apparent:

> *Oh, I get it now, I better write that out so I don't forget how to do that in the future. I can then always look through my notes again when I need help to remember, or if it is in my homework I now know a good strategy.*

In this example the increased complexity of knowing when it is a good idea to use a specific strategy is apparent in the 'when I need help to remember, or if it is in my homework'. In terms of knowing why a strategy is helpful at a given point this example includes reference to why writing the example down is a good idea, with reference to future use as well as within the immediate task. The inclusion of thinking forwards with regards to future learning ('or if it is in my homework…') also indicates evidence of planning.
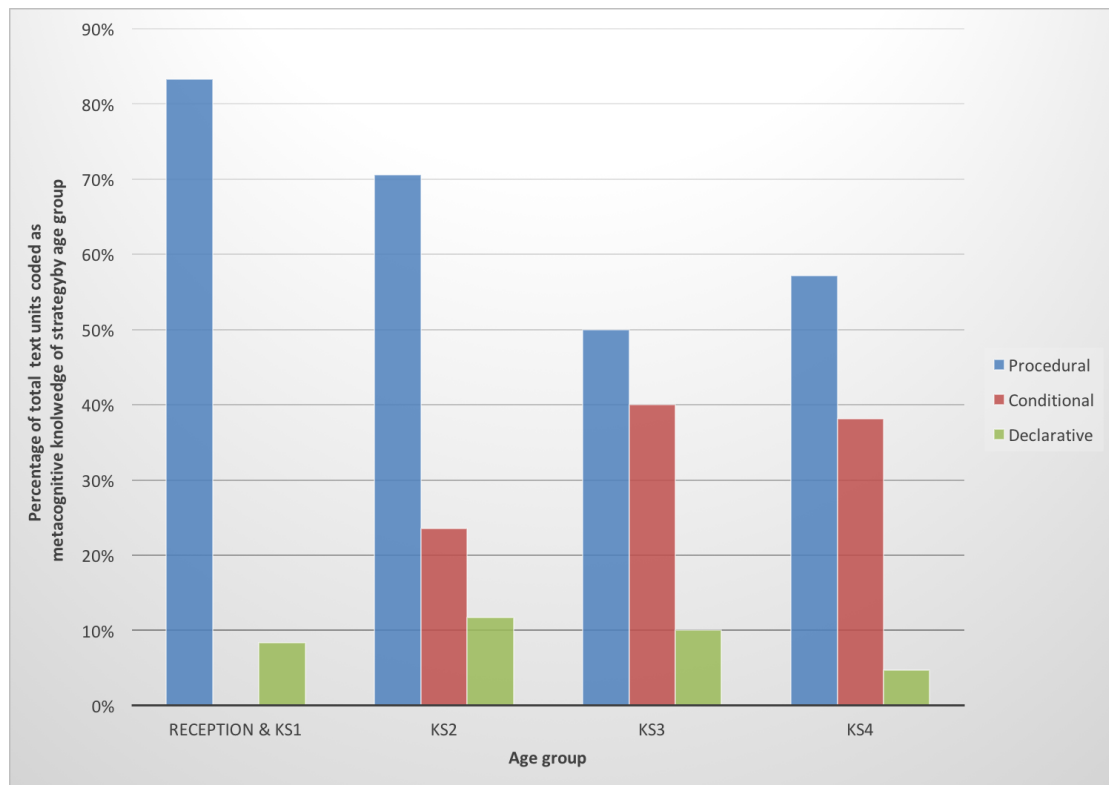
Figure 26: Percentage of metacognitive knowledge of strategy subdivisions (from total coded as metacognitive knowledge of strategy per age group)

Quantitative analysis of trends in specific facets of metacognitive knowledge of strategy is useful to a point, as it was for the three facets of metacognitive knowledge (person, task and strategy) coded. Due to minimum cell size requirements, statistical analysis of specific facets of metacognitive knowledge was not feasible. The richness of the data and the depth and relevance of trends relating to complexity increase across age groups would not have become apparent without the fine-grained qualitative analysis that has been presented. Hypotheses about the influence of public examinations upon quantitative trends in the data would not have been justifiable without this more detailed qualitative analysis. Linked to this qualitative analysis of the content coded as particular facets of metacognitive knowledge of strategy, is a consideration at the level of vocabulary in the PVT data. What follows revisits and considers the links between metacognitive development and literacy explored in 2.3.2.

Metacognitive vocabulary & word frequency analysis

The holistic and mixed method approach to analysis in this study included word frequency data. Produced in NVivo and presented in table format and word clouds provides a useful way of introducing and summarising the type of content that participants recorded on their PVTs. This information is useful in thinking about the overarching research question of this thesis, focussing on comments about learning in PVT data that are classified as metacognitive. The links between language and metacognition were introduced in 2.3.2. The literature suggested definite links between language used and development (age), these links focussed on three key areas:

- METACOGNITIVE LANGUAGE: exposure to metacognitive language and increased understanding of mental states. 'Mental verbs' (e.g. *know* and *think*) as forming the basis of the link between metacognition and language (Peskin and Astington, 2004)
- LANGUAGE AQCUISTION: the importance of language acquisition, particularly 'mental verbs' for the development of metacognition (Lockl and Schneider, 2006)
- COMPREHENSION: the links between comprehension and a child's cognitive capacity (the latter limiting the former). Examples of words given included 'know' and 'guess' (Miscione et al., 1978)

Once again reflecting on the main research question, the relevance of the following exploration of metacognitive vocabulary in this section becomes explicitly clear. The PVT data in this study illustrates an association between pupil comments about their learning and metacognition. Metacognitive vocabulary is one of the associations; there are links in the PVT data between the language used to describe learning by children aged 4-16 years and vocabulary defined as metacognitive within the relevant literature (2.3.2). Returning to the notion of teacher effect, it is once again important to consider this. The language used by specific teachers with their classes likely had an impact upon the language used by the students in their PVTs. This study did not incorporate methods by which to account for this (e.g. classroom observations), instead focussing on pupil responses on the PVTs themselves.

Table 20 shows the top 20 words (in terms of frequency in the PVT data) for the primary school year groups. The frequency of words like 'remember' is distinctive across the different year groups. 'Remember' appears firstly in the Reception year group at position 14,

this relates to findings discussed by Peskin and Astington (2004) regarding developmental trends in language associated with metacognition. Peskin and Astington (2004, p. 254) stated that by age 4 years that children can comprehend so called "mental verbs" or "language of thinking", they note that words like 'remember' suggest prior knowledge and that conversely the word "guess" would imply a lack of knowledge. The comparability of the PVT data to trends wider trends in metacognitive vocabulary identified in the literature further supports the utility of PVTs to explore metacognition with school-aged children. This direct link to the literature also serves to authenticate the findings reported in this section from the PVT data.

In the PVT data, by Year 2 (6-7 years) the word 'remember' is at position 3 in the word frequency table and by Year 6 (10-11 years) it is second. The use of the word remember in the PVTs appears to have increased with age in the primary school data but it is also interesting to note the changes, with age, in the contexts in which it is used. For example, a 4-year-old female wrote in a thought bubble: "thinking about it helps me to remember to spell my name", she is referring to spelling her name out using the individual letters (also written on the PVT) in order to help her remember it. Another female student, this time aged 7 years wrote: "Practising the word helps me remember it", we can see the development here from the quite non-specific language to the mention of a specific a strategy (practising) which can aid in remembering. In Year 6 (age 10-11 years) the context in which the word 'remember' is used appears to develop further and specific strategies including drawing things, writing things down and using number patterns are mentioned. The Year 6 data demonstrates both recall of what has been done (e.g. "I've learnt all about how the Victorians live now! I understand a lot more about them now..." Female, aged 11 years) and recall of an active thought process in the moment (e.g. "Oh I remember I can use the pattern of numbers" – male, aged 10 years). The latter example shows reflection on past learning in terms of remembering a strategy and applying it to a situation that is occurring at a different point in time.

Table 20: Top 20 words appearing in the PVTs for the primary age year groups

	Reception	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
1	Share	Know	Like	Rainforest	Learnt	Know	Know
2	Caterpillar	Pirates	Help	Know	Know	Chinese	Remember
3	Ate	Learn	Remember	Learnt	Name	Wonder	Draw
4	Chicks	Like	Easy	Like	Use	Get	Get
5	Sharing	Today	Know	Learning	Times	Learn	Ask
6	Thinking	Teacher	Helps	Wonder	Think	Like	Lot
7	Fun	Things	Learn	Plants	Like	Teacher	Now
8	Like	Easy	New	Today	Maths	Answer	Put
9	New	Hello	Practising	100	Thought	Hao	River
10	Chinese	Love	Good	Fun	Gospels	Learned	Think
11	Curly	Want	Maths	Might	Learn	Long	Believe
12	Good	Adding	Work	Work	Lindisfarne	Pictures	Five
13	Remember	Going	Fun	1000	Miss	Understand	Giant
14	Ants	Help	Love	Born	Remember	Work	Green
15	Apple	Helped	Need	Different	Tables	Xie	Just
16	Biscuits	Learning	Numbers	Easy	Ask	Ask	Like
17	Butterflies	Learnt	Practice	Forgot	Book	Best	Microorganisms
18	Dug	Literacy	Teacher	Going	Called	Bit	Really
19	Easy	Maths	Animals	Help	Enjoyed	Colour	Right
20	Fluffy	Writing	Concentrate	Learn	First	Find	Swing

Miscione et al. (1978, p. 1108) "investigated the development of semantic knowledge underlying children's comprehension of the words "know" and "guess". Miscione et al. (1978) concluded that in order for children to use the word know in an adult way that there needs to be acknowledgement of the existence of prior information, implying only one appropriate decision which when applied results in a successful outcome. An example from the PVT data that illustrates this point is given below, it was written by a 10-year-old male student:

> *Speech bubble: Do you know how to do this?*
> *Thought bubble: Oh I remember I can use the pattern of numbers*
> *(10-year-old, male)*

The example above demonstrates awareness that prior knowledge is necessary in order to complete the task at hand (the notion of knowing how to do this, or not, in the speech bubble). It also shows that the student has remembered that what he knows ("Oh I remember") and furthers his response by articulating how this relates to using a pattern of numbers in order to complete a given task.

Word frequency trends within the secondary school data (Table 21) and trends between the secondary and primary data follow similar patterns to those discussed in terms of the frequency of words like know and remember. However, in the secondary school data

the metacognitive language that is present is perhaps not as obvious if just looking at the word frequency data. For both Year 10 and Year 11 the most frequently used word is 'get', not overtly metacognitive on first glance. However, when looking at the context of the sentences in which the word 'get' is used on the PVTs, we can see that it could be taken to mean understand:

> *Thought bubble: I don't get this. I wish the others would be quiet so I can think. Oh. I see now I'm starting to understand*
> *(14-year-old, female)*

In the example above the student appears to be acknowledging their lack of understanding ("I don't get this"), recognising that they require quiet time to think it over and then at the end they are beginning to understand it.

The word frequency data for Year 11 highlighted a link with the fact that this is a year of schooling in which public examinations are taken (GCSEs). The word 'questions' was fourth in the word frequency count and 'revise' also appears in the top 20 (Table 21). The words 'remember' and 'know' are both present but there seems to be an added urgency to the remembering and knowing, perhaps for the purpose of forthcoming exams. In the example below there is a clear link made by the student, between the need to acquire and remember knowledge for exams (knowing that it may be useful in the exam and therefore needs to be remembered) and strategies employed by the student in order that they can do this (making a mind map):

> *Thought bubble: Wow I never knew that before, that could be useful in the exam. I'd better remember that, I'll make a mind map.*
> *(15-year-old, female)*

The focus on exams that is highlighted in the above example does not feature in the primary school PVT data and it seems to increase in frequency in the secondary school data, particularly in Years 10 and 11. This increase in frequency infers a direct link to impending GCSE exams for KS4 students in year 10 and year 11. The timing of the data collection in months leading up to summer exams was likely influential in this focus on the context of exams in the KS4 PVT data.

Table 21: Top 20 words appearing in the PVTs for the secondary school class groups

	Year 7	Year 8	Year 9	Year 10	Year 11
1	Help	Hard	Really	Get	Get
2	Really	Get	Something	Understand	Know
3	Term	Really	Lesson	Help	Answer
4	Understand	Help	New	Need	Questions
5	Miss	Like	Interesting	Remember	Teacher
6	Like	Know	Think	Just	Asking
7	Nth	Think	Understand	Like	Remember
8	Get	Learn	Learning	Now	Understand
9	Know	Understand	Learnt	Wonder	Ask
10	Algebra	Learnt	Easy	Answer	Just
11	Hard	People	Future	Easy	Knowledge
12	Learned	Lesson	Going	Going	Learnt
13	Answer	Need	Know	Mass	Lesson
14	Easy	New	People	Something	New
15	First	Quite	Wonder	Example	Work
16	Maths	Remember	Actually	Know	Write
17	Now	Subject	Bored	Learnt	Fact
18	Please	Talking	Learn	New	Learn
19	Example	Bit	Use	Right	Revise
20	Going	Continuing	Want	Sure	Trying

The word frequency tables and indeed word clouds show a decrease in language that is explicitly related to specific lesson content with age. In Table 20 we can see that in Reception the words caterpillar, chicks and ate appear in the top five words; these words are related to specific lessons that the participants spoke about with enthusiasm and at length during the PVT focus groups. The lesson content specific language runs right through for Reception class, but for other year groups this pattern is less so. In the Year 6 class, content specific words do not appear in the first 10 most frequent words but further down. In both Year 5 and Year 6 the most frequent word used is 'know' and the use of this word in the PVT data most often refers to one of two contexts: not knowing what is required in a given task (e.g. I don't know how to do this) or knowing something (e.g. I know that because…). The focus here in knowing, rather than specific lesson content, indicating perhaps that students are more able to transfer their learning or talk about learning strategies in general (as opposed to subject specific) as they get older.

In the secondary school data content specific language is present to a lesser extent than within the primary school data. The word clouds presented in Figure 27 (Reception, Year 2, Year 4, Year 6, Year 8, Year 10 and Year 11) illustrate this trend relating to subject specific language and an apparent decrease in this with age. A prominence of content

specific words can be seen including "Caterpillar", "Chicks" and "Chinese" in the Reception word cloud. Similar content specific language is present, but to a lesser extent, in the word cloud labelled Year 4 (such words are less prominent in the word cloud, for example "Lindisfarne" and "Gospels"). By Year 8 Figure 27 shows that it became much more difficult to pick out content specific or subject related language, this difficulty in picking out overtly content and subject specific language increased again for Year 11. The decreasing subject specific focus in vocabulary in the word clouds presented in Figure 19 suggests a decrease in subject specific vocabulary with age. This could indicate an increase in the ability to transfer learning across different scenarios with increased age, therefore reducing the importance of explicit subject specific references in their contributions. This might be an interesting area for further research.
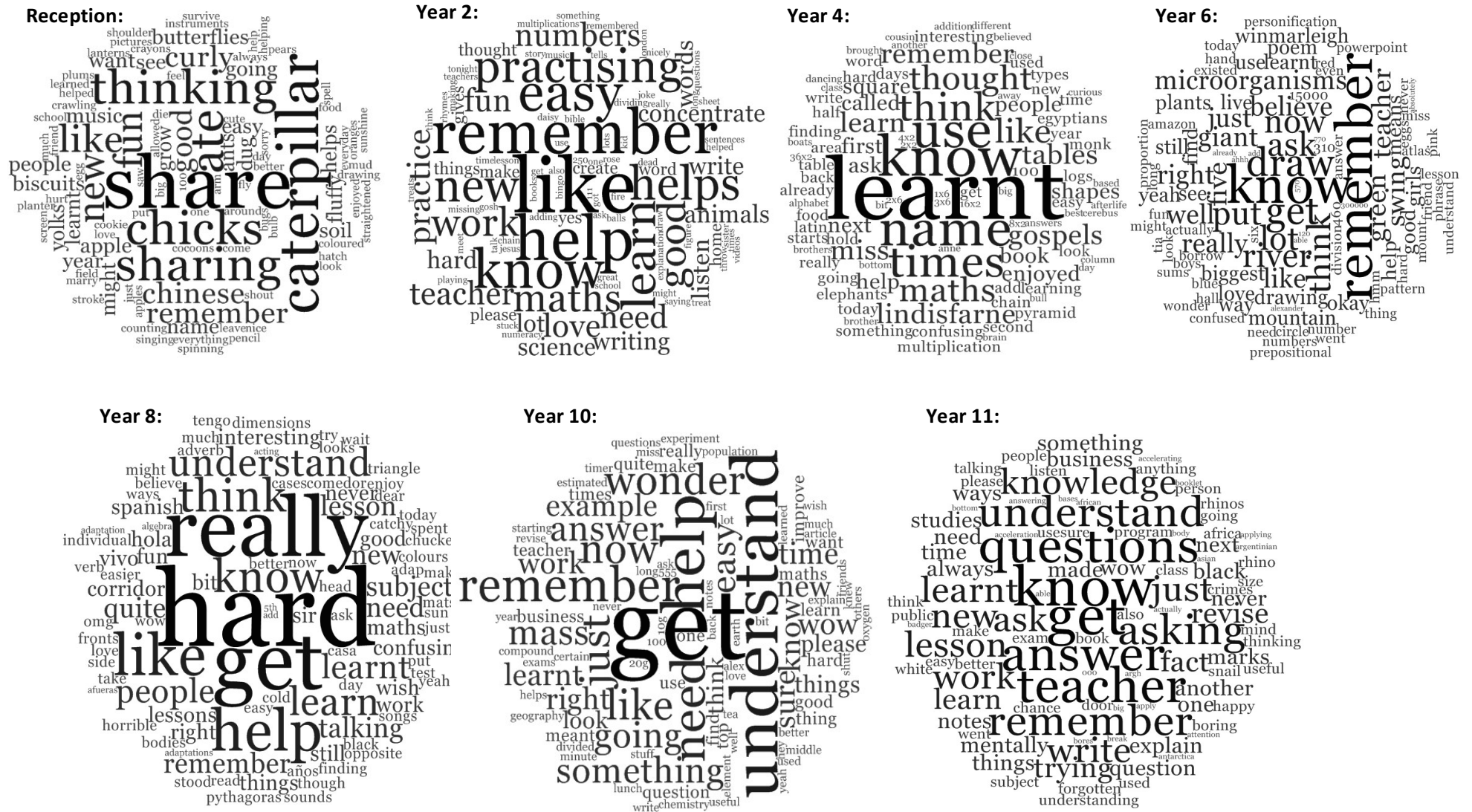
Figure 27: Word clouds of the PVT text by year group from Reception to Year 11

Considering 'offline' metacognitive skills and the links to metacognitive knowledge of strategy

In light of the literature reviewed in relation to various conceptualisation of sub-categories of metacognition, it is important to consider potential 'offline' evidence of metacognitive skills in the PVT data of this study. This importance stems from the links between this and metacognitive knowledge of strategy and the elicitation of metacognitive skilfulness in previous research using PVTs (Wall, 2008; Wall et al. 2012). In 2.1.8 under the subheading of 'Online or offline?' the notion of meta-metacognitive skilfulness was introduced, this idea was developed from a consideration of a wide body of literature including models of metacognition (in addition to Moseley et al., 2005) that included underlying cognitive skills 2.2.1. One of the models (Efklides, 2008) presented the idea of a meta-meta level, which included meta-metacognitive skills. This 'meta-meta' conceptualisation is not dissimilar to Pintrich's (2002) assertion of students' knowledge of 'meta-cognitive strategies' useful for planning, monitoring and regulating learning. In terms of the regulation of cognition or regulatory skill, Schraw (1998) divided this into three skills: planning, monitoring and evaluation. These three skills are also central to the definition of metacognitive skilfulness given by Veenman et al. (2005) (2.2.3) and applied in previous PVT research as stated above.

Importantly there is an apparent crossover between the notion of metacognitive knowledge of strategy as explored in this study (Table 12), i.e. metacognitive knowledge of strategies, and Pintrich's (2002) notion of knowledge of meta-cognitive strategies including planning, monitoring and evaluation which are more traditionally described as part of metacognitive skills or skilfulness (see Figure 11). It is beyond the scope of this thesis to explore this crossover in great detail. Nonetheless it is important to acknowledge that although established belief in the field is that metacognitive skills or skilfulness are better explored via 'online' methods, perhaps there is room for a consideration of 'meta-meta'.

Similarly, to the broad conceptualisation of metacognitive knowledge in previous PVT research, metacognitive skilfulness was also explored under a more general definition (see 2.2.3). If Efklides is correct and students can have 'meta-metacognitive skills', or knowledge of metacognitive skills (including planning, monitoring and evaluation) then it is important to consider the presence of these in the PVT data for this study in additional detail. The data analysed in this study did show evidence of aspects of all three of planning, monitoring and evaluation. There was evidence of future planning, in particular planning for

future learning and a consideration of how the learning episode described in the PVT may be utilised for this:

> *I might get an explanation tonight to learn about sentences (Reception & KS1)*

> *When I go home I am going to write the Chinese on a piece of paper so I can learn it. (KS2)*

The PVT data also contained evidence of monitoring and evaluation, in the first example below (KS2) there is evaluation of prior knowledge as comparable to new knowledge ('I never knew that') but also evidence of monitoring (bold) within the task in terms of the reflection on "ongoing on-task assessment of the quality of task performance" (Whitebread et al., 2009, p. 80) that can be inferred ('So if January is on a knuckle…'). If we also look at the definition of evaluation given by Whitebread et al. (2009, p. 80): "reviewing task performance and evaluating the quality of performance" we can see evidence of this (underlined) in the excerpts below:

> ***I never knew that you can use your knuckles to find out*** *how many days there are in the months of the year.* <u>*So if January is on a knuckle*</u> *then it must have 31 days. (KS2)*

> *Actually I could look back at the example I have written and* <u>*that will help me*</u>*. It will also help with my homework and revision. (KS3)*

> ***Mentally going over what they've learnt****. (KS4)*

> <u>*I am starting to understand this now*</u>*, I just need a few more examples in my book to revise from. (KS4)*

Deductive analysis of the PVT data revealed the complexity of the metacognitive strategies in the PVT data. This can be explored in relation to whether or not metacognitive knowledge of strategies is perceived to be related to a more immediate task in hand or if it involved planning for future (learning) activities and the potential evaluation and transfer of strategies. Veenman et al. (2004, p. 103), in a study exploring intellectual and metacognitive skills, concluded that: "Results show that metacognitive skilfulness is a general, person-related characteristic across age groups, rather than a domain-specific feature." The notion of metacognitive skilfulness being a general, person-related characteristic aligns well with the notion that it also includes the transfer of learning to similar problems (Veenman et al.,

1997) and would fit with the idea that metacognitive skills including planning, monitoring and evaluation are perhaps not as tied to an 'online' task as is thought in the field.

As opposed to asserting categorically that mainstream opinion in field is wrong in thinking about metacognitive skills or skilfulness as purely online, the purpose of this section was to facilitate questioning around the usefulness (or not) of the online/offline distinction. This distinction is frequently discussed and applied with little consideration of the potential crossover between metacognitive knowledge of strategy and metacognitive skills or skilfulness. It seems that there is a continuum of the links between these two concepts that are often presented as completely separate in the literature and without consideration of the evidence of planning, monitoring and evaluation that can be derived from metacognitive knowledge of metacognitive skills or skilfulness. Wall (2008) and Wall et al. (2012) talked about metacognitive awareness and awareness of the learning process, discussion in this section supports the notion that PVT data can facilitate meta-metacognitive skilfulness. Going forward in PVT research it is important to learn from this distinction and consider how it can be applied to other PVT data, perhaps in samples larger than that of this study.

4.3.4. What are the advantages and disadvantages of PVTs as a tool to collect data across a systematic sample of school-aged children?

Section 1.2.2 introduced the rationale and the research tool. Further research using PVTs to explore metacognition was required using a more systematic sample in order to both support and develop the findings in previous research. The systematic review (2.1) further rationalised the use of PVTs in this study by emphasising their unique characteristics within the field. Presenting the unique characteristics of PVTs within a field of 82 distinct tools or methods in the systematic review facilitated an objective approach to appraising the advantages and disadvantages of using PVTs across a systematic sample of school-aged children. What follows below in the evaluation of advantages and disadvantages of PVTs is directly linked to both the findings of this study and wider literature. What follows in 4.4 will build upon the notion of advantage and disadvantage explored here, in order to consider the potential limitations of this study in more detail. Table 22 outlines the advantages and disadvantages of PVTs, it presents and discusses information about the advantages and disadvantages of PVTs as a tool to collect data across a systematic sample of school-aged children in a concise and well-defined manner. Advantages and disadvantages are presented

alongside an interpretation of what has been learned with respect to these in this study, their correlation with previous findings in PVT research and new information gleamed from this study. The advantages and disadvantages presented are directly linked to both the unique characteristics of PVTs outlined in 2.1.9 and the suggestions for future research that will be presented in 5.3.

The mixed method approach to analysis in this study is reflected in the mixture of ways in which results have been both presented and discussed in this penultimate chapter. The evaluation of advantage and disadvantage in Table 22 is directly linked to both the findings of this study and wider literature. What follows in 4.4 builds upon the notion of advantage and disadvantage explored here, in order to consider the potential limitations of this study in more detail.

Table 22: The advantages and disadvantages of PVT use across a systematic sample of school-aged children

Finding/evidence from this study	Advantage and/or disadvantage	Interpretation of findings/evidence
The potential for PVTs to facilitate focus on and dialogue about a wide range of learning scenarios	Both	Only one design of PVT was used in this study, this showed that across a systematic sample of school-aged children one PVT could elicit evidence of metacognitive knowledge across the age range (4-16 years). However, it was potentially disadvantageous, the general focus of the PVT (*Think about a time when you learnt something new*) may have made it more difficult for some students to engage fully and remain on task. It would be interesting to explore a choice of PVTs across a systematic sample in future research. The wide range of foci is advantageous in appealing to a wide age range of children, if this is limited to one PVT (as in this study) it may impact upon the result
The utility of PVTs to elicit evidence of metacognitive knowledge in children as young as 4 years old and with a wide age range.	Advantage	The utility of PVTs to elicit evidence of metacognitive knowledge in children as young as 4 years old contradicts established belief within the field about the age at which metacognition develops and/or is observable. This study supports the findings of what seems to be an emerging body of research where evidence of metacognition in children as young as 3 years old has been evidenced (2.1.7). PVTs were one of only two tools identified in 2.1 that had an age range of 10 years
The lack of contextual data collection around the use of PVTs in this study	Disadvantage	Some other methods identified in the systematic review (2.1) used resources like video (e.g. Whitebread et al. 2009) to record data collection for viewing later as well as the data collected 'in the moment'. The dialogue around PVT completion in the focus groups for this study may have provided valuable information about metacognitive knowledge that could have been coded in addition to the written record of the PVT The notion of teacher effect could not be accounted for in this study – this contextual data may have revealed important insight into some of the patterns identified in the PVT data
The focus group completion of PVTs	Advantage	A consideration of dialogue and the impact that this likely had upon individual PVT completion is key. The social context of learning (2.1.8. 2.1.9) is important but the PVTs also provided an individual record of this dialogue for each child. There is a chance that the focus group environment for completion of PVTs could have led to participants influencing each other's completion of PVTs. The groups that PVT completion was completed in were recorded and there was limited evidence of this
The ecological validity of PVTs	Advantage	The 'worksheet' type format of PVTs was not unfamiliar in any of the participating schools (this was established prior to data collection). The familiarity of the activity and its completion in commonplace small groups meant that it was not an out of the ordinary activity for the children to complete
The general and more detailed evidence of metacognitive knowledge that could be extracted from PVT data	Advantage	As with the wide range of learning scenarios that PVTs can represent this relates to their flexibility as a tool for both research and learning (PVTs have been used by teachers in previous research as well as researchers). Evidence of metacognition in PVT data can be explored generally (at the level of metacognitive knowledge as in the statistical analysis in this study) or more closely focussing on specific aspects of metacognitive knowledge (e.g. person, task, strategy). The flexibility of PVTs leant itself well to the flexibility and reflexivity of the mixed method analysis in this study

4.4. Limitations

The balanced critique of the methodology and research design in 3.9.3 considered both benefits and potential limitations, alongside the potential implications of these upon the findings of this study. This section discusses the limitations of this study in relation to the results that have been presented and discussed in this chapter. A summary of the results and implications of this study for both research using PVTs and the wider field of metacognition follows this consideration of limitations in 4.5. This summary also encompasses contemplation of the overarching main research question identified in 1.3.1. Each of the subsidiary research questions discussed in 4.3 cumulatively facilitating a response to this central question.

The limitations of this study can be separated into two main groupings: limitations with regards to the research design and implementation and limitations of the research tool (PVTs) as it was applied (implementation and analysis) in this study. The time limited nature of a PhD thesis will always present limitations for both time and cost. In an education thesis where the data collection was completed in schools this is further compounded by the time investment of time required by the sampled schools. In 4.3.3 the number of schools in this sample compared to previous research using PVTs (Wall, 2008) was highlighted. With only three schools (two primary and one secondary) in this study it is more difficult to claim representative statistics in terms of potential contextual matters that may have affected the data (e.g. teacher effect, differing classroom discourse that was not accounted for within the data). In the secondary school the children did come from across the school and were routinely taught in different groups, to some extent this increases the representativeness of the statistical analysis for the secondary school sample (Year 7 – Year 11). On reflection, it is important to consider the aims of this thesis as set out in 1.2.2 - although the sampling in this study only included three schools it did develop the sampling in previous studies using PVTs (Table 1) further in other ways. The sampling in this study was more systematic, the sampling frame planned for 32 children per year group with equal split of males and females. Additionally, the sample in this study included children from every year group (Reception to Year 11) and it was independent from other research projects focussing solely on PVTs as a research tool.

Linked to the limited time for data collection and associated gathering of contextual data in the participating schools, it is likely that some of the differences in the data (e.g. the amount of cognitive skills or metacognitive knowledge recorded across different age groups)

were not related to age. Perhaps the quantitative statistical analysis is flawed in this respect. However, the robustness of the statistical analysis and the measures taken to achieve this (3.8.1), combined with the remainder of the mixed method analysis (both qualitative and quantitative) ensured a balanced approach to analysis and discussion. Whitebread et al. (2009, p. 78) noted that:

> *… simple frequency counts alone of particular behaviours cannot capture the*
> *full richness and quality of children's early metacognitions and, indeed,*
> *might be potentially misleading.*

Trends identified in the quantitative analysis have been supported by detailed qualitative analysis in order to capture the full richness of the PVT data. Indeed, the analysis of metacognitive knowledge in this study, in particular metacognitive knowledge of strategy goes further than many other studies have including Whitebread et al. (2009). The increased depth in the analysis comes from the inclusion of varied sub-categories of metacognitive knowledge of strategy. This included the exploration of generalised learning strategies (Weinstein & Mayer, 1986) and the idea that metacognitive knowledge of strategy can be further sub-divided to explore declarative, procedural and conditional metacognitive knowledge of strategy (see Table 12).

The pilot study (3.4) facilitated a consideration of many logistical and practical aspects of the data collection that ensued. One of the key decisions made as a result of this was which PVT would be used in the main data collection. The final PVT chosen with the prompt 'Think about a time when you learnt something new…' was chosen on the basis of its generality and the notion that this would not limit the scope of the pupil responses. It was thought that a subject specific PVT (e.g. learning something new in maths) could potentially constrain participation and responses if a child had a particular dislike of a specific subject, or if they found it particularly challenging. One PVT was used in the final data collection, reflective of the survey aim of this study and the subsidiary research question (1.3.1) that focussed on the utility of PVTs across the age range (4-16 years). This question would have been more difficult to address if several differently designed PVTs were used. However different designs and emphases may also have had the effect of increasing the reach of the PVTs, this would be particularly true if participants were given a choice of several PVTs each depicting different learning scenarios. On reflection the broad nature of the chosen PVT and prompt may have presented problems in making it more difficult for children to engage with the PVT discussion and activity. The general nature of the PVT used

(Figure 15) in the main data collection potentially made it more difficult for some children to imagine the scenario in the PVT and therefore complete their PVT and participate in the discussion. It is conceivable that a general scenario that is replayed in schools across the country (e.g. group work, paired work) may have actually added focus to the dialogue and PVT for some students. Nonetheless, across the sample the depth of the responses was fairly consistent for all age groups indicating that the design on PVT applied was applicable to the majority of the sample.

During the data collection the researcher scribed for some of the younger participants (3.6.2), this was valuable in terms of facilitating access to participants to PVT completion where they may have otherwise struggled. However, the notion of researcher effect must be considered in light of this. Although this scribing increased the accessibility of the data collection across the entire age range (see also 4.3.4), researcher effect cannot be ignored. The direct conversation with the participant and the researcher during scribing may have influenced what was written on the PVTs of these participants. However, despite consideration of researcher effect it is also important to remember the perceived mediating effect of the group dialogue – PVTs were completed in focus groups, as a mediated interview. The addition of scribing as an option in the data collection also made PVTs more accessible in terms of perceived assumptions of understanding placed on the participants (2.1). Scribing was one way for the researcher to check that there understanding, understanding was present amongst those youngest participants for whom PVTs were scribed.

The systematic review (2.1) went some way to negating the limitations of this study in terms of both justifying the use of PVTs and calculating the key considerations when implementing (e.g. presumed understanding and literacy demands; replicable methodology; clear reference to reliability and validity; and situating PVTs within the field). The transparency advocated in the findings of the systematic review (2.1) was at the fore in the research design and methodology (Chapter 3). It was central importance that the definition of metacognition rationalised and developed in Chapter 2 was clearly linked to the findings and analysis presented in this chapter. Chapter 2 explained in detail where PVTs were situated within the wider field and clearly rationalised their use in this study by way of their unique characteristics (2.1.9). It is essential to consider the limitations of the findings in this study but also crucial to acknowledge the contributions and ways in which these limitations have been accounted for. With this in mind, what follows returns to the overarching main

research question for this study (1.3.1), to summarise how the results presented and discussed in this chapter form a response to this.

4.5. Summary

In light of the results that have been presented and discussed in this chapter, Chapter 5 will underline the main conclusions and implications of this study. Nonetheless, before drawing conclusions and considering implications it is important to return to the overarching research question that was presented in 1.3.1:

> ***In a systematic sample of PVTs collected across school-aged children, what associations are apparent in pupil comments about their learning that are classified as metacognitive?***

In this chapter the four subsidiary research questions presented in 1.3.1 have been contemplated in detail, analysed with a pragmatic mixed method approach and discussed (including limitations). It is the role of this section to draw together the findings and discussion, in order to consider the degree to which they provide a response to this principal research question.

In 1.2.2 the rationale supporting the use of PVTs in this study was introduced, alongside the reasons why further research with PVTs was required. This study sought to gather data with school-aged children using PVTs with a more systematic sample, reflecting on the first part of the main research question this was evidently achieved (see Table 14). The latter part of the main research question (*what associations are apparent in pupil comments about their learning that are classified as metacognitive*) directly influenced the second and third subsidiary research questions focussing on evidence of cognitive skills and metacognitive knowledge in the PVT data. In this chapter, 4.3.2 and 4.3.3 presented and discussed evidence relating to both cognitive skills and metacognition. The links between the two sections (and their content – cognitive skills, metacognition) were clear, these links were discussed in 2.2.1 thus making clear the rationale for the inclusion of them alongside each other. This study affirmed the findings from the literature explored in 2.2.1 and confirmed the appropriateness of the approach to studying cognitive skills and metacognition simultaneously. The systematic review (2.1) identified very few tools or methods (or models in the theory behind tools or methods) that simultaneously explored both cognitive skills and metacognition. PVTs are comparatively unique in this respect and make a contribution to the wider field in terms of exemplifying how they can be used to elucidate these links,

showing how evidence of associations or patterns can be deductively explored in PVT data. The value of the analysis of cognitive skills in PVTs alongside metacognition enables a visualisation and analysis of the cognitive building blocks of metacognition.

In summary, analysis of the PVT data in this study showed an association between age and pupil comments about their learning classified as metacognitive (see 4.3.3). Similar associations were visible in analysis of the underlying cognitive skills as per the Moseley model (see 4.3.2). Other associations strongly suspected to have been present in the PVT data included teacher effect, it would be interesting in future research to explore this further perhaps by qualitatively building up a picture of the context in which the data is being collected (e.g. school level, teacher/classroom level, individual students). In brief, there is evidence, in systematic sample of PVTs collected across school-aged children, of developmental associations in pupil comments about their learning and those that are classified as metacognitive. Breaking this down as per the four subsidiary research questions identified in 1.3.1:

I.   PVTs have unique characteristics (including age range, cognitive/metacognitive explored simultaneously, mixed method approach) which contributed to the rationale of their inclusion in this study and the wider contributions that they make

II.   PVTs are unique in their exploration of cognitive skills alongside metacognition, the value of this has been confirmed by evidence presented in this study (4.3.2)

III. The PVT data in this study does show evidence of developmental patterns in comments classified as metacognitive knowledge. This study furthered evidence of metacognitive knowledge in previous PVT research (Wall, 2008; Wall et al. 2012) by exploring specific facets of metacognitive knowledge in finer detail. Indeed, this exploration also represents a contribution to the field where there is little evidence of research considering potential developmental patterns in in these finer facets of metacognitive knowledge (e.g. person, task, strategy – declarative, conditional, procedural)

IV.   Both the advantages and disadvantages of PVTs to collect data across a systematic sample of school-aged children have been made clear throughout this study. Not least the limitations discussed and summarised in this chapter (4.4). All of the tools and methods to measure or assess metacognition in school-aged children that were identified in 2.1 undoubtedly have advantages

and disadvantages. The resourcefulness of situating PVTs in this study, but also within a systematic review (2.1), enabled findings about their advantages and disadvantages (4.3.4) to be appropriately rationalised.

This chapter has presented the findings of this study alongside a discussion of their relevance for this study, research using PVTs and the wider field. This integrated approach fitted well with the pragmatic and educationalist perspective from which this PhD these was both conceptualised and subsequently accomplished. In the conclusions and implications (Chapter 5) that follow, the focus will return to the main research question and consider both the conclusions that can be drawn and the implications of this research in three key areas: metacognition research, PVT research and metacognition in practice.

Chapter 5 - Conclusions

5.1. Summary

This thesis has examined the use of PVTs to investigate developmental trends in metacognitive knowledge in school-aged children (4-16 years). Evidence was presented in Chapter 4 showing that analysis and discussion of the systematic sample of PVTs in this study did demonstrate evidence of metacognitive knowledge across the age range included. Analysis of this metacognitive knowledge indicated a developmental trend both in terms of detailed qualitative analysis of the content of pupil responses and a statistically significant relationship between the dependent variable (metacognitive knowledge) and independent variable (age group) in one-way ANOVA.

PVTs have been developed over the last ten years from a need within education practice to facilitate pupil voice in terms of pupil views on learning and teaching, in particular thinking about learning (metacognition) (Wall & Higgins, 2006). The importance of practice and pupils is key here; the standpoint of this study rests firmly in an educationalist and pragmatic approach to metacognition. The approach to examining developmental trends in metacognitive knowledge using PVTs was reinforced by a systematic approach to defining metacognitive knowledge. In order to develop an appropriate framework for analysis (Table 12), the systematic approach facilitated a phase of making sense of the 'fuzziness' of a concept (metacognition) that has been widely explored but seldom synthesised.

The systematic review (2.1) of methods used to measure or assess metacognition in school-aged children (1992 – 2012) makes an original contribution to the field. A paper developed from 2.1 (Gascoine, Higgins, & Wall, In press) is unique in its synthesis of methods or tools that have been used with children aged 4 – 16 years to explore metacognition. The systematic review provides a valuable contribution in terms of synthesis and it served to situate PVTs within the field. Key findings of 2.1 furthermore included a consideration of the ages those different tools have been used with, alongside the implications of this upon established beliefs about age and metacognition within the field. Evidence in this study aligns with other evidence listed in 2.1.7, supporting the notion that (using PVTs) metacognition can be investigated with children as young as four years old.

The empirical data collection using PVTs and mixed method approach to its analysis makes an innovative contribution to both research using PVTs and the wider field of metacognition. The systematic sample of PVTs in this study builds on the sampling used in previous studies (Table 1), supporting evidence in previous research of metacognition in children aged as young as 4 years. Originality in the mixed method approach to analysis of the PVT data contributes by way of exemplification of the value of a holistic and pragmatic approach to a complicated concept like metacognition. Chapter 4 placed complex statistical analysis alongside comprehensive qualitative analysis, including methods that crossed the boundary between qualitative and quantitative methods. Word clouds (3.8.2) are a quantitative approach to analysis of word frequency, this study demonstrates how they can also be analysed using a qualitative and visual approach providing an effective means by which to analyse the context and themes of data collected using PVTs.

The purpose of this chapter centres on making clear the contributions of this thesis and the implications of this for three key areas: metacognition research, PVT research and metacognition in practice. Within these three areas it is important to reference responses to each of the main and subsidiary research questions. It is also important to present proposals for future research, final reflections on the research process and finally closing comments.

5.2. Implications

The implications of this research span three key areas: metacognition research, PVT research and metacognition in practice. What follows identifies the key contributions and their implications under each of these headings. The contributions and implications are presented in light of the findings of the systematic review, the empirical data collection using PVTs and this thesis as a whole.

5.2.1. Metacognition research

The field of metacognition research is vast, complex and 'fuzzy'. The numbers of records screened and included in the systematic review of methods (2.1) make the multifarious nature of metacognition explicitly clear. With this in mind, the implications of the systematic review for metacognition research are clear:

- A synthesis of a previously un-synthesised area of the field
- The identification of key themes and trends amongst the different ways in which metacognition has been measured or assessed in school-aged children

- It facilitated a consideration of largely accepted and established assumptions within the field and how the findings of the systematic review may challenge these

The synthesis provided by the systematic review presented an overview of a complex and large field, forcing an appreciation of the variety of different methods and tools that have been used to explore metacognition in school-aged children. Appreciation of variety in this context is essential in moving forwards, without this future research cannot build upon and develop what is already in the field. Many new tools to measure or assess metacognition are being, or have been, developed but is this happening with an understanding of what is already in the field? The implications of this are uncertain, but the necessity of understanding the basis and rationale for the development of new tools and methods is key.

Key trends and themes in the analysis and discussion of the findings of 2.1 included those related to age and similarity in the characteristics of different tools and methods. The classification of the 82 tools or methods into four categories identified trends relating to age. The predominance of self-report measures and their use only with children aged over 7 years, led to a consideration of the application of self-report measures and the demands that they placed upon the perceived understanding and literacy abilities of the participants. Established belief in the field with regards to the age at which metacognition develops was introduced in Chapter 1, the notion that metacognition does not develop until aged 8 years and beyond (1.2.1). Based on findings around the predominance of self-report measures and the limited age appropriateness of some measures (including self-report), the findings of the systematic review have challenged this assumption. With this in mind, should focus in the field not therefore shift to questioning the impact of this prevalence of measuring metacognition in children aged over 7 years and the reasons for this? Is this dominance of theory about metacognition and older children, not a direct result of the fact that it is more difficult to explore metacognition with younger children and current research largely focuses on older children? In an emerging body of research with younger children, PVTs and other instruments identified in 2.1 have demonstrated that that it is possible to explore and elicit evidence of metacognition in children as young as 4 – 7 years old. The link between the pre-dominance of self-report measures and theory around the age(s) at which metacognition develops must be at the very least acknowledged.

The implications of the empirical data collection using PVTs centre on the further development of an emerging area in the field of metacognition research. PVTs are one of

few tools that have been used to explore metacognition with children as young as 4 years old and with a wide age range. This thesis aligns with the findings of previous research using PVTs (Wall, 2008; Wall et al. 2012) where an explicit analysis of metacognitive knowledge was included and resulted in evidence of metacognitive knowledge in children as young as 4 years old. The systematisation of sampling in PVT research that this study has contributed further reinforces the utility of PVTs within the field to explore metacognitive knowledge with a wide age range and within school settings.

Another key contribution of this study relates to the examination of metacognition alongside cognitive skills. This dual approach to analysis was directly related to the analysis applied in previous research (Wall, 2008; Wall et al. 2012) and based on the Moseley model (Moseley et al., 2005a). Literature explored in 2.2.1 supported the relevance of exploring cognitive skills alongside metacognition, something that is theorised in the field but that empirical examination of is relatively sparse. The exploration of cognitive skills alongside metacognition, further emphasises the importance of the link between the overarching concept of metacognition and what underlies it. An understanding of these cognitive building blocks in research using PVTs facilitates an important link to practice (2.2.2).

To summarise, the contribution of this study to metacognition research centres on the systematic and rigorous approach to appreciating the breadth of the field. This rigour was combined with a clear illustration of the importance of transparency in research concerning a concept as multifarious as metacognition. The importance in metacognition research of making clear the links between definition, method, application of the method and outcome – "How you test is what you get" (Desoete, 2008, p. 204) was exemplified in 2.1 and followed through in the subsequent chapters of this thesis. The rationale and context of this study clearly informed the development of the research questions identified in 1.3.1; clear links can be seen between these, the framework for analysis (Table 12) and the results and discussion.

5.2.2. PVT research

The contributions of this study and the implications of it for researching metacognition using PVTs are derived from the systematisation that this study has applied in all aspects of its approach:

- The systematic review highlighted the unique characteristics of PVTs within a vast and diverse field. The exemplification of these unique characteristics served to further justify the contribution of PVTs and the findings of this study.

- Previous research using PVTs identified a need for "further investigation of these templates" (Wall and Higgins, 2006, p. 51). In 3.5 and 3.6 discussion focussed on how the systematisation of this study (in the approach to defining metacognition, sampling and the use of one PVT across the entire school age range of 4-16 years) sought to meet this need for further investigation. The systematisation in this study facilitated clear links between the wider field and PVTs. Findings were gathered systematically and supported the findings of previous research using PVTs with regards to metacognitive knowledge.

- This study considered in detail the deductive approach to analysis that has been applied in previous research (Wall, 2008; Wall et al. 2012) and how this could potentially be developed in order to explore, at a deeper level, different aspects of metacognitive knowledge (e.g. metacognitive knowledge of person, task and strategy). A more fine-grained approach to the analysis of metacognitive knowledge enabled increased depth in the understanding of metacognitive knowledge in the PVT data. For example, the patterns in the complexity of different aspects of metacognitive knowledge, in particular metacognitive knowledge of strategy and its sub-facets, were identified and deeper analysis expedited contextualisation of these patterns in relation to age and complexity (4.3.3).

- The detailed exploration of relevant literature that preceded the development of the deductive coding scheme's additional elements in this study (and the exclusion of metacognitive skilfulness in Table 12 and 4.2) highlighted an area of uncertainty within the field that required further investigation. The usefulness of applying the popular online/offline distinction for different ways of exploring metacognition (2.1.8) was questioned in relation to the exploration of metacognitive skilfulness in previous research using PVTs (Wall, 2008; Wall et al. 2012). PVTs would be strictly described as an 'offline' method (4.3.3) but they blur some of the traditional boundaries in the field of metacognition research. Evidence of this furthers the unique characteristics of PVTs identified in 2.1.9 and exemplifies the contribution that they make.

- The findings of this study and literature explored in Chapter 2 indicated that there was an undefined overlap between offline metacognitive knowledge of strategy and

awareness of and reflection upon 'online' metacognitive skills or meta-metacognitive skilfulness. The two are undoubtedly connected in the process of learning and it is difficult to define and separate the overlap. It is important to learn from the findings of research using PVTs and other relevant literature that explores a level of awareness in relation to metacognitive skills and skilfulness. Consideration of the notion of meta-metacognitive skilfulness or metacognitive knowledge of metacognitive skills or skilfulness is significant. Comparative analysis of evidence of awareness of metacognitive skilfulness in this study supports previous analysis presented in Wall (2008) and Wall et al. (2012). The analysis presented in 4.2 is without metacognitive skilfulness (unlike previous analysis) to some extent this compromises the survey aim highlighted in 1.2.2. However, the inclusion of the comparative analysis (with dependent variables and unit of analysis both replicated from previous research) sought to mitigates this. The complexity of metacognition and its subdivisions is intricate, complex and not without overlap – there is no right answer. Nonetheless, the transparency in the methodology and analysis presented in this study has facilitated an objective exploration of the utility of PVTs to investigate metacognition with school-aged children.

A pragmatic and holistic approach to analysis, combined with a systematic approach to both defining and operationalizing metacognitive knowledge within this study, has facilitated an important contribution to research conducted with PVTs. A systematic sample across the entire school age range, using one PVT design has further demonstrated the utility of PVTs across a wide age range and their applicability for not only exploring pupil views of learning but also occasioning evidence of metacognition.

5.2.3. Metacognition in practice

PVTs were developed with practice in mind and have been used by both researchers and teachers to explore pupil views of learning (and metacognition) (Wall, 2008; Wall et al., 2012). Indeed, PVTs can be seen as a tool that can mitigate power relations between adults and the participating students (Wall et al., 2012). The implications of this research for practice can be divided into those concerning PVTs and their use in school settings, and the potential of PVTs to influence the decisions of policy makers.

In terms of policy, PVTs were developed to gather pupil views about learning; the potential to then feed into policy and the evaluation of policy in schools is clear. The pupil

voice agenda in the English national curriculum quite rightly shows no signs of slowing down and is intrinsically linked to effective leadership in schools and underpinned by international legislation (DfE, 2014d). PVTs are a low cost, accessible (for teachers or researchers), interactive (focus groups) way of capturing pupil views of learning in a fairly ecologically valid and familiar learning situation. The use of PVTs as part of national Learning to Learn projects (Higgins et al., 2007; Wall et al., 2010) makes clear their value as a reflective and evaluative tool; there also was evidence in this study to support this assertion. For example, frequent references were made by students inferring that they were reflecting on past learning experiences and participants frequently referred to reflective or evaluative processes within the text on their PVTs:

> *I can't believe how much I have learnt from last lesson. I had maths we are revising for a test, it's going to be hard but I can't wait as I have learnt so much. (Female, aged 12, Year 7)*

> *So all I need to remember is my mental maths and all the things I have learnt in the past lessons. (Female, aged 12, Year 8)*

In terms of reflection and evaluation, the utility of PVTs to facilitate this alongside metacognitive knowledge has been demonstrated in this study (examples above) and in prior research (Higgins et al., 2007; Wall et al., 2010; Wall et al., 2012). The use of PVTs in Learning to Learn serves to emphasise their potential to not only gather pupil views on learning, but also to evaluate policy within practice situations.

Reflecting on the contribution of PVTs to practice in terms of their impact in the classroom, used by teachers, it is important to consider the following scenario:

> ***If class teachers used PVTs regularly to evaluate or reflect on learning, children would be being asked in a familiar way to think about their learning and as we know, thinking about thinking is metacognition.***

In conversation with the head teacher of School B at the time of data collection the researcher learned that this particular school was trying out different ways of facilitating pupil voice. Thinking back to the links between metacognition and attainment identified in 1.2.1 it is important to consider the impact of this facilitation of metacognition in practice. In their toolkit, Higgins et al. (2012) identified metacognitive and self-regulatory strategies as being low cost but with a high impact for students. High impact with low cost is further evidence to support the development of PVTs as a tool for both researchers and practitioners and for their consideration in relation to policy around metacognition. It would

be interesting to contemplate the potential impacts of PVTs as a regularly used tool in the classroom. There is some evidence in Learning to Learn of PVTs as a regular tool for reflection having been implemented (Wall, 2008).

In terms of practice and metacognition, 2.2 demonstrated that PVTs are unique in their applicability to a large age range (4-16 years in this research) and their usability for both teachers and researchers. PVTs are a multi-purpose tool for research and practice, appropriate for the exploration of a multi-faceted concept like metacognition. PVTs also demonstrate applicability to the notion of *lifelong learning*, which like Pupil Voice is high on the agenda of education policy and in practice. Chapter 4 presented multiple examples of an awareness of need for transferable skills and of thinking about particular skills or learning in relation how they may be useful in future learning situations. The skills and knowledge of learning and how to learn (thinking about this is metacognition) are centrally important amongst the content knowledge of subjects that is required in school. Claxton (2008, p. 88) drew on the wisdom of Albert Einstein when he affirmed, "Education is what is left after you have forgotten everything you were taught at school"

5.3. Proposals for Further Research

The complexity of metacognition negates that in any research about it, there are always likely to be several avenues suggested for further research. The complexity of metacognition has expedited the identification of relevant questions regarding further ideas for research throughout this study. These proposals are both conceptual and related to conceptualising metacognition and practical in relation to the logistics of future research with PVTs.

- **A detailed consideration of the potential for overlap between metacognitive knowledge of strategy and awareness of or meta-metacognitive skilfulness**
  Consideration of the usefulness of the online/offline distinction precedes this proposal for further research. The systematic review (2.1) explored ways of measuring and assessing metacognition in detail, including the relevance of the online/offline debate. The systematic review also highlighted the importance of clarity and transparency for definition, method/tool, outcomes and the links between these. The review in 2.1 did not have the scope to consider in detail interaction and crossover between the various definitions of metacognition (and subdivisions of it) that were presented. Further systematic interrogation of the literature with regards to how metacognition (and subdivisions of it) are defined

would be necessary to effectively explore the notion of meta-metacognitive
skilfulness in PVT data.

- **Metacognitive vocabulary, context and the transfer of learning**

  In a sub-section of 4.3.3 entitled 'Metacognitive vocabulary & word frequency
  analysis' the potential for PVTs to explore metacognition via metacognitive
  vocabulary was introduced. Metacognitive vocabulary is emerging in terms of its
  contribution to the wider field; PVTs have the potential to make an important
  contribution to this. Further exploration of metacognitive vocabulary with PVTs
  could include an inductive approach to coding in order to investigate more fully the
  potential contribution that PVT data could make. This would also facilitate a more
  detailed consideration of evidence about the learning situations, context and the
  transfer of learning apparent in the pupils' comments about their learning.

- **Comments affective to learning**

  In previous research using PVTs (Wall, 2008; Wall et al. 2012) comments affective to
  learning were coded as this because in talking about feelings they demonstrated
  either a positive affect or negative affect on learning. In 2.2.5 literature around
  metacognitive experiences was explored, also referring to feelings about learning. It
  would be interesting in future research to develop the notion of comments affective
  to learning in relation to literature around metacognitive experiences (Efklides,
  2006, 2008) and explore the utility of awareness of this in PVT data. Similarly, to the
  notion of meta-metacognitive skilfulness this would be metacognitive knowledge of
  metacognitive experiences. Meta-metacognitive experiences is also not dissimilar to
  the social level of metacognition identified in Efklides' (2008) multi-faceted and
  multi-level model of metacognition.

- **The potential interaction between age, gender and metacognition**

  In previous research (Wall et al. 2012) complex analysis has been undertaken of the
  potential interaction between age, gender and metacognition (see also comparative
  analysis in Appendix D). It would be interesting in future research to consider the
  potential for these interactions to be further elicited in PVT data. Although stratified
  by gender the sample in this study is relatively small and not truly random. Possible

comparison could be made to other methods that have explored two-way trends between age, gender and metacognition in including Veenman et al. (2014).

- **Further exploration of the links between metacognition and positive outcomes for students**

  Reflecting on the utility of PVTs in practice it would be interesting to review the utility of PVTs to play a role in facilitating the links between metacognition and positive student outcomes, including attainment. The possibility of building PVTs into regular classroom practice, as an evaluative and reflective tool delivered by teachers could be explored further. Related to this is the notion of teacher effect and in future research examining in more detail (e.g. through classroom observations, analysis of planning) the impact of this on metacognition elicited in PVT data. Teacher effect in this sense could be an indication of positive practice with regards to facilitating metacognition.

- **The social context of learning and PVTs**

  PVTs, although completed by a single person, are part of a focus group. With this in mind, PVT completion could be explored as a more physically collaborative activity. Perhaps one larger sized PVT with small groups and the collaborative completion of that PVT would facilitate even more discussion about learning? This type of activity with PVTs could also potentially be accomplished with technology including interactive whiteboards or multi-touch tables.

- **Observation of PVT completion**

  Related to the points above with regards to collaboration and teacher effect, PVT completion could be videoed and transcribed. This would allow comparison of evidence of metacognition, both written on the PVTs and transcription of dialogue in the process. This could facilitate the validation of PVTs against another existing observation scoring system, for example the C.Ind.Le (Whitebread et al. 2009). It would be important to consider the expense and ethical issues associated with adding this additional layer to PVT data collection, particularly in terms of their applicability and usability in practice. The findings of PVT data could be compared alongside a more explicitly 'online' method of measuring or assessing metacognition within the same sample, like an observation schedule as suggested above. Importantly, there may be difficulties in applying such a schedule across the wide range of ages that was included in this study, given the smaller age range of

observation based methods (Table B, Appendix A) and their use with predominantly younger children.

- **Updating of the systematic review**

  An update of the systematic review as more studies are published and more methods developed would be a systematic and rigorous way to keep track of the field. Dissemination of the value of the data in the existing systematic review and any future updates would also need to be considered. The recently re-launched META database (Basilio & Marulis, 2013) is one such outlet, there is potential here to collaboratively extend the review including the younger pre-school age group that were not included in the review for this study.

The ideas above illustrate clearly that several different avenues could be followed in terms of further research based on this study, all of which would require careful planning and transparency at all stages. It would be essential to remember within this the importance of appropriately defining the concept being studied, considering how this links directly to the methods employed and the associated outcomes.

5.4. Concluding Summary

The complexity of the concept at the centre of this study is of key consideration in reflecting on the research process as a whole and in making concluding comments. The challenges of systematising such a complicated and inherently 'fuzzy' concept (Dignath et al., 2008; Scott & Levy, 2013) as metacognition were addressed in a rigorous manner; iteration in response to findings as they emerged was key. It is useful at this point to return to the research questions, ensuring that the final conclusions are directly related, thus coming full circle in this study. The main research question was:

> **In a systematic sample of PVTs collected across school-aged children, what associations are apparent in pupil comments about their learning that are classified as metacognitive?**

This study used a more systematic sampling method that incorporated the entire range of school-aged children (4-16 years) and found associations between pupil comments about their learning and metacognitive knowledge. Differences were identified in pupil comments about their learning and the complexity of the metacognitive knowledge that was recognised. This was particularly true of metacognitive knowledge of strategy. Evidence in

this study suggested that the complexity of metacognitive knowledge of strategy is related to the degree to which children refer to it in the moment of a single task or anticipate the usefulness and application of it in future learning. Simultaneous exploration of comments about learning on PVTs classified as evidence of cognitive skills enabled a consideration of metacognition that included the underlying cognition. Without cognition, <u>meta</u>cognition would not be so described or conceptualised; thus highlighting the importance of the building blocks (cognitive skills) in supporting the higher order concept of metacognition.

A rigorous approach to defining and operationalizing metacognition in this study facilitated clear links between the main concepts; method; application of the method; analysis and associated outcomes. The multifarious nature of metacognition means that historically it has faced challenges of being both oversimplified and overcomplicated. The middle ground achieved in this study stems from the clear links described above and the common pragmatic thread that this weaves through all sections of this study. The complexities of metacognition require an approach to research that is pragmatic and an openness that can appreciate multi-faceted concepts like metacognition, without them becoming too indistinct or too overcomplicated. PVTs are a research tool important in an area of emerging research in metacognition with younger children; uniquely they have been used across the school-age range. The pragmatic and educationalist epistemology underlying both PVTs and the rationale for this study, alongside its systematisation, mean that it has made significant contributions to both the wider field and specifically research using PVTs.

> *Despite the fuzziness of the concept of metacognition (Brown, 1987),*
> *differentiating its facets and levels of functioning is of critical importance for*
> *both theory development and applications… (Efklides, 2008, p. 285)*

A 'fuzzy' concept has been systematically and methodically examined in this thesis, but the fuzziness of metacognition and debate about it in the field remains. It is the role of individual researchers to transparently acknowledge and act upon (in definition, operationalization and outcomes) the multi-faceted and multifarious nature of metacognition.

Appendix A – Systematic Review (2.1)

Table A: The numbers of records from each database, including records excluded at each stage

Database searched	Total records	Records post de-duplication	Records excluded at 1st screen	Records remaining after 1st screen	Records not available	Records excluded at 2nd screen	Records forward to data extraction	Records excluded during data extraction	Records excluded reliability, validity &/or replicability	Total number of included records
AEI	225	207	173	34	12	19	3	0	0	3
BEI	234	233	231	2	0	2	0	-	0	-
ERIC	397	266	198	68	18	32	18	4	0	14
First Search Article First	17	6	6	0	-	-	-	-	0	-
First Search ECO	282	147	109	38	0	14	24	7	0	17
Psych Articles	17	0	-	-	-	-	-	-	0	-
PsycINFO	624	615	335	280	6	159	115	19	2	94
Web of Knowledge	925	615	512	103	4	84	15	2	1	12
Citations	-	-	-	-	-	-	-	-	-	13
Expert	-	-	-	-	-	-	-	-	-	-
Total	2721	2089	1564	525	40	310	175	32	3	153

Table B: The ages (in years) that individual tools were used with and the number of times they were used

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)												
					4	5	6	7	8	9	10	11	12	13	14	15	16
1. Bandura's Self Efficacy for Self-Regulated Learning Scale	Zimmerman et al. (1992)	Self report	3	7							2	2	2	2	1	1	2
2. CDR (Cognitive Developmental aRithmetics test)	Desoete and Roeyers (2006a)	Self report	2	3					1	2	1						
3. Classroom Coding System	Stright et al. (2001)	Observation	4	5	2	2	2		1	1							
4. Clinical Interview	Pappas et al. (2003)	Interview	2	3	2	2	1										
5. Computer based measure of metacognitive skilfulness	Veenman et al. (2004)	Task based	1	7							1	1	1	1	1	1	1
6. Concept maps	Ritchhart et al. (2009)	Task based	1	9					1	1	1	1	1	1	1	1	1
7. Conditional knowledge (part of a questionnaire)	Wolters (1996)	Questionnaire	1	5								1	1	1	1	1	
8. Constructivist Internet based Learning Environment Survey (CILES)	Wen et al. (2004)	Self report (internet based)	1	3											1	1	1
9. EPA2000 (Evaluation and Prediction Assessment)	Desoete and Roeyers (2006)	Self report (computerised)	5	6					2	5	5	1	5				2
10. Epistemic metacognition measure	Mason et al. (2010)	Retrospective Interview	1	2										1	1		
11. General Studies Metacognitive Orientation Scale (GSMOS)	Thomas and Au Kin Mee (2005)	Self report	1	4					1	1	1	1					

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)												
					4	5	6	7	8	9	10	11	12	13	14	15	16
12. Goal Orientation and Learning Strategies Survey (GOALS-S)	Dowson and McInerney (2004)	Self report	1	1											1		
13. Index of Metacognitive Awareness about Writing (IMAW)	De Kruif (2000)	Self report	1	3						1	1	1					
14. Index of Reading Awareness (IRA)	Jacobs and Paris (1987)	Self report	12	7					4	6	8	8	6	3	1		
15. Index of Science Reading Awareness (ISRA)	Yore et al. (1998)	Self report	3	6						2	2	3	3	3	2		
16. Individual interview – strategy use and metacognition	Throndsen (2011)	Interview	1	2			1	1									
17. Integrated Learning Assessment	Silver et al. (2011)	Questionnaire	1	3											1	1	1
18. Interview about Metacognitive Awareness (IMA)	Schmitt and Sha (2009)	Interview	1	6						1	1	1	1	1	1		
19. Interview from the Munich Longitudinal Study	Lockl and Schneider (2006)	Interview	1	2	1	1											
20. Inventory of Metacognitive Self-Regulation (IMSR)	Howard et al. (2000b)	Self report	4	7							3	4	4	3	3	3	2
21. Junior Metacognitive Awareness Inventory (JrMAI)	Sperling et al. (2002)	Self report	7	9					1	4	4	4	4	3	3	3	2
22. Knowledge and skills questionnaire	de Jager et al. (2005)	Questionnaire	1	2							1	1					

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)												
					4	5	6	7	8	9	10	11	12	13	14	15	16
23. Learning strategies assessed by journal writing	Glogger et al. (2012)	Task based (Journal writing)	1	3											1	1	1
24. Learning Through Reading Questionnaire (LTRQ)	Butler et al. (2011)	Questionnaire	1	5									1	1	1	1	1
25. Metacognition Applied to Physical Activities Scale (MAPAS)	Settanni et al. (2012)	Self report	1	4								1	1	1	1		
26. Metacognition of Nature of Science Scale (MONOS)	Peters (2008)	Self report survey	2	4								1	1	2	2		
27. Metacognition Scale	Yildiz et al. (2009)	Self report	1	4							1	1	1	1			
28. Metacognitive Processes in Physical Education Questionnaire (MPIPEQ)	Theodosiou et al. (2008)	Questionnaire	1	7							1	1	1	1	1	1	1
29. Metacognitive Ability Self-report Questionnaire (MASQ)	Panaoura and Philippou (2007)	Self report	3	4					3	3	3	3					
30. Metacognitive Attribution Assessment (MAA)	Desoete et al. (2001)	Rating scale	1	2					1	1							
31. Metacognitive Awareness Inventory (MAI)	Schraw and Dennison (1994)	Self report	5	6								1	2	2	3	3	3
32. Metacognitive Awareness of Reading Strategies Inventory (MARSI)	Mokhtari and Reichard (2002)	Self report	4	8						1	2	3	3	2	2	1	1
33. Metacognitive experiences	Dermitzaki and Efklides (2001)	Self report	4	9			1		1		1	1	3	3	2	2	2
34. Metacognitive Interview	Lu (1995)	Interview	1	4							1	1		1	1		
35. Metacognitive Interview (MCI)	Lefevre (1995)	Interview	1	7					1	1	1	1	1	1	1		

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)													
					4	5	6	7	8	9	10	11	12	13	14	15	16
36. Metacognitive Knowledge in Mathematics Questionnaire (MKMQ)	Efklides and Vlachopoulos (2012)	Questionnaire	1	5								1	1	1	1	1	
37. Metacognitive Knowledge Monitoring Assessment (KMA)	Tobias and Everson (1996)	Task based	2	3							1	1					1
38. Metacognitive Knowledge Questionnaire	Metallidou and Vlachou (2010)	Teacher rating	1	3							1	1	1				
39. Metacognitive Orientation Learning Environment Scale – Science (MOLE-S)	Thomas (2003)	Questionnaire	4	6								1	1	2	4	3	3
40. Metacognitive Questionnaire	Metallidou and Vlachou (2010)	Self report	1	3							1	1	1				
41. Metacognitive Questionnaire	Okamoto and Kitao (1992)	Questionnaire	1	2							1	1					
42. Metacognitive Skills and Knowledge Assessment (MSA)	Desoete et al. (2001)	Self report	3	4					1	1	2	2					
43. Metacognitive Strategies (MSTRAT)	Roeschl-Heils et al. (2003)	Self report	1	3										1	1	1	
44. Metacomprehension Strategy Index (MSI)	Schmitt (1990)	Self report	9	8				1	4	5	4	1	1		4	4	
45. Motivated Strategies for Learning Questionnaire (MSLQ)	Pintrich and De Groot (1990)	Questionnaire	9	7							2	4	6	3	3	5	3
46. Multi method assessment of meta-cognitive behaviours	Shamir et al. (2009)	Multi method	1	2	1	1											
47. Multi-Method Interview (MMI)	Wilson (1999)	Multi method	2	2									2	2			

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)												
					4	5	6	7	8	9	10	11	12	13	14	15	16
48. Observation (CASE@KS1)	Larkin (2006)	Observation	1	2			1	1									
49. Child 3-5	Whitebread et al. (2009)	Teacher rating	2	2	1	1											
50. C.Ind.Le	Whitebread et al. (2009)	Observation	2	2	1	1											
51. Original standardized test for metacognition	Kreutzer et al. (1975)	Interview	3	7			1	2	3	3	2	2	2				
52. Paper and pencil assessment	Neuenhaus et al. (2011)		1	2							1	1					
53. Private speech coding	Daugherty and Logan (1996)	Observation	1	2			1	1									
54. Problem solving interview	Carr and Jessup (1995)	Task based (interview)	1	2					1	1							
55. Prospective Assessment of Children (PAC)	Desoete (2007)	Self report	2	3						2	1	1					
56. Pupil Views Templates (PVTs)	Wall (2008)	Mediated interview	3	10	1	1	1	1	1	1	2	3	1	1			
57. Questionnaire about Learning in Mathematics (QLM)	Peklaj and Vodopivec (1998)	Questionnaire	1	2							1	1					
58. Questionnaire about Learning Slovene Language (QLSL)	Peklaj (2001)	Questionnaire	1	2							1	1					
59. Questionnaire about metacognitive beliefs	van der Zee et al. (2006)	Questionnaire	2	3							2	2	2				
60. Questionnaire based on Think Aloud	Schellings (2011)	Questionnaire	1	2											1	1	
61. Rating Student Self-Regulated Learning Outcomes: A Teacher Scale	Zimmerman and Martinez-Pons (1988)	Teacher rating scale	2	6							1	1	1	1		1	1

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)												
					4	5	6	7	8	9	10	11	12	13	14	15	16
62. Reading Strategy use scale (RSU scale)	Pereira-Laird and Deane (1997)	Self report	1	5							1	1	1	1	1		
63. Retrospective Assessment of Children (RAC)	Desoete (2007)	Self report	2	3					2	1	1						
64. Retrospective Questionnaire Interview (RQI)	Short (2001)	Interview	1	2			1	1									
65. Self Regulated Learning Scale (SRL)	Prupas (1995)	Self report	1	2									1	1			
66. Self report metacognitive learning strategies	Leutwyler (2009)	Self report	1	1													1
67. Self-Assessment in Metacognitive Comprehension Strategies Reading Survey	Pinto (2009)	Self report	1	2										1	1		
68. Self-Directed Learning Instrument	Hwang (1999)	Structured observation	2	4		1	1	1	1								
69. Self-Efficacy and Metacognition Learning Inventory – Science (SEMLI-S)	Thomas et al. (2008)	Self report	1	4										1	1	1	1
70. Self-efficacy for Learning Form (SELF)	Zimmerman and Kitsantas (2005)	Self report	3	6								1	1	2	3	1	1
71. Self-Regulated Learning Strategies Measurement Questionnaire	Eom (1999)	Questionnaire SR	1	2										1	1		
72. Self-report for cognitive and metacognitive learning strategies	Wolters (1999)	Self report	2	5									1	1	2	1	1
73. State Metacognitive Inventory	O'Neil and Abedi (1996)	Self report	5	8						2	2	3	1	1	2	1	1

Tool or method	Primary citation	Classification	Total records	No. of ages	Age in Years (Early Years/Foundation = 4-5 years, KS1 = 5-7 years, KS2 = 7-11 years, KS3 = 11-14 years, KS4 = 14-16 years)												
					4	5	6	7	8	9	10	11	12	13	14	15	16
74. Strategy knowledge in the domain of Chemistry	Scherer and Tiemann (2012)	Task based (ranking methodologies)	1	2											1	1	
75. Swanson Metacognitive Questionnaire (SMQ)	Swanson (1990)	Questionnaire	3	5						2	2	2	1	1			
76. Task based interview	Carr and Jessup (1997)	Task based (interview)	1	2			1	1									
77. Teacher Rating	Sperling et al. (2002)	Teacher rating	2	5							1	1	2	2	1		
78. The Teacher Rating	Desoete (2008)	Teacher rating	2	2					2	2							
79. Think About Reading Index (TARI)	Schreiber (2003)	Self report	1	7						1	1	1	1	1	1	1	
80. Think Aloud Protocol(s) (TAP/TAPs)	Veenman et al. (2005)	Observation	19	10			1	1	5	6	7	5	8	6	6	4	
81. Worksamples Interview	van Kraayenoord and Paris (1997)	Interview	1	4							1	1	1	1			
82. Würzburg Metamemory Test	van Kraayenoord and Schneider (1999)	Test	2	6				1	1	1		1	1	1			

Example of data extraction for the IMSR

Method / type of instrument:	Inventory of Metacognitive Self-Regulation (IMSR)
First record full reference:	Howard, Bruce C., McGee, Steven, Shia, Regina, & Hong, Namsoo S. (2000). *Metacognitive Self-Regulation and Problem-Solving: Expanding the Theory Base through Factor Analysis*. Paper presented at the American Educational Research Association 2000, New Orleans. http://search.proquest.com/professional/docview/62175370?accountid=14533
Definition of metacognition associated with original development of measure:	p. 1 "there are five particular metacognitive and self-regulatory constructs relevant to problem solving." And "our analyses indicate that the constructs measured by the IMSR are independent, and therefore a student may show preferences or "styles" of metacognitive strengths and weaknesses that depend upon his or her unique combination of constructs. If these "styles" can be further understood and delineated, it might be possible to train students to habitually use particular regulatory behaviors." p. 2 "Metacognition enables students to coordinate the use of current knowledge and a repertoire of reflective strategies to accomplish a single goal. Metacognitive awareness, therefore, serves a regulatory function and is essential to effective learning because it allows students to regulate numerous cognitive skills."
Aim of the study:	p. 2 "We began with the pragmatic goal of developing an instrument that would further our research and could also be used extensively in classrooms across the country to help teachers identify students' self-regulatory strengths and weaknesses. It was not our intention to replicate the work of our predecessors in this area. Instead, we wanted to develop an easy-to-use self report inventory for use with 12–18-year-olds that focused more specifically on metacognitive awareness and regulatory skills for solving mathematical and scientific problems."
Description of the tool or method:	• Focus on metacognitive awareness and regulatory skills • Phase 1 – based on JrMAI Version B and HISP (How I Solve Problems) inventory. • Phase 2 - "In Phase Two, our goal was to create a new inventory specific to metacognitive awareness and regulatory skills in the context of problem solving. To this end, we examined the 23 remaining items from the original two inventories and revised or rewrote them to increase reliability, and wrote additional items to clearly demonstrate the existence of the five factors that had emerged in Phase One." (p.2) • Particular emphasis on the importance of 'Knowledge of Cognition' • "The IMSR included 37 items with a five-point Likert scale. For each of the 37 items, students were instructed to circle the answer that best described the way they are when doing schoolwork or homework (1=never, 2=seldom/rarely, 3=sometimes, 4=often/frequently, 5=always)." (p. 4) Lots of links to the work of Swanson (1990)

Sample size (n):	Age range:	Average age (if applicable):	Setting of study:
829	Grades 6-12 (USA)	-	Schools, USA

Link to metacognition:			
Metacognition for something else (e.g. Mathematics achievement)	Internally testing metacogntion (e.g. solely measuring this or an aspect of it).	Testing the tool (e.g. assessing its reliability and/or validity)	Extra info if applicable
☐	☑	☑	

Type of study:			
Pre-test, post-test	Longitudinal	Experimental	Other:
☐	☐	☐	Unsure?

Reliability:	Validity:
"The overall inventory demonstrated a reliability of alpha=.935. We conducted an exploratory principle components factor analysis using a varimax rotation. The resulting solution revealed five factors with eigenvalues over 1.12, which accounted for 51.6% of the variance. Reliability for each factor ranged from alpha=.720 to alpha= .867. Table 1 shows the factors, their descriptions, and the factor weights above .40. In addition, Table 1 shows three items (asterisked) that weighed only moderately across several factors, or weighed heavily on factors different than those hypothesized. For future research we would recommend removing or revising these three items." (p. 4)	Face validity of the items in the inventory is discussed throughout as the items are selected and tested in the different phases.

Additional references:	Extra information that they add regarding this tool or method:				
	Setting of study	Changes to the tool or method	Link to metacognition	Type of study	Validity and/or reliability
Howard, Bruce C., McGee, Steven, Hong, Namsoo S., & Shia, Regina. (2000).	n = 1163 students Study focussed on the evaluation of an intervention using Astronomy Village software.	32 item inventory	Metacognition as a measure of learning. SR prominent in this study	Pre-test, post-test	Refers to validity in earlier paper.
Parcel (2005)	n = 140 2 schools 5th graders aged 10-12	-	Focus on metacognitive prompts and ability	Experimental	Current studies suggest IMSR has reliability alpha of .935
Howard, McGee, Shia, and Hong (2001)	n = 1502 students, grades 5–9, from schools across the United States	32 item inventory	One of the hypotheses is: "High levels of metacognitive self-regulation will compensate for low overall achievement, ability, or aptitude."	Pre-test, post-test	Refers to validity in earlier paper.

Appendix B – School Correspondence

Recruitment email sent to schools

Dear X,

I am a PhD researcher at Durham University, working under the supervision of Dr. Kate Wall and Professor Steve Higgins. I am emailing with regard to some research that I am currently conducting with [name of secondary school] (my contact there is X). For this research I also need to work with two primary schools that are feeder schools for X school, I am hoping that you would like to get involved.

The PhD research focuses on metacognition, a current and important concept especially given its prominence as high impact and low cost in the Pupil Premium Toolkit. This research aims to build on earlier research that Kate, Steve and others have done with a visual tool used to help pupils think about their learning called Pupil Views Templates (PVTs). Taking part in the research would involve small groups of children from each year group participating in a focus group centering on the completion of a Pupil View Template (see attached information sheet). Final decisions on the sizes of these small groups are due to be made (based on existing research) next Thursday but it would either be 5 focus groups of 3 pupils from each year group, or 4 focus groups of 4 pupils from each year group. Each focus group would take no longer than 20-30 minutes in total.

I have attached a participant information sheet that has more detailed information about the project. There will of course be significant opportunity for sharing information, in particular information about the method as well as the research findings - PVTs have been used successfully in the classroom in order to help children to reflect on their learning and progress whilst also encouraging metacognition.

I would love to speak to you further if you might be interested in participating in this research. I can be contacted on this email address or on [phone number]. Please don't hesitate to contact me if you have any questions.

I look forward to hearing from you in the near future and thank you in anticipation of your help.

Kind Regards,

Louise Gascoine

Information sheet sent to schools

This project forms part of a PhD thesis being completed by Miss Louise Gascoine in the School of Education at Durham University. Dr Kate Wall and Professor Steve Higgins supervise the PhD.

The title of the project is: **'Investigating the development of metacognition across school age children using Pupil Views Templates.'** Previous research using Pupil Views Templates has largely concentrated on and/or been associated with specific projects like Learning to Learn (L2L); this project will provide a wider and more systematic sample than has been used in previous research.

This project has 2 main aims:

1. **Looking at developmental trends in metacognition using Pupil Views Templates**
2. **Evaluating Pupil Views Templates as a research tool**

Pupil Views Templates are a visual tool (see Example 1) that facilitates discussion of learning by focussing on a specific learning scenario. The speech bubble(s) represent what a pupil would say in the given learning scenario and the thought bubble(s) what they are thinking/think about it. In this project the prompt or learning scenario will be "Think about a lesson when you learnt something new…"

The data collection will comprise:

- Working with groups of 3/4 pupils at a time, for 20-30 minutes talking about the given learning scenario
- Each pupil will each be asked to complete an individual Pupil Views Template during the course of the discussion.

Example 1: An example of a Pupil Views Template

© Southgate Publishers Ltd

Points to note:

- The data will be anonymous except for each pupil's age and gender, in order that developmental trends in metacognition can be analysed.
- Pupils will also be asked to record on the back of their sheet what sort of lesson that they were thinking about when they completed the template.
- The completed Pupil Views Templates will be kept in a secure location after the data collection during the analysis and be treated in the strictest of confidentiality.
- Discussion of the anonymous data will take place in supervisory meetings for this project in the School of Education at Durham University, but again the data will be treated with the strictest confidentiality.
- The data and its analysis will be shared with the participating school freely.

Copy of consent form signed by participating schools

Thank you for discussing your school's participation in the Pupil Views Template research today. Please can you read the attached Participating School Information Sheet and complete the form below to consent to participation in the project. Please contact me on louise.gascoine@durham.ac.uk at any time if you require any further information before, during or after the project.

TITLE OF PROJECT:
Investigating the development of metacognition across school age children using Pupil Views Templates.

(The participant should complete the whole of this sheet himself/herself)

Please cross out as necessary

Have you read the Participating Schools Information Sheet?	YES / NO
Have you had an opportunity to ask questions and to discuss the study?	YES / NO
Have you received satisfactory answers to all of your questions?	YES / NO
Have you received enough information about the study?	YES / NO

Who have you spoken to?   Dr/Mr/Mrs/Ms/Prof.   ....

Do you consent for your school to participate in the study?	YES / NO
Do you consent for the anonymised data collected to be used in publications relating to the PhD thesis that the project forms a part of?	YES / NO

Do you understand that you are free to withdraw from the study:
* at any time and
* without having to give a reason for withdrawing   YES / NO

Signed ....……….................

Date ....

NAME (BLOCK CAPITALS):

....……….............................

POSITION:

....………..

SCHOOL:

....………..

Appendix C – Completed PVT Examples and Data Analysis

PVT examples for Reception

PVT examples for Year 1
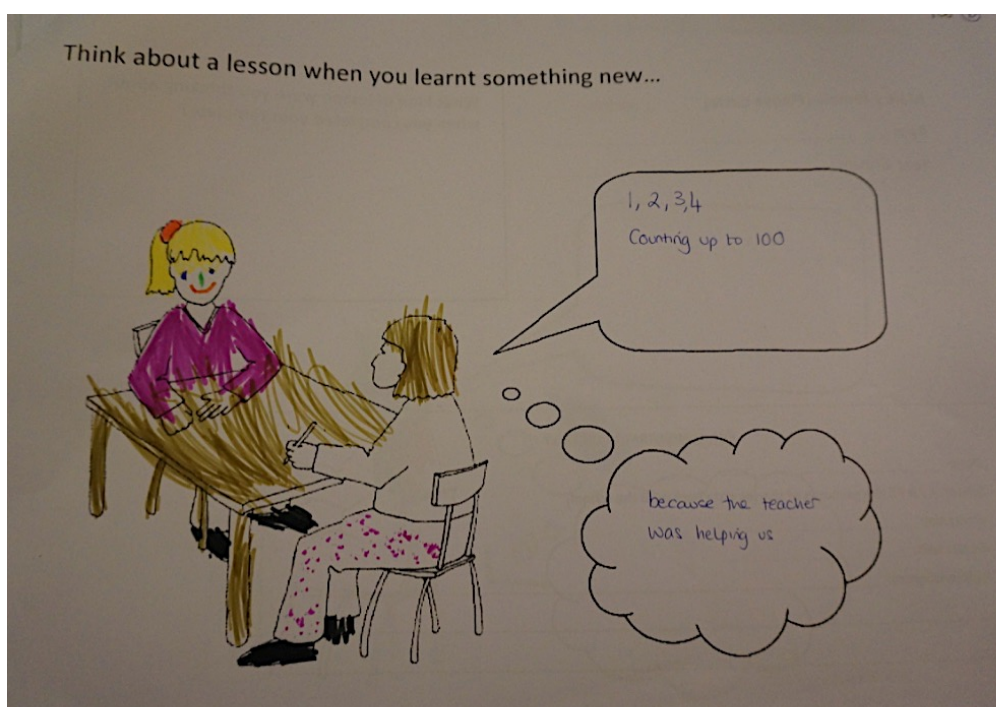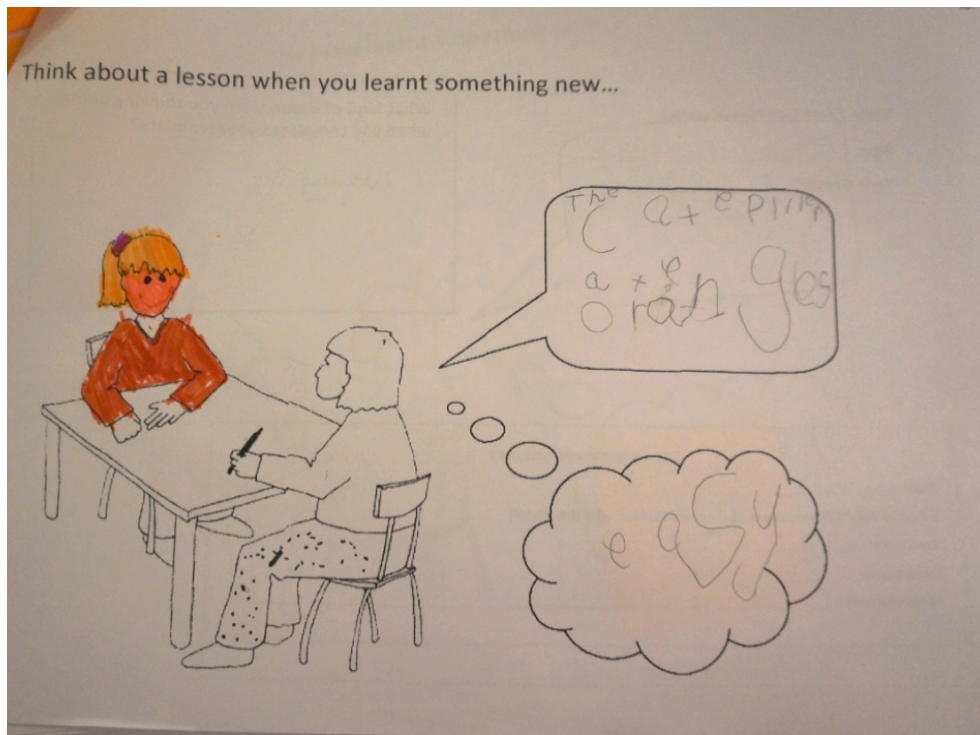
PVT examples for Year 1
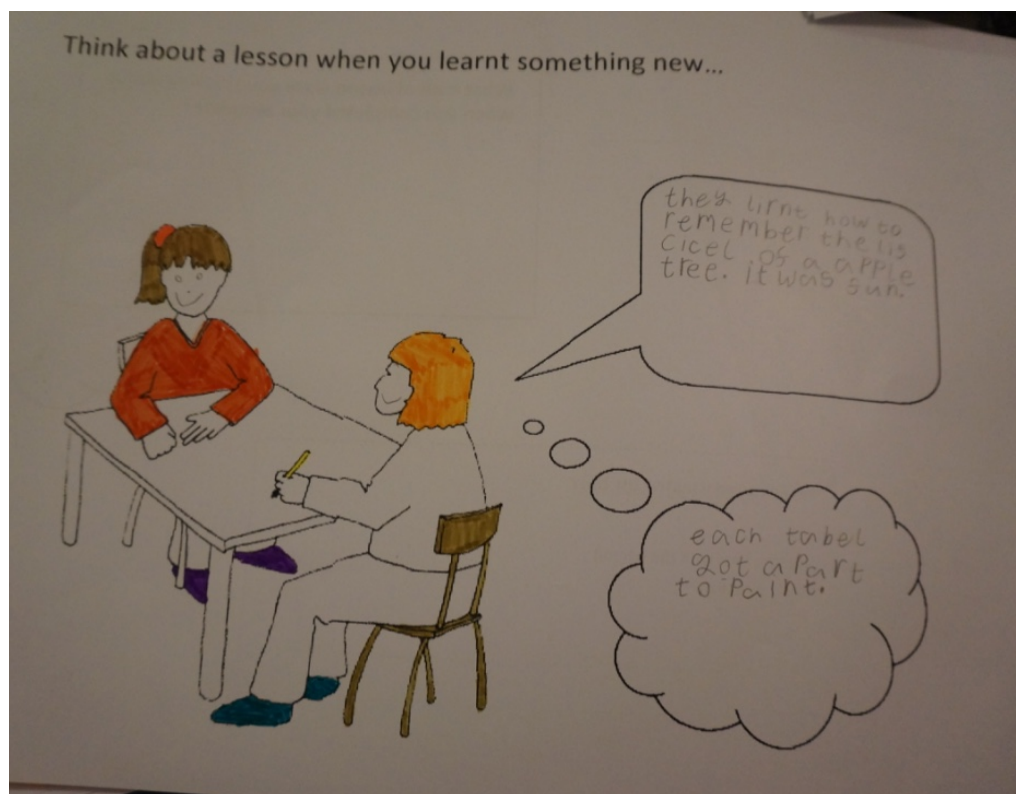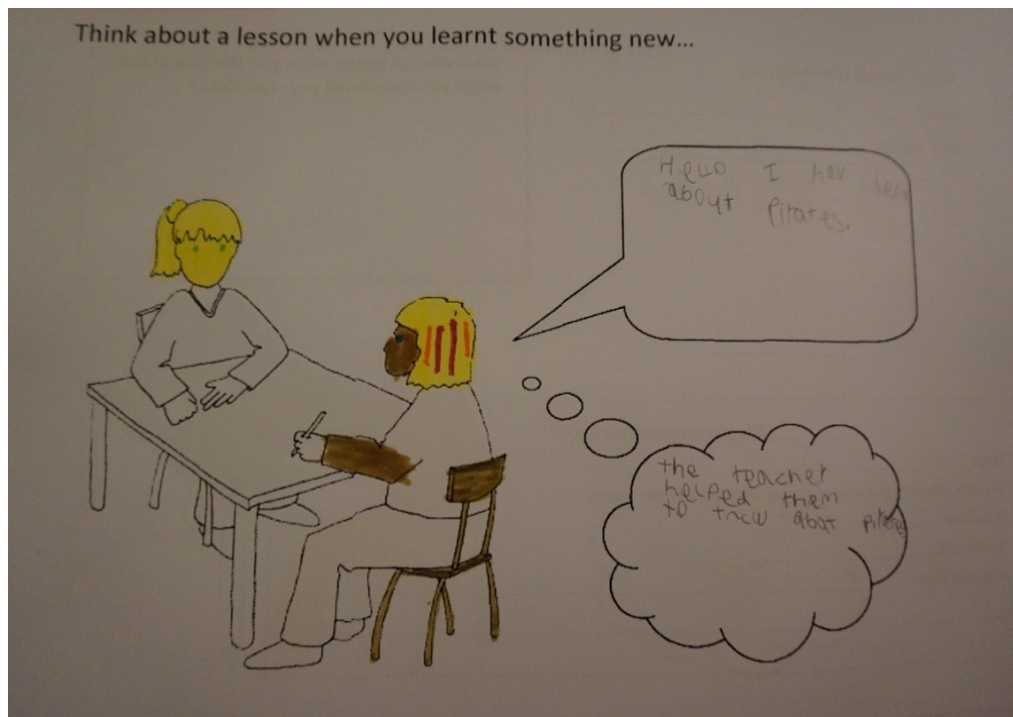
PVT examples for Year 2

PVT examples for Year 3

PVT examples for Year 3
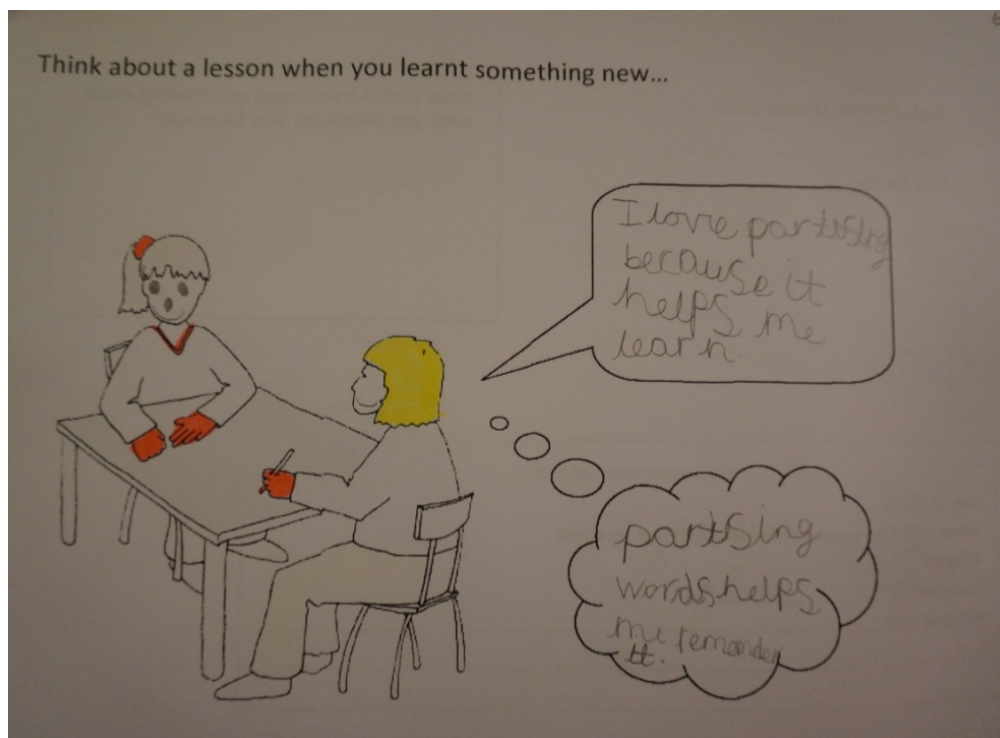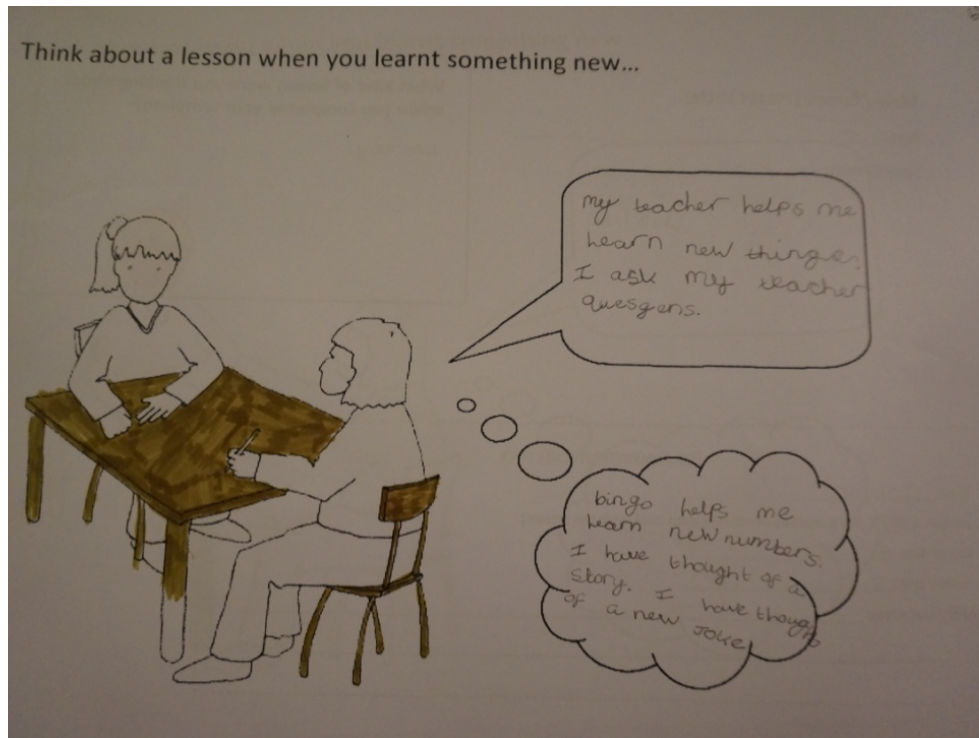
PVT examples for Year 4
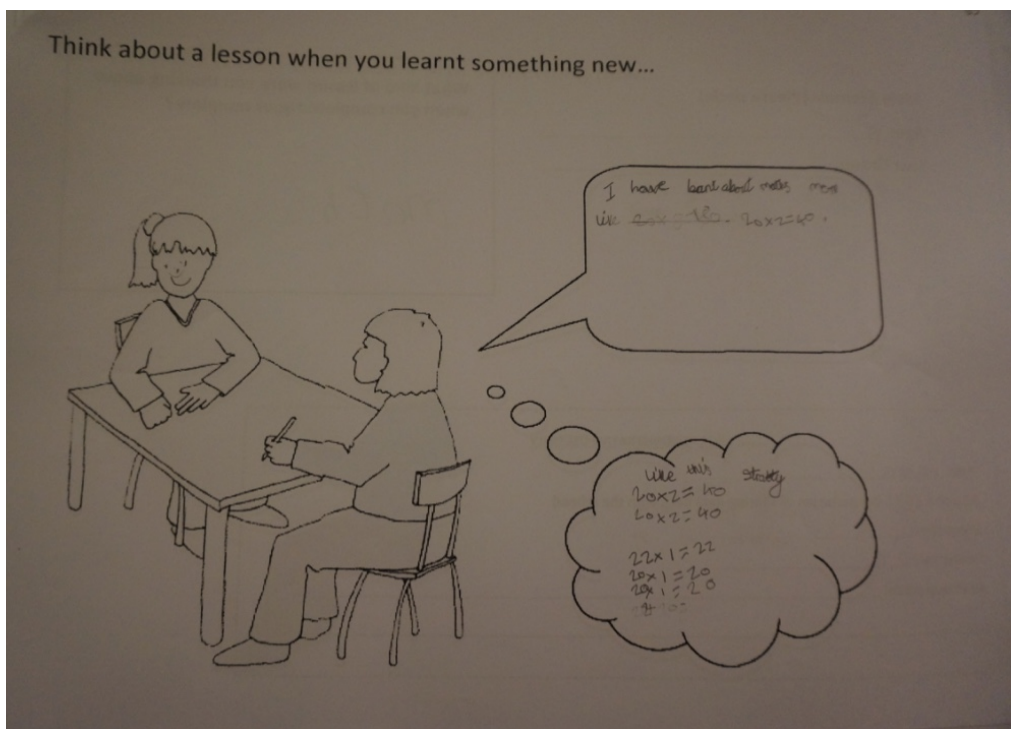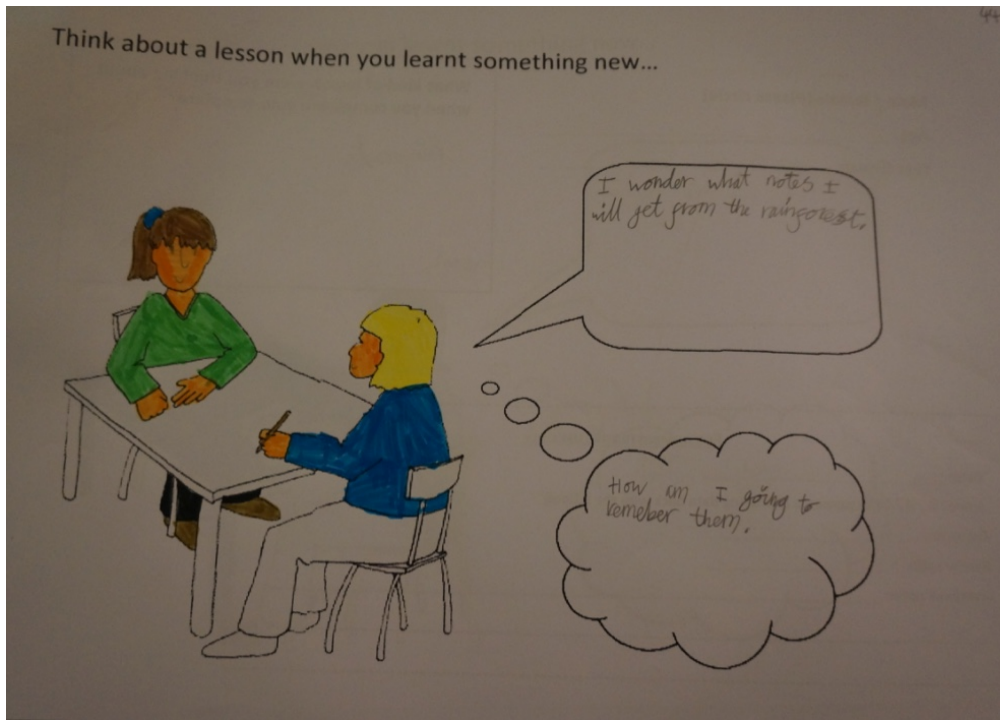
PVT examples for Year 4
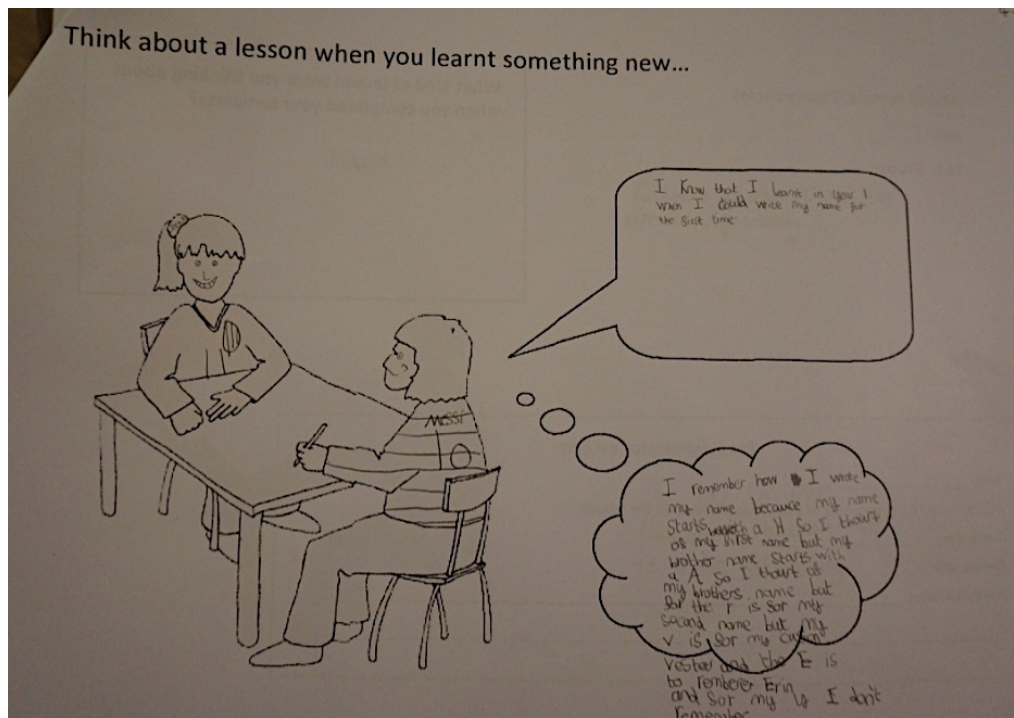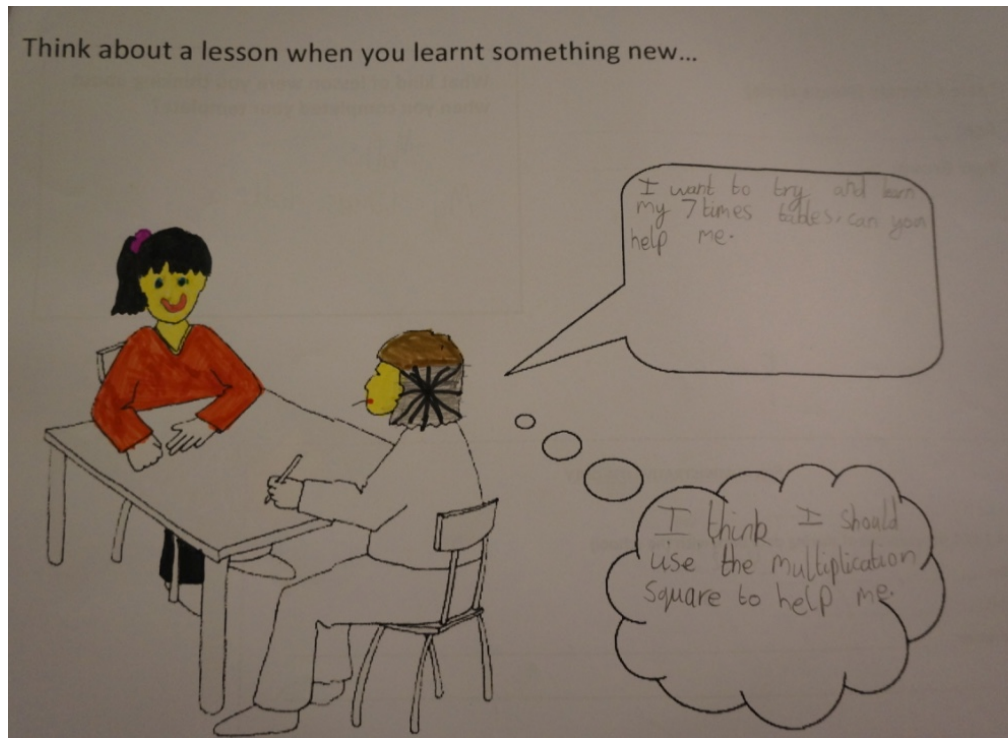
PVT examples for Year 5
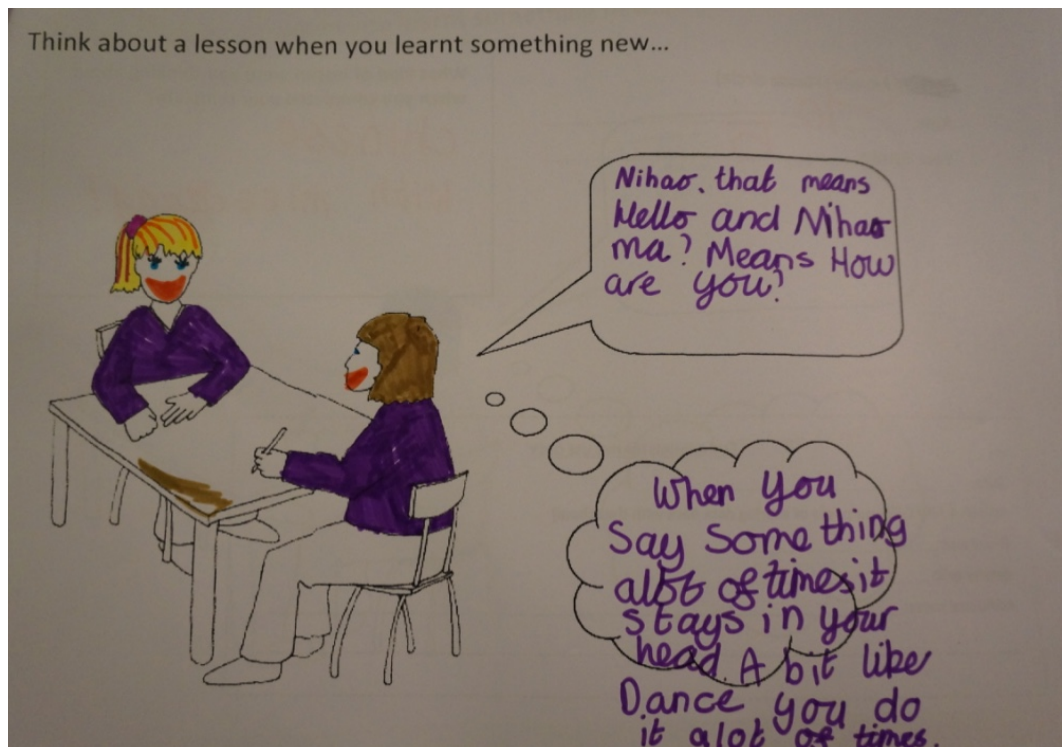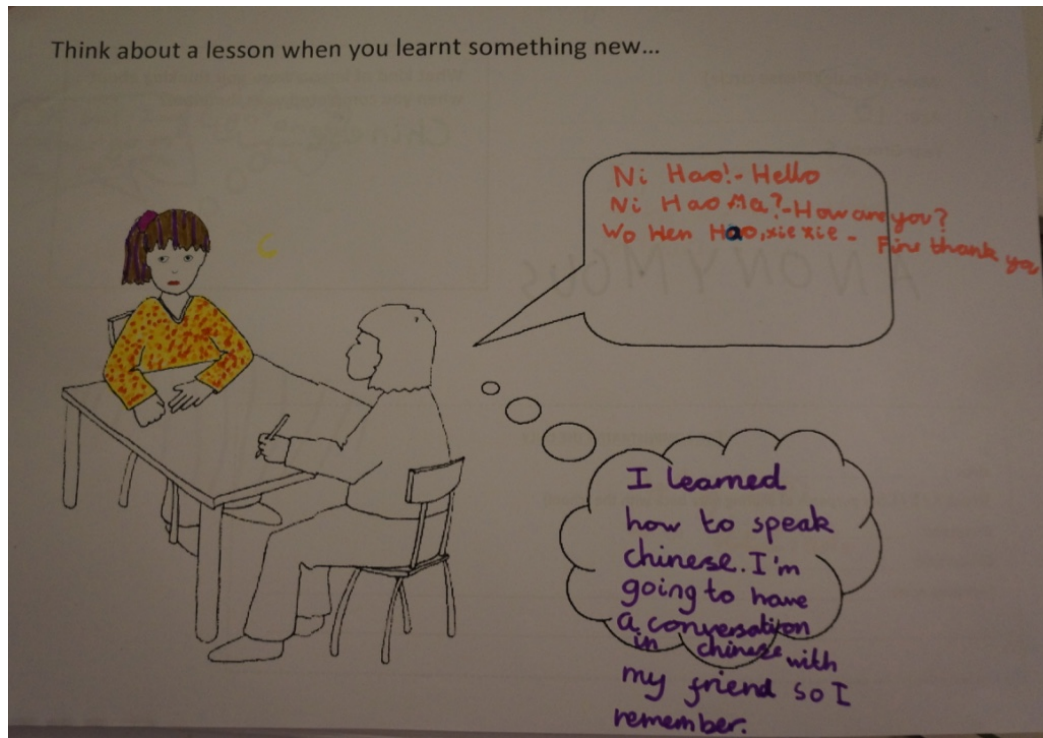
PVT examples for Year 6

PVT examples for Year 7

PVT examples for Year 8

PVT examples for Year 9

PVT examples for Year 10

PVT examples for Year 11

Histograms to explore the similarity in the non-normality of the data

Information gathering:

Productive thinking:

Metacognitive knowledge:

Robust Tests of Equality of Means

|		Statistic[a]	df1	df2	Sig.
Information gathering	Welch	4.075	3	158.540	.008
	Brown-Forsythe	4.461	3	150.596	.005
Building understanding	Welch	3.621	3	165.497	.014
	Brown-Forsythe	2.655	3	227.817	.049
Productive thinking	Welch	8.749	3	159.461	.000
	Brown-Forsythe	8.170	3	157.867	.000
Metacognitive Knowledge	Welch	13.063	3	156.845	.000
	Brown-Forsythe	11.144	3	153.967	.000

a. Asymptotically F distributed.

Kruskal-Wallis H Test hypothesis test summary (non-parametric)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Information gathering is the same across categories of Age Group.	Independent-Samples Kruskal–Wallis Test	.093	Retain the null hypothesis.
2	The distribution of Building understanding is the same across categories of Age Group.	Independent-Samples Kruskal–Wallis Test	.129	Retain the null hypothesis.
3	The distribution of Productive thinking is the same across categories of Age Group.	Independent-Samples Kruskal–Wallis Test	.000	Reject the null hypothesis.
4	The distribution of Metacognitive Knowledge is the same across categories of Age Group.	Independent-Samples Kruskal–Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

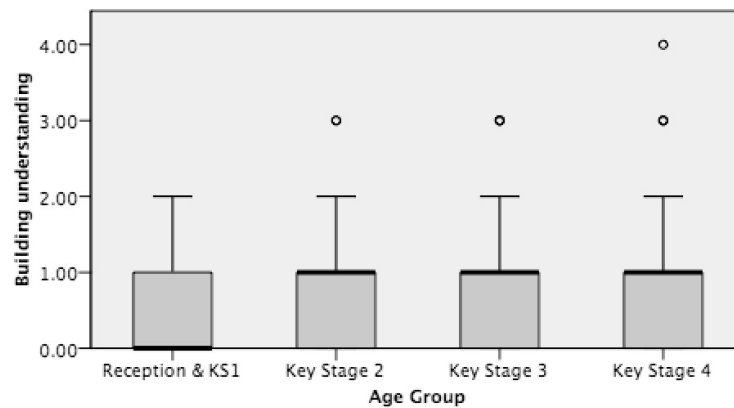## Information Gathering & Building Understanding (non significant)

Independent-Samples Kruskal-Wallis Test
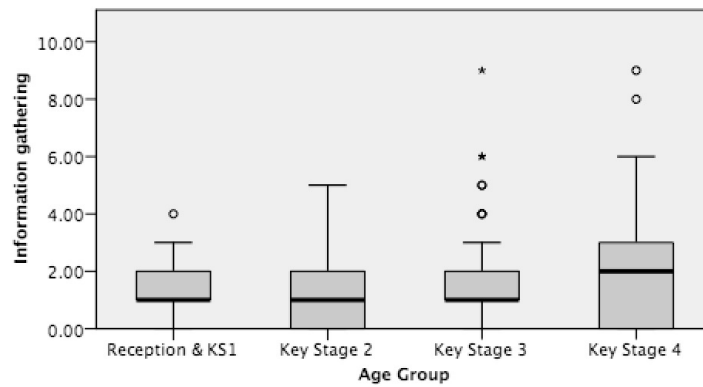
Total N	374
Test Statistic	6.421
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.093

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

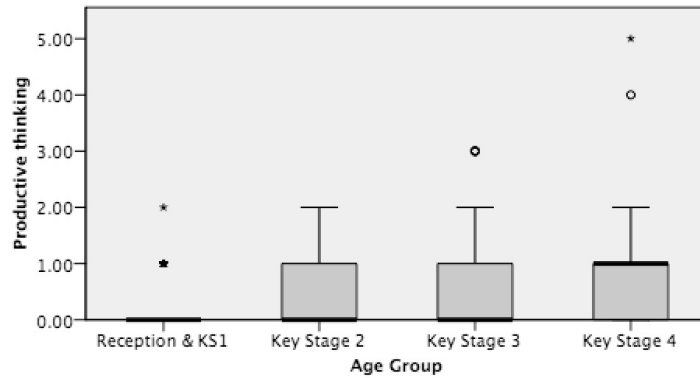### Independent-Samples Kruskal-Wallis Test

Total N	374
Test Statistic	5.670
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.129

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

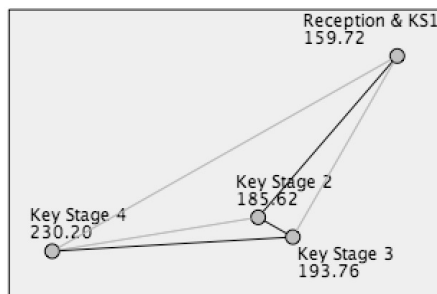**Productive Thinking (including pairwise comparisons)**

Independent-Samples Kruskal-Wallis Test

Total N	374
Test Statistic	22.740
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Pairwise Comparisons of Age Group

Each node shows the sample average rank of Age Group.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Reception & KS1-Key Stage 2	-25.906	11.904	-2.176	.030	.177
Reception & KS1-Key Stage 3	-34.042	12.726	-2.675	.007	.045
Reception & KS1-Key Stage 4	-70.485	14.998	-4.700	.000	.000
Key Stage 2-Key Stage 3	-8.135	11.904	-.683	.494	1.000
Key Stage 2-Key Stage 4	-44.579	14.307	-3.116	.002	.011
Key Stage 3-Key Stage 4	-36.443	14.998	-2.430	.015	.091

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Metacognitive Knowledge (including pairwise comparisons)
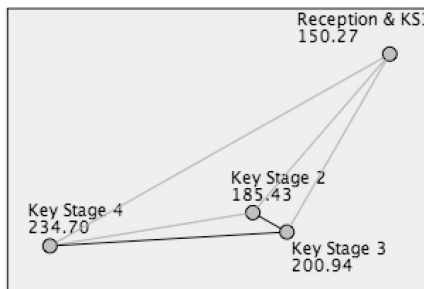
Pairwise Comparisons of Age Group

Each node shows the sample average rank of Age Group.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Reception & KS1-Key Stage 2	−35.159	13.224	−2.659	.008	.047
Reception & KS1-Key Stage 3	−50.667	14.137	−3.584	.000	.002
Reception & KS1-Key Stage 4	−84.433	16.660	−5.068	.000	.000
Key Stage 2-Key Stage 3	−15.508	13.224	−1.173	.241	1.000
Key Stage 2-Key Stage 4	−49.274	15.893	−3.100	.002	.012
Key Stage 3-Key Stage 4	−33.766	16.660	−2.027	.043	.256

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Independent-Samples Kruskal-Wallis Test
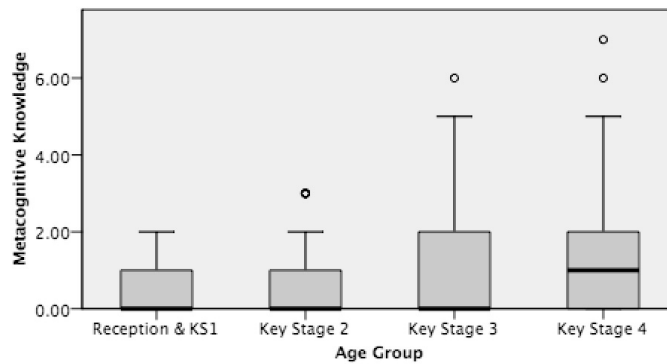
Total N	374
Test Statistic	28.278
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Appendix D – Comparative Analysis

A comparative analysis in which the unit of analysis is number of words, as opposed to number of text units is presented below. Analysis using number of words is in line with previous research analysis of PVTs (Wall, 2008; Wall et al., 2012). This comparative analysis also adopted the original framework of analysis, including distinction between metacognitive knowledge and metacognitive skilfulness as per Wall (2008) and Wall et al. (2012). The normality testing of the data in this comparative analysis is not far different from the assessment of normality presented in Chapter 3.

The inter-rater and intra-rater reliability were checked for a random sample of 20% of the total number of templates (n=374) in this comparative analysis (n = 75). Two separate random samples were generated using SPSS, one to calculate inter-rater reliability and the other intra-rater reliability. A colleague not associated with this research double coded the 75 templates for the inter-rater reliability calculation and I double coded the 75 templates for intra-rater reliability one month after they had been originally coded. The inter-rater reliability was 84% (Kappa – 0.55) and the intra-rater reliability was 98% (Kappa – 0.94).

Means, Standard Deviations and One-Way Analysis of Variance for the Effect of Age Group on Five Dependent Variables

Variable	Age group (Key Stage Altered)							
	Reception & KS1		KS2		KS3		KS4	
	M	SD	M	SD	M	SD	M	SD
Information gathering	7.80	6.42	11.02	9.92	13.36	10.44	16.83	21.72
Building understanding	4.82	6.01	9.22	12.16	13.29	16.10	12.99	18.77
Productive thinking	1.78	4.02	5.16	8.96	9.23	16.59	12.96	17.36
Metacognitive knowledge	4.13	5.69	7.77	12.26	12.03	14.74	14.74	17.40
Metacognitive skilfulness	1.26	3.63	3.87	8.28	8.20	15.82	11.00	16.37

One-Way Analysis of Variance for the Effects of Age Group (KS Altered) on Five Dependent Variables

Variable and source	SS	MS	Welch's F Ratio			ω^2[28]
			F	df	p	
Information gathering						
Between	3205.87	1068.62				
Within	51776.95	139.94				
Total	54982.82		9.22	3, 159	< .001	.05
Building understanding						
Between	4132.82	1377.61				
Within	65514.68	177.07				
Total	69647.50		12.19	3, 155	< .001	.07
Productive thinking						
Between	5338.81	1377.61				
Within	53850.17	177.07				
Total	59188.98		15.71	3, 149	< .001	.08
Metacognitive knowledge						
Between	5134.25	1711.42				
Within	58878.21	159.13				
Total	64012.46		14.14	3, 155	< .001	.07
Metacognitive skilfulness						
Between	4389.40	1463.13				
Within	47936.47	129.56				
Total	52325.87		13.55	3, 161	< .001	.08

---

[28] $\omega^2 = \frac{SS_M - (df_m)MS_R}{SS_T + MS_R}$ (Where SS_M = between-group effect, MS_R = the within-subject effect and SS_T is the total amount of variance in the data).

Results of post-hoc testing for one-way ANOVAS (Games-Howell) showing significant interactions between specified age groups

Dependent variable	Pairwise comparison	Mean difference (I – J)	SE	p	95% confidence interval		η[29]
					Lower bound	Upper bound	
Information gathering	KS2 – R&KS1	3.21	1.095	.019	.38	6.05	.27
	KS3 – R&KS1	5.56	1.25	< .001	2.21	8.81	.47
	KS3 – KS2	2.35	1.38	.325	-1.23	5.92	-
	KS4 – R&KS1	9.031	3.03	.021	1.02	17.04	.76
	KS4 – KS2	5.82	3.08	.24	-2.32	13.96	-
	KS4 – KS3	3.47	3.14	.69	-4.81	11.71	-
Building understanding	KS2 – R&KS1	4.40	1.24	.003	1.19	7.60	.33
	KS3 – R&KS1	8.47	1.75	<. 001	3.90	13.04	.64
	KS3 – KS2	4.07	1.96	.166	-1.02	9.17	-
	KS3 – KS4	.310	3.04	1.00	-7.63	8.25	-
	KS4 – R&KS1	8.16	2.63	.015	1.21	15.10	.61
	KS4 – KS2	3.76	2.77	.530	-3.53	11.05	-
Productive thinking	KS2 – R&KS1	3.38	.892	.001	1.06	5.69	.28
	KS3 – R&KS1	7.45	1.74	< .001	2.90	12.00	.62
	KS3 – KS2	4.07	1.87	.134	-.79	8.93	-
	KS4 – R&KS1	11.18	2.40	< .001	4.83	17.53	.93
	KS4 – KS2	7.80	2.49	.013	1.24	14.38	.65
	KS4 – KS3	3.73	2.91	.575	-3.85	11.32	-
Metacognitive knowledge	KS2 – R&KS1	3.65	1.23	.018	.46	6.84	.05
	KS3 – R&KS1	7.91	1.61	< .001	3.71	12.11	.63
	KS3 – KS2	4.26	1.86	.103	-.55	9.07	.34
	KS4 – R&KS1	10.62	2.44	< .001	4.17	17.06	.84
	KS4 – KS2	6.97	2.60	.044	.13	13.81	.55
	KS4 – KS3	2.71	2.81	.769	-4.63	10.05	-
Metacognitive skilfulness	KS2 – R&KS1	2.61	.820	.009	-.48	4.73	.23
	KS3 – R&KS1	6.94	1.66	< .001	-2.61	11.26	.61
	KS3 – KS2	4.33	1.77	.074	-.28	8.94	-
	KS4 – R&KS1	9.74	2.26	< .001	3.76	15.72	.86
	KS4 – KS2	7.13	2.35	.017	.95	13.32	.63
	KS4 – KS3	2.80	2.75	.739	-4.38	9.98	-

---

[29] $\eta = \dfrac{mean\ difference\ (i-j)}{\sqrt{MS_w}}$

Analysis and discussion: comparison between statistical analysis in Appendix D and 4.2

Comparison of the statistical analysis in 4.2 based on the coding explained in Table 12 is comparable to coding based more exactly on analysis from previous research (Wall, 2008; Wall et al. 2012). The means and standard deviations presented in Table 15 (4.2.1) and Appendix D indicate that to some extent the data analysed in 4.2 (text units not number of words) is more 'normal' (the lower standard deviations presented in Table 15 indicate less spread in the range of data values).

Moving on to explore the significance of the distribution of the means for the dependent variables, in relation to age group, similarities can be seen. In both analyses information gathering, building understanding, productive thinking and metacognitive knowledge were significant. The p levels were lower in the comparative analysis but nonetheless all values reported across both analyses were < .05. The effect sizes (ω^2) reported in Table 16 (shown in bold), compared to those in Appendix D, were very similar for information gathering (.04 and .05); productive thinking (.07 and .08) and metacognitive knowledge (.09 and .07). The increase in effect size for metacognitive knowledge in Table 16 is a positive finding in relation to using text unit as the unit of analysis. The effect sizes reported in both analyses for building understanding were the most different: .02 and .07), it is likely that this difference is to some extent is due to the non-normality of the data as explained in 3.8.1.

The post-hoc testing also has similarities across both the analysis reported in 4.2 and the comparative analysis in Appendix D. However, there were no significant pairwise comparisons for information gathering in Table 17. For building understanding there was only one significant pairwise comparison compared to three in the comparative analysis (Appendix D). Productive thinking had four significant pairwise comparisons in both analyses and for the same age groups. This was also true of the pairwise comparisons in both analyses for metacognitive knowledge. The lower numbers of significant pairwise comparisons for information gathering and building understanding in 4.2 is an interesting point to consider. Additional comparison, beyond the scope of this study, would be required to determine the influence of the sensitivity of the two units of analysis (words or text units) on these results.

Analysis in Wall et al. (2012) did not include post-hoc testing with pairwise comparisons but did show in significant main affects for age in all of the dependent variables. The comparative analysis in Appendix D is comparable across all of the five dependent variables included in this (including metacognitive skilfulness) and in both cases the significance is $p = < .001$. The analysis in Wall et al. (2012) was a two-way MANOVA exploring the potential for relationships between the dependent variables, age group and gender. The effects for gender presented were only significant for two of the dependent variables and the interaction between age and gender in one. With this in mind and because the sample size of Wall et al. (2012) was larger than in this study (see Table 1) MANOVA was not included in the statistical analysis of data in 4.2.

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