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A View through a Different Lens: Elicitng Pupils' Conception of a Good Mathematics Lesson Using Photovoice

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Abstract: *The purpose of this paper is to share our experience in using photovoice to explore what is a good mathematics lesson as conceived by the primary pupils. Photovoice is a participatory method of research that can be used as a reflection technique among children who developmentally are less inclined to engage in language-based data gathering methods.In the study, six 11-year old pupils were chosen to participate. The objective of the study was to gauge the effectiveness of photovoice as an alternative method to capture reflection. Pupils were asked to take photographs with digital camera the most effective moment in their mathematics lesson. Photo-elicited individual interviews were conducted. On the methodology perspective, result of the study shows that photovoice does enhance learner's critical reflection. However, the interpretation of photovoice data faces some validating issues such as personal judgment and multiple interpretations. We believe that by employing triangulation of different data sources may help to solve the problems. The analysis of the case study data using photovoice showed that primary pupils valued "concrete examples", "drill and practice", and "board work" as characteristics of a good mathematics lesson. This study supported photovoice as another viable approach for researchers to capture and elicit pupils' voice. In particular, the marginalized groups can be led to reveal their own perspectives on what they learned about a good lesson in mathematics.*

Keywords: photovoice, participatory approach, primary pupils, effective mathematics lessons

Introduction

Attempts to capture children's thoughts in verbal or written text are often challenging. This is because most children are developmentally less inclined to engage in language-based data gathering methods (Garcia, 2010). Scheer (2017) believes that voice conveys a reality where

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other methods cannot and that voice adds strength and validity in research. She added that children's perspectives become available once we allowed them to speak.

Much of the early research on the effectiveness of mathematics lessons focused on teachers' beliefs about mathematics, mathematics learning and teachers' instructional practices (Beswick, 2007; Leder, Pehkonen, & Törner, 2002). The study reported in this paper focuses particularly on how pupils view effective teaching of mathematics. One of the unique features of the study is it relied on the views of pupils as the primary sources of data for each mathematics lesson. Hence, pupils' voices are sought based on their reflection on the past classroom episodes. In the search for a valid method to elicit the silent voice in children, researchers (Scheer, 2017; Wang & Burris, 1997) showed that photovoice, a participatory research methodology that uses photographic technique to enable participants to identify, represent and enhance their community is one promising tool to facilitate the release of children's voice.

Past studies (e.g. Walker, 1993; Young & Barrett, 2001; Taylor & Dirkx, 2002) have shown that photovoice can be used for all types of participants regardless of their age, socio-economy or literacy level because it does not require the ability to read and write. The participants will only need to learn to use a camera to capture the relevant scenes or situations. This method does not add any extra cognitive-load since most cameras today are simple to use by just clicking the button to shoot a photograph.

Objective of the Study

With respect to learning studies, researchers have argued that mixed methods research has gain popularity over quantitative approaches in term of reliability (Archibald, Radil, Zhang, & Hanson, 2015). It was also observed that there is an overuse of language-based method and underuse of visual methods within social sciences and education research (Ciolan & Manasia,

2017). Following this line of thought, this study aimed to set the methodological ground for applying visual method such as photovoice to study primary pupils' conception of a good mathematics lesson. The objectives of the study were: (1) to describe the procedures in using photovoice as a qualitative data collection tool; (2) to highlight the limitation and reliability of the tool; and (3) to showcase the findings of a case study alongside data analysis strategies.

Research into Identifying Effective Mathematics Lesson

In the research of the roles of mathematics teacher, Chapman (2017) asserts that elementary teachers of mathematics are instrumental to students' development of effective learning. Likewise Protheroe (2007) believes that effective instruction begins with effective teaching. The terms 'effective lesson' and 'effective teaching' have been used interchangeably to study the characteristics of a good lesson in much of the research literature. The definition of the term "effectiveness" in teaching is broad and covers teacher behaviours, classroom practices, learning outcomes and other factors such as external and internal teaching context, and individual student characteristics beyond classroom processes (Ko, Sammons, & Bakkum, 2015). A search in literature shows that studies in effective teaching focus on teachers' believes of good teaching (e.g. Cai, Kaiser, Perry & Wong, 2009). Fewer studies transcend teachers' perspectives to recognize the importance of students' voice in ways that will provide a meaningful basis of students' conception of what makes a good mathematics lesson. Tapping into 'students' voice' by interviewing students, Kaur (2009; 2010) studied student perspective of effective mathematics pedagogy as part of the Learner's Perspective Study [LPS] (Clarke, Keithel & Shimizu, 2006). She found that good mathematics teaching in grade 8 comprised of whole-class demonstration (exposition), seatwork and, review and feedback. Meanwhile, Tan and Lim's (2010) study of 11-year-old pupils found that these pupils valued "concrete examples", "learning through mistake",

"board work" and "shortcut and tips" as elements contributing to an effective mathematics lesson.

What is Photovoice?

Wang and Burris (1994, 1997) introduce photovoice as an educational tool to record and to reflect people's needs, promote dialogue, encourage action, and inform policy through photographic documentation of their everyday lives. In this method participants use cameras to take photographs of persons, contexts, or situations they consider representative of a given prompt. Photovoice is a qualitative participatory action research method which is also known as photo novella. It is grounded in three theoretical frameworks, namely, empowerment education which stresses on individual-community dyad, feminist theory which acknowledges in women's role in gender relations, and documentary photography which empowers marginalized participants to capture photographs for critical dialogue and discussion (Wang & Burris, 1994).

In this study, the pupil participants were given the role of documentary photographers who make use of the visual image to reflect on the mathematics lesson in which they were a part of. The process is geared towards empowering participants to determine what constitute a good teaching lesson. The intention is parallel to Taylor and Dirkx's (2002) claim that photographs provided a frame for language and act as a catalyst to extend and enhance the interpretation of what the participants believed about the topic under study. The photographs are coded by the researchers into different themes based on participants' reflection. This is necessary as images that belong to a particular theme will share a specific set of meaningful objects and features (Rose, 2007).

Photovoice in Education and Learning Research

Currently the visual participatory research method is becoming increasingly popular due to its accuracy in gathering data (Graziano, 2004, cited in Ciolan & Manasia, 2017). Evidences have shown that the use of photovoice has been extended from health science (Wang & Burris, 1994) to other discipline such as education. For examples, Hall and Bowen (2015) used photovoice to explore university students' perspectives on themselves and others acknowledge that photovoice is an effective method for critical reflection. Werremeyer, Skoy, and Kelly (2016) found that photovoice is an effective method for the exploration of learning in which students capture their own learning way beyond the expectation of their instructors. Besides educational enhancement, photovoice is also been used as pedagogical tool in classroom (Hernandez, Shabazian, & McGrath, 2014) or as evaluation tool for student learning (Behrendt & Machtmes, 2016) in experiential settings.

Chew (2012) found that in general most primary pupils in Malaysia are limited in language competency, especially in using appropriate language to describe in writings. Likewise, researchers that engage verbal interview may encounter some challenges. According to Epstein, Stevens, McKeever and Baruchel (2006) verbal interview which relies on linguistic communication is outside of children's everyday sociolinguistic repertoire. Consequently, verbal language poses a limit on the issues and questions that the researcher can explore. They advocate the use of photographs during verbal interview with children to help to address the above problems. In view of the strength of photovoice in overcoming pupils' language incompetency, vocabulary and expressive ability (Lim, 2015), we chose photovoice as a research method in this study and use digital camera as a visualising tool to elicit pupils' voice of a good mathematics lesson. We adopted Ko's (2010, cited in Ko, et al., 2015, p.13) operative definition of

"effectiveness" as "the effectiveness of observable behaviours seen during classroom observation of a typical lesson".

Methodology

We engaged photovoice to explore students' perspectives about a good mathematics lesson. The participants were given a digital camera each and were assigned to take photographs that capture aspects of their salient thoughts. In the research procedure, we modeled Wang and Burris's (1994, cited in Ciolan & Manasia, 2017, p.4) framework that progresses in five sequential steps: (1) select the research problem, (2) recruit photovoice participants, (3) photovoice group meeting, (4) collect data, and (5) analyze data.

Selecting the Research Problem: The Observed Lesson

The discussion in this paper is based on one of the three observed lessons taught by one of the teachers. The selected topic is about the "Multiplication of a 5-digits number with a 1-digit number". The pedagogical flow of the lesson started with the teacher Ms C randomly picked a few pupils to test their recall of the multiplication table. She then revised the concept of multiplication by using boxes of white chalk as manipulative to elucidate the abstract concept. Next, she distributed randomly some pieces of paper with questions on the multiplication of 4-digit number with 1-digit number to several pupils. These pupils were asked to solve the problems on the blackboard. After that she began to deliver the topic of the day. Before ending the lesson she distributed again pieces of papers printed with different questions on multiplication of 5-digits number with 1-digit number to a different set of pupils and asked them to solve the question on the blackboard. She then concluded the lesson with a summary of the lesson and gave some exercises as homework.

The research problem of this study was about teaching the concept of multiplication with added level of difficulty from the previous 4-digit number to 5-digit number with 1-digit number. The lesson taught was a trivial archetypal form of teaching multiplication in primary mathematics. Nevertheless how pupils perceive visually the effectiveness of this particular lesson was novel and relatively new to most researchers.

Recruiting Photovoice Participants

The population of this study included six primary mathematics schools with a total of six teachers and thirty six 11 year-old pupils. The teacher participants taught mathematics at different grade levels in different schools. Each teacher was asked to select six pupils from one of his/her mathematics classes, with two pupils each from high, medium and low academic ability respectively. This is required to find out if diverse ability pupils might view an effective lesson differently. The 36 recruited pupils assumed the role of co-researchers. They took up the responsibility of taking photographs that eventually become the data for analyses and discussions (Ciolan & Manasia, 2017).

Photovoice Group Meeting

We the researchers cum facilitators held a preliminary meeting with the selected pupils to ensure that they understand their role in the assigned duty. We briefed the participants the aim of the project. This was followed by presenting them the prompt that guided them in photograph taking. We trained the participants to use the digital autofocus camera that we distributed to them. The photographers were told to avoid always putting their teacher or close up faces in the centre of every photographs. The cameras were returned to the facilitators immediately after the training session.

In this meeting, we posed an analogy question "When you have stomach pain, the doctor gave you a kind of medicine. You ate the medicine and there was no more pain. So you said the medicine is effective. What kind of teaching you would like to have or think is important for it to be effective?" to elucidate the abstract meaning of "effective lesson". Participants were prompted to take photographs of object or people, and situations that capture the moment of effective lesson.

Data Collection

In this study, qualitative data were collected through photo-elicited focus group interviews with pupils and in-depth interviews with teachers. The observed lesson was taken from one of Ms C's lesson. Briefly, the procedures for data collection are as follows:

Video recording of classroom teaching. Two video cameras were used to record the classroom teaching. One was focused on the teacher while the other was focused on the pupils. The lesson observed in this study was prepared by Ms C on multiplication of 5-digit number with 1-digit number. The duration of the lesson was one hour.

Photovoice. During the lesson observation, we gave each pupil participant a digital camera to capture moment that they think Ms C was teaching effectively. They are free to take any number of photographs as they like. After the lesson observation, we asked the six pupils to elaborate their views based on the photographs that they have taken. The aim of this focus group pupil interview was to explore what were the characteristics that the pupils valued as effective in this particular mathematics lesson. The focus group pupil interview was video-recorded for analysis purposes.

In the facilitated photo-eliciting interview with the pupil participants, we followed Hoole and Hannum's (2008) model to extract the visual data in five basic steps and engaged SHOWeD

method of questioning (Ciolan & Manasia, 2017; de Heer et al., 2008 as cited in Agarwal, Moya, Yasui, & Seymour, 2015; Wang & Burris, 1999).

1. Frame- Provide a guiding question(s) to frame the participants' selection of an image.
    - What do you See in this photo?
    - What can teachers Do to teach a good mathematics lesson?

2. Browse- Let participants browse the images until they find one that speaks to them in response to the question.

3. Reflect- Each person examines the images he or she has selected, and reflects on how the image connects in any ways to the framing question.

4. Share- The group (or sub-groups) sits in a circle. One person at a time shares his or her image(s).

5. Extend- Let participants select additional images to represent the next questions- or just focus the follow-up discussion on the additional questions.

Limitations and reliability issues. In the process of conducting the study, several limitations and some reliability and ethical issues regarding the photovoice methodology were encountered. For example:

The optimum number of photographs to be taken. Initially we were contemplating whether we should restrict the number of photographs taken by the pupils. Our main worry was that too many photographs might take up too much time during interview. On the contrary, we realized that if we restrict the number of photographs taken, we might impose restriction to the children's freedom and add to their uncertainty of when to take the "right" photographs. Subsequently, we might lose some of the significant and meaningful moments. Eventually results of our study showed that without imposing any restrictions, we managed to get a maximum of 14

and a minimum of three photographs taken by the pupils within the one hour mathematics lesson. Thus our initial worry was unfounded and we were more certain that we will not restrict the number of photographs taken in the future.

Preventing loss of important information. In the event of depending solely on the visual data capture by the pupil participants, we were ready to face with the issue that participants may miss their chance to capture certain meaningful scenes due to occasional moments of uncertainty or doubts. To overcome this problem, we make sure that Step 5 "Extending" is included in the data collection procedure. Prompting question such as "Why you did not snap this scene when the others did?" is believed to be able to help to recapture those lost moments by the participants.

Extra workload. In addition, we were faced with some ethical issues such as asking participants to shoot photographs while following the lesson. Our question was "Are we adding extra work to these pupils?" We were especially concerned with the less able groups that such action might disturb them from paying full attention while they were learning the lesson. To our relief, in our pilot study all the participants responded that the assigned photo-shooting task did not affect their learning attention and they found it interesting to carry out the task.

Trustworthiness. Our next focus was to make sure that the verbal description of the contents given by the pupils based on the photographs was trustworthy. To achieve this, we conducted the photovoice interview immediately after the observed mathematics lesson to avoid any misinterpretations as a result of forgetting caused by time lapse. The participants were also gathered in a special room during the interview session in order to reduce any untoward distractions.

Consistency of results. The consistency of the results extracted and analyzed based on the photovoice was another debatable issue in this qualitative research. In this study, we managed to extract the common values espoused in the participants by having the pupils to take part in Step 4 "Reflecting, Elaborating and Sharing". The photographs that overlapped may speak the common interest and thus the common value or may convey different value. To overcome this problem, we suggest conducting further study with the same pupils and the same teacher in at least three different lessons at three different times to consolidate and crystallize the common values.

Stimulated Recall Focus Group Interview

After the three lesson observations, we gathered all the six teachers together from each class for a debriefing workshop. In this workshop, we used stimulated recall interview with video playback (Busse & Borromeo Ferri, 2003) to facilitate these teachers to recall and reflect their lessons. The playback was occasionally interrupted by the interviewer (researcher) to give the teachers an opportunity to express their thoughts about and make connection to the immediate scene. The teachers were asked to list the characteristics of mathematics lesson that they perceived as effective which was in turn used as a reference to thematically code the images of the photographs received from the participating pupils.

Data Analysis

This study employed participatory analysis to analyse the data. Participants assumed the role as co-researchers presenting visual images of the moment of effective lesson. We discussed the photographs using Wang and Burris' (1999, p. 188) three fundamental stages: (1) selecting photographs, (2) contextualizing or storytelling, and (3) codifying issues, themes, or theories during group discussion.

In carrying out the above stages each participant was asked to select photographs captured by them that showed best "effective lesson". They were then asked to tell a story how each of the selected photographs was related to effectiveness.

Results and Discussions

Data from the Participating Teachers

This study has taken steps to explore what the teacher participants defined "effective" was actually practiced in teaching their lessons and was also reflected in their interviews immediately after each lesson observation. A careful analysis of video recording and interview transcripts using NVivo software led us to five major themes (see Table 1).

Table 1

Themes Representing Espoused and Observed Classroom Practice among the Six Teachers

	Teacher					
Theme	Z	R	C	L	G	K
Board work	✓○	✓○	✓○	✓○	✓○	✓○
Use of real or concrete objects	✓○	✓○	✓○	✓○	✓○	✓○
Different approaches for different types of pupils		✓	✓		✓	✓
Drill and practice	✓○	✓○	✓○	✓○	✓○	✓○
Engaging with ICT or courseware	✓○	✓○		✓○	✓○	✓○

✓ = espoused in interview ○= observed in classroom teaching

Board work. Board work refers to asking pupils to come out in front of the class to show their working or solution on the blackboard. Board work was valued as effective because it serves a few purposes. First, as assessment, teacher can assess the extent the pupils have

achieved the teaching or learning objectives. This is particularly applicable to the academically weak pupils.

Using real or concrete objects. Concrete objects such as real oranges, sampled money, 3D blocks, chalks, etc. were valued by all teachers as a feature of effective mathematics lesson.

Drill and practice. Drill and practice are in the forms of individual exercises, group exercises, memorization of multiplication tables and home work.

Different approaches to different pupils. Teachers apply different approaches to teach different types of pupils. They differentiate their pupils in terms of academic ability and grade level in determining the type of teaching approaches, or the amount and difficulty level of questions given.

Data from the Participating Pupils

We managed to collect a number of photographs taken by the six pupil participants ranging from 3 to 14 from each pupil. From the data shown in Table 2, we found no correlation between the numbers of photograph with pupils' performing level.

Table 2

The Number of Photographs Taken and Selected by the Pupil Participants

Performing level	High		Average		Low	
Pupil	A1	A2	B1	B2	C1	C2
No. of photographs taken	7	13	8	3	14	3
No. of photographs selected by the pupils	6	10	6	3	9	3

Coding the photograph. With reference to the five themes of effective teaching solicited from the six participating teachers coupled with the result of the photo-eliciting interviews with the pupil participants, we found three common themes emerged in the pupils' photographs: "use

of concrete objects", "drill and practice", and "board work" in Ms C's lesson on multiplication of 5-digit number with 1-digit number.

Visual representation of effective teaching. Below are displays of three photographs captured by three pupils from three different ability groups.

Theme 1: Use of concrete objects

High achiever

Average achiever

Low achiever

The pupils valued their teacher using boxes of chalk to explain the concept of multiplication. Such visual evidence supports Grouws' (2004, cited in Protheroe, 2007) argument that the value of using manipulative materials to investigate a concept depends not only on whether manipulatives are used, but also on how they are used with the students.

Theme 2: Drill and practice

High achiever

Average achiever

Low achiever

Pupils valued their teacher highlighting their mistakes through step-by-step explanation or comparison of correct and wrong answers. This approach was valued by pupils as effective. Pupils described it as "learning through mistakes". This finding corresponds to

the Shanghai and Hong Kong pupils (Mok, 2006; 2009) and Singapore pupils (Kaur, 2009) who valued their teachers checking their work and giving immediate feedback.

Theme 3: Board work

High achiever

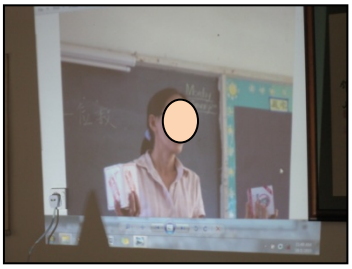
Average achiever

Low achiever

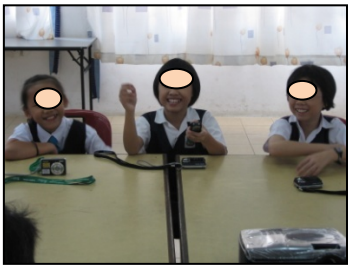
Board work is presenting the solutions or work in front of the classroom or on the blackboard. Pupils valued board work for they believed they could receive immediate response and correction from their teacher when they made mistakes during presentation. Further analysis of pupil interview showed that they valued board work as a platform for them to learn from each other. This might be achieved in possibly two ways. Firstly, weaker peers learned from the higher ability pupils when they showed their work on the blackboard at pupils' level of understanding. Secondly, when the weaker pupils were called out, the other pupils can learn from the mistakes they possibly made.

Reflecting, Elaborating and Sharing

Pupils sitting in a circle



Selected photo projected from the LCD



Reflecting, Elaborating and Sharing

All pupils sat around a round table and we projected the photographs selected one by one on the screen. For each photograph shown, the pupil who shot the photograph was asked to

reflect and elaborate on "what" and "why" that particular photograph was taken modelling SHOWeD method. Later, others in the group were asked whether they agreed or disagreed to the "moment of effectiveness" captured by their peers.

Extending

After we have discussed all the photographs, we continued to ask additional thought-provoking questions such as "Why you did not snap this scene when the others did?" or "Does the scene differ from the everyday practice in your class?" etc. These questions were aimed to seek additional information and feedback from the pupils.

Conclusion

This paper presents an alternative way to capture a good mathematics lesson conceptualized by primary pupils through the use of photovoice. It has discussed in detail the methodological procedures using data from a case study of Ms. C's teaching lesson. The procedure works well with Wang and Burris's five sequential steps: (1) select the research problem, (2) recruit photovoice participants, (3) photovoice group meeting, (4) collect data, and (5) analyze data. Moreover, Hoole and Hannum's (2008) five steps (Frame-Browse-Reflect-Share-Extend) has proven most helpful in extracting visual data from the photo-eliciting interview with the respondents.

Despite of the forte, some limitations in the data analysis were observed such as trustworthiness and consistency of the data. The interpretation of data also faces some validating issues such as personal judgment and multiple interpretations. We believe that using data triangulation may increase the credibility and validity of the data and hence strengthen the research. We noted that Step 2 "Describing" and Step 4 "Reflecting, Elaborating and Sharing" in

our procedure were very crucial. These steps allowed us to sieve, triangulate and double confirm the common values conceptualized visually by the pupils about a good mathematics lesson.

Result shows that photovoice did help to enhance learner's critical reflection. The presence of visual images is powerful enough and has indeed helped to encourage young pupils to recall and speak out their mind in details. Interestingly, using pupils' generated photographs to feature a conventional topic "Multiplication of a 5-digits number with a 1-digit number" has added unique window into a good mathematics lesson from the pupils' perspectives. In addition, we found that the competence to take meaningful photographs was not differentiated by individual variability in learning abilities. High, average and low achievers alike were capable of taking photographs that describe effective mathematics lesson without further assistance by the researchers. Photo-eliciting interviews from pupils of mixed abilities shared three common themes: "concrete examples", "drill and practice", and "board work". These three themes were valued highly by all groups as characteristics of a good mathematics lesson.

Despite that teaching a lesson on "multiplication" is a trivial thing, yet photovoice has enable us to capture unique and exclusive views from the lens of the 11-year old pupils. Pupils recalled and narrated creatively through their photographs, making connections between their teacher and the lesson, and providing interesting insights into their values of what constitutes a good mathematics lesson. We believe that qualitative data in visual form unleash greater levels of detail about a participants' rich experience than words-only data. Hence, we conclude that photovoice is a viable method that helps participants, especially young children to recall their experience much effective than the use of verbal interview alone.

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