Understanding children's epistemic beliefs in elementary education

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Abstract

Research shows that the beliefs individuals hold about knowledge and knowing (epistemic beliefs) influence learning approaches and outcomes. However, little is known about the nature of children's epistemic beliefs and how best to measure these. In this pilot study, 11 Australian children (in Grade 4 or Grade 6) were asked to 'draw, write and tell' about their epistemic beliefs using drawings, written responses and interviews respectively. Drawings were analysed, with the majority of children depicting external, one-way sources of knowledge. The written statements and interviews were analysed using inductive thematic analysis, showing that children predominantly described knowledge acquisition as processes of task-based learning.

Interviews also enabled children to describe a wider range of views. These results indicate that the methodological combination of ‘draw, write and tell’ allowed for a deeper understanding of the children’s epistemic beliefs which holds implications for future research.

Keywords

children’s epistemic beliefs; children’s personal epistemology; measurement of epistemic beliefs; draw and write methods

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The purpose of this pilot project was to investigate the nature of children's epistemic beliefs and new ways of measuring children's epistemic beliefs. There is a large body of research spanning the last four decades that investigates the beliefs individuals hold about knowledge and knowing (epistemic beliefs), and the influence of these beliefs on learning approaches and outcomes. However, research and research methodologies in this field have focused predominantly on adulthood and adolescence. Very little is known about children's epistemic beliefs. In this study, Grade 4 and Grade 6 Australian children in two elementary classrooms were asked to draw, write and talk about their epistemic beliefs in the context of classroom learning. We found that the combined use of drawings, written statements and interviews provided a more nuanced understanding of epistemic beliefs than drawings and written statements alone. The methodology used in this study has implications for further research related to children's epistemic beliefs.

Background

In recent years there has been growing interest in the development of young children's epistemic beliefs (Burr and Hofer 2002) because there are strong links between such beliefs and learning in classrooms. Epistemic beliefs refer to individual beliefs about the nature of knowing and knowledge and are considered to influence all other knowledge and beliefs. However we know much more about the epistemic beliefs of adults and adolescents, than we do about what children believe about knowledge and knowing.

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In this study we were particularly interested to understand both the nature of children's epistemic beliefs and ways to investigate such beliefs. The following section provides an overview of three main approaches that have examined children's epistemic beliefs. First, developmental research into changes in children's epistemic beliefs are discussed followed by an overview of multidimensional beliefs and child centred approaches. Table 1 provides a summary of these main traditions and the attendant methodologies.

[Insert Table 1 here]

Developmental traditions: using epistemic tasks, vignettes, interviews, and drawings

Over the last four decades, the developmental tradition has constituted an enduring approach to understanding epistemic beliefs, particularly for adults and adolescents. This tradition focuses on how epistemic beliefs change over time (Hofer 2004). Kuhn and her colleagues (see Kuhn, Cheney and Weinstock 2000; Kuhn and Weinstock 2002) exemplify this tradition. They argue that individuals' beliefs change over time. First *Absolutist* beliefs involve a view of knowledge as facts, absolute and 'black and white', that can be transmitted through direct instruction. In the occurrence of two competing facts, only one can be right. Individuals who hold absolutist beliefs are likely to see that learning is about repeating and memorising the information that the teacher is providing in class. Next, *Multiplist* beliefs reflect a view that knowledge is constructed based on one's personal opinions. Here knowledge is idiosyncratic and not able to be challenged because a person has the right to hold his/her own opinion. Competing opinions are of equal value, so individuals who hold such beliefs are likely to listen to and value others opinions in class but without evaluating such opinions. Finally, *Evaluativist* beliefs refer to a perspective that knowledge is changeable and derived from judgments, which are based on evaluation of a range of sources of evidence. One competing judgment can be better than another because of the supporting evidence and sources that are

analysed in making that judgment. Individuals who hold evaluativist beliefs are more likely to engage in some form of critical reflection whereby they assess competing ideas and construct knowledge based on the evaluation of multiple perspectives.

One of the earliest studies into children's epistemic beliefs from a developmental tradition involved Burr and Hofer's (2002) use of *epistemic tasks* with puppets (See Table 1). The epistemic tasks relied on investigating changes in beliefs in the context of stories or narratives. They focussed on measuring children's epistemic beliefs and examining if there was a relationship between such beliefs and children's theory of mind. Theory of mind describes the extent to which young children comprehend that other people have a range of mental states (beliefs, cognitions, etc.) which can influence behaviours (Astington and Baird 2005). In the *seeing task*, children were shown an image of a dog and another of a cow. They were then presented with a bear puppet and told that the bear was going to participate in a hiding game. The child then explained to the bear puppet how the two pictures differed. The researcher blindfolded the bear puppet and the child was also asked to close his/her eyes while the researcher hid the pictures (one under a scarf and the other in a box). The child was then reminded that the bear could not see. The bear put his hands under the scarf to feel the picture hidden there. The child was asked to lift the scarf, take a look at the hidden picture and describe the picture to the researcher. The researcher then pointed to the bear puppet and asked the child if the bear knew what the picture was under the scarf and how the bear knew (or didn't know) what was under the scarf. The *feeling task* was similar to the seeing task. When objects were hidden the bear put his hands into his pockets. The child was asked to touch the object and describe if it was hard or soft, and then if the bear knew if the object was hard or soft. These seeing and feeling tasks provided a way to understand the source of children's knowledge and if they could determine the puppet's knowledge based on their understanding of what the bear had experienced. The use of puppets is likely to render the

stories more concrete and less abstract for children. They argued that an early stage of epistemic development called egocentric subjectivity precedes the development of theory of mind. Burr and Hofer proposed that this version of subjectivism is unlike multiplism in which personal opinions are equally valid (Kuhn and Weinstock 2002). Instead children seem to think that others see the world as they do.

Vignettes have also been used to examine children's epistemic beliefs from a developmental perspective, with some also using puppets to help tell stories. Table 1 summarises four studies which have made use of vignettes to examine children's epistemic beliefs. Wildenger, Hofer and Burr (2010) examined epistemic beliefs in 3, 4 and 5 year olds. They found that children's multiplist beliefs actually declined between ages 3 to 5 years as their theory of mind developed. This is similar to research undertaken by Burr and Hofer (2002) who also found that egocentric subjectivity and pre-dualism preceded absolutism: '…children make highly relative and subjective judgments before theory of mind and then become rather rigid in their absolutism once they embrace the objectivity permitted by theory of mind' (p. 239).

In the Wainryb, Shaw, Langley, Cottam and Lewis (2004) study of 5, 7 and 9 year old children, it was found that children became more relative and tolerant in their views as they aged. The children were read vignettes that involved two puppets, one of which disagreed with the beliefs held by the child. These vignettes were used to investigate relativism and tolerance of divergent beliefs across the domains of moral values, ambiguous facts, aesthetics and personal taste. For example, in the domain of personal taste, the child was asked if he or she thought chocolate ice cream tasted yummy or yucky. The child was then introduced to two puppets, one who agreed with the child and the other who disagreed. The child was asked if only one of the puppets could be right, if both could be right, and if it is okay for the puppets to have different beliefs.

Mansfield and Clinchy (2002) also used vignettes to find out what children aged 10, 13 and 16 years believed about knowledge. A short vignette was introduced in which two characters disagreed (in the domains of taste, values, fact). The children were interviewed to determine why they thought there was disagreement between the characters, if one of the characters was right, and if and how the problem could be solved. They noticed that as children aged, they become increasingly able to articulate the difference between the objective and the subjective nature of knowledge and also demonstrated constructivist ways of knowing. In a similar manner, Kuhn, Cheney and Weinstock (2000) and Walker, Wartenberg and Winner (2012) used vignettes to examine changes in children's epistemic beliefs but did not use puppets to present these stories.

Vignettes enable the researcher to ask interview questions that are 'contextualised …and subjects do not need to make assumptions about examples for rather general statements' (Moschner et al. 2008, 127). This ensures that the task is more concrete and likely to be within the experience of the child, although language capacity is a factor that needs to be considered when interpreting data. The concerns around language are also evident in interview methodologies.

Interviews have often been used to measure adults' epistemic beliefs particularly in terms of changes in beliefs about knowing (source and justification) and knowledge (certainty of knowledge). This approach has not been commonly used in research with children, possibly because thinking about epistemic beliefs can be quite an abstract task and open-ended questions that focus on such beliefs may prove to be too challenging for young children in terms of language demands (Moschner et al. 2008). Yang and Tsai (2010) used content analysis of interviews to investigate the nature of 6th Grade children's epistemic beliefs in science. They provided children with newspaper reports that depicted contradictory information on a range of issues (earthquake prediction, land subsidence). Children were

interviewed using questions that investigated various aspects of their epistemic beliefs for example certainty (e.g., do scientists have the same opinions and can experts eventually agree on science issues?) and justification (asked to provide reasons for why they believed that earthquakes might or might not be able to be predicted) of knowledge. The analysis indicated that children mainly held absolutist epistemic beliefs (69%). They also found that children who held multiplist beliefs were more likely to connect evidence and theory in their reasoning.

It could be argued that epistemic tasks, vignettes and interviews, although made less abstract through the use of puppets, can still 'run the risk of being ambiguous, misconstrued and adult biased' (Bradding and Horstman 1999, 171). Moschner et al. (2008) agreed that interviews with children can be problematic because of the abstract nature of epistemic beliefs and the complexity of language required to be able to respond to interview prompts. They also recognised that interviews make it possible to clarify any misunderstandings. Young children might also be highly sensitive to social norms and significant others and their responses may reflect these rather than their true opinions and/or beliefs (see Bradding and Horstman 1999).

Multidimensional epistemic beliefs: using questionnaires

Another enduring approach in epistemic beliefs research involves multidimensional epistemic beliefs research. Marlene Schommer-Aikins (Schommer 1990) argued that epistemic beliefs were multidimensional and independent (Duell and Schommer-Aikins 2001). This means that rather than being developmental in nature, epistemic beliefs are considered to vary across a range of different types of beliefs. She used questionnaires to measure five sets of epistemic beliefs. These were (a) structure (is knowledge siloed or integrated?); (b) stability (is knowledge changing or stable?); (c) source (does knowledge come from other experts or does one construct knowledge based on evidence?); (d) speed (does learning occur quickly or not

at all?) and (e) ability (is it based on innate ability or can effort be applied in the process of learning?). For example, it is possible for an individual to believe that knowledge is certain and unchanging and at the same time espouse beliefs in the source of knowledge as internally constructed. Over the years these dimensions have been refined but essentially questionnaires that measure epistemic beliefs tend to consider beliefs as multi-dimensional and independent of each other.

Elder (2002) was interested in Grade 5 US children's epistemic beliefs in the context of inquiry learning in science. She used a questionnaire to measure science epistemic beliefs with 211 children. The first part of the questionnaire asked children to respond in writing to three open-ended questions related to their views about the nature and sources of science. In the next part, children responded to 25 questions on a likert scale about '(1) the changing nature of science, (2) the role of experiments in science, (3) the coherence of science knowledge, and (4) the sources of science knowledge' (p. 357). The study showed that children held a mixture of epistemic beliefs. They viewed science as "a developing, changing construct that is created by reasoning and testing" (p. 360), while at the same time not understanding the extent to which knowledge acquisition in science relies on effort.

Building on Elder's (2002) study, Conley et al. (2004) investigated Grade 5 children's epistemic beliefs in the domain of science using a 26-item questionnaire that measured beliefs similar to those proposed by Schommer (see Schommer, 1998). These included

- source ('Whatever the teacher says in science class is true');
- certainty ('All questions in science have one right answer');
- development (similar to stability dimension described by Schommer 'Sometimes scientists change their minds about what is true in science') and
- justification ('Good answers are based on evidence from many different experiments') of knowledge.

Students rated their agreement using a 5-point likert scale ranging from 1 strongly disagree to 5 strongly agree. Conley et al. reported that over a 9-week science unit children developed stronger beliefs in the uncertainty knowledge and became less focussed on teachers and other experts as the source of knowledge. Boz, Aydemir and Aydemir (2011) also used a questionnaire to measure 4th, 6th and 8th Grade children's epistemic beliefs using a measure similar to the one used by Conley et al. (2004). This questionnaire examined children's beliefs about justification, development, and a combined source/certainty dimension. The researchers showed that from the 4th through to the 8th Grade, children's beliefs about justification and development of knowledge became less focussed on evaluating evidence and more focussed on knowledge as internally constructed but composed of multiple right answers.

Questionnaires may provide a way in which to reduce the risk of children perceiving the need to respond in the 'correct' way with adults present. However, as discussed below such measures have other challenges that need to be considered when investigating children's epistemic beliefs. There is much debate about the effectiveness of using questionnaires to measure epistemic beliefs with adults and this concern also applies in the context of measuring children's epistemic beliefs. Moschner et al. (2008) reviewed measurement of epistemic beliefs with children and argued that questionnaires in general have poor reliability and validity. They also argue that questionnaires, like interviews, are difficult for children to respond to because of the abstract nature of epistemic beliefs (this is also a problem for adults) and because of the concerns about the level of language required to respond to such measures of epistemic beliefs.

Child-centred approaches: drawings and 'draw and tell' processes

A relatively new way of investigating epistemic beliefs involves the use of drawings which reflects a more child-centred approach. The use of drawings when researching with children

and young adults is not new (Freeman and Mathison 2009) and may offer further insights into epistemic beliefs research. This approach provides children with an opportunity to demonstrate their thinking about matters normally considered beyond their sphere of competence (Mair and Kierans 2007) and enables researchers to take a child-centred research perspective.

Using drawings to understand children's views and feelings has been used extensively in the past in therapy, but more recently these have been used to help researchers understand children's perspectives on a range of topics. However, little is known about the effectiveness of measuring children's epistemic beliefs using drawings.

Drawings may be a useful way to illicit children's epistemic beliefs because they 'enable students to convey their beliefs in more open and inventive ways than ordinarily permitted by structured questions and Likert scales' and 'compensate for articulation difficulties' (Briell et al. 2010, 662). Children's ability to retrieve information through drawing as opposed to a verbal response may often be easier for them as they are more likely to attend to sensory and perceptual information than to semantic information (Driessnack 2006). Another potential benefit of using drawings to measure epistemic beliefs is that it requires children to use different cognitive processes than if they were asked to verbalise or write their response only (Kearney and Hyle 2004). The mental process used when drawing, assists participants to sort and attach meaning and so may prepare children to process their thoughts more easily (Kearny and Hyle 2004). This approach may help children to communicate concepts which may be too complex to describe verbally or in writing (Freeman and Mathison 2009) and thus may produce much richer data than verbal/written data alone. Drawings can overcome the previously discussed concerns about epistemic tasks, vignettes, interviews, and questionnaires as being abstract, adult-biased and leading to children expressing views that they think the researcher wants to hear (Bradding and Horstman 1999).

They can allow children to take some control and time to reflect on their responses (Freeman and Mathison 2009).

It is possible to extend on the use of drawings to allow children to use different senses by using a combination of drawings and verbalisation. 'Draw and write' studies are new to research in educational settings and are viewed as a non-traditional methodology (Kearney and Hyle 2004). The draw and write technique is essentially one in which participants (1) respond to a researcher's enquiry with drawings; (2) elaborate through a written response, and/or; (3) engage in an interview where the picture is further described and clarified (Mair and Kierans 2007).

Solomon and Grimley (2011) investigated the epistemic beliefs of Grade 5 and Grade 6 New Zealand children using drawings and interviews (See Table 1). They noted that many children reported on the affective dimension of maths knowledge – reporting feelings such as fun, excitement or boredom. They also observed that schools and teachers tended to influence the nature of these beliefs in mathematics. They suggest that using drawings to understand children's beliefs about mathematics can help teachers to better understand children as learners and how they feel about the learning process.

Research into epistemic beliefs has generally relied on making inferences based on (a) conceptions of learning, (b) reasoning and decision making, and (c) making meaning of experiences (Briell et al. 2010). Briell and his colleagues commented that given the often implicit nature of epistemic beliefs, there are difficulties associated with making inferences from implicitly held beliefs. Hence a more concrete approach as evident in the use of drawings as a research methodology may be useful. There are no studies, that we are aware of, that have used drawings, statements and interviews as a way to investigate children's epistemic beliefs. This study aimed to address this gap by exploring the following research question: 'To what extent do drawings followed by written responses and interviews (draw

and tell process) provide a useful way to understand children's epistemic beliefs about the source and acquisition of knowledge?'

The study

This study draws on data from a broader international study of epistemic beliefs with Grade 4 and Grade 6 children. The current pilot study relates to the Australian data set, and specifically a subset of 11 children across Grade 4 and Grade 6 who agreed to be interviewed following their drawing tasks. This means that the children were in their fourth and sixth year of schooling (excluding the preparatory year) respectively. The children attended a private elementary school located in a large metropolitan city in Australia. The large majority of the student population (70%) was from a high socio-economic status. At the time of data collection, there were no Indigenous students enrolled at the school and 3% were from a non-English speaking background. The school was close to or above the Australian national average in literacy and numeracy standards (ACARA 2010).

Collecting the data

Participation involved a drawing activity/task that took approximately 30-45 minutes. The task was conducted in class time. The researcher asked the children to look around the classroom and asked 'What do you see that looks like knowledge?' Students had the opportunity to ask questions about the task. The researcher then asked the children to write down a list of five things that looked like knowledge using the A4 sheet of paper provided and to draw a picture of each thing. The children were asked to complete their drawings in pencil rather than in colour. Driessnack (2006) suggested that a pencil is the most appropriate tool to use in 'draw and tell' tasks as pencil is a familiar tool to children; it leaves a mark that can be erased easily or remain permanent; the grey colour of a pencil is emotionally non-committal compared with having to choose a colour/s; and importantly to a hesitant 'artist' a pencil is considered 'safe'.

Next, children were asked to write three sentences regarding one of their five drawings. Driessnack (2005) suggested that in using the draw and tell technique it is important for the children to draw first and tell later. This allows children to organise their thoughts before they share them particularly regarding constructs they might find difficult to describe (Driessnack 2006).

Finally, interviews took place with 11 children who had participated in the draw and write components of the data collection (six Grade 6 children and five Grade 4 children). The interviews were unstructured in that the students' drawings and written statements were the catalyst for the discussion (Varga-Atkins and O'Brien 2009). For example, the children were asked to describe in more detail what they meant in the written statements used to describe why their drawing looked like knowledge as well as to further explain their drawings. The focus was to understand more about what they had written in their responses and about why the drawing they chose represented knowledge. Combining the methodological approach of Driessnack (2005), Salmon (2001) and Varga-Atkins and O'Brien (2009) supported the methodological sequence of 'draw, write, and tell' applied in this study.

Data analysis

Drawings. Whilst drawing was a crucial component of this research study it was important that we did not make assumptions based purely on the drawings alone (see Rubin 2011). Analysing drawings can be difficult and it needs to be appreciated that drawings are not direct translations of mental images or states and the setting and culture of the school and curriculum will be likely to influence the nature and process of the children's drawings and statements (Backett-Milburn and McKie 1999). Since previous studies using the draw and write technique expressed concern in using projective analysis (Bradding and Horstman 1999), we analysed the drawings at face value. By adhering to this 'face value' principle, we

deliberately kept interpretation to a bare minimum. Later in the data collection process when interviewing some of the children, we were confident from the children's verbal responses that we had indeed correctly 'understood' their drawings and had not placed our own interpretations on the data.

Written statements and interviews. The written statements and interviews with children were analysed using inductive thematic analysis (Braun and Clarke 2006). To begin with, the written statements and interview transcripts were read by each researcher in order to develop a familiarisation with the transcripts. Next, each researcher analysed the transcripts using a data driven or inductive approach to thematic analysis. Thematic analysis 'is a method for identifying, analysing and reporting patterns (themes) within data' (Braun and Clarke 2006, 79). At this stage, the themes were allowed to emerge from the data. The next phase in the analysis involved comparing the emergent themes with the literature related to epistemic beliefs. This is referred to as theoretical thematic analysis (Braun and Clarke 2006) where the researcher's preconceived understanding of the field drives the categorisation of the data at this final stage of analysis. Interrater reliabilities of 90.5% and 86.6% were established for the Grade 4 and Grade 6 students, respectively. Inconsistencies in coding were resolved through group consensus.

Findings

When children were asked to draw what knowledge looks like in class and explain why these drawings looked like knowledge, a range of epistemic beliefs were evident in their pictorial, written and verbal responses in interviews. Children's drawings reflected where knowledge was located (internal or external) which represented the source of knowledge. When they were asked to explain why their drawings looked like knowledge in the written statements and follow up interviews, they described how knowledge was gained (knowledge acquisition).

Drawings

With regard to drawings, all children (*n*=11) in both grade levels viewed sources of knowledge as predominantly external to themselves which were depicted as either objects or authorities. We acknowledge the limitations of asking children to describe 'what looks like knowledge' because it is possible that children believed that they needed to document something that was visible in the classroom. However, this phrasing of the task can also be understood from an introspective point of view. That is, two students mentioned internal sources of knowledge that indicated that they believed knowledge resided within themselves. The objects that were drawn most often included books (*n*=10), black boards or whiteboards (*n*=7), computers (*n*=6), and clocks (*n*=4). The authority figures (*n*=6) depicted were usually teachers with a couple of examples that depicted class mates. Children's drawings mostly depicted an external source of knowledge which suggested a one-way interaction (child not part of knowledge construction) much like what was found in Briell et al.'s study (2010). Briell et al. assumed that external (or something in the mind only) one-way knowledge was more naive than a combination of internal and external two-way illustrations of knowledge. Also images that are purely of external formal objects do not indicate a connection with personal experiences (Briell et al. 2010).

Written statements and interviews

The children were asked to describe why their chosen drawings looked like knowledge in the written statements and interviews. These responses overall reflected the children's views about how knowledge is acquired, with nine distinct categories emerging during the analysis of the written statements. These categories were then applied deductively to analyse the interview transcripts. The nine categories could be grouped in two main ways. The first five categories reflected beliefs about the process of knowledge acquisition ranging from more

passive through to meaning making. The final four categories described a range of influences on, or characteristics of, knowledge. Each of the nine categories is now discussed with quotes to exemplify these views.

Category 1, *Receive knowledge* and Category 2, *Observe* suggest a one-way-interaction with the child taking a relatively passive role in acquiring knowledge. *Receive knowledge,* as the title suggests, is about knowledge being passively received from an external source (teachers, books): 'Books can teach you facts' (AU4-2-M9 statement)[1]. The second category *Observe* also included a view of knowledge acquisition as more passive such as seeing, listening, or being shown something*:* 'I listen to what has been happening around the world' (AU4-3-F9 statement). Category 3, *Task-based learning*, was a description of some sort of learning activity and often included things such as reading, repeating things, writing things down, googling/searching, and word processing: 'If you have to learn a different language you can read about it' (AU4-1-F9 statement).

The next two categories, Category 4 *Sense-making* and Category 5 *Active processing* reflected approaches to knowledge acquisition which evidenced some form of making meaning. They represented a shift in thinking about knowledge acquisition from the earlier three categories because there was a stronger focus on children actively making meaning of their experiences, rather than receiving (Category1), observing (Category 2) or simply engaging in Task-based activities (Category 3). Category 4, *Sense-making* involved making sense of something, working something out, playing games, discussing ideas or putting something into their own words: 'Other sorts of books help you to understand things like how to predict the weather and how to make things' (AU6-25-M11 statement). Category 5, *Active*

[1] Note: AU4-2-M9 shows that the child is from Australia (AU), is in 4th grade (AU4), has identifier number 2 (AU4-2), is male (AU4-2-M) and is 9 years of age (AU4-2-M9).

processing involved things like problem solving, decision making, reflection and using imagination and reflected: 'Literacy games or maths. You have to solve things' (AU4-3-F9 interview).

The final group of categories (Categories 6 through to 9) referred to other dimensions which were not directly related to the process of acquiring knowledge but nonetheless play a role in influencing or characterising it. The *Affective* dimension (Category 6) was about either motivation (fun, rewards) or relationships (the importance of love and caring) as influences on knowledge acquisition: 'I think (teacher) is awesome maybe. He thinks he is awesome and he likes to make jokes.' (AU6-3-M10 interview). Category 7, *Innate Ability*, described how knowledge acquisition depended on some sort of innate ability like being 'smart'. Some children thought ability was age or education related: 'Because they (teachers) know more stuff than we do because they are older than us and they have already done what we are doing' (AU6-19-F11 interview). Next, *Utilitarian* views (Category 8) simply reflected how certain objects like pencils could be considered as knowledge because they were instrumental in gaining such knowledge. Finally, Category 9 *Certain Knowledge* described a view that knowledge acquisition was about gaining 'facts' and reflected an absolutist view of knowledge: 'Mr. H will mark the books and then he will tell us if they are right or wrong' (AU6-11-F11 interview).

Comparison of written statements with interview data

There are two key findings that emerged from the comparison of the written statements with the interview data (See Table 2). First, in all but one case, each child was able to articulate a wider variety of views about the process of knowledge acquisition and influences/characteristics of knowledge acquisitions than was evident in the written statements. Second, when children's views about the process of knowledge acquisition were

examined in more detail (Categories 1 through to 5 only), the focus was on how knowledge was acquired, rather than the influences or characteristics of knowledge acquisition (See Table 3). In terms of theses process of knowledge acquisition categories, only the views that represented the strongest focus on meaning making for each child (most sophisticated responses) were recorded to see if there was any difference in beliefs across the two data sets.

[Insert Tables 2 & 3 here]

To summarise, most children described slightly more Sense-making views of acquiring knowledge in the interviews than they did in the written statements. There were two exceptions: one child who described Task-based learning in the written statements and Active processing in the interview and another who focused on Task-based learning during both forms of data collection. The following individual cases provide descriptions of how children described knowledge across all three data sources.

Child **AU6-9-F10** (Grade 6, female) described all knowledge as external. She drew four objects (computer, books, posters, TV, window) and one picture of her teacher. She chose the teacher as the best representation of knowledge and indicated in her written statements that knowledge acquisition was about ability: 'Mr. H is smart. Mr. H helps the class. Mr. H looks like knowledge because he is older than us and knows more'. These statements suggested that knowledge acquisition was about having ability and being smart and that this ability develops through experience. However, throughout the interview she described a broader range of views about knowledge acquisition that went beyond a focus on ability to include Receiving knowledge (Category 1), Observing (Category 2), Task-based learning (Category 3), Sense-making (Category 4), as well as Affective – motivation (relational), Ability, Certain knowledge and knowledge as Utilitarian in nature. The views

clearly showed that knowledge acquisition involved more than just ability as was described in the written statements to include sense-making (Category 4): ‘sometimes people don’t put up their hand so he just picks randomly out of the class and they have to figure out themselves’. The child described a stronger view of Sense-making (Category 4) in addition to a range of other categories that were not expressed in the written statements.

Child **AU6-8-M11,** (Grade 6, male), depicted knowledge in his drawings as external with four objects (dictionary, computer, pencil, blackboard) and a teacher. He selected the computer to write about in his statements, describing this as knowledge because it promoted Task-based learning (Category 3): ‘Computers look like knowledge because you can look up things from images to information. You can find out about things you have never heard of. You can learn things about other parts of the world and there (sic) language’. When interviewed, Task-based learning (Category 3) continued to be the main focus of his comments although he also referred to knowledge acquisition as Received (Category 1) and Sense-making Category 4) ‘You can look up things you don’t understand and stuff that you want to know about...they can give you an idea of what it looks like and how it works’. He also described how knowledge acquisition was based on Ability and was Utilitarian in nature. Once again the child describes a stronger view of Sense-making (Category 4) in the interviews in addition to a range of other categories that were not expressed in the written statements.

Child **AU4-3-F9** (Grade 4, female) depicted knowledge in her drawings as external objects – computer, clock, books, whiteboard and charts. She chose to write about the computer in her statements indicating that it looked like knowledge because ‘you can learn things from it, you can do research on it and you can write things on it’. These responses suggested a view of knowledge acquisition as active (Category 3). However, in the interview she extended this description to include more Sense-making (Category 4) views of knowledge

acquisition. She went beyond simply receiving knowledge (Category 1) and Task-based learning (Category 3) to include Sense-making (Category 4), Active processing (Category 5) and Affective aspects of knowledge acquisition (motivation).

For example, Active processing was evident in the following focus on problem solving:

Interviewer: What does playing the games do?
Child: You have to solve things and it teaches you your times tables.

Sense-making was evident in the following example:

Interviewer: So just copy and paste it from the computer?
Child: Or you put it in your own words.

The interview enabled this child to articulate a far broader range of responses about why something looked like knowledge as well providing a stronger focus on making meaning in the process of knowledge acquisition. These examples provide evidence that interviews allow for more nuanced data collection, that is a broader range of categories (see Tables 2 and 3).

Discussion

In this study, children seemed to depict and describe predominantly objectivist epistemic beliefs. On the whole, their drawings showed knowledge sources to be mostly external, one-way sources of knowledge which was also reflected in the written statements and interviews about why their drawings looked like knowledge. While, the drawings provided a useful way to find out about what children considered to be sources of knowledge, the follow up written statements and interviews proved to be revealing. In the follow up explanations, in keeping with external one-way sources of knowledge, children often described knowledge acquisition

as a process of Task-based learning such as reading and searching the internet rather than a process of making meaning. While these views do not reflect a completely passive role as was evident in Category 1 Receive knowledge, they still suggested that the child did not focus on actively making meaning or constructing knowledge. This would suggest an objectivist set of epistemic beliefs. It was interesting to note that children reflected upon knowledge acquisition as Sense-making (Category 4) during the interviews to a greater extent than they did in their written statements. The written responses reflected a view of how knowledge was acquired and, on the whole, most children described knowledge acquisition as Task-based learning (like reading, searching the internet etc.) rather than a process of Sense-making which was evident in the interviews.

It was also noted that children were able to describe a wider range of views about the process of how knowledge was acquired in the interviews as compared with the drawings and written statements. Tables 2 and 3 showed that during the interviews children viewed knowledge acquisition and the influences on knowledge in diverse ways which were not captured in the drawings and written statements. This is likely due to the opportunity to respond verbally in interviews and their overall more interactive and interpersonal nature of interviews in comparison to the individual and non-interactive data collection forms of drawing and writing statements.

Overall these findings suggest that a multi-method approach (i.e., children's drawings and written statements followed by an interview) can provide a more nuanced understanding of children's epistemic beliefs about the source and processes of acquisition of knowledge. The use of 'draw, write and tell' processes may provide a way in which to make epistemic beliefs questions less abstract for children (Bradding and Horstman 1999). In a similar way to the use of vignettes, where interview questions are 'contextualised …and subjects do not need to make assumptions about examples for rather general statements' (Moschner et al. 2008,

127), the drawings seem to have provided a way to contextualise the topic of knowledge within actual classrooms. This contextualising may help to ensure that the questions are within the experience of the child, although language capacity is a factor that still needs to be considered when interpreting data.

According to Freeman and Mathison (2009) the 'draw, write and tell' processes are also beneficial because they help children to take more control of the research process. This child-centred research perspective is in keeping with 'a new image of the child as a competent participant in research' (Folque 2010, 240). Folque argues that engaging in conversations with children during research not only helps children to feel that they are competent and valued but may also provide a useful strategy in which children can come to understand their own views about knowledge and learning. Brownlee, Schraw and Berthelsen (2011) noted that one of the most commonly described ways of facilitating changes in epistemic beliefs in adults was to encourage explicit individual reflection on the nature of epistemic beliefs. This awareness seems to enable individuals to think differently about their epistemic beliefs over time (Brownlee, Purdie and Boulton-Lewis 2001). From a teaching perspective, Vygotzky's (1978) Zone of Proximal Development can be utilized through interviews or other guided methods of reflection and instructional scaffolds to help children become aware of their epistemic beliefs and to foster their epistemic development towards more sophisticated levels. In summary, the 'draw, write and tell' methodology may provide children with a way in which to reflect on and demonstrate their own epistemic beliefs as a prelude to changing such beliefs over time.

The data collection methods used in this pilot study may provide useful tools for teachers to explore what children think about the source and acquisition of knowledge. We know from the extensive research with adults and adolescents that students' epistemic beliefs provide a lens for understanding approaches to learning and learning outcomes in the classroom (for a review see Brownlee, Schraw and Berthelsen 2011). For example Yang and

Tsai (2010) noticed that children who believed that the source of knowledge was internal and knowledge was personally constructed (multiplist beliefs) were more likely to engage in critical thinking (using evidence including theory). Classrooms that focus on such critical thinking are described as 'epistemologically based' (Schommer-Aikens, Bird and Bakken 2010, 48) and evaluativistic in nature (Feucht 2010). In such classrooms, Schommer et al. (2010) state, 'the teacher encourages his/her students to look for connections among concepts within the text, with their prior knowledge, and with concepts found in the world beyond themselves' (p. 48). Teachers may be able to use the 'draw, write, tell' process to gain an understanding of their students' epistemic beliefs as a prelude to promoting and supporting such critical thinking in the classroom.

The current study relates to a specific Australian data set, with a subset of 11 children across Grade 4 and Grade 6 who agreed to be interviewed following their drawing tasks. Most of the children (70%) were from a high socio-economic area and there were no Indigenous students enrolled at the school. Only 3% were from a non-English speaking background. The school was close to or above the Australian national average in literacy and numeracy standards (ACARA 2010). It would be important in future studies to examine the effectiveness of the 'draw, write and tell' methodologies with larger and more varied samples of children and to examine what can be done to promote more sophisticated epistemic beliefs over time. Furthermore, there are no studies, that we are aware of, that have used drawings, statements and interviews as a way to investigate children's epistemic beliefs. This suggests that future research may need to consider using a combination of drawings, written statements and interviews to ensure a more nuanced understanding of children's beliefs. It seems that drawings and written statements can be utilized to prompt and elicit children's epistemic beliefs and then augmented by using interviews to verbally probe more deeply about their beliefs.

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Table 1. Overview of research into children's epistemic beliefs from the developmental, multidimensional beliefs and child-centred approaches

Developmental approaches			
Methodologies	Authors	Sample	Purpose
Epistemic tasks	Burr & Hofer (2002)	3-5 year olds (USA)	To examine connections between theory of mind and the development of epistemic beliefs.
Vignettes	Wildenger, Hofer, Burr (2010)	3 year olds, 4 year olds & 5 year olds (USA)	To examine whether young children's epistemic beliefs are related to theory of mind.
	Wainryb, Shaw, Langley, Cottam, & Lewis (2004)	5 year olds, 7 year olds & 9 year olds (USA)	To examine whether young children's thinking about beliefs that differ from their own varies with age and domain of disagreement.
	Mansfield & Clinchy (2002)	10 year olds, 13 year olds and 16 year olds (USA)	To examine changes in epistemic beliefs longitudinally from 10 to 16 years of age.
	Kuhn, Cheney & Weinstock (2000)	10 year olds to adulthood (USA)	To examine epistemic judgments across domains.
	Walker, Wartenberg & Winner (2012)	7-8 year olds (USA)	To examine the relationships between dialogic pedagogy, skills of argument and epistemic beliefs.
Interviews	Yang & Tsai (2010)	6th Grade students (Taipai)	To examine the relation between scientific reasoning in informal contexts and the epistemic perspectives demonstrated by elementary school students.
Multidimensional beliefs approaches			
Methodologies	Authors	Sample	Purpose
Questionnaires	Conley, Pintrich, Vekiri &	5th Grade students (USA)	To examine how epistemic beliefs change over time and

	Harrison (2004)		the role that gender, ethnicity, SES and achievement play in their development.
	Boz, Aydemir & Aydemir (2011)	4th, 6th & 8th Grade students (Turkey)	To examine 4th, 6th and 8th Grade students' epistemic beliefs and how these beliefs change with grade level and gender.
	Elder (2002)	5th Grade students (USA)	To examine nature of science beliefs.
Child-centred approaches			
Drawings	Solomon & Grimley (2011)	5th & 6th year of elementary school (New Zealand)	To report on how teachers and schools influence epistemic beliefs in mathematics.

Table 2. Methodological comparison: Drawings, written statements and interview data

Method / **Child**	**Drawings**	**Written statements**	**Interviews**
	Focus: Source of knowledge	Focus: process of knowledge acquisition & influences/characteristics of knowledge	
	Codes: External – internal sources	Categories: 1 - 9	
AU4-1-F9	External – 4 objects (**books**[2]**,** computer, maps, clock) 1 authority (teacher)	Observe Task-based learning	Receive knowledge Observe Task-based learning Sense-making
AU4-2-M9	External – 5 objects (**books**, black board, maps, clocks, art)	Receive knowledge Task-based learning Certain knowledge	Receive knowledge Observe Task-based learning Sense-making
AU4-3-F9	External – 5 objects (**computer**, clock, books, white board, charts)	Task-based learning	Receive knowledge Task-based learning Sense-making Active processing Affective (motivation)

[2] Bold font signifies which drawing was chosen to reflect upon in the written statements and interviews.

AU4-4-F9	External – 4 objects (**books**, maps, clock, dictionary); Internal -1 (**brain**)	Ability Task-based learning	Task-based learning
AU4-10-F9	External – 5 objects (w/board, black board, books, **electronic w/board**, computers)	Task-based learning	Receive knowledge Task-based learning Sense-making
AU6-8-M11	External – 4 objects (dictionary, **computer**, pencil, black board) 1 authority (teacher)	Task-based learning	Receive knowledge Task-based learning Sense-making Ability; Utilitarian
AU6-9-F10	External – 4 objects (computer, books, posters, TV, window) 1 authority (**teacher**)	Ability	Receive knowledge Observe Task-based learning Sense-making Affective–motivational, relational Ability; Utilitarian; Certain knowledge
AU6-11-F11	External – 3 objects (maths books, computers, **library**) 2 authority (teacher, classmates)	Ability Task-based learning	Receive knowledge Observe Task-based learning Sense-making Ability; Certain knowledge
AU6-19-F11	External – 3 objects (books, black board, **computer**)	Task-based learning	Receive knowledge Task-based learning

	2 authority (teacher, someone working)		Sense-making Ability; Certain knowledge
AU6-20-F10	External – 4 objects (b/board, paper, **books**, pencil) Internal material (student – me)	Receive knowledge	Receive knowledge Task-based learning Sense-making Affective – motivation; Utilitarian
AU6-21-F11	External – 4 objects (maths books, maps, laptops, **library**) 1 authority (teachers)	Ability Task-based learning	Receive knowledge Task-based learning Sense-making Ability;Utilitarian;Certain knowledge

Table 3. Comparison of most sophisticated beliefs about process of acquisition of knowledge in written statements and interview responses.

Method / **Child**	**Written statements**		**Interview responses**	
	Focus: most sophisticated beliefs about process of knowledge acquisition			
	Categories: 1 - 5			
AU4-1-F9	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU4-2-M9	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU4-3-F9	Task-based learning	(Category 3)	Active processing	(Category 5)
AU4-4-F9	Task-based learning	(Category 3)	Task-based learning	(Category 3)
AU4-10-F9	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU6-8-M11	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU6-9-F10	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU6-11-F11	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU6-19-F11	Task-based learning	(Category 3)	Sense-making	(Category 4)
AU6-20-F10	Receive knowledge	(Category 4)	Sense-making	(Category 4)
AU6-21-F11	Task-based learning	(Category 3)	Sense-making	(Category 4)