Am I Engaged with Mathematics? A Child's Perspective!

Paul Benjamin Hobson, University of Hull

Abstract

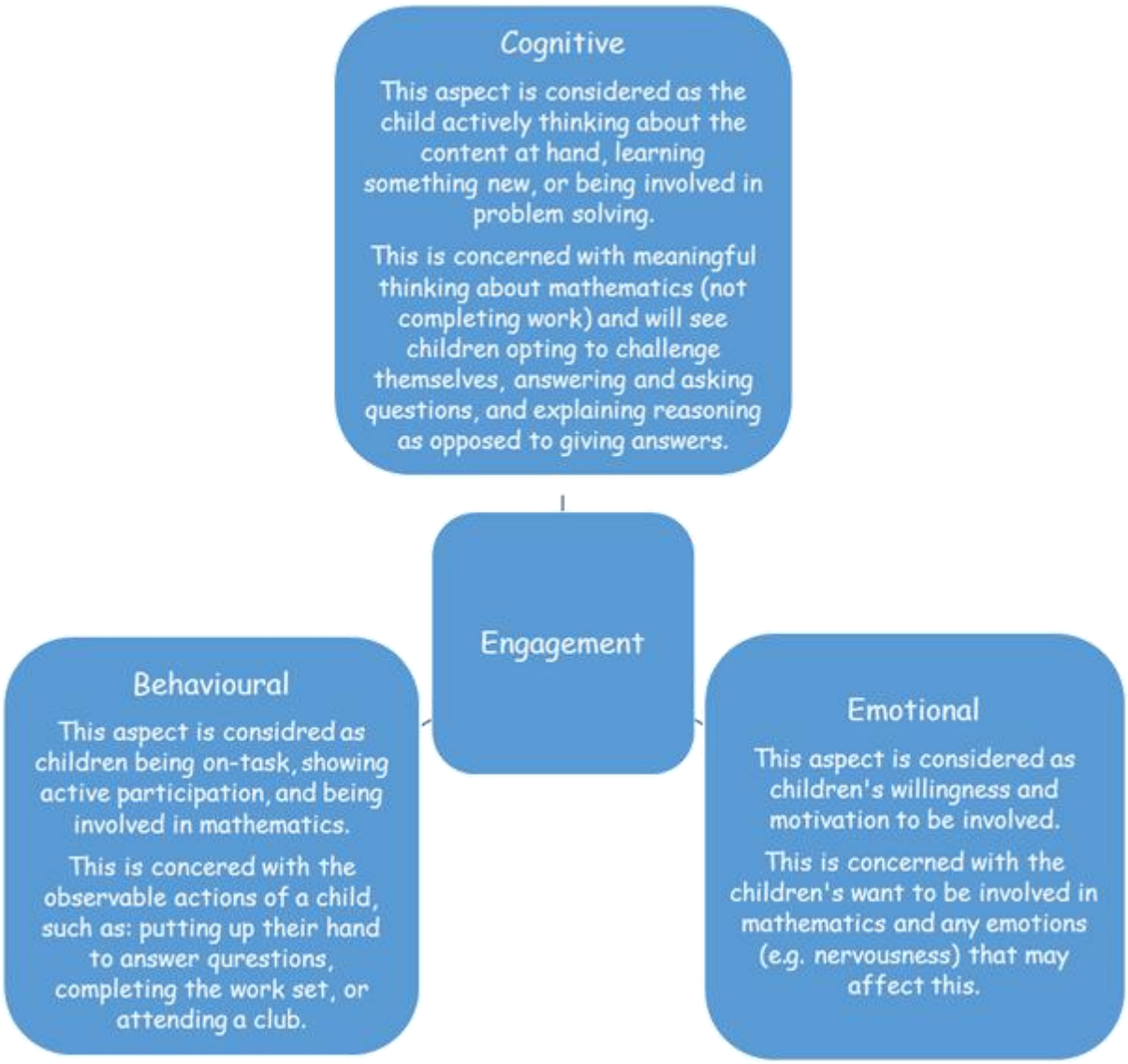
This study explores the reasons for children's varying levels of engagement with mathematics. Although new approaches to the learning of and engagement in mathematics continue to be developed, it has been argued by Boaler (2009) that levels of engagement continue to drop. Therefore, this study seeks to identify what factors children consider engage them, as opposed to teachers and researchers. The study consists of semi-structured, non-participant observations of four children (two boys and two girls) in a mixed year 3 and 4 class. These observations were followed by individual semi-structured interviews and other relevant data collection. The findings indicate that behavioural engagement is not always consistent with cognitive and emotional engagement, yet cognitive engagement may have a resulting impact upon behavioural engagement. Overall, the children considered several factors that engage them in the mathematics classroom with the application of mathematics to 'real-life' situations being one of the most prevalent. The implications of the study for teachers are the identification of different indicators of engagement in children and suggestions as to how to enhance cognitive (and other forms of) engagement.

Introduction

Whilst studying the field of mathematics as part of my educational degree, I have been concerned by the remarks from teachers, children and authors that some children hate mathematics. As mathematics is a subject I am particularly interested in, I am convinced that any child can begin to enjoy mathematics if it is presented to them in a meaningful and engaging way. This, and authors commenting on this lack of engagement in the subject (for example, Attard, 2013; Boaler, 2009), led me to study engagement in mathematics for my undergraduate dissertation. With many new practices constantly appearing to engage children, and levels of engagement seeming to continue to drop (Boaler, 2009), I have considered it vital that a focus on what children themselves consider to be factors in engaging them with mathematics is more important than what adults think.

Literature Review

It is firstly important to define engagement as not doing so will limit the usefulness of the study (Helme and Clarke, 2001). There are many representations of what engagement is and what it consists of. Some commentators have linked the amount of time on task or the doing of mathematics to engagement (Peterson and Fennema, 1985; Hickey, 2003) but others argue that this simplistic view can be easily misinterpreted as children may appear to be engaged without actually learning (Helme and Clarke, 2001; Erickson and Shultz, 1992). During my studies and observations, I have concluded that children can be engaged in different ways, and that, if learning is to be considered of vital importance, simply considering engagement as 'heads down and working' is not enough. I have therefore outlined three aspects of engagement below by summarising work from many authors (Attard, 2012; Connell, 1990; Fredricks et al., 2004; Helme and Clarke, 2001; Kong et al., 2003).



There are three main ways to engage: cognitively, behaviourally and emotionally. Behavioural engagement can be summarised as children being on-task, showing

active participation, and being involved in the mathematics. This could be observed in the classroom as a child completing work set, putting their hand up to answer questions, or by attending an extra-curricular club. The positive aspect of this type of engagement is that it is noted that students who are engaged in this way are less likely to disrupt classes, will follow instructions and are attentive (Park, 2005; Kong et al., 2003). However, behavioural engagement should not be considered necessarily to promote learning as children may just appear to be learning (Boaler, 2009; Kong et al., 2003). This is a major disadvantage of promoting behavioural engagement in isolation to the other two types; children may appear to be learning because they are completing the tasks and watching the teacher yet they may not understand the content of the lesson or learn anything new.

The second aspect of engagement, the emotional aspect, is considered as the child's willingness and motivation to be involved in mathematics. This could be observed in the classroom by children being positive, curious and excited about mathematics. Emotional engagement also encompasses emotions that are involved in the engagement process (for example, being nervous). This could be seen as children unwilling to take part in mathematics because they are nervous about calculating the correct answer or they are bored by the work set. This aspect of engagement is vital as Marks (2000) suggests that children who are engaged in this way will find school more rewarding, and Sullivan et al. (2005) suggest that poor emotional engagement may limit children's life choices as they may not take mathematics in further education. Furthermore, considering that 'too many children hate mathematics' (Boaler, 2009:1), emotional engagement may be the key to change.

The third aspect of engagement, the cognitive aspect, occurs when the child is actively thinking about the mathematical content at hand, learning something new, or being involved in problem solving. This could be observed in the classroom through children meaningfully thinking about mathematics (not completing work) and by children challenging themselves, answering and asking questions, and explaining their reasoning as opposed to simply giving correct answers. By defining engagement in this way, cognitive engagement is probably the most vital for learning and progression in mathematics. Although there is research showing that increased cognitive engagement facilitates learning and leads to higher academic achievement (Helme and Clarke, 2001; Swing et al., 1988), all three aspects of engagement have been considered to be vital as lowered engagement in any could lead to disruptive classrooms (behavioural), children hating mathematics (emotional), or children not learning (cognitive). Arguably, considering any aspect of engagement as less important would be naïve, yet considering that children are simplistically engaged or not engaged would also be inappropriate.

This research considers the different circumstances that engage children. Attard (2013) notes that children may be engaged because of influences that are initiated outside and inside the classroom, as well factors considered to be core. Researchers (Attard, 2012; Attard, 2013; Boaler, 2009; Bragg, 2012; Elia et al., 2010; Helme and Clarke, 2001; Hopkins, 2008; Martin et al., 2009; Ricks, 2009; Van De Walle et al., 2010) suggest many different factors. Outside of the classroom there are factors such as the home environment and social attitudes about mathematics which can influence a child's engagement. In the classroom, the opportunities to discuss

mathematics and engage in social interactions, the effective utilisation of resources, the grouping of children, and the learning environment are some of the factors that are considered to affect engagement. Finally, within the core factors, the teacher's performance is considered in several ways. This includes: relationships with the children; knowledge of the children and their needs; and knowledge and passion for mathematics. The task itself is also another core factor mentioned. It needs to be: fun and enjoyable, relevant to the children, based on real-life situations, and appropriately challenging.

Methodology

The research was undertaken in the form of a case study in a year three/four mathematics lesson at a primary school in Yorkshire. As a case study may be prone to bias (Nisbet and Watt, 1984), I made no overarching assumptions as to what the children would consider engages them in mathematics, including those considered through literature. This lack of a concrete theory allowed for progress in the study (Gorard, 2004) as a theory adopted beforehand may have encouraged the researcher to observe what he/she wanted to observe, making them oblivious to other factors. A variety of methods were used to collect evidence, including observations, interviews, discussions with the teacher and analysis of children's work. The data collection was mostly qualitative and the study is from an interpretive perspective. Although generalisations should not be made due to the size and type of study (Sharp, 2012), specific events do raise many interesting patterns.

An observation of a mathematics lesson was undertaken which focused on the behaviour of four children (two boys and two girls) via a semi-structured approach. The lesson observed was a review and input on fractions. The teacher presented the new material through interaction with pupils in the form of teacher led discussion. Then children completed three examples; this work was followed by a class discussion. Finally, children worked on a practical task. This task involved the children making a fruit salad from fruit they were given using a recipe that was given in fractions (for example, two eighths of the blueberries). I sought to record behaviour at certain intervals but added extra notes as I thought necessary. A schedule from Sharp (2012) was adapted as it gave a good structure for recording observations. Although the observations mainly focused on behavioural engagement, I looked for signs of cognitive engagement and used a list of suggested indicators of cognitive engagement by Helme and Clarke (2001). These included, but were not limited to, children raising questions, verbalising thinking, exchanging and contributing ideas, explaining procedures and reasoning, and seeking feedback or help.

During the observation, a non-participant approach was used where I remained detached from activities so as not to affect the outcomes of the observation (Sharp, 2012). I moved to different areas of the classroom to increase opportunities to observe all that occurred. While I tried to maintain a purely observational role, I did intervene at times in the observation to check for cognitive engagement and understanding of the mathematical concepts. The children were closely observed several times during each section of the lesson and their behaviour was recorded.

In addition to the considerations made, I was careful not to overlook several issues, including the following: observations may change the behaviour of the class teacher and the children; the rapport between the teacher and researcher may affect observations. Notes were made where it was observed that the children may have modified their behaviour due to the presence of an observer. Secondly, as a semi-structured approach was used and the lesson was not videotaped, extra notes were taken during the observation and afterwards. Notes beyond this point were not added to ensure that selectivity of memory did not bias the study. I ensured that I did not bias the results by reading literature beyond that mentioned in the review.

After the observation took place, the four children were interviewed on a one-to-one basis. Although Greig and Taylor (1999) argue that a group interview could stimulate discussion and be less intimidating, I was concerned that the children may have influenced each other's answers and that peer pressure could have affected the results. A set of questions was designed for the interview to try and elicit information about engagement from the children without biasing their answers in any way. However, the interviews adopted a semi-structured approach as this allowed for questions to be used to start discussions with the children and for further discussion following children's initial responses. These questions were open-ended as Wright and Powell (2006) suggest that using open-ended questions may give more accurate results.

During the interview, it was important to ensure that children understood that their answers remained confidential and that there were no correct answers, as this hopefully reduced the possibility of them inventing answers to please me. The interviews were conducted in an open yet confidential area (school library) and a mind-map was used to ease the children into the interview. A dictaphone was used to aid in interpreting and reviewing the conversations later. The interviews themselves were intended to last approximately ten minutes; however, some interviews lasted longer as conversation flowed freely. Although the interviews could be seen as subjective due to their interpretive nature, I kept an open mind at all times, did not giving prompts and have triangulated findings with other research methods (such as observations, discussions with the teacher and book reviews) to reinforce the reliability of the study.

When working with the children in the observation and interviews, it was important to consider that children self-reporting on their own thinking may have been unreliable (Helme and Clarke, 2001). However, it was important that I obtain views of the children as Wilson (1998) points out that a study involving children's thinking will require them to self-report. I have therefore used other data sources, as suggested by Wilson (1998), to try and overcome this possible issue. These included: a discussion with the teacher to establish how the children's behaviour compared to normal and if there had been any unusual behaviour on that day from any of the children; the collection of lesson details and other resources (mentioned by the children) for further analysis; the reviewing of children's mathematics books to check for quantity and quality of work, and to check for up-to-date marking; and the collection of data regarding the children's levels and progress. Although it is difficult to ascertain the accuracy of data collected from another person, it has been collected to confirm that children are learning and making progress in their mathematics lessons and to support the research findings.

Questionnaires were not used during the process as I felt that interviews were more helpful in deciphering what engages the children, and that observations supported the validity of these interviews. Although interviews can be difficult to interpret (Sharp, 2012), they allow for a flowing discussion which may not have been possible from a questionnaire (Cohen et al., 2011).

Discussion

During the observations, two of the children stood out as contrasting cases. Whilst there are many interesting points raised in general, I will begin by discussing these two children in greater detail.

Child A

During the classroom observation of Amy, it appeared from a quick glance that she was engaged (behaviourally) as she was observing the teacher, raising her hand to answer questions and giving correct answers during the teacher's input. Under normal circumstances, an observer may have a whole class to observe and may have considered Amy to be engaged in the lesson. However, with closer and prolonged observations, several issues 'came to light' regarding Amy's apparent engagement.

Firstly, it could be seen, with close observation, that although Amy was seemingly participating in the lesson behaviourally, there was an issue with her cognitive engagement: she was copying answers from other children. This became apparent during the input as she was waiting for other children to write down the answers and then glanced across and copied them (with no working out). This continued into the task where the children had to calculate the answers to three questions from the board (for example, what is 5/6 of 30?). Amy started to attempt this question, but she soon became 'stuck' and then, again, copied the answer from a peer. This became apparent in the class discussion when she answered the question 'what is 5/6 of 30?' but was unable to explain 'why she found 1/6 first'. She was able to give the answer of 25 easily but avoided the second question by trying to use other information to quickly repeat the answer. She continued to raise her hand for answers but not to give explanations. Further to this, later in the lesson, after Amy had no more answers, she began to play with her pen and her whiteboard. During the fruit salad task, Amy was initially interested in the context but again allowed others in the group to work out the answers. She was listening and watching but began to lose interest and became less involved in the mathematics. Therefore, although she was, seemingly, behaviourally engaged initially, questions can be raised about Amy's cognitive engagement and how this then began to affect her behavioural engagement in the classroom observation.

During the interview, Amy told me that she 'liked' mathematics but preferred easier as opposed to harder or more challenging work. Whilst it is difficult to ascertain her level of emotional engagement from 'liked', it is apparent that her willingness and motivation during the lesson were somewhat compromised by her emotional engagement. However, her comments about practising mathematics at home would suggest behavioural engagement and some elements of emotional engagement

(willingness to complete extra mathematical activities). Furthermore, her comments to opt for easier work would suggest a preference for lower levels of cognitive engagement. This was confirmed in discussions as she was unaware of her targets in mathematics (although targets had been given) and did not mention any factors that made her 'think' mathematically when discussing engagement. It was further confirmed by the fact that she could calculate '2/5 of 10' and 3/5 of 10' in the interview which may show that she can work with fractions and understands how to calculate them but opted not to on that day. Discussions with the teacher about Amy's attainment and progress (which are good) raise questions about her levels of engagement being 'normal' for her on this occasion.

Although Amy's level of cognitive engagement could be questioned, it was interesting to discuss what factors she considered would engage her as this could reveal further problems with her engagement. Interestingly, she said that she preferred to work on her own because in group work 'others want to do all the writing'. This linked up with the observation but could be regarded as an excuse for not participating. Nevertheless, she suggested that to engage her, a large piece of paper was required so that everyone could contribute more evenly. This is important to consider because, although much literature supports group work, it seems that this approach can cause disengagement for some pupils through the problems it poses. She also said that she enjoyed lessons that were fun and that fun meant eating fruit, learning times tables, learning new methods and using a number line. This links to the observation that she showed a higher level of emotional engagement when the fruit task was introduced than just before or after. When questioned about her times tables, Amy mentioned chanting as being a fun way to learn these. However, most interestingly, she also mentioned the enjoyment of being able to 'calculate and count'. Considering this and the other factors from the observation and interview, could Amy be focusing on a procedural outcome of mathematics where the 'right answers' are the outcome as opposed to a conceptual outcome where understanding is of greatest importance? This would link with her need to produce the correct answers for the teacher, while being less concerned to work out her answers (hence her behaviour when 'stuck').

Child B

During the classroom observation, there were several immediate and intermittent indicators, early on, that would suggest Beth was not behaviourally engaged: writing on her whiteboard, playing with her bracelet, fiddling with her socks and not looking at the teacher. These behaviours were intermittent and mixed with Beth answering questions that the teacher asked and writing answers on her whiteboard. Furthermore, one observation of her whiteboard work showed that she had written the title 'fractions' thus suggesting that some of her unrequested writings were linked to the lesson content. At the calculation stage of the lesson, Beth was working incorrectly but sought help from the teacher and then began to calculate answers correctly. She again showed behavioural disengagement (opting to chew her bracelet) but then became highly involved in the lesson by giving correct answers, trying to calculate answers to questions, and asking a question. The fruit salad task seemed to engage Beth as, although she appeared uncertain at first, she attempted the task, was successful (with her partner), and could clearly explain what she was doing and why. The observation showed at a quick glance that Beth was not always

behaviourally engaged but that her willingness to engage and her cognitive engagement were both apparent (she learnt how to calculate fractions during this lesson). Interestingly, her emotional engagement may have prompted her desire for cognitive engagement as she was willing to ask questions and wanted to take part in the lesson. However, her behavioural engagement can be seen in two ways. On the surface, Beth appeared not to be behaviourally engaged during several parts of the lesson due to several off-task indicators. Yet she had been involved in the mathematics during this lesson which could have been the consequence of her cognitive engagement.

During the interview, Beth stated that she 'enjoyed' mathematics and that she would like to use mathematics in different areas of the curriculum (art, etc.). This showed that mathematics held a greater depth of meaning for Beth than Amy: Amy simply commented on her liking of mathematics yet Beth gave a more detailed answer as to her further uses for mathematics. Furthermore, Beth suggested that she enjoyed learning different mathematical methods in preparation for secondary school, was able to comment on the level she was performing at, and could consider targets for herself. This discussion indicated Beth's understanding of a range of purposes in mathematics especially regarding her future, and her ability to employ a mixture of methods as opposed to just 'getting the correct answer'. This showed emotional and behavioural engagement with mathematics. Beth showed her cognitive engagement through discussing her preference for more challenging mathematics work that is 'not too easy' and by reciting answers and methods to tasks that she had enjoyed from seventy-five days prior to the interview.

When asking what engaged Beth, the task she mentioned (above) was one of the main discussion points. It included the children selecting a meal in a restaurant and calculating the total cost of the meal (and for their friends as well). She discussed the task as not only challenging but described a situation where she imagined being there (a real-life situation). She commented that these types of challenging tasks inspired her as they were not too easy and took time to complete. Other tasks that engaged Beth included: working with food, fruit or wraps (physical objects and real-life); mathematical games because they were fun (giving examples); using ICT, especially a program where she could complete shopping questions (real-life situations); and reading about mathematics (not in stories but in books with a clear mathematical content). Whilst there are many discussion points, two of Beth's common themes were real-life situations, and challenge. It is noted that engaging mathematics was considered 'fun' sometimes but not always. An issue with 'fun' is that it could overshadow cognitive engagement as children may not always be learning and being challenged when they are having fun. A contrast with Amy is that Beth appears to have a 'bigger picture' for mathematics. Could this be linked to a conceptual understanding of mathematics where understanding and purpose are more important than the 'right answers'? It is noted that Beth is making very good progress in mathematics.

General discussions

Two boys were also observed during the lesson and showed high levels of behavioural, emotional and cognitive engagement. Although it is unfruitful to discuss their levels of engagement, as they were both engaged, their comments on what

engaged them are useful to support the comments from the two girls discussed above.

Carl suggested that he enjoyed mathematics because he 'gets to work things out'. He linked this to mathematics being 'like a problem' and mentioned a maze task that Beth also commented on. This consisted of calculating the correct fraction to exit a maze. This could, again, be linked to real-life situations as this context was related more closely to real-life than just answering abstract questions about fractions would have been. Carl also suggested that, although he found it fun to work things out himself, he enjoyed working with others for support and to give support. This was evident in the observation when Carl and a peer became stuck on a question as a consequence of a misconception. However, Carl was able to correct this misconception and aid his peers as well (there is a danger in group work that misconceptions as well as correct answers could become adopted by the group). Carl also discussed resources as being useful for helping him during class. He mentioned small white boards as aiding his thinking process, yet the comment that it could be 'fun to play and eat fruit' shows that resources might also be a distraction to learning: 'Fun to play' seemed more important to him than 'fun to learn'. Finally, Carl mentioned that the teacher helps him to think by questioning him during class. This is an interesting point to raise as questioning seemed somewhat to restrict Amy from thinking for herself.

Dan suggested that it was 'fun to work in a group' and to help each other 'get the correct answer'. Whilst this supports the requirement of social interaction that Carl also sought, it is interesting to note that Dan worked with Amy and another peer during the fruit salad task. Therefore, his suggestion that working in a group is 'fun' may have overshadowed his need to help Amy during the task. Had his engagement come at the expense of another child's? Other interesting points raised by Dan were that he enjoyed learning 'different methods' because this process made him think; and that he enjoyed 'hard' questions because they challenged him to link several methods together. This showed his need, like Beth, to link methods together as opposed to finding the correct answer. Dan needed to understand the process. However, Dan mentioned that a challenge that was too difficult would frustrate him and he would no longer enjoy the work (resulting in lowered emotional engagement).

Recommendations

The first point of interest that arose was with regards to the interaction between behavioural and cognitive engagement. Although one may assume that a cognitively engaged child would display signs of behavioural engagement, this did not always appear to follow. In Amy's case, it could be seen that her initial behavioural engagement did not appear to be consistent with her cognitive engagement. In Beth's case, it can be seen that her initial signs of behavioural disengagement did not appear to affect her ability to become cognitively engaged. However, it was seen in both cases that cognitive engagement later affected behavioural engagement. Amy started to show signs of behavioural disengagement and Beth started to show more signs of behavioural engagement. From this, it is suggested that strategies such as a 'no hands up policy' may appear to be effective in keeping all children 'thinking' and on task as all children could potentially be asked a question at any point during the lesson. They would not be able to disengage cognitively whilst

others considered the teacher's questions. However, I would recommend that children are not simply expected to answer a question but that they are asked to explain and justify their answers, to promote the need for understanding.

There were several considerations that the children raised as to how their engagement in the mathematics classroom might be increased. The first consideration pertains to inside the classroom but it is not considered core by the literature; it is the way in which resources are utilised. It can be seen that resources can be a useful tool for engaging children. Carl suggested that whiteboards aided his thinking (cognitive engagement), and there were many mentions of resources making lessons more fun (emotional engagement). However, it was also observed that resources can distract children from being engaged. In the case of the whiteboards, Beth was distracted by the whiteboard and she exhibited lower levels of behavioural engagement. Carl mentioned that it was 'fun to play and eat fruit' which could indicate a distraction from learning (cognitive engagement). The first recommendation is, therefore, to ensure that resources are used to engage children but care should be taken to ensure that they do not become a distraction to learning. One suggestion is for a teacher to make explicit to the children the reasons for the resources being used and their purpose in learning.

The possibility of opting to disengage raised an important question in my own mind: the problem of disengagement itself. If a child chooses to disengage with mathematics, to what extent are the strategies mentioned above or suggested in the literature going to solve this problem, or might they merely mask it? It can be seen that two of the children who were engaged cognitively with mathematics (Dan and Beth) both mentioned a requirement for understanding and working with different methods. Yet, Amy, who seemed the least cognitively engaged, appeared to focus on a procedural approach for finding the 'right answers'. She did not persevere to work out the correct answer but simply looked for the quickest way to achieve it – copying from a peer. However, Beth sought the correct method even though she could not calculate fractions at first. It is therefore suggested that developing an underlying understanding of the purpose of mathematics may be the answer to increasing student's cognitive engagement.

This idea is closely linked with the children's views. The most prevalent way to engage the children, as they mentioned, was the use of real-life situations (a core issue - the task). Firstly, it could be seen that there was a possible link to personal interests as both of the tasks Beth mentioned related to money and shopping, and the task mentioned by Carl and Dan was the maze. Although this is beyond the scope of the study, this may be of interest for future research into emotional engagement and its impact upon cognitive and behavioural engagement. Secondly, it was interesting to note that those who were seemingly cognitively engaged and searching for understanding placed a greater emphasis on real-life situations. In a real-life situation, children are asked to apply their mathematical knowledge to a situation beyond the 'separate mathematical world' and therefore a purpose is given to mathematics. Does this then lead to children having a better understanding of the purpose of mathematics? It is difficult to suggest an answer to this. However, it can be seen that as teachers we may be asking and aiding children to produce correct answers in mathematics; we may even have strategies to engage them and discuss with them how they calculated methods, but are we asking the children, and most

importantly ourselves as educators, why are we doing this and what is its purpose? It appears the children are!

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