Mathematical Pedagogy within the Early Years: Does the use of board games support the development of numerical skills and mathematical graphics within Early Years.

Introduction

Maths is emphasised in the Early Years Foundation Stage (DfE, 2012) which suggests that the Foundation Stage is crucial to giving children a mathematical start (Ofsted, 2011; DfE, 2012). The revised EYFS includes maths as a specific area, sub areas include ‘playing and exploring, learning actively and creating and thinking critically’. This indicates new strategies for maths in the Early Years will be beneficial. Prior to this study the researcher observed children in many settings and year groups. Maths was identified to be an area that children were less actively engaged in, however when given the chance children did choose to engage in maths based resources, using them in an enjoyable and individual way.

The aim of this study is to identify characteristics of early counting skills and number recognition through use of math games, focusing specifically on board games. The effectiveness of this teaching strategy will be critically analysed to support future practice within the foundation stage and enable the researcher to hold a constructively critical and creative approach towards innovation and adapting beneficial strategies within practice. The researcher will identify whether this approach is successful in including children in their own learning and will allow the children to partake in chosen math games leading to the production of their own math games in order to identify whether this approach supports early stages of mark making whilst encouraging active learning and a willingness to participate. The aim to broaden counting opportunities for children through the use of various games as a strategy to continually measure children’s development will be offered and studied by the researcher. Although math games are not believed to be a new strategy they are often not promoted within the foundation stage in which the researcher is based, the games are not always explained or demonstrated to the
children in order develop understanding of how these games should be used. This means the games are not used to their full potential and the practitioners are currently not using them as a tool for assessment.

Literature review

The Early Years Foundation Stage Framework (EYFS) document suggests that mathematics in the Early Years should be provided through a variety of learning experiences including songs, stories, games and imaginative play (DfE, 2012). This framework suggests specific learning goals for the end of Foundation Stage. Included in the specific area of mathematics, aspect one: Number, children are expected to count reliably from 1 to 20, hold the ability to place numbers from 1 to 20 in order and say which number is one more or one less than a given number. Foundation Stage students are expected to add and subtract single-digit numbers using quantities and objects. Young children should hold problem solving skills such as doubling, halving and sharing. For aspect two of Mathematics: Shape, space and measure children are expected to use everyday language to talk about size, weight, capacity, position, distance, time and money to compare quantities and objects and to solve problems (Abid, 2014). There is an uncompleted widespread concern regarding standards of achievement in mathematics, this has being acknowledged since as early as 1982 when the Cockcroft report was published, there has also been some extensive curricular revision since this including the National Numeracy Strategy (NNS). In current curricula the term numeracy is used over mathematics and implies the everyday uses of the subject (DES, 1982; Pound; 2006).

Counting is identified as one of the cornerstones for mathematical development. Connections are made through language, symbols, pictures and real-life situations. Learning is effective when cognitive connections are made by the learner however if any of the four elements are not experienced then possible problems may arise (Haylock and Cockburn, 1989; 2003; Haylock and Thangata, 2007). These elements are displayed in the connective model of learning mathematics shown below (Haylock and Thangata, 2007).

Image source: (Haylock, 2008) Pg. 10
It is identified that many professionals find this model effective for planning the teaching of mathematics and adapt the aspects into practice, however it is argued that the model is challenging by Swann (2005) (The Devon Mathematics Team, 2009).

There is seen to be a large emphasis on reading and writing phonics in the Early Years and Key Stage one, however a gap in the assessment of mathematics has been identified which is a concern as math is seen to be an essential part of everyday life (Cross et al, 2008). Throughout research and experience the characteristics of effective learning are predominantly seen and encouraged in the area of phonics, in the specific area of literacy (DfE, 2012). This ideology is supported by practices and policies such as the Phonics screening check (2013) that confirms all children by the age of six (the end of year one) should undertake a phonics screening check to identify whether they are using the vital decoding skills required for reading. This check is also to be carried out again at the end of year two for any children that do not reach the required standards at the end of year one, it is intended that the children who do not meet the requirements at age six will be given extra support, this policy works on supporting the abilities of the children rather than the teaching strategies used (DfE, 2013). Literacy is seen to be of more importance than mathematics within practice however as they are both a specific area of the EYFS, a concept difficult to understand by many. To reiterate this point the 2012 revised EYFS has no longer deemed mathematics to be a prime area, instead the three prime areas include personal, social and emotional development, physical development and communication and language (DfE, 2012). The reasons for communication and language being a prime area is plausible and supported by a great deal of research, without any language or communication children would have very little or no understanding of the academic subjects evident within the specific areas of the EYFS (Browne, 2009). Mathematics however is considered to encourage children to develop confidence and critical thinking skills (DCSF, 2009’ Miller et al, 2010; Tassoni, 2012). When researching methods of encouraging active learning in mathematics it was established that if children do not understand symbolic representation then they will not be able to record numbers as this being a symbolic process (Carruthers and Worthington, 2006). This led to further research of understanding symbolic representation linking with the effective characteristics of learning. Maths games in particular board games seem very popular with practitioners and children, linking with the effective characteristics presented in the EYFS.

- **How children learn essential early mathematical skills**

Learning to count capably involves the acquisition of skills through involvement in key experiences using language of number and comparison. Children’s number skills should comprise of learning number names in order, counting objects by touching them, moving completely from counting concrete objects to counting abstractly (Kilpatrick et al, 2001; Montague-Smith, 2002). In order for counting opportunities to remain stimulating
practitioners must carefully and strategically plan the learning environments to tailor the needs and interests of the children within their provision.

The idea of active learning instigated by Piaget’s constructivist theory is identified to be the catalysis for cognitive development. As learning develops through clearly defined ages and stages a variety needs to be present from functional play through to symbolic play and subsequently to play with rules (Tucker, 2010). Unlike Piaget, Vygotsky (1978) draws emphasis to the significance of social interaction, specifically the use of language. The theory of the ‘zone of proximal development’ is supported in learning through play with peers as the adults or peers that children are actively engaged with can provide information to support these ‘zones’. Bruner (1991) shares the ideas of social constructivist theories highlighting the significance of interacting with others. Socialisation is supported through play and the idea of learning about and adhering to rules and roles are encouraged, this is seen as moral development studied by Piaget as an extension of cognitive development. Piaget found that children between the age of three and four do not consider consequences of actions for example lying or being deceitful. Moral developed is defined as an aspect of socialisation by which children learn to conform to certain expectations. Before the age of eight it is believed that children see rules as fixed and unchangeable. Quality interactions are provided by proactive practitioners who ‘scaffold’ children’s learning by creating interesting and engaging environments. The National Numeracy Strategy (1999) reflects the need for children to revisit ideas and accomplish their learning before moving onto the next stage of mathematical development, this is seen in the repeated learning objectives each term. This is supported by Bruner’s ‘spiral curriculum’ where children return to activities and play materials however use them differently each time to increase development (DfEE, 1999; Lindon, 2001; Tucker, 2010).

It is also understood that children learn through the use of memory. Semantic memory is organised by meaning and is the memory of facts. The information processing paradigm approach orders the mind as a set of processes. Several important divisions of the memory are identified in this approach. Encoding is the first which includes taking information and converting this into memory, followed by storage, described as the way that information is represented in the brain and finally retrieval where the information from memory is made available. If any one stage fails then the memory will not be put into place (Roth, 1990; Lee and Gupta, 2003). Models of memory allow the process of memory to be understood, the Modal model of memory is one of the simplest but most effective models.

The first stage known as the sensory registration stage holds information that has only just entered the cognitive system, at this stage information is raw for example an image or sound, this information is unusable until developed. The need for children to develop short and long term memory is essential in any subject especially mathematics and strategies must be put into place to enable development of these skills. Lee and Gupta (2003) suggest rehearsal and describe this as repeating short term memory aloud; this strategy is believed to extend short term memory to long term memory indeterminately. From research into the application of strategies it is identified that spontaneous rehearsal
does not appear until the age of seven (Flavell, Beach and Chinsky, 1966), therefore the need for support from a more knowledgeable other to enter this zone of proximal development is key. Although the short term memory of children is comparable to adults in many ways they do not process the powerful strategies especially in the Early Years, hence the importance of practitioner intervention (Chi, 1978).

The schema theory first put forward by Barlett (1932) indicates how information is acquired. Skills and behaviours are controlled by schemas for example playing the piano or following game rules, theorists recognise schemas as cognitive structures. It has been confirmed by others as ‘forms of though, like pieces of concepts’. Although this theory is similar to the one of Piaget it is not identical. Barlett (1932) argues that memory is a construction rather than a copy of information that is presented and memory limitation is due to strategies and organisation rather than capacity. From research it is evident that children learn their own strategies for effective learning from the age of seven onwards and the need for adult support before and during this stage is essential to memory development, although there is strong research around the understanding of memory it is identified that the way children learn is still to be exactly understood (Lee and Gupta, 2003; Atherton, 2014)

- **Learning through play**

  “Numeracy doesn’t have to be dull, or confined to the indoors!”
  
  (Dancer, 2014: 41)

The National Research Council recommends that everyone needs representation; this can be something physical, spoken or written, in order to communicate about numbers (National Research Council, 2007). Sarama and Clements (2009) discuss children’s mathematical ideas that are important for learning and suggest that when children are given the opportunity they are able to possess informal knowledge through engaging in substantial amounts of free flow play by exploring patterns, shapes, acquiring special awareness, mathematical thinking and reasoning (Sarama and Clements, 2009)

From the research of Burns (1998) it has been found that those adults who feared the concept of maths were mesmerised by math puzzles. This research was then developed by Tate (2008) who proposes that authentic learning will not take place at any age unless students are involved and engaged in their learning (Burns, 1998: Tate, 2008). Prior to this the Cockcroft review also identified that maths is feared by adults. It was acknowledged that many professionals working with children share negative attitudes regarding numeracy and can at times express this as being ‘boring’ as a result (DES, 1982; Pound, 2007), this is where the need for mathematics to be fun engaging and less apparent is seen by the researcher. Williams (2008) composed a review of mathematics based around the teaching of this subject. There are recommendations in this review that support the idea that children need to learn through an active process. The revised EYFS development matters (2012) adopts these principles declaring that for the principles linked with the theme of ‘learning and development’, practitioners must teach
children by ensuring that the opportunities provided are challenging and playful across both the prime and specific areas. The characteristics of effective learning are seen to include playing and exploring: finding out and exploring, playing with what they know and being willing to ‘have a go’, active learning: being involved and concentrating, keeping trying and enjoying achieving what they set out to do and finally creating and thinking critically: having their own ideas, making links and choosing ways to do things. These characteristics require children to be motivated, engaged and develop critical thinking skills. In schools the Foundation Stage is now expected to move towards a philosophical orientation of teaching that favours more active learning, allowing children to be active constructors of their own and others’ knowledge (Ellerman, 1999; Moyles, 2014).
Mathematical graphics in the Early Years

Mathematical graphics are described as early written numerals in the child’s own written method, this term refers to the visual marks and representations that young children choose to use in order to explore mathematical meanings and to communicate their thinking. This term can include an assortment of graphics such as scribbles, drawings, writing, invented and standard symbols and is also defined by practitioners as mark making. (Carruthers and Worthington, 2006; NCETM, 2008). The use of mathematical graphics allow children to be free to explore their own mathematical thinking and meanings (Carruthers and Worthington, 2005; Carruthers and Worthington, 2006; DCSF 2008). The importance of mathematical mark making is also supported by the Early Years Foundation Stage (EYFS) and PNS (DfE, 2012). The Independent review of mathematics and teaching in Early Years settings and Primary Schools (DCSF, 2008) suggests that practitioners should focus on mathematical mark-making, however it is thought that many practitioners are uncertain of how to approach creative methods in mathematics (Carruthers and Worthington, 2006). Williams (2008) states that all educational settings should commission a resource to allow educators to understand children’s mathematical mark-making and develop pedagogical skills in this area. Vast emphasis on mark-making in role play and emergent writing was found in recent studies; however mathematical mark-making is still a challenge (Lewis, 1999; Worthington and Caruthers, 2006; Williams, 2008). From this review the Department for Children, Schools and Families (DCSF, 2009) formed a resource to support professional in developing children’s ability to think mathematically. This review emphasises the need for children to learn mathematics through a broad range of experiences that are interesting to them, it
also states that ‘Numeracy is a proficiency which involves confidence and competence with number and measures’ DCSF, 2009: 68).

Assessing early mathematical development

Assessing children’s development is essential in order to provide a differentiated curriculum. Two forms of assessment are evident in the Early Years, including a summative assessment, used to sum up the child’s attainment and achievements at a particular stage, and a formative assessment; this provides evidence of successful teaching and learning. Both forms of assessment are identified as relevant and essential for assessing mathematics as practitioners need to know which stage each individual child is at in order to plan for the next stage of learning (Fox and Surtees, 2010).

As revealed phonics screening checks are introduced at year one, however the compulsory assessment of mathematics does not appear until year two. This is due to change in September 2016 as discussed by GL assessments, it is thought that DfE has approved a baseline assessment for Reception tailored by GL assessments open for use from 2015 as this baseline assessment is reported to become compulsory in September 2016. This assessments aims to measure language, literacy and mathematics through the use of two interactive tablets designed to be fun and engaging for pupils. Nevertheless this assessment does not allow hand o experiences and the identification of personal, social and emotional development as a prime area of the EYFS (DfE, 2012; DfE, 2014). The use of interactive tablets in settings are rising, positive benefits have being shown as a results however from research there are undesirable issues in comparison. Currently the EYFS handbook defines the expectations of making EYFS profile assessments and recording children’s attainment. There are no compulsory methods of recording at this stage although a sample proforma is included in annex 1 of the handbook and practitioners are expected to feedback to parents with a written summary usually known as the child’s end of year school report (DfE, 2014).

- Effective teaching strategies for mathematics

Play is recognised as an appropriate context for mathematics beyond the foundation stage. It is encouraged that teachers should be flexible in their teaching, this is supported in many documents such as the Early Years Teaching Standards, Primary Framework for Literacy and Mathematics, EYFS and the Independent review of mathematics teaching in Early Years settings and Primary Schools (Pound, 1999; DIES, 2006; DCSF,2008; Tucker, 2010, DfE, 2012; NCTL, 2013). Board games to aid mathematical development is emphasised by Dolk and Twomey Fosnot (2001), it is seen that using board games acts as ‘a rich context for mathematical learning’ (Page 37), However from research it is seen that most young children do not understand the aspect of probability in board games and may see this more as a competition, this is a main barrier to the use of board games with young children. However this approach in the Early Years should be
embraced as the strengths found for games reinforcing number and shape recognition, counting and grouping or subitising, hand-eye co-ordination skills and social skills positively outweigh the weaknesses making this strategy for developing mathematical skills and recognising developmental stages an appropriate teaching strategy within the Early Years (Rosenfield, 2005; Gomez et al, 2010). From similar studies by Siegler and Reamani (2008) and Cavanagh (2008), it is evident that games do enhance learning, particularly of those from a less affluent background. Within these studies the gap for enhancing the development of mathematical graphics is noticeable and drives an interest into how this aspect can be developed further. It is identified that games can be made relevant to children and is tangible for children to touch and see. These studies found that middle-class families were more likely to have experience in playing board games at home, making these children more able in terms of development and mathematical language. Maths games have also seen to effectively reduce the feeling of failure, increasing self-esteem and successful learning. Different learning styles are reinforced by math games and this can help to reinforce knowledge (Briggs and Davis, 2008).

Methodology

Action research will be used for this study. This methodology was thought to be developed in 1953 by Corey for the purpose of educational improvement, this was established from the work of Lewin in the 1940’s and his theory of reflecting on action supported Corey’s work. This proposed methodology will enable the researcher to improve upon practice to identify whether the use of board games are an effective teaching strategy in the area of mathematics. Action research is perceived as worthy methodology, studying change is a useful way of learning about how things work (Bryman, 1989; Denscombe, 2003). Throughout this study the action research cycle will be followed, this comprises of four phases. Phase one, choosing to change has been demonstrated in the rationale. The literature review and methods suggested demonstrate phase two, planning for change. The research and analysis of data show evidence of phase three, creating the change and finally the conclusions of the completed study will support phase four, sharing the lessons (Naughton and Hughes, 2009).

Two groups of 4 children aged between four and five with an average age of 4 years 7 months will be used for this research; they will be mixed ability and genders however there will be equal numbers of boys and girls originating from the same area and school. These children will be randomly selected to avoid any bias using a random sampling technique. Two groups of four have been chosen to check validity and increase representation, the use of a larger sample size will support the ability to generalise the results (O’Hara et al, 2011). For the interviews the researcher will gain the consent of the Foundation Stage teacher, as there is only one Foundation Stage teacher present in this environment there is no necessity for a sampling method. The proposed sampling method is a random sample. The sample will be purposive, hand-picked for the research, as it is important that the sample is mixed abilities and the participants are based in foundation stage 2 ages 4-5 years for the research question to be met and the results to be relevant.
Two methods of data collection will be used including structured observations, also known as systematic observations, interviews with the children with the use of a dictaphone (voice recorder) for validity together with interviews with the Foundation Stage teacher to gain their views, opinions and experiences to provide further support of the current research. These methods will allow information to be gained to provide relevant results for the sub questions that will be used to support the research question.

Observations have been chosen for this study as they provide direct access to the social phenomena under consideration. The skills that are to be identified in the structured observations are supported by previous research and theory. It is seen in order for children to become proficient at counting they must first acquire basic principles including:

- Cardinal-ordinal or cardinality principle- understanding that’s the last number counted represents the amount in that group
- Subitising - The process of immediately recognising how many items are in a small group
- One to one correspondence- understanding that each number counted is counted only once and no more whilst understanding that number counting

(Kulm, 1985; Gelman and Gallistel, 1986; Montague-Smith, 2002; Askew, 2011)

The main advantages of this method being: directness, diversity, flexibility and applicability, provision of a permanent record and complementarity with other approaches evidently outweigh the disadvantages of practicability, observer bias and observer effect. (Emerson et al, 2001; Bryman, 2008; Downer et al, 2010).

Walliman (2011) suggests that interviews and questionnaires are best used together as they complement each other. The children and practitioner will be interviewed separately and informally to gain their views of the resources used in this study, in this case the use of board games. These interviews will be semi structured, they will seek certain information and minimise variation whilst allowing the researcher to explore beyond clear boundaries of the question schedule (Kvale and Brinkman, 2009; O’Hana et al, 2011).

The use of a Dictaphone in these interviews will enable the participants to feel the interview is less formal and they can be more relaxed as the researcher will then be able to refrain from scribing and the interviews can flow with no distractions.

Ethics are to be followed by the researcher to ensure that the research will be reliable and demonstrate credibility. Informed consent will be gained from all participants and confidentiality and anonymity will be maintained throughout the process. Tthe ethics will safeguard the researcher throughout the study, ethical implications must be taken seriously due to the legislative and regulatory framework operating in society (BERA, 2004; Walliman, 2006; Bryman, 2008; O’Hana, 2011).

**Research findings and discussion**

As the researcher will be focusing on actions and behaviours within this study and
coding the text, content and thematic analysis is proposed. (Naughton and Hughes, 2008). Qualitative data has arisen from this research; it is common for interviews and observations to produce this data (Robert-Holmes, 2005; Gabriel and Lester 2015). Triangulation of data has being practiced throughout combining several methods and sources of information to gain data and a clear understanding of results and understandings relating to the topic and research question ( Cohen et al, 2010). The research question appears to have been met by these findings, diminutive differences in the skills displayed was shown in the different games however interest was shown through the whole research project by participants and on-lookers.

- Aspects of mathematical skills used whilst engaging in the games

1. Basic skills

The observations recorded identify basic mathematical skills that the participants acquired. The researcher has made a colour coded analysis of each observation that can be seen in appendix 4, 7, 9 and 11.

Below the four tables clearly present the key skills demonstrated by each participant in the separate observations.

Key

✓ - Displayed independently  S- reached with support  X- Not demonstrated

Table 1.0

Table 1.0 visibly identifies that 3 of the 4 participants in group 1 independently displayed the skill of 1:1 correspondence within the game of ‘snakes and ladders’, while the forth participant was able to achieve the skill with support from the researcher. Subitising however was only achieved by 2 participants, these participants did so independently. All four participants demonstrated cardinality independently and opportunities for mark making were provided in this observation.
<table>
<thead>
<tr>
<th>Observation 1</th>
<th>1:1 correspondence</th>
<th>Subitising</th>
<th>Cardinality</th>
<th>Mark making/Mathematical graphics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>S</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Participant 2

Participant 3

Participant 4

Table 1.1

Findings from observation 2 identified that there were no mark making skills demonstrated by any of the four participants in the particular activity, ‘Going to Granny’s’, however ample opportunities for 1:1 correspondence was available and all four participants were able to demonstrate these acquired skills independently indicating that this approach encourages this skill indefinitely.

<table>
<thead>
<tr>
<th>Observation 2</th>
<th>1:1 correspondence</th>
<th>Subitising</th>
<th>Cardinality</th>
<th>Mark making/Mathematical graphics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Participant 6</td>
<td>✓</td>
<td>S</td>
<td>S</td>
<td>X</td>
</tr>
<tr>
<td>Participant 7</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Participant 8</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1.2
From these findings it can be seen that previous participants that did not show certain abilities in the earlier observations have developed these skills as a result of partaking in the mathematical board games. For example Participant 6 was unable to show the skill of subitising in Observation 2 however proceeded to demonstrate this skill in observation 3.

<table>
<thead>
<tr>
<th>Observation</th>
<th>1:1 Correspondence</th>
<th>Subitising</th>
<th>Cardinality</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>X</td>
<td>S</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 3</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 4</td>
<td>X</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 5</td>
<td>X</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Participant 6</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 7</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 8</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1.3

Once more this table demonstrates that mathematical skills have been acquired by participants as a result of this mathematical approach. Participant 1 revealed no ability of subitising in observation one, in observation three this participant began to develop the skill of subitising with the support of the researcher. From the findings in observation 4, it is now apparent that this participant is able to independently demonstrate strong subitising skills; this is thought to be an outcome of participating in the games provided within this study.
## 1:1 correspondence Subitising Cardinality making/Mathematical graphics

<table>
<thead>
<tr>
<th>Observation</th>
<th>1:1 correspondence</th>
<th>Subitising</th>
<th>Cardinality</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>✓</td>
<td>✓</td>
<td>S</td>
<td>X</td>
</tr>
<tr>
<td>Participant 2</td>
<td>✓</td>
<td>✓</td>
<td>S</td>
<td>X</td>
</tr>
<tr>
<td>Participant 5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Participant 7</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
</tbody>
</table>

It is shown that the basic skills required for early mathematics (Clough and Nutbrown, 2012) are encouraged by the use of maths games. 1:1 correspondence has being developed throughout all four observations.

### 2 Shape, space and colour awareness

Participants were able to identify shapes without prompting and speak about these shapes sharing information with peers (Appendix 9, line 98). This research revealed that participants were aware of various shapes such as oblongs, triangles, squares and circles supporting the expected EYFS goals for ages 30-50 months (DfE, 2012).

The participants displayed in-depth knowledge of colour awareness in observation 3 and 4 (Appendix 9 and 11), this is surprisingly not a goal included in the EYFS framework (DfE, 2012); however it is thought that this is developmentally accurate for this age group.

<table>
<thead>
<tr>
<th>173</th>
<th>Participant 4</th>
<th>Passing Participant 8 a purple and a brown pen</th>
<th>Ok do it purple and brown, I will draw another one</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>Participant 5</th>
<th>Picks out the blue counter from the table</th>
<th>Doesn’t matter, can I have blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>13:37 Participant 7</td>
<td>Picks up the red counter</td>
<td>Well I will have red</td>
</tr>
<tr>
<td>6</td>
<td>Participant 1</td>
<td>Picks up the green</td>
<td>Aw, I wanted blue. I will have to have green</td>
</tr>
<tr>
<td>7</td>
<td>Participant 2</td>
<td>Passes the yellow counter to Participant 2</td>
<td>Here Participant 2 do you want yellow</td>
</tr>
</tbody>
</table>
3 Problem solving

Participants worked together to solve problems that occurred; they made every effort to help their peers with any problems and were able to use new knowledge to incorporate this into the games. In observation 4 (Appendix 11) participants recognised that winning was practically impossible by one participant when to reach the sweet shop on the game a one was to be rolled, with the use of two dice the participants discussed independently how this is impossible to happen as the lowest number to roll would be a 2. They decided to take one dice away to solve this problem that they had not thought of prior to choosing to use two dice.

<table>
<thead>
<tr>
<th>65</th>
<th>14:01 Participant 5 Thinking hard</th>
<th>Erm, no! What are we going to do, that means I cannot win!</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>Participant 1</td>
<td>We could take one of the dice away and then it would be easier</td>
</tr>
</tbody>
</table>

- **What are the prospects for mathematical graphics?**

1 Mark making

It is evident that children were using their ability of forming mathematical graphics in appendix 4 and 9, although evidence of this during the other observations is not apparent. The board games do not provide much scope for encouraging mark making unless prompted by an adult, this is done in observation one line 140 ‘if you would all like to get a piece of paper from the drawer and a pen I would like you to write your name and your number on there that way we won’t forget’. Without this prompting from the researcher this snakes and ladders game would provide no obvious opportunities for mark making. Observation 3 (Appendix 9) however provided ample mark making opportunities, children set themselves tasks to draw shapes, cut them out and write the numbers 1 to 25 on here, when numbers were formed incorrectly they self-corrected these, sometimes the help of peers was required, however correction still occurred successfully. The expectations of the EYFS, for children to form numbers from 1-20 has being independently extended by the participants in this approach. It is seen that the participants are stretching their abilities with self and peer motivation.

2 Number formation

Individual number formation ability was identifiable in observation one and three. From this is was found that participant 3 was unable to form the number 2 and needed support with number 8, the games provided scope for repetition of number formation as suggested in recent literature that this would support development however the results conflict with the ideas of Lee and Gupta (2003) who believe rehearsal will increase memory. However the abilities of other participants were also identified and the researcher quickly became aware of the participants capabilities.
• Are children actively engaged and absorbed in the games used?

1 High levels of involvement

High levels of involvement are identifiable in all observations by all participants; this is also supported by the interview with the Reception Teacher. However the misconception of probability when playing the game leads one participant to become less involved in Observation 1 (Appendix 4). The children were eager to make the game and looked to continue this even throughout their own play time showing high levels of engagement.

Examples of the participants demonstrating enjoyment throughout the games and interview with Foundation teacher include:

Teacher: Participant 2 asked to show her dad the game this morning and she wants to extend this learning at home, she enjoyed it very much, she was very proud. (Appendix 13).

This indicates that Participant 2 was fulfilled with her learning by asking to share her experiences with a family member and especially to want to continue this activity at home.

2 Listening and understanding commands and basic instructions

It was acknowledged from the interview with the Foundation Stage teacher (Appendix two) that it is difficult for children to understand and follow instructions of board games, making this approach
complicated and time consuming. Although it was proven to be time consuming the understanding shown from the children was competent, they demonstrated the level of understanding expected from the EYFS. It was understood by the researcher that children thoroughly understood the rules, the participants corrected peers when rules were broken or if they forgot to do something for example climbing up the snake on snake and ladders.

‘You have landed on a snake; you have landed on a snake. Go down it’- Participant 1 to Participant 4. (Appendix 4: observation one)

An example of participants listening and understanding commands and basic instruction is a common theme in the observations and demonstrated greatly throughout.

3. Critical thinking

Critical thinking skills were revealed throughout the research by most participants. They spoke about their own ideas and made links to other experiences, this was identified most in observation three: making the game (Appendix 9).

4. Non-mathematical skills

This research was carried out with the intention to discover mathematical skills developed from the participation of board games, unpredictably non-mathematical skills were demonstrated as often as mathematical skills and the findings show that this research support all aspects of learning mentioned in the EYFS, an added advantage of this approach in the Early Years (DfE, 2012).

4.1 Moral development

It can be seen that moral development is established by the use of board games. In observation one it can be seen by participant one that consequences of actions are not understood as this participant continually tries to win by not following rules and expectations set by the researcher. This is a reoccurring issue by this particular participant in this observation identifying that moral development and maturity is not as advanced as the other participants involved, from reflection this attitude developed throughout the observations as a result of participation.

(Observation one: Snakes and ladders)

<table>
<thead>
<tr>
<th></th>
<th>researcher</th>
<th>Passing the dice to Participant 1</th>
<th>Come on Participant 1 your turn now</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Participant 1</td>
<td>Holds the dice, finds number 6 and slowly places this onto the floor.</td>
<td>6! I got 6!</td>
</tr>
<tr>
<td></td>
<td>Smiling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In observation three, making the game, Participant 3 suggests using snakes on the game that will lead to participants going down these when landed on. These rules have stemmed from the game of snakes and ladders in the first observation and seen as unchangeable by participant three supporting the idea that children see rules as fixed before the age of eight.

4.2 Social learning

This study didn’t expect to find any other aspects of learning other than mathematical development however the observation clearly identified aspects for social, emotional and intellectual development. Participants worked collaboratively to share and construct new knowledge in a social context. They often helped their peers and provided support and encouragement when peers felt that they weren’t succeeding as expected. For example Participants here are encouraging participant one to continue the game although this participant is becoming disengaged as he is not taking the lead in this game and rolling low numbers. Also here participant 2 reminds participant 4 that the dice has not been moved and asks if this is something she could do to help. Occasions like this are continually shown throughout all observations. This research has promoted positive relationships with the children.

- Can this teaching strategy be used to measure mathematical development?

1 Individual abilities
The individual abilities of each child were distinguishable during this research. The board games enabled the researcher and on-lookers to identify areas that the participants required further support with for further development to arise. It was seen that Participant 3 required support forming numbers in Observation 3 (Appendix 9). From the interview with the Foundation Stage teacher after research had taken place it was discussed that the research had enabled her to become more familiar with the interests and abilities of each participant, she commented on how the research had enabled areas for improvement to be recognised and how this would encourage further development. From Appendix 13 cutting abilities were recognised by the researcher and Foundation Stage teacher ‘The children also need a lot of work on their cutting skills, I was already aware of this but making the game has reminded me of this’.

**Characteristics of effective learning**

From these studies analysis has shown that all characteristics of effective learning proposed in the EYFS (2012) are demonstrated throughout. The participants are seen to engage in all activities the majority of the time by finding out about how to participate and exploring the prospects of being involved in the game, some participant are able to play with what they know whereas others are given the opportunity to become familiar with this approach and all participants show the willingness to have a go. The participants are involved throughout and provide motivation for peers in order to keep trying, they show enjoyment in achieving what they set out to do. In observation three especially, aspects of creating and thinking critically are analysed as the participants show their own ideas, make links to other experiences and choose their own ways of doing things while working together as a team (DfE, 2012).
Discussion

Qualitative data has arisen from this research, it is common for interviews and observations to produce this data (Robert-Holmes, 2005; Gabriel and Lester 2015). Gabriel and Lester (2015) suggest that “Insights from qualitative research are having a transformative effect on how we understand and manage our world”. Evidence has being identified by various participants and their understandings, no generalisations have been made in this study as an outcome of interpretive research. Triangulation of data has being practiced throughout combining several methods and sources of information to gain data and a clear understanding of results and understandings relating to the topic and research question (Cohen et al, 2010). The research question appears to have been met by these findings, diminutive differences in the skills displayed was shown in the different games however interest was shown through the whole research project by participants and on-lookers.

What aspects of mathematical skills are being used whilst engaging in board games?

From the findings it is apparent that board games do have a positive impact on the development of young children and their early mathematical skills and this meets the main intention of the study. The main themes identified in the observations included subitising, cardinality and 1:1 correspondence. These are considered the basic skills needed for counting (Baroody and Benson, 2001); the observations recorded show that this teaching strategy supports these skills indefinitely. These mathematical skills are crucial at this stage as it is understood that all children must be confident and proficient with the basic skills before they are able to progress to learning at key stage one level (Sarama and Clements, 2009). It can be recognised from all observations that the participants are using play based learning to develop basic principles through a process of operating and manipulating concrete materials. This study was proven to be time consuming and challenging for the researcher as few children were not sufficient in the basic counting skills needed, this often lead to some participants double tagging the numbers on the dice or been unaware of the numbers shown on the dice, also participants would double tag spaces on the board, this is seen to be a common misconception of early counting (Dolk and Twomey Fosnet, 2001; Cockburn and Littler, 2008). The need for a more knowledgeable other was apparent in all observations one, two, three and four (Appendix 4, 7 and 9), without a more knowledgeable other participants mistakes and misunderstanding would not be rectified, however as the participants became more aware of how to play the games they were able to support peers and self-correct any misconceptions, also more able participants with the basic mathematical skills needed were willing and able to provide further support to the group. This supports Vygotsky’s theory for the need of a more knowledgeable other in order to allow participants to exceed their zone of proximal development (Bee and Boyd,2010; Reys et al 2015)
Are children actively engaged and absorbed in the games used?

High levels of involvement were shown in all observations from participants, it was identified that children who hadn’t engaged in board games in their home environment were more actively engaged in the games used however on occasion required further provision. The interviews provided the researcher with the information of which participants had experience of board games outside of the school environment and which participants hadn’t. Using Laevers scale of involvement theory has allowed the involvement levels to be identified appropriately. On occasions it was seen that some participants in particular Participant 1 did lose focus, this was seen to be due to the misconception of probability and the intention of winning the games. More involvement was identified in observation 3 and 4 by this particular participant and also other participants (appendix 9 and 11), this is thought to be due to the fact that the participants were required to take an active role in physically making their own game and integrated their own interests into their learning (Vygotsky, 1978; Tucker, 2010), Also the final game played by the participants in observation four was less time consuming that the others and slightly more challenging due to it having two dice rather than the one.
The ideas of Sieglar and Ramani (2008) and Cavanagh (2008) who all confirmed the use of board games can raise attainment for children coming from low-income families were supported in these studies.

**What are the prospects for mathematical graphics?**
Opportunities for making mathematical marks were not identified to be liberal from reflection on the research observations and photographs, making mathematical marks were reinforced by the researcher, without the presence of an adult supervisor the prospects for mathematical graphics may be non-existent. To encourage this skill to be developed, the board games may need to be specifically made with new rules to meet these goals and intended outcomes for participants to progress. Also modelling these skills is required by the supervising adult in order to introduce mathematical graphics. These findings support the ideas of Worthington and Carruthus (2006) who found that teachers of children aged between 3-7 are unsure how to provide opportunities for mathematical mark making as the mark making only occurred when children were prompted, However these games did enable children to work collaboratively to share and construct knowledge in a social context (Bruner, 1991: Tucker, 2010).

**Can this teaching strategy be used to measure mathematical development?**
The findings from this study specify individual abilities relating to basic mathematical skills, suggesting that this approach is an effective tool of assessing children’s development. This research focuses on specific mathematical skills in order to meet the research question; these specific skills were identified as stepping stones to enable children to acquire basic mathematical awareness by many researchers in the literature review. This approach could be enhanced and designed by practitioners to meet specific learning goals; this would then permit this teaching strategy to become a highly effective tool for assessment in order to identify the current knowledge and understanding of each participant. The researcher is able to easily assess the abilities of the children using this approach therefore argues that this approach is an effective tool towards formative and summative assessments, as underlined by Fox and Surtees (2010 ) both forms are vital to identify the stage of each child and plan for the next steps of learning (Fox and Surtees, 2010). The limitations to using this strategy to measure mathematical development is the lack of moral development and understanding what is expected, for example from the findings it can be seen that participants would prefer to not follow the instructions and try to finish the game first instead of demonstrating their correct knowledge of number acquisition. This could lead to inadequate findings, although this is seen to be rare throughout the study and the level of involvement shown by the participants outweighs this restraint.

**Conclusion**
The approach used in this study unmistakably provides concrete opportunities for the development of early maths skills within the Early Years. The understanding of teaching approaches has being developed by the researcher and the relevance of mathematical graphics has being revealed. It is acknowledged that differentiation is essential in order for all children to become actively engaged in these activities and maintain high levels engagement throughout, whilst being provided with the
opportunity to access a choice of games at their own level. The skills and knowledge acquired by the researcher from this study will be used in order to improve future practice within the Foundation Stage and has generated possibilities for change. The results appear to support the main research questions and show strong indications of the board games impacting on early mathematics. This study has provided substantial feedback as a result of a cyclical process.

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