Prioritising the Voice of Researched: Using Photographs to Elicit Mathematical Thinking of Participants

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Seeking to represent the views of participants, as opposed to those the researcher, can require the latter to suspend their views. To achieve this in a way that prioritises the researched over the researcher, the method of stimulated recall can offer potential. This paper discusses the method used for collecting young people's ways of working *in situ* across a number of workplace settings.

Coming to understand how participants think mathematically requires the researcher to suspend his/her judgements on how it may be possible to mathematise a situation and to prioritise the perspective of the participant/s. Much of the work in situated learning (e.g. (Masingila, 1993) has sought to identify the practices from the perspective of the participants which is in contrast to the literature on ethnomathematics where the purpose has been to uncover or identify the ways in which mathematics has been embedded or hidden (Gerdes, 1986) in particular social and cultural activities. However, in both cases, the research methods and theoretical tools employed by the research paradigms have sought to identify mathematical activities within particular frameworks. Skovsmose (1994) has argued strongly that the formatting power of mathematics works to coerce the interpretation of activities within particular mathematical frameworks whereas this may not the case from the perspective of the participants. As part of a large research project which sought to identify the numeracy practices of young workers, a method was needed which allowed the research team to understand the practices from the perspective of the participants. To this end, stimulated recall was used to identify how young people undertook and understood their work practices and how, if at all, these work practices used mathematical concepts and processes. This paper discusses the method, its advantages and its limitations.

Stimulated Recall as a Method

Stimulated recall has been widely used in areas such as education, nursing and counseling. Within education, it has been used to explore teacher knowledge (Meijer, Zanting & Verloop, 2002; Zanting, Verloop & Vermunt, 2001) and in students' problem solving process (Artzt & Armour-Thomas, 1997). It is an introspective process where it most often involves the display of video passages and requires the participant to elicit their thinking. Photographs similarly have been used to stimulate recall (Carlsson, 2001; Walker & Weidel, 1985) with considerable success. In most cases, the participant is shown visual images and asked to think aloud according to some predetermined foci. Often this focus is in relation to metacognition so that the researcher is able to gain insights into the thinking processes of the participant which would not be otherwise accessible. The tool has been effective in eliciting such responses from participants. In mathematics classrooms, the tool has been useful in identifying the metacognitive processes in problem solving (Artzt & Armour-Thomas, 1997). Similarly, in teacher education where often the tacit knowledge of teachers is unarticulated by teachers, stimulated recall prompts teachers into articulating the thoughts behind their actions (Meijer et al., 2002).

Different approaches have been used by researchers when using stimulated recall. In designing their research, Artzt and Armor-Thomas (1997) coded their data and then set the video to particular points upon which the students then discussed their actions and thoughts. Similarly, the researcher may cue the video to particular moments and ask the participant to talk about these sections of the tape. In other cases, the researchers use a time sampling method where incidents are cued at regular intervals. The design of these methods has been to create a shorter viewing time while preserving particular elements. In the latter case, the random selection of snippets based on time eliminates particular biases of the researcher. In contrast, the pre-selection of snippets by the researcher predetermines what the researcher is looking for and potentially excludes other data that may yield significant finding unintended by the researcher.

In their use of stimulated recall, Dunkin, Welch, Merrit, Phillips and Craven (1998) adopted an approach where the researchers looked at the video, developed questions which were then posed to the teacher as he/she observed the video with the researchers. They reported that the questions posed may have been influential in eliciting particular categories of responses from their participants, thus confirming the problems when data is prefigured in some way or another when using stimulated recall.

Lyle (Lyle, 2003) supports the use of stimulated recall but has been somewhat critical of these approaches since he argues that selecting some snippets, or in the case of Dunkin et al, (1998) where questions were posed, the approaches can be seen to preempt the expectation of the researcher. Furthermore, Tjeersdma (Tjeersdma, 1997) has criticized the use of video data in that the comments of participants to viewing themselves on video may be a reflection of their reaction to the video rather than the extracts themselves.

Overall, those researchers who have used stimulated recall reported that the data that was collected was rich in that the visual stimulus prompted participants to provide insights into their thinking and actions that would not have been possible in the more traditional data collection methods – observation and/or interview. As others have also recognized, the method is not without limitations.

Using Photographs for Stimulated Recall

There is very little research on the use of photographs for stimulated recall. Indeed, the searches of literature for photographs for stimulated recall yielded no hits. That is not to say that there are none, but that our search could not find them. It is suggested that this dearth in the literature is perhaps due to the ease of video collection over photographic. In the recent past, the superiority of the video camera has perhaps given it precedence over the still camera. However, with the development of digital cameras, there is considerable potential for this new technology to be used within field work. This technology allows the researcher to photograph many incidents in the arena of study and to use these as the stimulus for interviews through the playback mode (as opposed to expensive development of photographs). The viewing mode possible with digital cameras means that the researcher is able to ensure that the photographs that are taken are of a high quality and capture the events clearly. Many photographs can be taken and there is no delay in producing photographs for interviews.

The advantage of the digital camera was noted across a number of areas. In the first instance, time was an important consideration. Gaining access to workplaces was difficult, in part, due to concerns of employers that the research would take the employee away from his/her tasks and hence reduce productivity. The approach taken within the research was that of non-participant observer where the researcher would observe the worker at work and not intervene in the work process. While nineteen case studies were conducted, there were considerably more sites contacted but who would not permit access. In most cases they did not want their employees taken off the job. As one employer responded "*This is a very important project but we will not be able to participate as our staff are expected to earn their pay. We would however be very interested in the results*." As such, the time imperative was critical to the project so the use of video data would have generated too much interview time. This could have been reduced if an approach were adopted that coded or cued extracts. However, the project did not want to pre-empt categories. Using a video camera over a period of three days would have generated too much data and been too intrusive. In some cases, it would not have been possible due to safety reasons – such as climbing on house frames where the researcher needed to ensure balance on the beams making operating a video camera dangerous. With these constraints, the digital camera offered the flexibility to move around the workplace, capture the participants in their various tasks in their work, and to allow for all photographs to be included in the final interview which had to be contained in time.

Data Collection Using Stimulated Recall

Prior to commencing the field work in any site, the researcher conducted a brief interview with each participant to gain a sense of their mathematical backgrounds, the nature of the work, and the participant's perceptions about the ways in which mathematics was used (or not) in their work. At this stage, ethical clearance was also sought from each participant. The researcher would then workshadow the person for at least three days, or parts of those days, depending on the nature of the work. During this time, she took photographs of the person working. The photographs allowed the researcher to follow the person as they undertook their daily work but without intruding on their work. This was essential as it had been very difficult to negotiate access to work sites in fear that the project would hinder staff productivity. The photographs were used as catalysts for the final interview in which the stimulus picture would allow the participant to talk about their work in more detail. Following the day of field work, field notes would be made of the day's observation so that clarification could be made during the final interview should issues have arisen or contradictions between the observer and participant arose.

The final interviews took up to one hour in which the researcher would display each photo (in chronological order) and ask the participant to talk about what they were doing and if they were using any mathematics while doing the task. In some cases, prompts were offered to clarify how the participant was undertaking his/her work. As the project had been identified as exploring numeracy work practices, most of the participants readily commented on their thinking and whether or not it was mathematical in orientation.

The interviews were tape-recorded and transcribed. The text is then placed with each photograph so that it becomes possible to identify the nature of the work being undertaken in the fields observed and the participant's ways of working mathematically (or not). In some occupations, there was considerable variety in the work undertaken (such as boat builders) whereas in other occupations (such as bricklayers, painters, sales assistants and receptionists) there was very little variety. The researcher would take photographs of all work undertaken, ensuring that any new work/tasks were captured. In some industries, such as building, this required the researcher to assume similar positions (climbing on to roofs) to capture the 'essence' of the work being undertaken. In other sites where workplace health and safety regulations (machine shop) were very tight, the researcher had to assume a position on the sidelines and take photographs from these positions.

The value of this methodology was in the depth of data collected. When the original descriptions of the jobs were compared with the stimulated recall data, there is a much richer data source. Furthermore, the method allowed the data to be the voice of the participants rather than an interpretation, potentially framed by the lens of the researcher, of the observations. In the following section the case of boatbuilding will be used to demonstrate the richness of the data that can be collected through stimulated recall.

The Case of a Boatbuilder

The industry observed was a large employer (nearly 1000 staff) in the luxury boat industry. The company had a very strong ethos of staff development and recruited its apprentices predominantly through school-based traineeships. Staff were employed across a number of occupations including engineers, mechanics, finishers, upholstery, electicians and boat building. In this example, I draw on the interview data from Tony[1]. In the original interview, when asked to describe what he does, the 3rd year apprentice offered the following description:

> Tony: Generally, I’ve been here for three and a half years now, so I know pretty much most of it. Apprentices get rotated through different sections, so for the last 12 months I’ve been in Fitout 2, which is all your bulkheads, all your gloss bulkheads, putting them up, your lounges, making lounges, measuring and cutting, things like that.

When asked about what mathematics he uses in his work, Tony’s response was:

> Tony: A little bit. Basically just subtraction, adding, multiplication, division sometimes too. Just basic maths really.

As the researcher was not familiar with any of the worksites or the nature of the work being undertaken, questions were used to clarify responses. In Tony’s case, he was keen to share his knowledge and understandings, but this was not the case with all of the participants. In some cases, probing did not elicit further clarification. I will return to this issue later in the paper as it raises a limitation to the research tool.

In the following examples, the power of the tool becomes evident in that it encouraged Tony to articulate what he was doing and how he went about the work – from his perspective. Unlike other studies of workplace numeracy cited earlier in this paper where there is a risk of interpretation from the researcher’s perspective, the use of stimulated recall has allowed the research to identify the ways of working from the perspectives of the participants.

In each case, the researcher would ask the participant to talk about what they were doing and how they think about the work as they go about the task. This text aligns with each photograph. Where the participant did not articulate their thinking or there was a need for further clarification, interaction between the researcher and participant sought such information.

In the case cited here, approximately 50 photographs were taken over the three days. In part, this was due to the variety of work undertaken by the participant. He was a third year apprentice and was working in an area which, as Tony noted in the initial interview (see earlier transcript extract) involved considerable variety in the fitting-out process.

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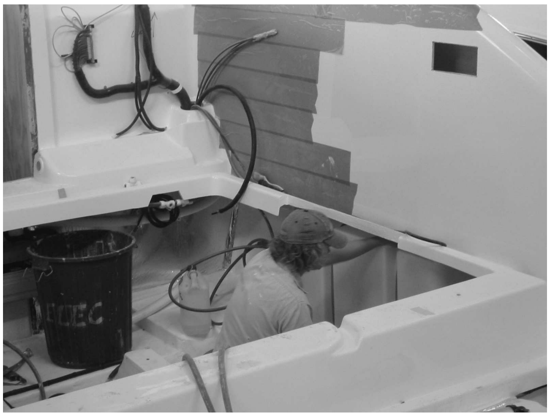
[1] Pseudonyms are used for the participants



Tony: Fitting water tanks. There's no mathematics about fitting the water tanks. What I was doing there was lining up the steel bar that straps around the water tank. All you got to do is make sure it's in the middle of the two straps that are on the water tank.

R: How do you do that?

Tony: By eye

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Figure 1. Fitting tanks.

In Figure 1 Tony was estimating where to place the straps that would hold the water tanks in place. The comments he offered indicate the process he goes through as he undertakes the work. His comment that there was "no mathematics about fitting the water tanks suggested that he has a particular view about what is mathematics.

As part of the boatbuilding process, the apprentice mixes a two-part mix which is used to join items or to fix holes (see Fig 2). The darker colour is a catalyst which reacts with the other component to make it harden. The product lists that the mix should be 1.% to 2% catalyst to the main mix but as the comments from Tony indicate, they do not undertake this calculation. Rather, the process that he uses is determined by the context of the work. He is talking about the weather conditions as being an important consideration – if the temperature is high, then the mix will harden quicker and be unworkable so on hot days less is added. Later he refers to the amount of mixture to be used. If the quantity is large, then less is added so that the mixture will remain malleable for longer periods – an important consideration when working with a big quantity. The photograph provided the stimulus for him to articulate how he estimates the quantity to be added, the considerations

Figure 2. Estimating a 2-part mixture.

Tony: That was bog for the dash.

R: How do you determine what the mixture is, how much you would put it?

Tony: Depends on the time really, like if you want a hot brew, the darker the better. But if you got to work with it, if you need time, you just put a little bit in. You're supposed to measure up with scales and all that, but we don't have any scales.

R: So you just guess?

Tony: Well, yeah, say we've got a pile like that (gestures large pile) and we want it to go off really slow, we just put a little line about that much (small line) hardener in it.

he makes, and how he judges the right mixture which is done by colour rather than formal measurement.

Tony: We measure with everything. Like say, two finger gap there, same on that side, that's what I was using my pencil for as well trying to line up gaps like that.

R: Fingers and pencils and all that sort of stuff.

Tony: Yeah, well we don't always use a tape measure.

Figure 3. Using informal units of measure.

In Figure 3, Tony was placing a catch on a door. The photograph shows him using his fingers to measure the length of the item. In an earlier photograph, he had used his pencil to measure the gap between a door and wall to ensure that there was an even gap at the top and bottom of the door so that when hung, "it would like right".

Throughout the study, it also became very apparent, that informal and intuitive methods of working were common. In the Figure 3, Tony was measuring using his fingers but also explained that he often used other informal tools for measuring. From this photograph, Tony was able to articulate how measurement was undertaken. In a subsequent photograph where he was measuring with pencils, he commented that this was an easy way to measure things. Collectively, the photographs built a rich picture of how measurement was undertaken in the trade. There were photographs of Tony using a tape measure in some situations.

What is central to this method is the collection of the broad range of activities – some of which will be mathematically orientated, others not. The researcher needs to suspend his/her assumptions (as best as possible) as to what activities are being undertaken. The use of the digital camera enabled the researcher to take many snapshots of the various tasks undertaken across the time of the fieldwork for each case study. In some cases, the work was very repetitious and there was little opportunity for variety in the participants' work. This was the case with the retail assistant, chef and receptionist. Each day was very much the same as the previous days. In these cases, there was little opportunity for the depth of study that was possible with the boatbuilders (as well as builders, motor mechanic, or lab technician) where each day contained different tasks from the previous ones. In the latter cases, there were many photographs from each site, whereas with the restricted occupations, there were considerably less stimulus pictures.

Richness in the Data Collected

In considering the original comments offered by Tony in the preliminary interview, there was little depth to the description of his work or the numeracy practices of that work. As the few examples used in this paper indicate, the responses offered by Tony when shown the photographs offered a much richer data base to his workplace numeracy practices. This outcome was repeated across all worksites to greater or lesser degrees depending on a number of factors including the nature of the work and the participant's reaction to being involved in the project.

Limitations of the Method

While the overall success of the tool is apparent from the data illustrated, there were a small number of participants/worksites where the method has limited success. In those cases where the job was very repetitious (such as the chef, receptionist and sales assistant), there were few opportunities for photographs and by implication, limited opportunity to explore the nature of work and the mathematics of the workplace. Despite this limitation, the method still yielded more detailed accounts of the workplace than the initial interview.

A second issue emerged in some sites where the participant was either shy or not as willing to cooperate. In these (limited) cases, the participant would only offer limited comments in the final interview. This creates a dilemma for the researcher in walking a fine line between pushing the participant beyond their comfort zone (and perhaps flawing the data), or to leave the responses in their limited form. For this study, I opted to have the shorter version of the data since it was seen to verge on ethical issues to push the participant into responding.

Perhaps the most difficult aspect of the project has been to suspend judgment on young people's approaches to their work and not judge them as inferior or less valid. The young people have been very successful in their work and such success suggested that their ways of working mathematically, while different from those anticipated by a formally-trained educator, may be most suitable for their context of work. The challenge that this finding poses to mathematics educators can be quite challenging and confronting since it challenges many of the beliefs that underpin much of school mathematics.

While every attempt was made to capture the variety of activities undertaken by the participants, it was assumed that this was achieved with a high degree of success within the time frame allocated to each case study (i.e. three days). While there may have been other activities that constituted the usual work practices of the young people, it is not possible to gauge whether or not the project was successful in capturing the range of numeracy practices across a given site. In order to address this potential gap in the fieldwork, the final interview question asked participants if there were any other aspects of their work that had not been captured through this means.

Conclusion

The use of stimulated recall provided the researchers with considerable data as to how young people go about their work, the work that they undertake as part of their daily routines, and the ways in which they use (or not) mathematics. It was not the purpose of this paper to discuss the mathematical thinking of the young participants. What has been central to the paper is a tool for eliciting the ways in which young people undertake their work and how they use (or do not use) mathematics to solve their problems. The value of stimulated recall in eliciting participants explanations of their work practices and the numeracy within those practices has been very high. Not only in the quantity of responses but the access to how young people undertook the numeracy aspects of their work has been very productive.

Since the purpose of the study was to investigate how young people undertook their work, the use of stimulated recall has allowed accounts of the workplaces studied to be developed. The accounts offered are the interpretations and actions of the participants. Unlike some other methods where there is potentiality for the researcher to search for school mathematics in particular practices, this project needed to identify the ways in which young people undertook the tasks. As such, stimulated recall has been most successful in eliciting this knowledge. In many of the photographs, there is a potentiality for a mathematical lens to be applied to the task and for the researcher or teacher to argue that the participants are doing/using/thinking mathematically. Interestingly, the outcomes of the project are suggesting that for young people, key strategies for working mathematically involve estimation and problem solving over the basic skills (arithmetic, four operations) identified as core skills by older participants (Zevenbergen, 2004). These data suggest that there may well be different forms of numeracy being used by young people in the workplace that needs to be documented in greater depth and across more sites. This method of stimulated recall seems to offer considerable potential – pragmatically, theoretically, mathematics and methodologically – to understand the issues of workplace numeracy.

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