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**The effect of visual and auditory aids on
the learning experiences of Foundation
Phase pupils (Reception to Year 2,
ages 4-7).**

ECAD7004: Researching the Learning

1902994

	<i>Target...</i>	<i>What have I done in this assignment...</i>
<i>Target 1</i>	Ensure that the colon and semi-colon are used correctly.	I have proofread my use of semi-colons and colons and used online resources to secure my understanding of their use.
<i>Target 2</i>	Find a balance between positive and negative reflections on my professional practice.	I have tried my best to look at my practice from different perspectives during the reflective section of the paper.

Introduction

As society and education venture forward, shifting between reforms (Bryk et al., 2015) and trialling innovative ideas, bugs in the system arise and it becomes a duty within the profession to try and solve them. During my time at my first partner school, the bug I noticed was the frequency of visual and auditory aids used in primary education. Aid implementation increased as I moved from Key Stage 2 to the Foundation Phase, and in my Foundation Phase placement, I observed that auditory and visual aids were used in every lesson, particularly mathematics. Aids, representations, manipulatives, and their variations are, of course, essential in bridging the gap between prior and new knowledge, especially for young learners, but with so many of these aids implemented, I was not certain how, or if, the students' learning experiences were affected by them. Thus, I was interested in learning about how the students experience these aids and the impact these aids have on their experiences during the lesson. This research has allowed me to further my understanding of these multimodal methods of enhancing a child's learning experiences and comprised of my and my team's employment of specific learning aids within a planned and delivered lesson, and the measurement of the students' engagement with these during their learning. Using this collated information, we proceeded to conduct post-lesson interviews with a small sample of students to discuss their reactions to the implemented aids, and made appropriate changes based on the students' observed experiences and opinions.

Context

As noted above, in my class, as well as many others, visual and auditory aids are common practice. In the Foundation Phase, working walls, pictorial representations and hands-on manipulatives are available to students to aid them with mathematics, and my mentor and I used repetitive number chants to help the students warm up at the beginning of their mathematics lessons. Furthermore, understanding the age of my students, it was imperative that my team and I explored a topic with which the students were familiar and to which they could provide feedback upon prompt. We discussed studying the students' responses to and experiences of visual and auditory

aids during a mathematics lesson and agreed that researching our question within a mathematics setting would produce interesting results and a fresh insight into how we may value students' input and opinions in our professional practice. For my class, a mixed ability class of Year 1 and 2, and the case classes – a mixed-ability Reception class and a second Reception class comprised of the year group's youngest students – this research meant understanding the supports appropriate for their ages and using them to create an enriching learning experience.

Literature

To gain further insight into the existing discussions surrounding this topic, research was conducted into the most appropriate literature. However, it became apparent that evidence surrounding the specific question was limited, and thus it became appropriate to examine and research the elements of the question as separate entities. This review concerns itself with theories underpinning visual and auditory learning, and representations in instruction, while also examining the available research surrounding visual and auditory aids.

Research published by Hayes (1999) suggests that for students to have engaging experiences, there should be opportunity for exploration and enjoyment in the learning is a necessity. Students' experiences may be enhanced through sensory stimulation, such as through one's visual and auditory senses. The terms 'visual' and 'auditory' are popularly associated with the concept of 'learning styles', an umbrella term that while having no one definition, comprises of a variety of modalities of learning within which students can be categorised according to their individual preference and effectiveness (Pashler et. al, 2008, 2009). Learning styles were popularised by an influx of publications in the 1970s and 1980s, such as Gardner's theory of Multiple Intelligences (1983) and Kolb's theory of Experiential Learning (1984). Of all learning style theories and models available, Fleming's neuro linguistic VAK/VARK model (1987, 1992) is the most common model used in modern educational practice (Bishka, 2010). This model suggested that learners could be categorised into three types of 'learning styles' (four in Fleming and Mills' revised model), these being visual, auditory, read-write (Fleming & Mills, 1992), and kinaesthetic.

Several researchers have attempted to define visual learning. On learning styles, Bricheno and Younger (2004, in Land, 2013) and Westby (2019) note that visual learners are speculated to learn best through visual images, such as graphs and diagrams; while Grigg (2010) elaborates several 'characteristics' of visual learners, such as enjoyment in reading. However, despite Dekker et al.'s (2012) assertion of the concept of learning styles as a "*neuromyth*", and widespread criticism of the model and the concept of learning styles (Pashler et al., 2008; Rohrer and Pashler, 2012), it is nonetheless a phenomenon in education and research. Though a growing body of studies have failed to validate the existence of such 'learning styles' in recent years (Coffield et al., 2004; Geake, 2008), in 2007, Estyn noted that schools should be prepared to accommodate students of visual, auditory and kinaesthetic learning styles across schools in Wales. While this paper aims not to explore or support the categorisation within the VAK/VARK model, but instead aims to understand how the use of visual and auditory aids within these models impact the learning experience.

One key model of visual learning was developed by Jerome Bruner in the 60s in his *The Process of Education and Towards a Theory of Instruction*. Bruner's theory of development describes three modes of representation: the enactive, the iconic, and the symbolic (Bruner, 1966; Conway, 2007). In contemporary research, Bruner's theory is commonly known as the Concrete-Pictorial-Abstract (CPA) (Leong, Ho & Cheng, 2015) or the Concrete-Representational-Abstract approach (CRA) (Bouck et al., 2018; Milton, 2019). This theory suggests that there are three overlapping stages of development that contribute to a person's understanding of a subject. The enactive, or concrete stage utilises physical objects to create meaning; in mathematics, these might be manipulatives such as Numicon, Cuisinere rods or Dienes blocks. The iconic, or pictorial/representative stage translates these enactive models into pictures that the student may use to construct their understanding, such as number lines. Finally, the symbolic, or abstract stage enables the student to understand the concept in an associative form; Conway's (2007) example of associating a dollar sign with the concept of currency echoes this. Per Conway (2007), visual aids' effectiveness, particularly those that use a CPA/CRA approach, enable students to learn, understand and recall any subject provided these supports are accessible and appropriate to the student and their developmental stage.

Auditory learning techniques are an oft utilised method of supporting numerical development in practice; however, the effect of auditory techniques on the young learner are not as well documented. Researching the literature surrounding auditory aids suggests a shortage in evidence surrounding the specific type of auditory aids we aimed to use in this study. The use of music in mathematics education has been researched frequently, yet these studies concern themselves with the effects of classical music within lessons and their effect on cognition and student achievement. However, there seems to be a growing body of literature surrounding the topic (Sposet, 2008; Geist et al., 2012). Further research by Medina (2002) and Chrysostomou (2004) emphasise the benefits of music integration in mathematics, suggesting that such practices facilitate children's development of thinking skills and representations of new concepts.

A review of the literature surrounding this topic suggests the necessity for more research in the field, particularly in evaluating the impact of visual and auditory supports via students' own judgements. This study aims to not only enhance the researchers' own understanding of the topic, but also facilitate a dialogue with the students surrounding the effects of visual and auditory supports in stimulating their learning experiences.

Methodology

Lesson Study

This research is designed around the lesson study model, a subset of action research which encourages collaboration and is characterised by the systematic reflection of practitioners researching within their own fields in order to improving professional practice and learning standards (Costello, 2003; Lewis & Hurd, 2011; Dudley, 2013; Stols & Ono, 2016). Several studies indicate lesson study as an effective practice model (van Gronnigen & Bennet, 2012; Godfrey et al., 2019), and the model comprises of several principles, such as:

1. Two or more partners collaboratively planning, teaching and observing lessons, working towards the goal of improving student achievement and experiences;

2. The partners jointly developing or refining a specific technique that is proven, through their research, to have a positive impact on student outcomes; and
3. Sharing their practice with other professionals.

(Ono & Ferreira, 2010; Pang & Ling, 2012; Dudley, 2014; Stols & Ono, 2016)

While lesson study is traditionally conducted in a whole-class environment, in Schools W and Y it was decided by the researchers and their mentors that a smaller sample of students would receive instruction during the lesson study. This was due to the Reception students' ages and abilities.

Data Collection

Observation

Literature indicates that observation is an effective method of documenting behaviour, especially children's (McMillan & Schumacher, 2006; WAG, 2008; Kawulich, 2012). This study used non-participant observation, wherein the observer passively observes and draws conclusions without interfering with the research activity (Cohen et al., 2018; Kumar, 2011; Kawulich, 2012). To avoid any interference with the results, i.e. the Hawthorne effect, wherein subjects alter their responses as a result of developing awareness of their observation (McCarney et al., 2007; McCambridge et al., 2013), the teaching researchers in each study ensured that students became familiar with the observing researchers prior to the lesson. Data was collected on a set of sheets (Appendix 3). The students' use of and engagement with the aids were graded against the Leuven Scale of Involvement (Appendix 3A). The aim of the study was to deepen the researchers' understanding of the effects of these aids on the students' learning experiences, and though Bruce (2006) notes the scale to be effective in evaluating the strength of a student's learning, one flaw in the scale's design is the possibility of a "one size fits all" categorisation of the students' involvement. To avoid this, we aimed to also note any additional behaviours observed to ensure an accurate grading of students on the scale.

Interview

Interviewing children is effective in lesson study as it allows the researching teachers to gain valuable insight from the eyes of their students (Dudley, 2011). A semi-structured focus group interview was most appropriate as we aimed to gain valuable insight on our sample students' experiences. The semi-structured interview used a short series of open-ended questions (Appendix 4) and were designed to be simple, using words our students would be able to understand despite their limited vocabulary. Following each lesson, per the lesson study model (Dudley, 2011) the researchers conducted an interview with a small sample of three students who represent different tiers of ability within the class. In School U, a Year 2 student (high ability), a second Year 2 student (middle ability) and a Year 1 student (mid-low ability) were interviewed. In Schools W and Y, as mentioned above, the parameters were adjusted and the groups involved were the high ability groups within their classes; however, these students displayed a range of ability within their groups and students representing these groups were selected accordingly.

Recording interviews is popularly used when conducting focus-group interviews (Bloor & Wood, 2006; Stewart, Shamdasani, & Rook, 2007) and Al-Yateem (2012) suggests that because researchers rely on this practice to collect and analyse interview data, recording this process increases the validity and reliability of the data analysed. The interviews were captured by using an audio recording device (Appendix 7) and in accordance with BERA (2018) guidelines, the team ensured that only the participants' pseudonyms were used during the interview. To preserve the integrity and value of the students' responses (Cohen et al., 2018), the interviews were conducted immediately following the lessons' conclusions.

Reflection

My partners and I decided that the Kolb (1984) cycle of reflection was best suited to our research activity (Appendix 5). Grounded in theoretical perspectives from Dewey, Lewin and Piaget, the Kolb cycle theorises that learning is achieved through direct experience (Kolb, 1984). Kolb's cycle is comprised of four steps, and whilst researching this reflective model, it became apparent that the Kolb model and the structure of Lesson Study share similar milestones, i.e. both are grounded in a

concrete experience, require general and abstract conceptualisation to make sense of the experience, and both encourage the practitioner to reflect on any changes necessary before restarting the cycle. Thus, using this model to reflect on the lesson study experience seemed appropriate as it allowed the reflection of each step in a structured format that reflected each cycle of the lesson study process. Reflections were completed at the end of each cycle.

Aid Selection

It was decided that the visual aids studied would form a small theme. After consulting with my research partners, we settled on a marine theme and designed the following visual aids accordingly. Influenced by prior experience in the Foundation Phase and the Concrete-Pictorial-Abstract approach, the **visual aids** studied were:

- A **number line** worksheet (School U, Year 2 focus group) and supports (Appendices 9D, F and G);
- A worksheet activity using **Numicon** (all year groups) (Appendix 9E); and
- A hands-on group activity using the '**Afon Adio**' and a **100 square (Pictorial and Abstract)** (Appendix 9B) (all year groups)

The **auditory aids** studied in this activity derived from those experienced at School U; the first song was a 'rap' about the number bonds of 10 (Appendix 9A.1) and the second was a new 'rap' created specifically for the study (Appendix 9A.2). The raps combined the auditory and visual experience by incorporating hand movements.

Ethics

There are many ethical considerations when conducting research, particularly with young children. The ethical considerations were measured in the Ethics Form (Appendix 9) and considered all possible areas, including risks to the researcher, participants and the University. All procedures, such as student participation,

researcher protection, and data collection and protection, were considered and implemented ethically throughout the study, which followed ethical guidelines (see Ethics Form). Parental consent was obtained for all students involved in the study and further parental consent was obtained from the parents of the student representatives (Appendix 5) (see Ethics Form). Furthermore, assent was received by the student representatives during the interview using a set of three, traffic light-coded faces (Appendix 6) and all were informed of their right to withdraw from the questions and from the study at any time (see Ethics Form)

Evaluation

Lesson Study 1: School U

In School U, a lesson was conducted on the concept of '10 more', aligning with the requirements of the National Literacy and Numeracy Framework (LNF) (2013, 2019), and the Foundation Phase Framework (2015). For the main activity, Plentyn A used the *number line* in a focus group with the teaching researcher, Plentyn B used the *Afon Adio* and the *100 square* support in a pairs/independent activity, and Plentyn C used the *Numicon* in a focus group activity with the teaching assistant.

Results and Analysis

Overall, the students of School U showed positive reactions and high levels of engagement throughout (Appendix 3A). By the end of the lesson, all students achieved the lesson goal of adding 10 to any given number between 20 (Year 1) and 100 (Year 2), with some successful adding 10 to numbers beyond their Framework skill.

Plentyn A and Plentyn C showed enthusiasm towards the auditory aids and were eager to perform alongside their peers (Grade 4), while, Plentyn B showed limited engagement and indifference at the onset of this activity (Grade 3). During the conclusion, all students exhibited high levels of engagement and motivation. All case students were ready and able to contribute to the post-rap questioning, e.g. "*Beth yw 4 adio 10?*", and 'C' was observed to be using their fingers consistently to support the second rap (Appendix 9A.2). This observation was not pursued. During the interview,

'A' and 'C' indicated that the 'number bonds of 10' rap was useful in their learning but gave no further comment on the 'adding 10' rap (Appendix 4A). 'B' noted that the rap did not support their learning during this lesson. Like 'A' and 'C', 'B' gave no comment on the second rap, suggesting it did not impact student learning as effectively.

The *visual aids* also proved to be successful, producing an overall positive reaction. 'A' showed positive engagement with the number line (Grade 4) and their engagement with it was further confirmed during the interview where they stated that they could use the number line to answer the questions (Appendix 4A). 'B's reaction to and use of the Afon Adio was mixed. While they indicated positivity towards the aid during the interview, further interview remarks and observations suggested that the aid was unnecessary in supporting the student's learning (Appendix 3A.4, 4A) as they understood the concept beforehand.

Using the Numicon, 'C' was noted to be engrossed in their work and successfully completed the task provided within the lesson (Appendix 3A.3). Upon interview, the student explained that the Numicon was useful and helped them solve the questions. Furthermore, upon prompt about what the student enjoys using to learn, 'C' stated that they favoured the Numicon, a 100 square, and that their experience was enhanced by the assistance of the classroom assistant (Appendix 4A).

The first round of lesson study and interviews suggested that the auditory and visual aids had an overall positive effect on the students' experiences. However, student reflections indicated that changes were necessary to the structure of the lesson and the aids implemented in the study. In my reflections (Appendix 5A), I recommended that the students in the next cohort be able to experience all aids rather than a select few (Appendix 1B). Additionally, while 'A' demonstrated a positive attitude towards the number line during the lesson, we decided against using this aid during further studies as prior experience in Schools W and Y informed the team that number lines had previously proven ineffective due to the students' young ages.

Thus, we decided to make the following changes to the remaining aids:

- reducing the *auditory aids* to 'number bonds of 10' (Appendix 9A.1);
- removing the numbers from the laminated fish (Appendix 9B.1.3); and

- adapting the Numicon work sheet (Appendix 9G).

These changes were necessary to accommodate the change in stage (Year 1/2 to Reception) and the skills suitable for that stage (WAG, 2013, 2015).

Lesson Study 2: School W

As we worked with one group rather than the whole class, each student was able to experience all resources. Students who finished the main Numicon activity then progressed to the Afon Adio again for an independent or pairs task (Appendix 1B).

Results and Analysis

Observations of students in School W indicated the success of the visual and auditory aids in generating high levels of engagement within the lesson (Appendix 3B). The auditory aids received positive reactions from all case students, while the visual aids were useful in supporting student learning.

Students were observed to be engaged at Grade 4 during the rap performance (Appendix 3B.1). Plentyn Ch showed consistent enthusiasm towards the rap and performed the movements eagerly throughout; however, during the conclusive performances, the student performed at Grade 5. The student highlighted the rap as a positive element of the learning experience (Appendix 4B). Plentyn D, meanwhile, was observed to be somewhat insecure at the start of the rap and took some time to grow comfortable with the idea of performing in front of others. Student was graded 4 as the student's enthusiasm increased as they grew more comfortable. During the interview, the student highlighted the rap as an enjoyable aspect of the lesson (Appendix 4B). Plentyn Dd, meanwhile, demonstrated consistent enthusiasm and engagement during the rap and responded positively to the auditory portion; this observation is supported by the interview (Appendix 4B).

Plentyn D and Dd were the only students to engage with the Numicon during the worksheet activity. Students were graded 4 on the Leuven Scale and concentration was consistent during usage (Appendix 3B.2). However, these students were able to begin the task without the support of the Numicon and only utilised the apparatus to

correct their work. Plentyn Ch, meanwhile, did not need the support of the Numicon during the activity; instead, they made use of the visual aid on the worksheet and completed the work successfully (Appendix 3B.2). Student was graded 4 on the scale due to consistent engagement with the task.

The Afon Adio was used throughout the lesson; however, only Plentyn D progressed to the independent task during the main body. A whole-class observational consensus indicates that the aid sparked enthusiasm in all students, with all case students graded at level 4 (Appendix 3B.3). Students were eager to have the opportunity to use the aid during the introduction and were able to use it successfully to answer questions. While Plentyn D exhibited some loss in concentration at the beginning of the lesson, they soon renewed their interest and focused their concentration on the task (Appendix 3B.3). During the introductory activity, Plentyn Dd was observed using their fingers to support the counting process. This was not followed up directly, but they and their fellow students indicated in the interview that finger counting was an aid they frequently used in their mathematics lessons (Appendix 4B). On the Afon Adio, Plentyn Dd was the only student to highlight the aid as a useful tool in aiding their understanding of the lesson goals.

Data from the second lesson suggests that the aids implemented had a positive impact on the students' learning experiences. Students' verbal consensus suggests that the rap had a large impact on their experiences, while the visual aids, though resulting in positive outcomes, had less of an effect on their overall experiences in the session.

Plentyn D's initial reaction to the rap indicated changes needed to how the rap was presented. My reflections (Appendix 5B) noted that supporting the rap's content with an additional visual support might be suitable for the younger Reception cohort; thus, we decided to evaluate how adding the Numicon to help the students visualise the song's content.

Lesson Study 3: School Y

Results and Analysis

The results of the final lesson study were positive overall. Students achieved the lesson goal of adding (at least) one more to any given number within 10. On average, engagement was high during all aids, considering the case students and the whole group, yet the visual aids received more feedback than the rap during the interview stage. Overall, the effect of these aids on student engagement and their experiences was positive.

Observations indicated that the students' understanding of the rap's content were enhanced by the Numicon (Appendix 3C.2), which itself received some positive feedback from Plentyn E during the interview process (Appendix 4C). Student activity during the rap was high. Plentyn E exhibited some insecurity at the start of the rap but grew more comfortable upon introduction of the Numicon (Appendix 3C.1). Similarly, Plentyn F, after a period of exhibited shyness, demonstrated a high level of enthusiasm as their learning of the rap progressed, and the use of the Numicon to support the stages of the rap facilitated this change in engagement as they progressed from Grade 3 to 4 (Appendix 3C.1, 3C.2). In the interviews, Plentyn F remarked their enjoyment of the rap during the lesson but stated that it did not help them learn (Appendix 4C). Meanwhile, Plentyn Ff demonstrated consistent engagement with the rap, and the Numicon was somewhat helpful in supporting the content for this student. The student exhibited a high level of confidence when performing the rap and its movements and was eager to answer questions based on its content (Appendix 3C.1). Interviewing the student about the rap indicated that the aid was very helpful in supporting their learning, and the student provided examples of the number bonds of 10 from the rap without using the song (Appendix 4C).

The visual aids, meanwhile, were received well by the whole group. As in in the second lesson, the Afon Adio was introduced during the introduction and sparked a high level of interest in all students involved. Case students exhibited high levels of engagement, with Plentyn E and Ff engaging at Grade 5 and Plentyn F at Grade 4 (Appendix 3C.3). These students were very eager to use the aid in their learning and were confident in answering the accompanying questions. By the end of the lesson, Plentyn E's engagement with the aid decreased to Grade 3 as they lost interest and

concentration; however, Plentyn F and 'Ff' remained focused and engaged throughout, and eagerly participated in the questioning and the activity itself to demonstrate their learning (Appendix 3C.3).

The Numicon activity, however, received mixed reactions. Plentyn E and F engaged with the Numicon frequently during the main body activity; 'E' used the aid to support their learning throughout the task, while 'F' used it to correct their work towards the end of the task (Appendix 3C.3). Meanwhile, Plentyn Ff demonstrated a higher level of ability than their peers and was able to complete the whole task successfully without the assistance of the aid. They then progressed to the Afon Adio until the conclusion. The interview indicated that the Numicon was helpful to Plentyn E, but neither Plentyn F nor 'Ff' mentioned this aid in their responses (Appendix 4C).

Studying the students of School Y in action confirmed that the visual and auditory aids provided beneficial support to the students' learning experiences. Student engagement was consistent throughout this lesson and the students exhibited positivity while using all aids. My reflections (Appendix 5C) emphasise how the repetition of the auditory aid was beneficial to the students' ability to answer questions about the number bonds of 10; however, the student interviews suggest that the impact of the aid was not as lasting as the Numicon.

In future lessons, my reflections suggest the necessity of ensuring that all aids implemented create a positive and enriching learning environment that enables every student to reach their full potential and closes the gap between the students' prior knowledge and newer concepts (Appendix 5C).

Findings

Discussion

On average, the nine case students demonstrated generally positive reactions towards the supports used during the lessons, and the data indicates that there was a balance between the effectiveness of these aids. All case students in School W listed a form of visual aid as their preferred mode of support during mathematics learning, and

students in Schools U and Y also indicated a preference for visual support. However, the participants' lack of response to some questions (see Appendix 4) affects the overall reliability of the data gathered.

A recurring theme during the observations and the interviews was the students' use of and preference in using their fingers to count. Plentyn C's engagement with the song and positive attitude suggested that their personal visual support via finger counting enhanced their understanding of the content of the song. Finger counting enabled Plentyn C's ability to participate successfully in the rap, and evidently this strategy aided her as she successfully answered questions on the raps' contents with confidence (Appendix 3A.1). Interestingly, finger counting was also noted to be a favourable strategy in interview data collected from School W (Appendix 4B). While Moeller (2011) evaluates the arguments surrounding the use of finger representation in mathematics instruction, research by Boaler et al. (2016) suggests that finger counting is an effective visual for counting that leads to greater mathematical development.

Another recurring theme was the students' engagement with the auditory aids. While interviews with Plentyn B, E and F indicated that the auditory aids had little impact on their long-term memory, the short-term experiences observed in their classrooms suggests that in action, the students engaged positively with the aid. Research by Geist et al. (2012) indicates that music has a positive effect on student engagement and helps promote positive attitudes towards mathematics. However, this inconsistency in the data can be explained by the lack of practice time for students in Schools W and Y, the latter of whom were our youngest participants.

Plentyn C and case students from School Y gave responses which indicated a strong relationship with their teachers and teaching assistants. These students, when prompted during the interview, noted that their experiences were enhanced by the aid of their teacher rather than an aid solely, and expressed positivity and confidence when explaining this. These students have confidence in the adults in the classroom and have developed a strong connection with them; they put their trust in these adults and how they use the aids.

Implications for Student Learning

A trend in the research data collected from the interviews suggests that the School W Reception cohort prefer using finger representations during their daily mathematical instruction, and observations of Plentyn C suggests this as a valid mode of visual representation. Thus, the research suggests that further development of finger counting is necessary during the Foundation Phase and, as Boaler et al. (2016) suggest, from birth through adulthood.

Deepening our understanding about the aids that students found most effective will influence the way in which we integrate visual and auditory experiences during our mathematics instruction in future. The results indicated that auditory aids were very popular amongst the Reception cohort; thus, if I should experience teaching Reception-age children in my future career, implementing auditory aids such as these might be an effective strategy, especially in developing basic number skills and number sense.

Conclusions

A major limitation to the study was its length. A trend in lesson study literature measures and assesses the impact of the method over a period, from several weeks to several months, and often a period of two years (Fernandez, 2002; Fujii, 2014; EEF, 2017), whereas this study was conducted once in three different classrooms. Thus, research suggests that lesson study should be implemented across a longer period. Should I undertake a lesson study again, I would extend the research period over a minimum of a week in each case classroom to evaluate the impact of these supports on the experiences of the case students. For example, in School U, the structure of the lesson plan (Appendix 1A) resulted in the case students experiencing one visual aid each during the main body of the lesson. In lesson studies that last a week, the case students could rotate between aids every day for as many days needed, thus enriching the quality of student feedback.

Furthermore, the decision to refrain from conducting whole-class observations at School W and Y also affected the impact of the results. This was influenced by the

age of the participants involved. The students in School Y are the youngest of the Reception year; therefore not as advanced in their cognitive development as their slightly older peers in the case study group, it was determined that only one group should participate in the study so that the range between the results was narrower. Heary and Hennessy (2002) suggest that focus group interviews as conducted in this study are unsuitable for children under 6 years old, owing this to their limited social and/or language skills. Thus, future research with Foundation Phase pupils in Reception should consider other forms of qualitative data collection, such as video recording.

The interview aspect was not as insightful as anticipated due to the type of questioning and the participants' ages. Despite attempts to rephrase the questions used in the interview, some of the case students struggled with providing relevant and valuable responses. Questioning is vital to the interview and the lesson study process (Dudley, 2014) and I do not believe our implementation of the method was successful in this study. Due to their ages and lack of vocabulary, the students' responses were superficial and limited in detail. I strongly believe that the most valuable insight in this study was gained from observing the students in their learning environment. Further research with the Foundation Phase should emphasise the observational element over the interview process, and future research should interview the students casually in action rather than targeting them with questions in an enclosed environment.

Recommendations

In light of the research, it is clear that there are benefits of including visual and auditory aids in professional practice. Overall, this research suggested that Foundation Phase students' use of visual aids enables them to enrich their understanding of mathematics. Despite the positive results of this study, changes that could be made that would enhance the reliability and validity of this study. I would suggest the following:

- R1:** Elements of the interviewing process needs to be revisited when consulting with children in the Foundation Phase, such as question phrasing, to ensure that all data is usable and of high quality.
- R2:** More research into effective questioning practice involving children is necessary.
- R3:** Any further research activity that evaluates the impact of a specific mode of instruction on student experiences should be extended over a period.

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