Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives

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Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives

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ABSTRACT

This study explored Irish teachers' perspectives on the use of cooperative learning methodology in mathematics in primary school. Research questions addressed frequency and types of cooperative learning used by teachers, as well as its benefits and challenges. A mixed method approach, informed by pragmatist philosophical paradigm, was taken, with quantitative data gathered from 21 questionnaires, and qualitative data from two semi-structured interviews. Findings suggest that half of teachers use structured types of cooperative learning on a regular basis. According to participating teachers, the most significant benefits of CL are academic gains, improved social skills, and language development, while the most significant challenges are a range of academic ability among pupils, pupil relationships and behaviour management, and organisational issues.

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LIST OF ABBREVIATIONS

Cooperative learning (CL)

National Council for Curriculum and Assessment (NCCA)

CHAPTER 1 - INTRODUCTION

1.1 Introduction

Mathematics is one of the three core subjects in Irish primary schools and widely considered crucial for all future scientific education of children (NCCA, 1999b). A substantial body of research has been devoted to identifying the most effective ways of developing pupils' mathematics competence (Frid and Sparrow, 2009). One such effective methodology is cooperative learning (Bentham, 2002; Boaler, 2022).

This chapter provides an overview of this research project that focused on the use of cooperative learning in mathematics in primary schools in Ireland. It outlines the origin, background, and rationale for the study, followed by the dissertation layout.

1.2 Origin of the Dissertation

The researcher's own interest in and experience of teaching mathematics has led her to formulate the concept for this research project. When working as a substitute teacher in fifth class in an urban school, she invited pupils to engage in cooperative problem solving. Pupils seemed reluctant to work together and said, 'We are not allowed to work together in maths.' That surprising statement inspired a question of how many children in Ireland have a similar experience, or put differently, how many Irish teachers employ cooperative learning in their teaching of mathematics.

1.3 Background of the Project

Cooperative learning, together with other child-centred methodologies, stems from the constructivist approach in education (Bentham, 2002; Adams, 2006). It has been widely researched in different subject areas, including mathematics, and has been demonstrated to be effective in enhancing pupils' learning in various developmental areas, such as cognitive, social, and language development (Kalina and Powell, 2009). At the same time, there is conflicting research on frequency of use of this methodology in mathematics in different countries (Slavin, 2011). Experts in the area point to a plethora of challenges to its implementation that need to be fully understood to better support teachers in utilising cooperative learning in mathematics (ibid.).

1.4 Rationale

The Irish primary mathematics curriculum presents Irish teachers with broad aims and explicitly names cooperative learning as one of the main methodologies to be employed in the educational process (NCCA, 1999b). However, little is known about the employment of CL by Irish primary school teachers. There is scarcity of research on the use of this methodology in any subject area, including mathematics (Byrne and Prendville, 2020).

The aim of this study was to address this gap in knowledge on the use of cooperative learning in the teaching and learning of mathematics at the primary level in Irish schools. The study aimed to create a picture of the extent of the use of this methodology, its types, what strands teachers use it in, and the teachers' perspectives on its challenges and benefits in mathematics.

1.5 Dissertation Layout

The Dissertation consists of six chapters. The first one, Introduction, outlines the origin, background, and rationale of the study. The second chapter, Literature Review, provides an overview of Irish and international literature on cooperative learning methodology, its philosophical origins and implementation, with particular emphasis on the area of mathematics. The third chapter, Methodology, describes the methods used to conduct the study, their philosophical grounding, sampling, data analysis, and study limitations. The fourth chapter, Findings, presents findings from both the qualitative and quantitative parts of the study. The fifth chapter, Discussion, analyses the findings in light of the literature on the topic. The final chapter, Conclusion, draws on the Discussion to reflect on the overall findings from the study and on its limitations, and to offer some recommendations for future research and practice.

1.6 Conclusion

In order to ensure best practices of mathematics teaching and learning in Irish classrooms, teachers' views need to be explored and understood so that effective methodologies, such as cooperative learning, can be implemented successfully (Slavin, 2011). The study explored these views and experiences in order to add to the scarce body of research that had been performed in this area in Ireland thus far.

This chapter presented the origin of this research project, with the theoretical background and rationale for the study. The research aims were introduced and explained by presenting the background of the topic of cooperative learning and study of mathematics in the Irish context. The next chapter explores the literature on the topic of cooperative learning in general and in the field of mathematics in particular.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

This chapter provides a critical analysis of literature on the use of cooperative learning. It starts with the definition of CL, its origins and philosophical background, followed by presentation of different types of CL and its benefits for different areas of pupil functioning. It moves on to discussing implementation of CL in mathematics, with benefits and challenges in this area, after which it paints a picture of what is known about CL in mathematics in the Irish context. At the end it presents the research questions as they emerge from the critical review of the literature and research data.

2.2 Cooperative learning – definition, origin and benefits

Cooperative learning refers to methodology of organising pupils into small groups in which they share responsibility for each other's learning (Johnson and Johnson, 2009; Slavin, 2012). It has been popularised and implemented on many levels of education and in different academic areas for the last forty years. It has a robust basis in theory and has been widely researched (ibid.).

The concept of cooperative learning can be traced back to John Dewey, a philosopher and educationalist, who promoted the idea of children engaging in discovery learning and stimulating activities in collaboration with others (Schon, 1992).

These premises are also prominent within the constructivist approach to education, formulated by Piaget and Vygotsky (McCarthy, 2006). According to constructivism, children are active participants in their own learning, not mere recipients of knowledge received from others; they need to construct their understanding while engaging in stimulating activities and all the learning happens within a social context. Vygotsky, the father of social constructivism, created a concept of zone of proximal development which he defined as:

"distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p.86, cited in Davidson, 2021).

According to Vygotsky, as children are most likely to operate within each other's zone of proximal development, they will stimulate each other's learning when working together.

Piaget claimed that social interactions are necessary for individuals to acquire all that is mediated socially, such as language, norms, rules, or symbol systems. Piaget coined the term 'disequilibrium' which is central to a child's mental growth and the development of his mathematical reasoning. Interactions with peers are central to challenging a child's current conceptualising and therefore support development by disturbing the equilibrium (McCarthy, 2006; Boaler, 2022).

Engagement in cooperative learning activities support children's cognitive development as they allow them to practise new skills, to be exposed to the next steps they need to take in their learning, to elaborate on what they are learning and to use language in the process.

Many different well-defined types of cooperative learning have been developed over the last forty years. Among the most prominent, listed by Davidson (2021), are: Think-Pair-Share (Nyman), Jigsaw (Aaronson), Group investigation (Sharan and Sharan), Constructive controversy (Johnson and Johnson), Co-op co-op and Numbered heads together (Kagan), Student Teams Achievement Divisions (STAD), Teams-Games-Tournaments (TGT), Team-Assisted Individualization (TAI), Success for All (Slavin and Madden).

Even though there is a great variety of methods, and their theorists and practitioners place an emphasis on different elements of cooperative learning, all the approaches share some essential elements that have been proven to be effective in the extensive body of research as well. Davidson (2021) composed a synthesis of critical attributes of cooperative learning approaches: group task, individual accountability, positive interdependence, cooperative behaviour norms and focused group interaction and discussion.

There now exist an extensive body of evidence to its positive effects in a range of subjects and age groups. It has positive impact on a range of outcomes – academic achievement, language acquisition, critical thinking skills, conceptual development, motivation and attitudes towards subjects, social cohesion, relations with peers, inclusion of pupils with special needs, behaviour in class (Murphy, Grey and Honan, 2005; Slavin, 2003; Fujita, Doney, Flanagan and Wegerif, 2021).

2.3 Cooperative learning in mathematics

There has been an abundance of research studies conducted on the topic of methodologies most effective in the teaching and learning of mathematics, especially in the area of academic achievement but also in such aspects as students' attitudes to and interest in the subject.

A common thread in the various research projects is that it juxtaposes the 'new' constructivist approach to 'doing' mathematics in the classroom with the traditional 'transmission' model (Swan, 2006; Savelsbergh, Prins, Rietbergen, Fechner, Vaessen, Draijer, and Bakker, 2016; Boaler, 2022). Research shows that the transmission model of teaching mathematics results in pupils memorising a series of what they perceive to be unrelated facts that do not require reasoning and are not of transferable value (Swan, 2006; Boaler, 2022).

The aim of the newer, alternative approaches is to engage pupils in sense making, discussing, sharing ideas and creating mathematics together so that they perceive mathematics as a practical and creative subject that they can succeed in and use in practical applications (Swan, 2006; O'Shea and Leavy, 2013). All those new approaches and strategies share some common features, and the use of cooperative learning is prominent among them. In fact, they require the use of cooperative learning if pupils are to engage in discussions and sense making instead of being handed down a list of procedures to follow (Mercer and Sams, 2006; Boaler, 2022).

It has been noted numerous times that even though small children express an enthusiasm for mathematics and science for the first few years of primary school, that interest tends to wane in the middle and senior classes. With the decreasing interest, a change in the pupils' attitude towards mathematics can be observed, from a positive to a more negative one. One of the effects measured in the research on non-traditional methodologies of teaching mathematics is that of a change in pupils' attitude towards mathematics towards a more positive one. Savelsbergh et al. (2016) conducted a meta-analysis of 56 studies that checked for effects of 'interest-oriented' teaching approaches in mathematics, one of them being collaborative learning strategies, on both academic achievement and attitude of students. Results showed that all of approaches resulted in improved academic performance and more positive attitude of students towards the subjects of mathematics. As the researchers conclude, there is overwhelming evidence that employment of 'interest-oriented' methodologies in mathematics is a worthwhile endeavour.

A systematic review of close to a hundred studies on the effects of student-centred strategies on academic achievement in mathematics performed by Tumkaya and Ulum (2020) revealed a significant positive change in the experimental groups. Collaborative Learning, together with Realistic Mathematics Education and Computer Assisted Teaching Method, was identified as one of the most prominent methods.

Capar (2015) performed a meta-analysis of twenty-six international studies which showed that cooperative learning had a positive effect on both academic achievement and pupil attitudes towards mathematics. Similar results can be found in numerous quasi-experimental studies conducted in primary and secondary schools internationally (Johnson and Johnson, 2002; Davidson, 2021).

Cooperative learning has been found to be an effective method of fostering engagement in, enjoyment and understanding of mathematics in numerous studies. Attitude, motivation and interest have been shown to be determinants of depth and quality of learning and student persistence (Savelsbergh at al., 2016). What is more, it has now been proven that the employment of interest-oriented approaches does not happen to the detriment of academic achievement, on the contrary, it enhances it (ibid.).

2.4 Challenges to use of cooperative learning in mathematics

Even though most researchers and educators consider collaborative learning to be effective, it has not become common practise in the classrooms (Gatton and Hargreaves, 2009). While some researchers point to a widespread use of cooperative learning methods in the classrooms of primary schools (Slavin, 2012), others suggest and bemoan the opposite – a limited use of mostly unstructured forms (Galton and Hargreaves, 2009). Some research shows indeed that cooperative learning is used infrequently especially for the core subjects such as mathematics and English (Swan, 2006; Buchs, Filippou, Pulfrey, and Volpé, 2017; Fujita, Doney, Flanagan and Wegerif, 2021). There therefore seems to be a huge discrepancy in educators' practice on an international scale.

In addition, more often than not, it is its informal and unstructured forms that do not have firm research backing that are practised. However, simply placing children in small groups and telling them to work together does not necessarily result in effective group work (Johnson and Johnson, 2009; Slavin, 2012; Fujita et al., 2021).

Even though the use of cooperative learning methodology in mathematics has been proven to bring positive results in various aspects of pupils' functioning, its implementation is not without challenges. These challenges are most probably causes of teachers' reluctance or inability to use cooperative learning, so they need to be understood further if this methodology is to become more popular and effectively used in classrooms (Slavin, 2012; Buchs et al., 2017; Langer-Osuna, 2017; Davidson, 2021).

Langer-Osuna (2017) focused on the issue of student intellectual authority and how its impacts on effectiveness of students working in groups. One of key characteristics of collaborative mathematics classrooms is a distribution of authority among teacher and students. In such a situation, relationships of power within the peer group regardless of mathematical competence will have a strong impact on authority held by different students during mathematical group learning. That, in turn will decide whose ideas are listened to, taken up or ignored. In addition, student social identities, such as belonging to minority groups or being a girl, have an impact on the relationships of authority in a class as well. Full consideration of these issues can support such an organisation of students' work that it maximises chances for constructive and effective group learning.

Complexities of dynamics within cooperative groups in mathematics class and their impact on students' goals were the focus of research conducted by Summers (2006). According to research, students' achievement motivation in mathematics drops in the upper primary classes while social goals gain in significance at that time. Pupils pursue academic and social goals simultaneously when engaging in group work in mathematics. Hence, Summers investigated changes in students' group and individual motivation resulting from engagement in collaborative learning in 6th class. The results showed that students became more performance avoidant over time as a function of group membership. This finding has important implications for classroom practice as it points to some potential negative effects of engaging students in cooperative learning.

Another challenge related to the use of cooperative learning is linked to the social constructivist approach that it stems from. According to O'Shea and Leavy (2013) social constructivism poses a special challenge to teachers as it is a theory of learning, not teaching. As such, it requires teachers to translate the principles of pupils learning into instructional strategies. This process demands a deep understanding of the learning processes and which

teaching strategies and techniques can answer the pupils' needs. Hence, a great number of teachers find the challenge too demanding (ibid.).

Buchs et al. (2017) conducted research exploring difficulties teachers face when implementing cooperative learning. They list the following areas as the main sources of challenges for teachers: 'implementing cooperative learning principles, locus of responsibility and authority, the teacher's role as facilitator, alignment with curriculum, class and preparation time and assessment' (p.3-4). Results of the study showed significance of teachers' beliefs regarding learning as well as pragmatic obstacles such as curriculum and time requirements. The authors suggest these issues should be addressed in the teacher education programmes so that teachers are more prepared to implement cooperative learning methodologies.

2.5 Cooperative learning – Irish context

Collaborative learning is among the methodologies recommended in the current Irish Primary School Curriculum Introduction (NCCA, 1999c). The Introduction stems from a particular philosophical view of education itself, and it is closely linked to the content and methodologies presented in the curriculum and the central role of the child in the educational process.

That curriculum stems clearly from the constructivist approach in educational psychology as it treats the child as an active participant in his own learning, talks about the importance of active and discovery learning, the importance of social relationships and language to child's development and uses the concept of teachers as facilitators of children's learning (McCarthy, 2006).

The Curriculum Introduction calls collaborative learning one of the underlying principles of the curriculum and states that it 'should feature in the learning process' and that 'working collaboratively provides learning opportunities that have particular advantages' (NCCA, 1999c, p.8 and p.17). In addition, the curriculum recognises social and emotional dimensions and language as factors central to the learning process.

The mathematics curriculum refers directly to the constructivist approach to mathematics learning (NCCA, 1999a). It calls for active engagement of the child in the learning process

through experimentation and discussions among peers and pupils and teachers. Language is thought to be of special significance for development of mathematical skills and knowledge. One of the aims of the curriculum is to enable the child to use mathematical language competently. The curriculum refers here directly to the role of collaborative methodology in supporting language development by suggesting that 'The child may be helped to clarify ideas and reduce dependence on the teacher by discussing concepts and processes with other children' (NCCA, 1999a, p.6).

Regarding current practice of employing collaborative learning methodology in the teaching of mathematics in primary schools in Ireland, little research has been done to explore this area.

Byrne and Prendville (2020) conducted research investigating the potential of social interactions with peers in assisting the development of mathematical language of pupils of 4th class in the measures strand. Based on the results of their research, they concluded that engagement in collaborative group work can support development of mathematical language as pupils from the experimental group showed greater ability to use that language, especially when evaluating their own practice.

O'Shea and Leavy (2013) conducted research to investigate the experience of several Irish primary school teachers of organising collaborative problem-solving lessons in mathematics from an emergent constructivist perspective. It transpired that the teachers faced such difficulties as: finding a balance between individual and group learning, creating appropriate learning experiences, accommodating constructivist philosophy in the prevalent conservatist culture in the Irish schools that does not encourage teaching for understanding and dealing with societal expectations. What is more, teachers' identity, beliefs, knowledge, experience as well as school context and curriculum have an impact on implementation of constructivist approach in the teaching of mathematics.

2.6 Research questions and conclusion

Considering the importance placed on the cooperative learning methodology in the Irish Primary Curriculum and rich body of scientific evidence on its effectiveness in mathematics instruction, there is scarcity of data about its use in teaching of mathematics in Irish primary schools. Therefore, the focus of this study was to address this gap in knowledge by examining

the perspectives of Irish primary school teachers on the use of cooperative learning in the teaching of mathematics.

The following research questions were formulated by the researcher:

1. To what extent do Irish teachers use cooperative learning methodology in teaching mathematics at primary level? In what strands do they use it?

2. How do they apply the cooperative learning methodology in mathematics lessons?

3. What do they perceive to be the benefits and challenges to its use?

The next chapter presents methodology chosen to conduct the study aimed to address the research questions.

CHAPTER 3 - METHODOLOGY

3.1 Introduction

This chapter outlines methodological issues related to the study. The study's aim was to explore Irish teachers' perspectives on the use of cooperative learning methodology in the teaching and learning of mathematics in primary school. The study was informed by the pragmatist paradigm that allowed the use of methods most suitable to the study. A mixed-method approach with questionnaires and semi-structured interviews was employed. Participants of the study were primary school teachers in several urban schools with at least three years teaching experience. Data analysis included descriptive statistics for the questionnaires and thematic analysis of the interviews. Due attention was given to the issues of robustness of the research, ethical considerations, and the limitations of the study.

3.2 Research Paradigm/Philosophical Worldview

Educational research needs to be guided by a coherent theory that forms a basis for all the decisions regarding the research project (Pring, 2004; Scott and Morrison, 2006; Wright, 2008). These decisions include research questions or hypotheses, design and methods, type of data collected, data analysis, and conclusions drawn based on findings.

For a long time, there existed a dualism in educational research that stemmed from two contrasting worldviews – positivist and interpretivist, also called constructivist (Alexander, 2006; Wright, 2008). Positivist thinkers and researchers apply empiricism used in the natural sciences in the field of social sciences. They conduct larger scale, replicable, quantitative research by means of experiments (ibid.).

Interpretivists see all knowledge as a construction created by participants of an experience that is unique to individuals (Scott and Morrison, 2006; Tavallaei and Abut Talib, 2010). These researchers try to paint a detailed picture of observed phenomena, present a deep understanding of human experience, and recognise the influence of their involvement on what they study. They conduct smaller scale, qualitative research (ibid.).

This dichotomy in the field of educational research has been deemed unnecessary by some theorists who have proposed pragmatism as a third paradigm (Badley, 2003; Alexander, 2006; Hall, 2013). Some researchers have used pragmatism in a simplistic way for its 'do what works'

approach. Pragmatism, however, has a sound philosophical background and as such, can provide a holistic new approach to conducting educational research (Hall, 2013; Morgan, 2014).

That of an American pragmatist John Dewey's, can be successfully employed as theoretical grounds for a research paradigm (Alexander, 2006). According to Dewey, all inquiry, including scientific inquiry, is a process of resolving problems that arise in experience. Dewey's concept can serve as a basis for a pragmatic paradigm in research since 'pragmatism points to the importance of joining beliefs and actions in a process of inquiry that underlies any search for knowledge' (Morgan, 2014, p.7).

Pragmatism adopts an eclectic, open approach to different scientific methods, and considers which methods are best applied to answer the research questions at hand, as it assumes existence of both 'objective' reality and its social constructs (Badley, 2003; Alexander, 2006). Pragmatism is the philosophical worldview that guided this research project.

3.3 Research Design

In line with pragmatism, an open approach was taken when considering the research design and methods. Creating a general picture of the extent to which primary school teachers use cooperative learning in mathematics was a complex task. Hence, there was a need to obtain some numerical, quantitative data. Understanding the perceptions of teachers regarding the benefits and challenges of cooperative learning methodology was another aim of the study. Descriptive, in-depth qualitative data was needed for this part of the project.

Hence, a mixed-method approach was chosen for the research design. Mixed-methods approach offers such advantages as: integration of both numerical and narrative data, more accurate and complete picture of a phenomenon, and increased accuracy of data (Cohen, Morrison and Manion, 2011; Whitaker and Fitzpatrick, 2021).

A mixed-method sequential explanatory design with two different data collection points was used (Scott and Morrison, 2006). It started with surveying a group of teachers, thus collecting quantitative data from questionnaires since 'a survey study may be regarded as a snapshot of a situation at a particular time' (Wolf, 2005, p.28).

In the second phase of the project, qualitative data was collected from semi-structured interviews with two teachers. The use of this type of interviews allows researchers to 'seek in-depth understandings about the experiences of individuals and groups, commonly drawing from a small sample of people, frequently selected purposively' since the interviewees are free to use their own words and refer to themes that are not previously predetermined by the researcher (Scott and Morrison, 2006, p.134).

The use of questionnaires allowed to gather answers to the 'what' questions, while the interviews allowed to gather answers to the 'why' and 'how' questions (Scott and Morrison, 2006). Both the questionnaires and the interview questions were designed by the researcher herself.

Ahead of administering the questionnaires and conducting the interviews, both methods were piloted on one teacher colleague to ensure that the methods were clear, unbiased, would provide answers to the research questions, and required an acceptable level of time commitment.

3.4 Sampling & Participants

With regards to the two major types of sampling, probability or non-probability, their practical limitations were considered. There are serious disadvantages to using non-probability sampling, such as its lack of being representative and so having a high chance of bias (Wolf, 2005; Cohen, Morrison and Manion, 2011). However, the short time frame and small scale of the research did not allow to implement probability sampling. Hence, purposive and convenience sampling was used for both the questionnaires and the interviews. Still, an attempt was made to gather as representative a sample to participate in the quantitative part of the research as possible.

Thirty paper questionnaires were distributed to primary school teachers in three different urban primary schools. Two of the schools have a DEIS status. All the schools are two-stream and co-educational. The schools had been known to the researcher through her school placement and substitute teaching experiences.

Twenty-one questionnaires were returned to the researcher for analysis. The questionnaires were filled in on a voluntary basis by teachers who met inclusion criteria. The inclusion criteria

were being a full-time class teacher for at least three years, and the classes taught ranging from 1st to 6th class. Teachers of infant classes were excluded from the research project due to particularities of early years education.

The two teachers who participated in the interview part of the research were purposely chosen from the group of teachers who expressed an interest in being interviewed. They were chosen due to substantial teaching experience (more than ten years in both cases).

3.5 Data Analysis

Data from the questionnaires were exported to Microsoft Excel and then cleaned, annotated, and represented in graphical forms. The results of the questionnaires were organised into several broad categories that were guided by evidence gathered from literature review. Descriptive statistics were conducted on the numerical data.

The two semi-structured interviews were conducted by the researcher herself in the second, qualitative phase of the research project. They were fully recorded on the researcher's mobile phone and then transcribed. The transcripts were used for thematic analysis (Braun and Clarke, 2006). A phased approach was followed by the researcher when analysing the data. It consisted of the following stages: familiarisation with the data, generating initial codes, searching for common themes, reviewing, and defining of the themes, and finally discussing findings in a written form (ibid). This process, however, was not linear, and involved moving between different stages according to the need to clarify and refine the themes (Maguire and Delahunt, 2017).

3.6 Robustness of the research

The issue of robustness of any research project, that is of its validity and reliability, are of paramount importance if the results of the research are to bear any meaning (Scott and Morrison, 2006; Whitaker and Fitzpatrick, 2021).

Validity and reliability are viewed and treated differently in quantitative and qualitative research, hence a research project that uses a mixed-method approach will also use a mixture of approaches to these measures of robustness (Cohen, Morrison and Manion, 2011). In quantitative research, validity centres around issues of controllability, replicability, predictability, objectivity, and sample randomisation. In qualitative research, the term

‘validity’ itself is often replaced with that of ‘understanding‘ which centres around richness of data, depth and breadth of analysis, and researcher’s honesty and attention in discussing his involvement in research (ibid.).

The use of mixed methods, by combining varied approaches to data gathering and analysis, has some huge advantages such as enhancing credibility of findings (Hall, 2013).

One of the main sources of validity in this mixed-methods research project was methodological triangulation as two different methods were used. The use of triangulations ensures a richer and more diverse data and provides an opportunity to compare results from the two different methods hence heightening the validity of research (Scott and Morrison, 2006).

Validity of the quantitative data in the research described here was maximised by triangulation where data obtained from interviews was compared with data obtained from questionnaires.

Validity of the qualitative data, on the other hand, was also maximised by recording of the interviews and transcribing them, storing the raw data for future reference, use of open questions that avoided bias and allowed the participants to present their own points of view, and the researcher’s scrutiny of her own attitudes towards the research topic.

Another crucial measure of robustness of any research project, namely reliability, refers to how accurate the results are. In quantitative research, it deals with issues of stability, equivalence, and internal consistency. Maximum reliability of the questionnaire data was ensured by analysing the data in accordance with a recognised framework, scrutinising internal consistency, and piloting the method ahead of conducting the research (Whitaker and Fitzpatrick, 2021).

In qualitative research, however, many theorists contest the use of the term ‘reliability’ and replace it with the term ‘dependability’ (Cohen, Morrison and Manion, 2011). Dependability of the interview data was maximised by its accurate recording and transcription, careful thematic analysis, and inclusion of the full range of data.

3.7 Ethical considerations

When planning and conducting the research, due care was taken to ensure that the participants would not experience any harm due to participation in the research project. At every stage of the study, 'Ethical Guidelines for Educational Research' were followed (British Educational Research Association, BERA, 2018). Prior to commencing the data gathering phase of the research, full ethical consent was obtained by the researcher from the Hibernia College Ethics Committee.

At all phases of the research project, the principles of respect, justice, autonomy, and informed consent were applied (Scott and Morrison, 2006; Whitaker and Fitzpatrick, 2021).

All participants were provided with information letters. Afterwards, all participants filled out consent forms and received clear information of their right to withdraw from the research at any point.

All the questionnaire and interview data were stored anonymously and confidentially, which all the participants were made aware of as well. The participants were informed that they could receive access to their own data at any stage, up to three years following research, as that is the time frame defined by the Hibernia College for storage of research data.

Another means of ensuring the ethical nature of the study was the pragmatic worldview represented by the researcher. One of the consequences of this approach is a deep respect for all research participants, viewing them as partners, and ensuring their voice and needs are answered at all phases of the project (Hall, 2013; Morgan, 2014).

3.8 Limitations

Due to the small scale of the project, there are several limitations that need to be considered. Firstly, the small size of the sample does not allow for the results of the research to be applicable to a wider population of Irish teachers. Convenience sampling means that the sample is not representative of a general population of Irish teachers; the sampling error was not calculated either.

Another source of the project's limited scientific value is the fact that the questionnaire was developed by the researcher. Its validity and reliability measures were not calculated due to small scale of the study; hence these values are unknown. All these issues are of crucial

importance if the results are to be considered valid and reliable (Walt, 2005; Whitaker and Fitzpatrick, 2021).

Furthermore, only descriptive statistics were carried out on the results of the questionnaires. Ideally, further statistical analysis would consist of more complex tests that would allow for deeper understanding of the relationship between the variables.

Despite all these limitations, the research findings from this project might be considered 'relatable' and are of interest as they might be useful for further studies on the topic and considered a starting point for further investigation (Bell and Waters, 2018).

3.9 Conclusion

This chapter outlined all the issues relating to the methodology of the research project. It explained the philosophical worldview represented by the researcher which guided the pragmatic research paradigm that justified the use of the mixed method. Both questionnaires and interviews were used to complete the research project. Ethical issues, robustness and limitations of the study were carefully considered. The results obtained through the methods explained here are presented in the following chapter.

CHAPTER 4 - FINDINGS

4.1 Introduction

This chapter presents data gathered in the two phases of the research: the quantitative numerical data from the questionnaires, and the qualitative data presented in themes developed from the raw interview data. There was a 70 per cent response rate for the questionnaires, as of the 30 questionnaires distributed in three different schools, 21 were completed and returned to researcher. Regarding the interview data, the teachers who were interviewed volunteered from the same school. The interviews explored in depth all the topics addressed in the questionnaires.

4.2 Questionnaire findings

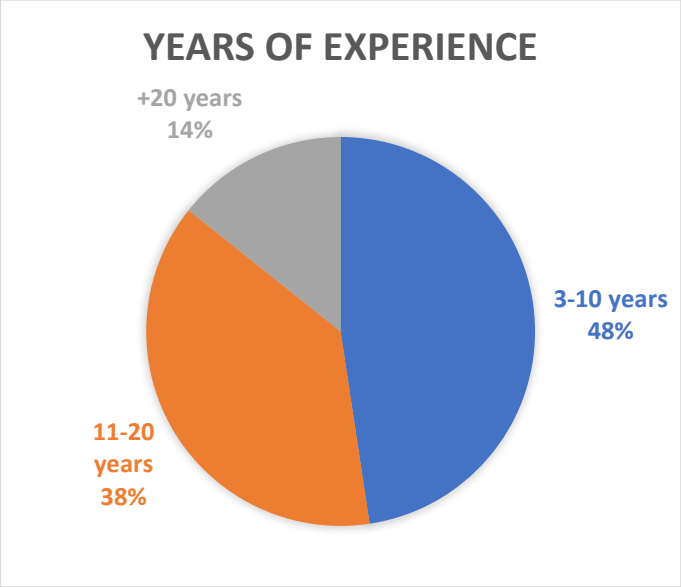

Table 1: Years of teaching experience

Of all the teachers who answered the questionnaires, almost half had 3 to 10 , more than a third had 11 to 20, and 14 percent had more than 20 years of experience. Hence, teachers with different amounts of experience were represented in the study. Teachers with less than 3 years of experience had been excluded from the study as they would not have had enough time to develop their practice to a sufficient level.

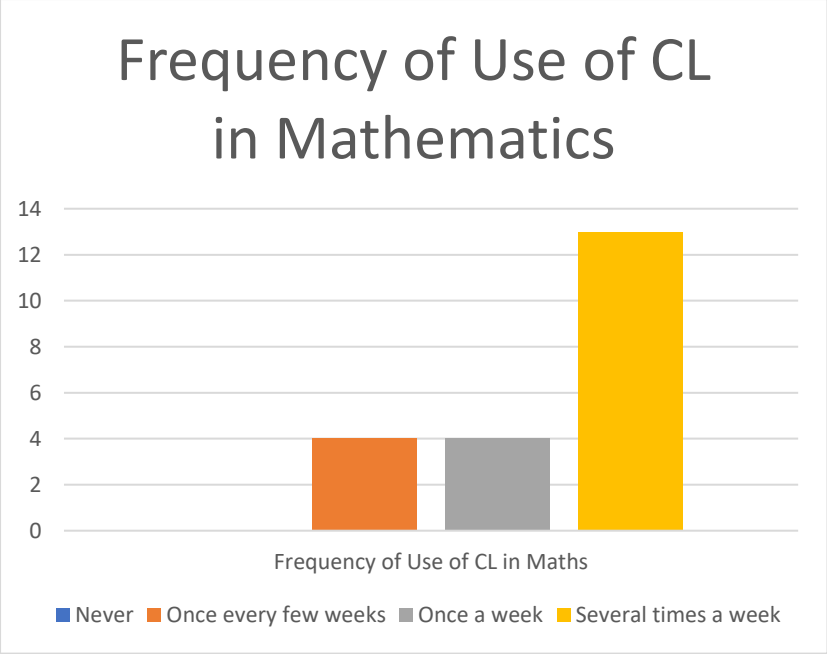

Table 2: Frequency of use of cooperative learning in mathematics

All the teachers confirmed their use of cooperative learning methodology in the teaching of mathematics in general. More than half stated that they used it several times a week, which constitutes regular use. The remaining teachers divided equally between using it once every week and once every few weeks, which constitutes irregular or infrequent use.

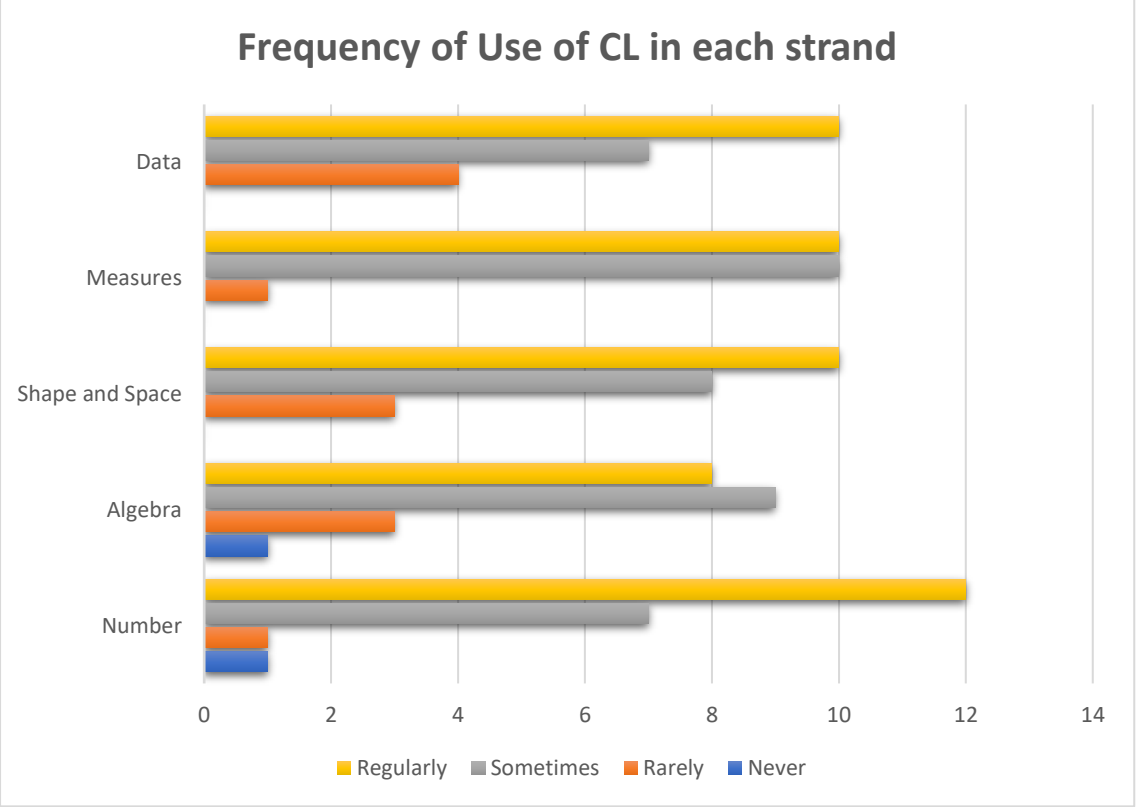

Table 3: Frequency of use of cooperative learning in each strand of mathematics.

(Regularly – most lessons, sometimes – about once a week, rarely – 1-3 times a month)

When it comes to the frequency of teachers' use of CL in different strands in mathematics, half of them reported using cooperative learning regularly in all the strands. Of the remaining teachers, the majority engaged pupils in cooperative learning in all the strands about once a week, with only some teachers using it rarely. Number and Algebra were reported as the only strands in which some teachers never used cooperative learning.

Based on these numbers, it can be said that about half of the teachers use cooperative learning in all the strands regularly while the other half use it irregularly or infrequently.

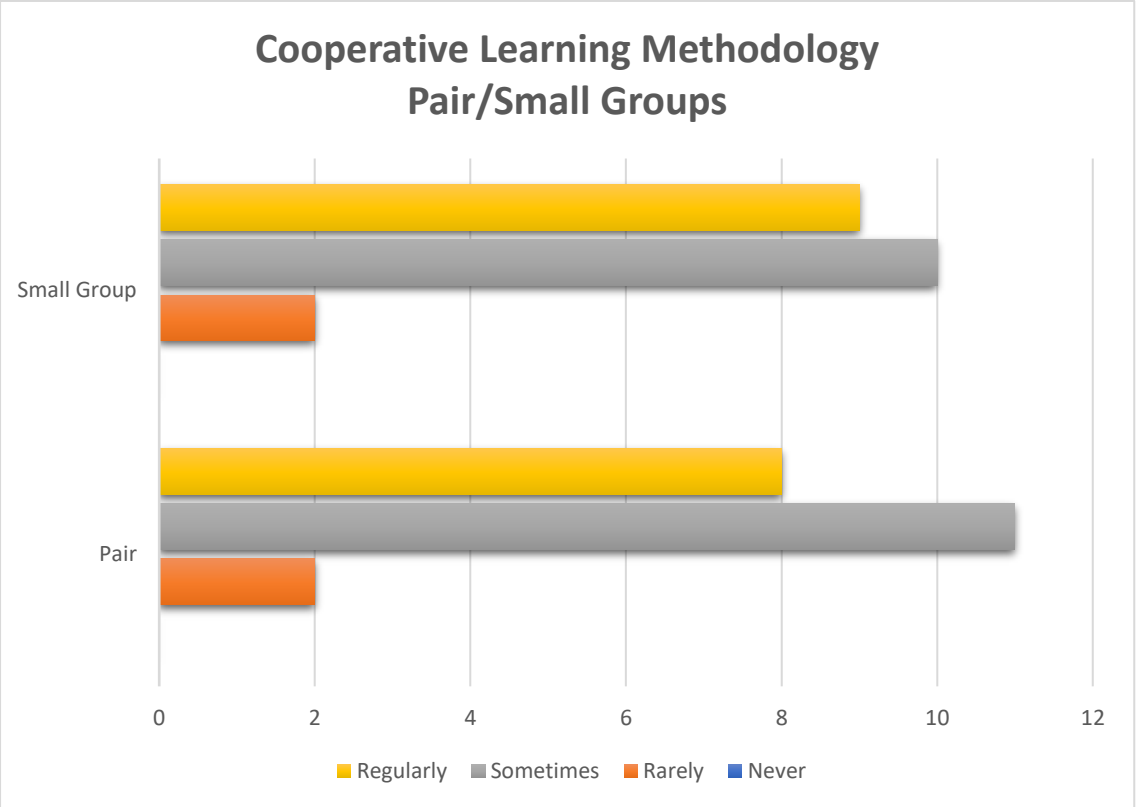

Table 4: Frequency of use of pair and small group work in mathematics

(Regularly – most lessons, sometimes – about once a week, rarely – 1-3 times a month)

Both pair and group work were used by all the participants in the study. None of the participants used only one of these types of CL, the numbers of teachers using each of them were very similar. Half of the participants used small group or pair work sometimes, while a slightly smaller group used them regularly. Only two teachers rarely used each of these types of cooperative learning.

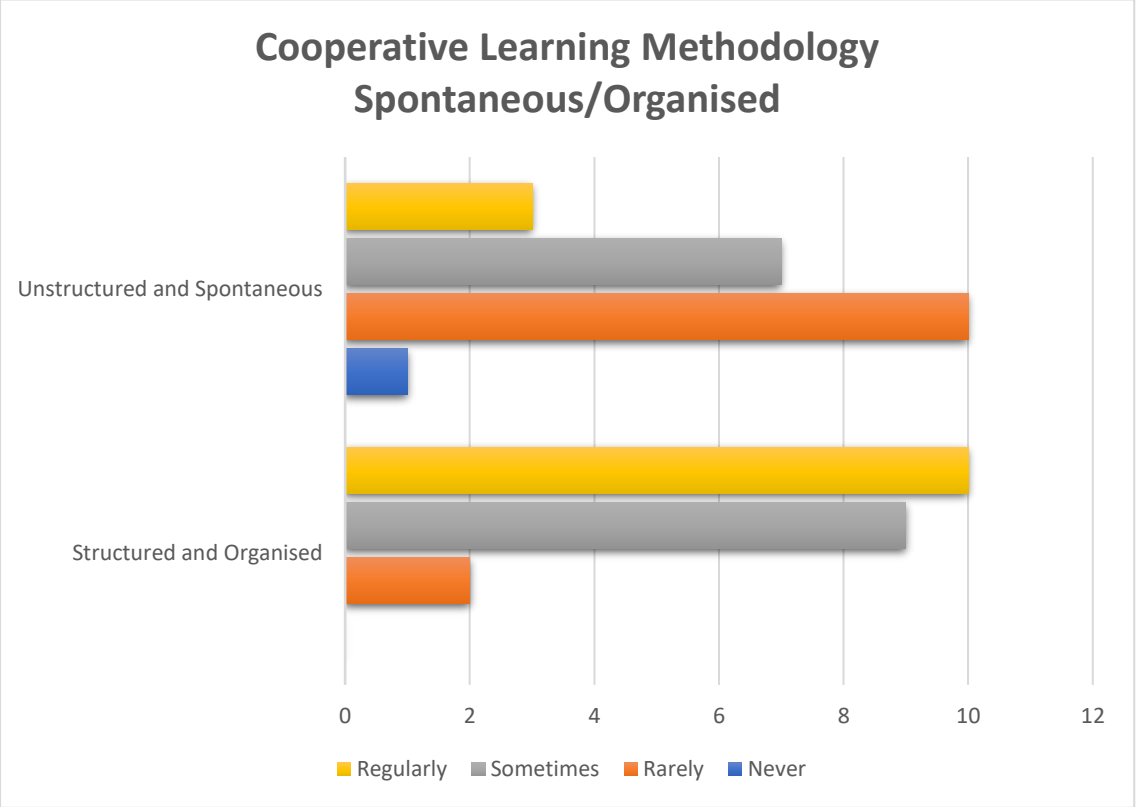

Table 5: Frequency of use of spontaneous and organised types of cooperative learning in mathematics

(Regularly – most lessons, sometimes – about once a week, rarely – 1-3 times a month)

Significantly more teachers reported using structured and organised types of cooperative learning compared with the unstructured and spontaneous types. In fact, there was a teacher who reported never using the spontaneous type. Only three teachers used the unstructured and spontaneous types regularly, with seven using them sometimes and ten rarely using them. At the same time, ten teachers use the structured and organised types of cooperative learning regularly, with eleven using them sometimes or rarely.

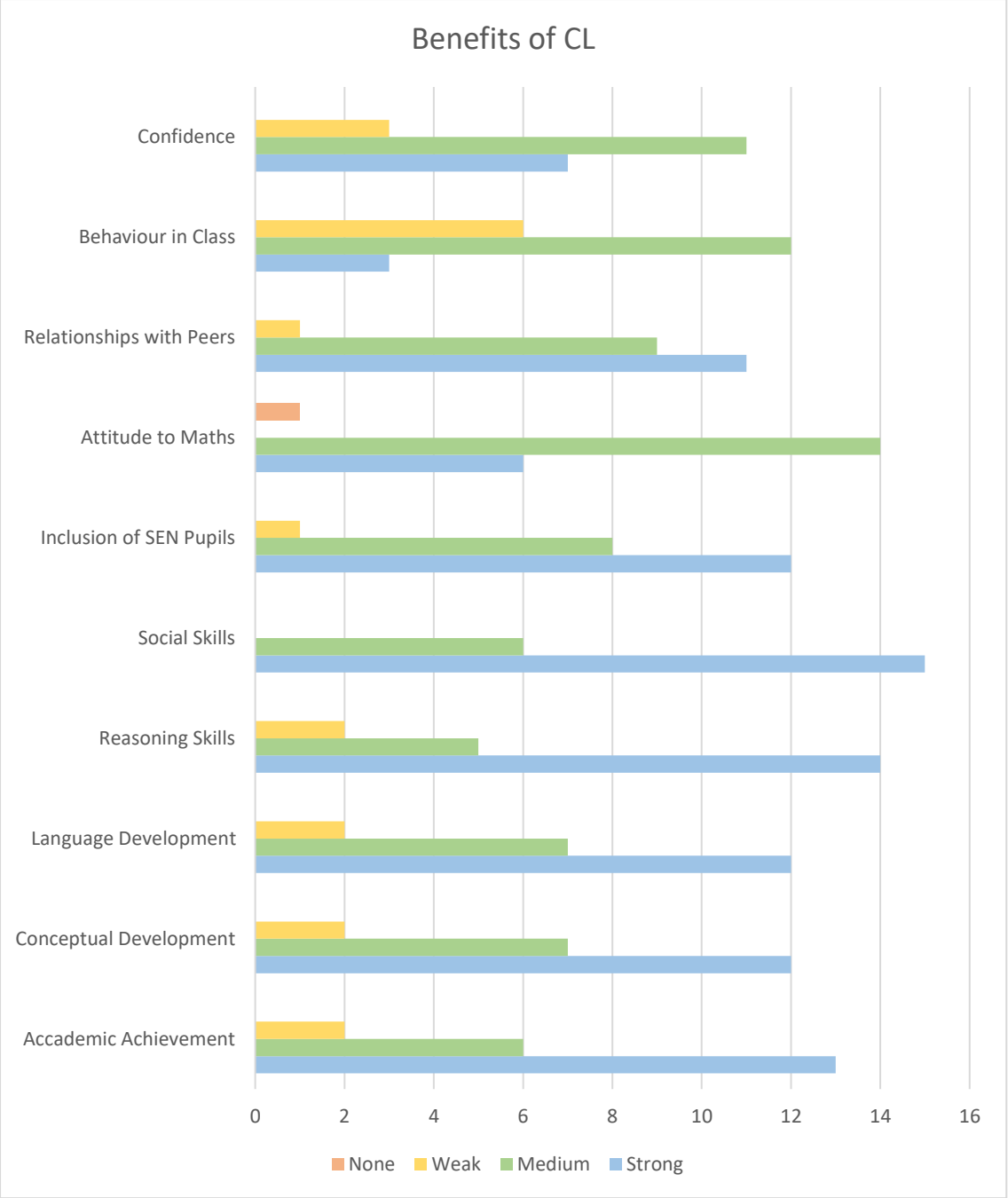

Table 6: Benefits of use of cooperative learning in mathematics

From these results, it can be seen that the vast majority of participants in the study perceived cooperative learning to have a range of benefits for pupils. Weak benefits in different areas of pupils' functioning were named by only one to three participants in most cases.

Medium benefits were named by most teachers for such categories as: attitude to mathematics, behaviour in class and confidence. Engaging pupils in cooperative learning is believed by the teachers to bring the least benefits to these three areas of pupils' functioning.

Strong benefits were named by the majority of teachers in all the other areas, namely: relationships with peers, inclusion of pupils with special educational needs, social skills, reasoning skills, language development, conceptual development, and academic achievement.

These results strongly suggest that the majority of teachers perceive CL to have multi-faceted benefits for pupils' academic and social functioning.

Table 7: Challenges to implementing cooperative learning in mathematics

With regards to the challenges to implementing cooperative learning in mathematics, the results suggest that teachers perceive there is a wide range of challenges.

The most prominent ones are: organisation of cooperative learning activities, range of academic level of pupils, pupil relationships, time demand, and organisation of resources.

The areas that appear to be a lesser source of challenge are: teacher's role as facilitator, creating appropriate cooperative learning activities, curriculum implementation, assessment, behaviour management, and insufficient training.

Data gathered from questionnaires give an indication of a wide range of issues that relate to implementation of CL in mathematics. It does not provide a clear picture on which benefits and challenges are perceived by teachers as the most pronounced.

4.3 Interview findings

Following data collection from questionnaires, two semi-structured interviews were conducted to further explore all the topics from the questionnaires, and to gather individual teachers' viewpoints on what they experienced as especially relevant when implementing cooperative learning in teaching mathematics. Thematic analysis of the two interviews led to formulation of three main interconnected themes with several sub-themes, which are as follows:

1. Prerequisites to implementing cooperative learning activities

- resources and time
- pre-teaching
- grouping of pupils

2. Benefits of engaging pupils in cooperative learning activities

- pupil enjoyment
- social skills
- language development
- academic gains

3. Challenges to implementation of cooperative learning activities

- range of academic abilities of pupils
- pupil relationships and behaviour management

Theme 1: Prerequisites to implementing cooperative learning activities

Both interviewees talked at length about the work that they needed to complete before a lesson to ensure successful implementation of CL activities. They explicitly denied that these aspects were 'challenges' but emphasised that CL required additional work from the teacher. This aspect links directly with the challenges discussed later on in this chapter.

The first one is the organisation of resources and time required as explained by Interviewee A: '*getting all the resources (…) it's the random household items that you're walking around … trying to find…*'.

As Interviewee B answered the question on whether time demand or resources organisation were a challenge '*Not really. An extra 10 or 15 minutes in the morning to go down to the maths cupboard to get the resources, … you know that it's going to benefit the children'.*

Both interviewees emphasised the importance of detailed planning and teacher-led teaching as an introduction to cooperative learning activities that enable teachers to introduce concepts, new language involved in the lesson, and clearly assign tasks and roles to pupils.

Without these pre-teaching processes, pupils would not be able to benefit from the CL activities: *'a lot of planning, maybe more planning than if you're just doing talk at the top of the classroom because it has to be that they don't need you there with them'*. That point was also expressed numerous times by Interviewee B: '*A lot of the success of collaborative learning stems from the pre-teaching.'*

The final aspect of organising cooperative learning is grouping of pupils, which is closely related to the challenge stemming from the range of abilities of pupils. Interviewee B explained this aspect clearly: '*I'm very conscious that when I am moving the pupils, that it is a kind of a fine balance (…) when it's group work, you want a mix of pupils'.*

Theme 2: Benefits of engaging pupils in cooperative learning activities

Both teachers named a range of benefits of cooperative learning in maths, and these benefits were in their view interconnected.

The first benefit of CL as defined by Interviewee B is pupils' enjoyment: '*the children are having fun with each other. They love spending time with each other*'. Both interviewees stated that this enjoyment might translate into improved attitude to mathematics, confidence, and academic gains. Enjoyment seems to be the source of other benefits, as it makes pupils stay engaged in the activities which in turn allows them to practise their social skills, as explained by Interviewee A: '*Most of the kids like it, it makes it more fun…And… when they're having fun learning, and they're learning through play, they learn more… it develops other skills like cooperation and sharing.'*

Opportunity to practise social skills was discussed at length as expressed here by Interviewee A: '*they're going to put everything you talk about in SPHE into practice, (…) they have to share the resources, they have to work together, they have to communicate…, take turns'.* Interviewee B linked this benefit with a challenge that pupil relationships might pose *'if you've got a group of children who aren't able to be respectful or that they find social settings difficult, (…) they may not be able to respond to each other appropriately*'.

Through engaging pupils in working together, cooperative learning provides a clear path for pupils' language development, as stated by both interviewed teachers, as they referred to pupils' ability to practise using language that they had been pre-taught by the class teacher beforehand. This benefit links closely with the prerequisite of pre-teaching described above by Interviewee B.

Academic gains, such as reasoning skills and concept development, are named by the two teachers as another clear benefit. It also links to pupils' language development as children talk through their thinking process and use the new language at the same time. It is also related to pupils' decreased inhibitions as they communicate more freely with their peers rather than teachers. What is more, '*holistic development of all the skills,'* as defined by Interviewee A, allows them to '*achieve more'.*

Theme 3: Challenges to implementation of cooperative learning activities

Both interviewed teachers were clear on the challenges to implementation of CL in mathematics lessons. They repeatedly referred to the range in pupils' academic ability and to behaviour management related to relationships between pupils as two main challenges.

Interviewee A defined the first challenge clearly: *'if you have mixed ability groups, that can be the challenge to making sure you're finding a task that they can all learn from and benefit from mathematically'*. According to both teachers, when engaging pupils in CL in mathematics, there is a high risk of the 'less able' pupils being lost and fully depending on the work of the 'more able' pupils, with the 'highly able' pupils taking over and doing all the work. It then becomes the class teacher's responsibility to ensure that all the children are participating and learning: '*but for the children who have got difficulties, and if they're split up around the classroom, you are split up around the classroom and the difficulty is to try and get all those pupils'.*

Even when talking about inclusion of pupils with special educational needs, both teachers emphasised that cooperative learning can be beneficial with the condition that the pupils have a good academic level. As Interviewee A explained: *'it depends on their ability in maths, if they are weak at maths and they find it difficult, then I think it can be more challenging for them in that they might opt out and just kind of stand on the side-lines and not really take part, or they might behave in a challenging way'*.

Linked to the previous challenge is that of pupil relationships which was repeatedly named by both interviewees. As CL involves pupils working together, it gives them an opportunity to practise social skills. It also requires a certain level of these social skills, and for pupils to cooperate in a focused and respectful way. This can be too big a challenge for some children who cannot put their differences aside for the duration of a lesson as stated by Interviewee A: '*you'd always be thinking of that person can't work with that person, or that person fights with that person, or they clash, or they'll dominate the group, or they'll go off on their own, yes, you do have to think about the dynamics for it to work*'.

That leads to teachers needing to carefully consider groupings, to resolve conflict, and to monitor pupils' behaviour to the extent that it impacts on their ability to focus on the teaching

and learning: '*your ability to actually engage with them in terms of maths …, it kind of turns into just management and making sure everyone's safe and everyone's on task'.*

Interestingly, both interviewees named behaviour management as a significant potential challenge to implementing CL, while questionnaire respondents did not. Questionnaire respondents did, however, name relationships between pupils as a potential challenge, and these two categories seem to have a strong connection with each other. Behaviour management, as explained by the interviewees, can often stem from pupils' inability to cooperate with one another, or to communicate effectively. It is therefore possible that questionnaire respondents focused on the relationships as a possible challenge rather than more general behaviour management.

Another noteworthy point is that while the interviewees placed an emphasis on the importance of organising resources, they did not perceive this aspect as a challenge, contrary to what emerged from the questionnaire data. Possibly, the open format of the interview allowed the teachers to clarify the meaning while the questionnaire did not provide that option.

In many aspects, the questionnaire and interview data support each other, especially in that they both highlight a variety of benefits and similar challenges of CL.

4.4 Conclusion

This chapter presented findings obtained from the two phases of the study. The questionnaire findings gave clear indication that about half of teachers surveyed use cooperative learning in maths on a regular basis in all the strands. While the teachers saw significant benefits of implementing cooperative learning in maths in different areas of pupil functioning, they also perceived significant challenges. The interview data obtained from two interviewees shed some light on practical aspects of implementing CL in maths, and it clarified what benefits and challenges these teachers viewed as most important.

In the next chapter, these findings are discussed further in light of the current literature to establish how the implementation of CL in maths by Irish teachers compares to what is known about this area in the wider international context.

CHAPTER 5 - DISCUSSION

5.1 Introduction

This chapter presents a discussion of the research findings in light of current international research and literature on the topic of implementation of cooperative learning methodology in mathematics.

The findings are discussed following the framework of the findings chapter, starting with the numerical data on the types and frequency of teachers' use of CL in maths, followed by potential benefits of CL use, and finally by challenges to implementation of CL in mathematics lessons. The theme of prerequisites to implementing CL will be discussed together with the challenges, as these two areas are logically connected, and the prerequisites are discussed in the literature on the topic as challenges.

5.2 Types of CL and frequency of its use in mathematics

The results of the study offer valuable insights into the amount and types of cooperative learning used by Irish teachers in the area of mathematics, especially in light of scarcity of data in this area (Byrne and Prendville, 2020).

As about half of surveyed teachers reported using cooperative learning in mathematics lessons on a regular basis and in all strands, it stands in contradiction to finding of these researchers who claim that CL is still used scarcely and mostly in its unstructured forms (Swan, 2006; Galton and Hargreaves, 2009; Buchs, Filippou, Pulfrey, and Volpé, 2017; Fujita, Doney, Flanagan and Wegerif, 2021). On the contrary, if half of teachers is enough to claim widespread use of cooperative learning, then the findings support the views of Slavin, according to whom CL is a well-established practice at this stage (2012).

With regard to types of CL implemented by surveyed teachers, most teachers claimed that they use structured and organised types much more frequently than the unstructured and spontaneous types. This finding is a positive one suggesting that Irish teachers tend to use CL in its more effective forms, as it has been shown that CL needs to be planned and structured in order to fulfil its role (Johnson and Johnson, 2002; Slavin, 2012; Fujita et al., 2021).

There is another, more complex issue to be addressed at this point. Effectiveness of implementation of CL relies heavily on its critical attributes, such as positive interdependence

and individual responsibility (Johnson and Johnson, 2002; Davidson, 2021). Even though teachers claimed using structured forms of CL, they did not answer questions on implementation of the critical attributes. Hence, the details of how teachers structure their CL activities is maths are not known. This is a serious consideration for potential future research in the area.

5.3 Benefits of engaging pupils in cooperative learning activities

Both interviewees and questionnaire respondents expressed their opinion that there is a wide range of benefits of employing cooperative learning in mathematics.

The first benefit named by the two interviewed teachers, and one that according to them lies at the core of other benefits, was enjoyment that children draw from working together. This benefit links to an improved attitude towards mathematics, which is a result of children having fun when doing mathematics.

This pathway of enjoyment leading to increased and sustained interest, which in turn results in deeper and prolonged engagement with mathematics activities, explains the multi-faceted benefits of CL in academic gains in maths (Savelsbergh, Prins, Rietbergen, Fechner, Vaessen, Draijer and Bakker, 2016).

Interestingly, most questionnaire respondents did not name improved attitude towards mathematics as a significant benefit of CL, which stands in contradiction with overwhelming evidence from meta analytic studies that suggest that CL, as one of 'interest-oriented' teaching approaches, results in more positive attitude towards mathematics for students (Capar, 2015; Savelsbergh et al., 2016).

All of the research participants named a range of academic gains in mathematics as benefits of CL. These included: reasoning skills, academic achievement, and conceptual development. Here, participants' opinions coincide with results of numerous research projects, which demonstrated that employment of 'interest-oriented' approaches to mathematics enhances academic achievement (Johnson and Johnson, 2002; Savelsbergh et al., 2016; Davidson, 2021). The pathway to increased reasoning ability might be connected to another significant benefit of CL, namely language development.

Language development has been identified as a significant benefit by both questionnaire respondents and the interviewed teachers. Teachers pointed out that CL gives pupils an opportunity to practise using the new mathematical language in context and feeling more confident to practise it with their peers rather than teachers. This study corroborates what Byrne and Prendville reported from their study on how social interactions with peers support language development in the measures strand (2020). Competent use of mathematical language is one of the aims of the mathematics curriculum which explicitly refers to cooperative learning as the methodology most appropriate to achieve this aim (NCCA, 1999).

Teachers participating in the study named improved social skills as the next significant benefit of CL. As one of three core subjects, mathematics presents great opportunities here as it is taught on a daily basis. During CL activities in maths lessons, pupils put all the social skills into practice as they need to communicate effectively, share resources, and solve problems together. This benefit of CL strongly supports the theoretical grounding of cooperative learning, namely social constructivism as formulated by Vygotsky (McCarthy, 2006; Davidson, 2021).

Study findings presented here and those from international research pointing to such a broad range of benefits of employing CL in mathematics can be explained by the social constructivist theory. Cooperative learning is the methodology that puts the social constructivist principles into practice: children actively construct their meaning, and they do it in a social context, using language, and with people who operate within their zone of proximal development (Davidson, 2021).

5.4 Challenges to implementation of cooperative learning activities

Considering the well documented benefits of the use of CL in mathematics, its endorsement by the mathematics curriculum and teachers' own conviction of its effectiveness, there is a large proportion of teachers only sporadically implementing CL in mathematics. Of all the participants of the study presented here, half claimed to use CL regularly. The other half claimed to implement it only once a week or several times a month. The reason for this might be the fact that teachers perceive many significant challenges to the implementation of CL in maths.

Interestingly, both interviewed teachers talked about prerequisites necessary for effective implementation of CL in mathematics. When asked, they explicitly denied that these were 'challenges,' but it appears that they understood the word 'challenges' as something negative rather than something that needs consideration and additional work and effort. Here, and in relevant literature, challenges are understood as these elements related to implementation of CL that require additional workload from teachers.

The challenges viewed as the most significant by the questionnaire respondents were organisation of the CL activities, preparation of resources, and time required. Interestingly, most of the prerequisites to implementing CL in maths discussed relate directly to organisation of CL activities. These were: time and resources, and grouping of pupils. These challenges are often mentioned in literature on the topic (Buchs et al., 2017).

Another potential complex challenge of translating constructivist principles into cooperative learning activities in mathematics has been demonstrated in research completed by O'Shea and Leavy (2013). Related to this is the challenge of alignment of CL activities with the curriculum (Buchs et al., 2017). These challenges have their roots in the connection of CL methodology to social constructivism, which is not a theory of teaching but of learning (ibid.).

However, participants in the study described here did not express such concerns. On the contrary, both interviewees said that the curriculum is 'set up' for CL activities and that they have no difficulties implementing the curriculum through CL activities. Similarly, 'Creating appropriate experiences' and 'Curriculum implementation' were rated as not at all to only moderately challenging by the majority of questionnaire respondents. These results suggest that the study participants are well familiar and confident translating the curriculum objectives into cooperative learning experiences for pupils.

All of the research participants pointed to relationships between pupils as a possible challenge and an important aspect to consider when implementing CL in maths. Interviewees talked about careful grouping of pupils and ensuring that the groups had a mixture of pupils of different academic ability. They also discussed considering pupils' ability to cooperate with others, pupils' emotional maturity to show others respect and to listen to others' ideas, possible conflicts between pupils, and pupils who might dominate others.

This is a well-recognised and documented challenge when implementing CL, and one that needs careful consideration as it has a direct impact on how effective CL is for all the pupils (Summers, 2006; Langer-Osuna, 2017). It has been shown that relationships of power have an impact on whose voice is listened to in a cooperative setting among students (Langer-Osuna, 2017).

Range of academic ability has been clearly identified as the most significant challenge by all the research participants. The interviewed teachers also said that pupils with special educational needs benefitted from cooperative learning when they had a good level of academic ability in mathematics. They also said that they often needed to personally support pupils of lower ability as these pupils would not be able to learn from other pupils and fully benefit from cooperative learning with their peers. These findings stand in contrast with the literature on the topic as it points to effective inclusion of pupils with special educational needs as a potential benefit of CL (Murphy, Grey and Honan, 2005; Slavin, 2012).

Interestingly, 'pre-teaching' or range of academic ability described by the interviewees have not been described in literature on the topic as potential challenges either. Possibly, these concepts have a connection to the challenges identified as locus of responsibility and authority, and the teacher's role as facilitator (Buchs et al., 2017). Even though research participants claimed not to find these aspects challenging, it is possible that due to their own beliefs about educational process and the school culture within which they work, they actually have difficulties with their changed role. It could also link to the difficulties with true implementation of constructivist principles and allowing pupils to carry some of the responsibility for their own learning. This would be an interesting topic of further research investigations.

5.5 Conclusion

The findings of the study on teachers' perspectives on the use of cooperative learning in mathematics have been discussed in this chapter. That about half of research participants claimed to use cooperative learning in mathematics on a regular basis corroborates some international research results. Teachers who used cooperative learning in maths systematically claimed to do it in a structured and organised way which is encouraged by

cooperative learning theorists and practitioners as the more effective than the unstructured types of cooperative learning (Davidson, 2021).

Research participants identified a wide range of benefits of cooperative learning in maths, ranging from better peer relationships to improved academic achievement. These findings align with literature on cooperative learning and the link of the methodology to the social constructivist philosophy (Johnson and Johnson, 2013).

A range of challenges to implementation of cooperative learning in maths were identified by the research participants as well. Here some of the research findings differed from those found in international literature as one of the most significant challenges identified by research participants was range of academic ability of pupils.

The issues of the limitations of this study and of how the research findings could inform future research, policy and practise are further explored in the next, concluding chapter.

CHAPTER 6 - CONCLUSION

6.1 Introduction

The study conducted aimed to explore Irish teachers' perspectives on the use of cooperative learning methodology in the area of mathematics at the primary level. It followed from recommendations for further study of the topic from international literature (Slavin, 2012; Davidson, 2021).

This chapter summarises the study's findings and their implications for practice within the area of teaching and learning of mathematics in Irish classrooms, as well as research and policy that inform it.

6.2 Summary of key findings

Findings from the study indicated that about half of all the participants used CL in mathematics regularly, with the other half using it sporadically. Majority of teachers used the structured and organised types of CL.

Majority of teachers perceived CL as having a wide range of significant benefits, such as in relationships with peers, inclusion of pupils with special educational needs, social and reasoning skills, language and conceptual development, and academic achievement.

Among the significant challenges to implementing CL identified by the teachers were organisation of cooperative learning activities, range of academic level of pupils, pupil relationships, time demand, and organisation of resources.

6.3 Limitations to the study

The research achieved its intended outcomes as it provided an overview of the frequency of use of CL in maths by Irish teachers. It also created a picture of benefits associated with CL and challenges hindering wider employment of this methodologies.

The study came short in exploration of types of CL used by teachers. Its scope did not allow for detailed questions on how teachers ensure implementation of critical attributes of CL, such as positive interdependence and individual accountability (Johnson and Johnson, 2002), nor did it allow to investigate whether teachers use any particular types of CL (Davidson, 2021).

As this study was completed on a small sample of participants in a short time period, its findings cannot be generalised to the Irish population. All the participating schools are in the same greater area, and the sample of participants was not random. Teachers who were interviewed volunteered for the study, and they might therefore not hold representative views on the topic.

Both research tools, the questionnaire and the interview questions, would require additional development and statistical analysis to ensure their reliability and validity (Whitaker and Fitzpatrick, 2021).

The findings could instead be treated as an indication of some teachers' experiences and perceptions on the use of CL in mathematics. From the findings of the study, ideas for further exploration could be developed.

6.4 Recommendations for future research

The research questions regarding cooperative learning used in mathematics by Irish teachers could be investigated more extensively. Large-scale quantitative research would provide a reliable picture on the frequency of use of CL, as well as its types and methods. The topic of how teachers structure the CL activities and how they attend to the principles of CL could also be investigated.

Benefits and challenges of CL in mathematics could be explored in larger scale studies, with qualitative research clarifying why Irish teachers perceive range of academic ability as the most significant challenge to implementing CL in maths. Research findings could then inform Irish policy and practice to facilitate implementation of the methodology.

6.5 Recommendations for policy and practice

A number of practical recommendations might benefit the practice of Irish teachers. Policy might address the use of CL in mathematics with teachers receiving broader training in the methodology, both at the initial stage of teacher training and as part of continual professional development.

Training ought to address the areas of challenge identified by teachers. It should also focus on practical implementation of crucial attributes of CL and embedding the CL activities firmly

within constructivist approaches, allowing for pupils' autonomy and participation in inquiry based, engaging activities (Duran and Duran, 2004; Frid and Sparrow, 2009).

On an individual school level, teachers who feel confident and employ CL in mathematics regularly could support their colleagues and work collaboratively to improve implementation of this methodology throughout schools.

6.6 Concluding Remarks

Cooperative learning has been demonstrated to be effective in teaching and learning within many subject areas at primary level, including mathematics (McInerney, 2005; Rigelman, 2007). Furthermore, it is recommended as one of the main methodologies in the mathematics curriculum (NCCA, 1999a, 1999b). Yet, as this research showed, it is used by only around half of teachers on a regular basis. It could be argued that this situation needs attention as pupils' mathematical skills have a central role in their cognitive development. Hence, more research and then training interventions should be put in place to ensure that all teachers are competent at employing this methodology at all levels of primary school.

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APPENDIX 1 – LETTER TO PRINCIPAL

Dear Principal,

I am writing to you in relation to a research study I will be undertaking in fulfilment of my Professional Master of Education degree I am completing with Hibernia College, Dublin.

I would like to provide you with information about my study and seek your consent to conduct the research with members of your teaching staff.

The title of my research project is 'Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives'.

There has been an abundance of research studies conducted on the topic of methodologies most effective in the teaching and learning of mathematics, especially in the area of academic achievement, but also in such aspects as students' attitudes to and interest in the subject.

Cooperative learning is a methodology linked to the constructivist approach to education, one that is mandated by DES and recommended for extensive use in the teaching and learning of mathematics in the Primary Curriculum (NCCA, 1999). What is more, cooperative learning has been proven effective in enhancing varied outcomes for pupils of all ages, such as academic achievement, attitude and motivation, behaviour and peer relationships (Johnson and Johnson, 2002; Davidson, 2021).

However, there is little data available on the experiences and perceptions of Irish teachers regarding the use of cooperative learning in teaching and learning of mathematics at primary level.

The aim of my research project is to identify practices of Irish primary school teachers regarding use of cooperative learning methodology in teaching and learning of mathematics. The research will examine how often teachers use cooperative learning in maths, in what strands they use it, and how they implement it. The research will also explore teachers' perspectives on the challenges and benefits relating to the use of cooperative learning in mathematics.

The research project will consist of two methods: first teachers will fill in paper questionnaires, after that two teachers may be asked to participate in semi-structured interviews of thirty minutes relating to the topic. Teacher invited to participate in the study need to have at least three years of experience teaching a class in the range from first to sixth.

My project has received ethical approval from the Hibernia College Ethics Committee. Questionnaires would be filled in by the teachers at their convenience and then collected by me at an agreed date. Interviews would be held at the convenience of the teachers

concerned and on school premises. I would provide all participants with information sheets on the study. With the participants' written consent, interviews would be recorded for transcription and dissemination purposes, the questionnaires would be transcribed as well. Participation in the study is voluntary. Participants may refuse to answer any questions or withdraw from the study at any time. No school, teacher or student will be identified specifically in any publication of the work. I am writing to you to gain your informed consent that I may request members of your teaching staff to participate in the study. I would request you to distribute the questionnaires to the participating teachers in February. I would hold the interviews in your school in March/April. Confirmation of your consent can be collected by me in person at your convenience.

If you have any questions, please do not hesitate to contact me by phone at 085 1078241 or e-mail at joannanarostek@gmail.com.

Thank you for your time and consideration of my request. I look forward to hearing from you.

Sincerely,

_____ (Researcher)

APPENDIX 2 – RESEARCH INFORMATION SHEET FOR QUESTIONNAIRE PARTICIPANTS

Research Information Sheet

Researcher:

Organisation: Hibernia College Dublin

Title of study: Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives.

Purpose of the study: Completion of a small-scale study which forms part of the final year of the Professional Master of Education (Primary) with Hibernia College Dublin.

Outline of research study:

There has been an abundance of research studies conducted on the topic of methodologies most effective in the teaching and learning of mathematics, especially in the area of academic achievement but also in such aspects as students' attitudes to and interest in the subject.

Cooperative learning is a methodology linked to the constructivist approach to education, one that is mandated by DES and recommended for extensive use in the teaching and learning of mathematics in the Primary Curriculum (NCCA, 1999). What is more, cooperative learning has been proven effective in enhancing varied outcomes for pupils of all ages, such as academic achievement, attitude and motivation, behaviour and peer relationships (Johnson and Johnson, 2002; Davidson, 2021).

However, there is little data available on the experiences and perceptions of Irish teachers regarding the use of cooperative learning in mathematics at primary level.

Aims of the project:

The aims of this research are to: identify practices of Irish primary school teachers regarding use of cooperative learning methodology in teaching and learning of mathematics. The research will examine how often teachers use cooperative learning in maths, what strands they use it in and how they implement it. The research will also explore teachers' perspectives on the challenges and benefits relating to the use of cooperative learning in mathematics.

Your role as a participant:

Your participation in this research project is greatly appreciated. This research project has received ethical approval from Hibernia College Dublin. If you agree to participate, you will fill in a questionnaire. Any information you provide about your own identity or that of the school will be anonymous and confidential. The questionnaire data will be transcribed. This research will be used in a publication of a thesis for Hibernia College Dublin. It may also be used in conference proceedings or used in academic articles. You are free to withdraw from the study at any time up to a month following collection of data. You can request access to your own data at any stage of the study and up to three years following its completion.

APPENDIX 3 – RESEARCH INFORMATION SHEET FOR INTERVIEWEES

Researcher:

Organisation: Hibernia College Dublin

Title of study: Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives.

Purpose of the study: Completion of a small-scale study which forms part of the final year of the Professional Master of Education (Primary) with Hibernia College Dublin.

Outline of research study:

There has been an abundance of research studies conducted on the topic of methodologies most effective in the teaching and learning of mathematics, especially in the area of academic achievement but also in such aspects as students' attitudes to and interest in the subject. Cooperative learning is a methodology linked to the constructivist approach to education, one that is mandated by DES and recommended for extensive use in the teaching and learning of mathematics in the Primary Curriculum (NCCA, 1999). What is more, cooperative learning has been proven effective in enhancing varied outcomes for pupils of all ages, such as academic achievement, attitude and motivation, behaviour and peer relationships (Johnson and Johnson, 2002; Davidson, 2021). However, there is little data available on the experiences and perceptions of Irish teachers regarding the use of cooperative learning in teaching and learning of mathematics at primary level.

Aims of the project:

The aims of this research are to: identify practices of Irish primary school teachers regarding use of cooperative learning methodology in teaching and learning of mathematics. The research will examine how often teachers use cooperative learning in maths, what strands they use it in and how they implement it. The research will also explore teachers' perspectives on the challenges and benefits relating to the use of cooperative learning in mathematics.

Your role as a participant:

Your participation in this research project is greatly appreciated. This research project has received ethical approval from Hibernia College Dublin. If you agree to participate, you will be asked to participate in a short semi-structured interview with the researcher. Any information you provide about your own identity or that of the school will be anonymous and confidential. Quotes from the interviews may be used and may also be published in the research; however, your name and the name of the school will not be published. The interviews will be audio recorded and then transcribed. This research will be used in a publication of a thesis for Hibernia College Dublin. It may also be used in conference proceedings or used in academic articles. You are free to withdraw from the study at any time up to a month following collection of data. You can request access to your own data at any stage of the study and up to three years following its completion.

APPENDIX 4 – CONSENT FORM (PRINCIPAL)

Consent Form (to be completed by the principal)

Researcher's name:

Organisation: Hibernia College

Title of study: Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives

I, _____ have read and understood the Letter of Information provided to me by Joanna Narostek. I agree that in order to conduct research about teachers' perspective on the use of cooperative learning methodology in mathematics she may request participation from teachers in the school. Upon expressing an interest and giving a written consent, teachers will be asked to fill in a questionnaire and/or participate in an interview with the researcher. The researcher will conduct interviews on school premises at times convenient for the teachers and the school. Participating teachers will fill in the questionnaires at their convenience and the researcher will collect the questionnaires at an arranged date. I understand that participation is voluntary and that there are no physical or psychological risks associated with the study. I know that all answers provided in questionnaires and during the interviews will be used for the purposes of the study only and that all responses will identify no individual or the school itself.

Principal's signature: **Date:**

Researcher's signature:

APPENDIX 5 – CONSENT FORM (QUESTIONNAIRE PARTICIPANTS)

Consent Form

Have you read the information sheet about the study? Yes/No

Have you had an opportunity to ask questions and discuss this study? Yes/No

Have you received satisfactory answers to all your questions? Yes/No

Do you understand that you are free to withdraw from this study at any time without giving a reason for withdrawing and without your withdrawal having an adverse effect for you? Yes/No

Do you agree to take part in this study, the results of which may be used for conference presentations or academic papers? Yes/No

Have you been informed that a copy of this consent form will be kept by the researcher? Yes/No

Are you satisfied that any information you give to the researcher will be kept confidential? Your name and the name of the school will not appear in the research report. Yes/No

APPENDIX 6 – CONSENT FORM (INTERVIEWEE)

Consent Form (to be completed by the participant)

Researcher's name:

Organisation: Hibernia College Dublin

Title of study: Use of cooperative learning methodology in the teaching and learning of mathematics in primary school – teachers' perspectives.

Have you read the information sheet about the study? Yes/No

Have you been fully informed/read the information sheet about this study? Yes/No

Have you had an opportunity to ask questions and discuss this study? Yes/No

Have you received satisfactory answers to all your questions? Yes/No

Do you understand that you are free to withdraw from this study at any time without giving a reason for withdrawing and without your withdrawal having an adverse effect for you? Yes/No

Do you agree to take part in this study, the results of which may be used for conference presentations or academic papers? Yes/No

Have you been informed that a copy of this consent form will be kept by the researcher? Yes/No

Are you satisfied that any information you give to the researcher will be kept confidential? Your name and the name of the school will not appear in the research report. Yes/No

Participant's name (print):

Participant's signature: **Date:**

Researcher's signature: **Date:**

APPENDIX 7 – QUESTIONNAIRE

Questionnaire to explore the use of cooperative learning methodology in mathematics

Cooperative learning methodology includes pair and group work.

Please consider the questions carefully and tick the answer that best reflects your experience.

1. What is your gender?

☐ Female

☐ Male

2. How many years have you been teaching full-time?

Altogether: ☐ 3-10 years ☐ 11-20 years ☐ more than 20 years

3. How many years have you been teaching at each of these class levels?

1st/2nd class: ☐ none ☐ 1-3 ☐ more than 3

3rd/4th class: ☐ none ☐ 1-3 ☐ more than 3

5th/6th class: ☐ none ☐ 1-3 ☐ more than 3

3. How often do you use cooperative learning methodology in mathematics lessons?

☐ Never ☐ once every few weeks ☐ once a week ☐ several times a week

4. When teaching *each strand*, how often do you use cooperative learning methodology?

	Never	Rarely (1-3 times a month)	Sometimes (about once a week)	Regularly (most lessons)
Number	☐	☐	☐	☐
Algebra	☐	☐	☐	☐
Shape and space	☐	☐	☐	☐
Measures	☐	☐	☐	☐
Data	☐	☐	☐	☐

5. What types of cooperative learning methodology do you use in your maths lessons?

	Never	Rarely (1-3 times a month)	Sometimes (about once a week)	Regularly (most lessons)
Pair	☐	☐	☐	☐
Small group	☐	☐	☐	☐
Structured and organized	☐	☐	☐	☐
Unstructured and spontaneous	☐	☐	☐	☐
Other:	☐	☐	☐	☐

6. What are the benefits of cooperative learning in mathematics, in your opinion?

Rate the strength of positive impact on each area.

	Strong	Medium	Weak	None
Improved academic achievement	☐	☐	☐	☐
Conceptual development	☐	☐	☐	☐
Language development	☐	☐	☐	☐
Reasoning skills	☐	☐	☐	☐
Social skills	☐	☐	☐	☐
Inclusion of pupils with special needs	☐	☐	☐	☐
Attitude to mathematics	☐	☐	☐	☐
Relationships with peers	☐	☐	☐	☐
Behaviour in class	☐	☐	☐	☐
Confidence	☐	☐	☐	☐
Other:	☐	☐	☐	☐

7. What are the challenges related to the use of cooperative learning methodology in mathematics, in your opinion?

Rate the significance of each challenge on your practice.

	Strong	Medium	Weak	None
Effective organisation of group work	☐	☐	☐	☐
Teacher's role as facilitator	☐	☐	☐	☐
Curriculum implementation	☐	☐	☐	☐
Translation of curriculum content into cooperative learning activities	☐	☐	☐	☐
Creating appropriate learning experiences	☐	☐	☐	☐
Range of academic levels of pupils	☐	☐	☐	☐
Pupil relationships within class	☐	☐	☐	☐
Time demand	☐	☐	☐	☐
Assessment of pupils' work	☐	☐	☐	☐
Behaviour management	☐	☐	☐	☐
Insufficient training in the methodology	☐	☐	☐	☐
Organisation of resources	☐	☐	☐	☐
Other:	☐	☐	☐	☐

Other:

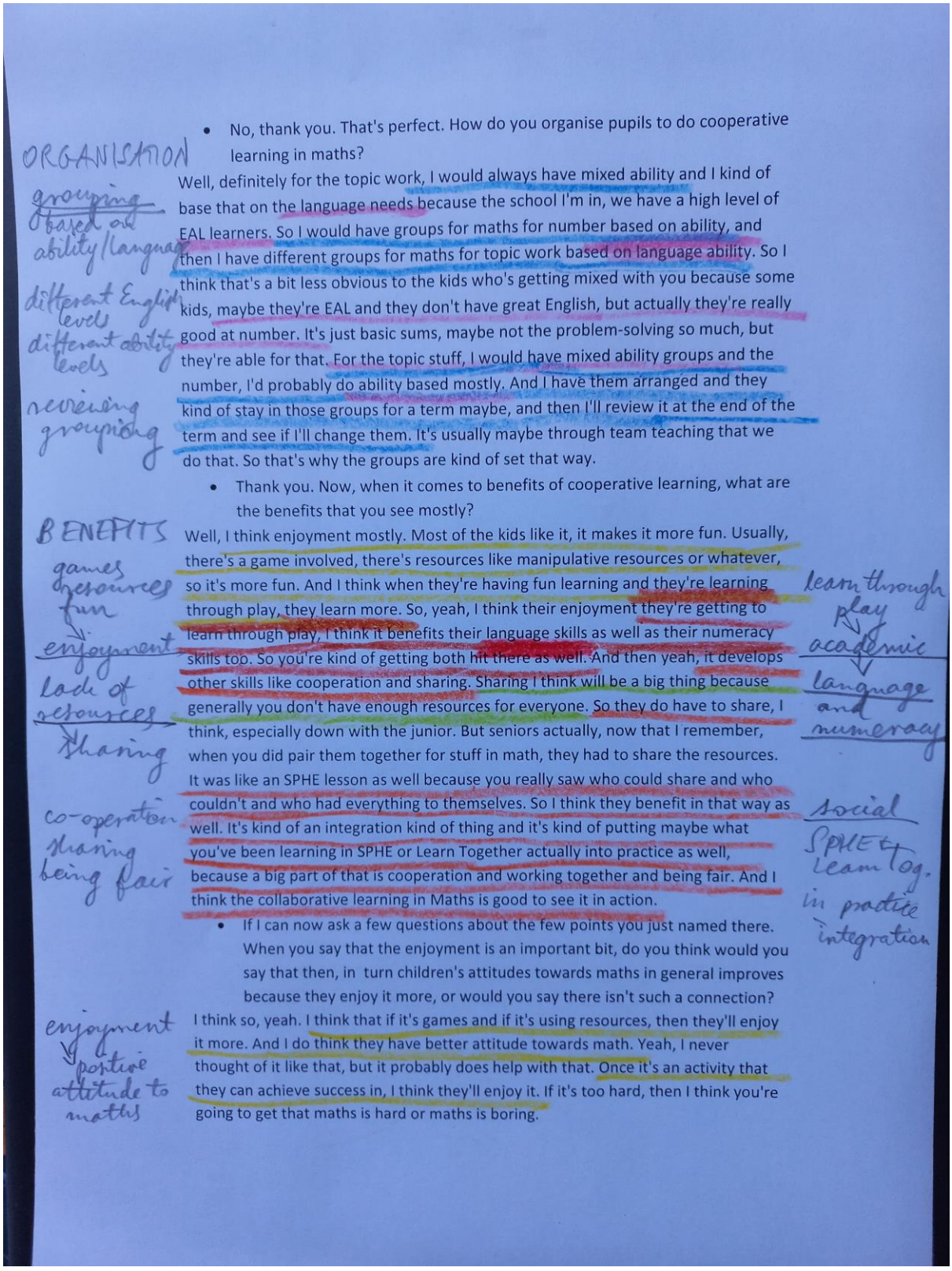
8. Do you have any other comments to make regarding cooperative learning methodology in mathematics and its implementation at primary level?

APPENDIX 8 – TOPIC GUIDE INTERVIEW QUESTIONS

Topic Guide Interview Questions

Focus area	Question	Probe
Opening	Can you tell me about your experience in the school?	How long have you been working here? What classes have you taught?
CL as a methodology	What is your experience of using cooperative learning methodology in primary school?	Do you use CL in different subject areas? Which ones? What types of CL do you use? How often do you use it?
Use of CL in maths	What is your experience of using cooperative learning in maths?	What strands do you use it in? How often do you use it? How do you organise pupils in CL? What types of CL do you use in maths (pair/group, organised/spontaneous?
Benefits of CL in maths	What benefits of cooperative learning in maths do you see?	Depending on interviewee's answer to the initial question on benefits: Are there academic benefits? What are they? Are there social benefits? What are they? Does CL have any impact on pupils' attitudes towards maths? Does CL have any impact on pupils' confidence? Does CL have any impact on pupils' language development?
Challenges of CL in maths	Are there any challenges related to using cooperative learning in maths?	Depending on interviewee's answer to the initial question on challenges: How do you find organisation of CL activities in maths? How do you find implementing the curriculum through CL activities? How do you assess pupils when they engage in CL? Do you feel you have enough training in the area of CL? How do you find class management when pupils engage in CL? Do pupil relationships have any impact on how they engage in CL?
Other issues	Is there anything else you would like to add in relation to using cooperative learning in maths?	

APPENDIX 9 – THEMATIC CODING (EXAMPLE PAGE)



ORGANISATION

grouping based on ability/language

different English level

different ability levels

reviewing grouping

- No, thank you. That's perfect. How do you organise pupils to do cooperative learning in maths?

Well, definitely for the topic work, I would always have mixed ability and I kind of base that on the language needs because the school I'm in, we have a high level of EAL learners. So I would have groups for maths for number based on ability, and then I have different groups for maths for topic work based on language ability. So I think that's a bit less obvious to the kids who's getting mixed with you because some kids, maybe they're EAL and they don't have great English, but actually they're really good at number. It's just basic sums, maybe not the problem-solving so much, but they're able for that. For the topic stuff, I would have mixed ability groups and the number, I'd probably do ability based mostly. And I have them arranged and they kind of stay in those groups for a term maybe, and then I'll review it at the end of the term and see if I'll change them. It's usually maybe through team teaching that we do that. So that's why the groups are kind of set that way.

- Thank you. Now, when it comes to benefits of cooperative learning, what are the benefits that you see mostly?

BENEFITS

games resources fun → enjoyment

lack of resources → sharing

co-operation sharing being fair

Well, I think enjoyment mostly. Most of the kids like it, it makes it more fun. Usually, there's a game involved, there's resources like manipulative resources or whatever, so it's more fun. And I think when they're having fun learning and they're learning through play, they learn more. So, yeah, I think their enjoyment they're getting to learn through play, I think it benefits their language skills as well as their numeracy skills too. So you're kind of getting both hit there as well. And then yeah, it develops other skills like cooperation and sharing. Sharing I think will be a big thing because generally you don't have enough resources for everyone. So they do have to share, I think, especially down with the junior. But seniors actually, now that I remember, when you did pair them together for stuff in math, they had to share the resources. It was like an SPHE lesson as well because you really saw who could share and who couldn't and who had everything to themselves. So I think they benefit in that way as well. It's kind of an integration kind of thing and it's kind of putting maybe what you've been learning in SPHE or Learn Together actually into practice as well, because a big part of that is cooperation and working together and being fair. And I think the collaborative learning in Maths is good to see it in action.

learn through play → academic → language and numeracy

social SPHE & Learn Tog. in practice integration

- If I can now ask a few questions about the few points you just named there. When you say that the enjoyment is an important bit, do you think would you say that then, in turn children's attitudes towards maths in general improves because they enjoy it more, or would you say there isn't such a connection?

enjoyment → positive attitude to maths

I think so, yeah. I think that if it's games and if it's using resources, then they'll enjoy it more. And I do think they have better attitude towards math. Yeah, I never thought of it like that, but it probably does help with that. Once it's an activity that they can achieve success in, I think they'll enjoy it. If it's too hard, then I think you're going to get that maths is hard or maths is boring.