COURSEWORK COVER SHEET

SCHOOL OF EDUCATION

UNIVERSITY COLLEGE CORK

NAME OF STUDENT	Sheela O Regan / Síle Ní Ríogáin
STUDENT NUMBER	119225904
PROGRAMME AND YEAR	Year 3
MODULE CODE	ED6035
TITLE OF COURSEWORK	DISSERTATION IN EDUCATION
LECTURER/TUTOR	Dr. Margaret O' Donovan
DATE SUBMITTED	4th June 2022
DUE DATE *(IF DIFFERENT)*	8th June 2022

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Pupils' experiences and perspectives of integrated STEM in a Gaelscoil setting

Thesis submitted to the School of Education, University College Cork in partial fulfilment of the requirements for the degree of Masters in Education under the supervision of Dr Margaret O' Donovan

June 2022

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Signed Declaration

I, Sheela O Regan, declare that this work is my own work for the purpose of this dissertation and has not be submitted for another degree either at University College Cork or elsewhere.

All external references and sources are clearly acknowledged and identified within the contents.

Signed: Sheela O Regan Date: 4/6/2022

Abstract

Integrated STEM (Science, Technology, Engineering, Mathematics) education has its origins in industry but has permeated education systems globally. There is a dearth of research on schoolchildren's perspectives of integrated STEM education, particularly in immersion education settings such as Gaelscoileanna (Irish medium schools).

This study garnered children's experiences and perspectives of an eight-week integrated STEM unit in an Irish medium primary school. The teacher researcher (TR) and critical friend (CF) observed the second-class children during this collaborative learning experience. Following each task, the children were interviewed in groups about their experiences as well as reflecting in their individual STEM journals.

It was found that the children thoroughly enjoyed the integrated STEM experience, particularly because they had an opportunity to play and were involved in group work. Both the TR and the CF noted differences between boys' and girls' activities in integrated STEM. Furthermore, the pupils reported that group work aided their problem-solving abilities. However, the children found the Engineering Design Process difficult. Finally, the children reported no difficulties communicating through Irish.

This study uses innovative approaches to capture the students' perspectives and is of great value to the sparse repository of studies on integrated STEM in primary schools, particularly in immersion contexts. It raises pertinent questions for policy, practice and research including the importance of a Content and Language Based approach in Gaelscoileanna as well as children being viewed as co-constructors of a new integrated STEM curriculum.

Key words: integrated STEM, Gaelscoileanna, Pupil Voice, Groupwork, Social Metacognition, Content and Language Based Approach

Acknowledgements

I would like to thank many people for their help, guidance and support throughout this research process.

Ar dtús, is mian liom mo bhuíochas ó chroí a ghabháil leis an bhfeitheoir, Dr Margaret O Donovan, Coláiste na hOllscoile, Corcaigh. Threoirigh sí mé le foighne agus le cineáltas. Táim go mór faoi chomaoin aici.

Ba bhreá liom mo bhuíochas a ghabháil leis na daltaí iontacha is álainne a ghlac páirt sa staidéar seo agus a tuistí, an Bórd Bainstíochta, agus príomhoide na scoile a thug cead dom an taighde seo a dhéanamh. Chomh maith le sin, ba bhreá liom buíochas ar leith a ghabháil leis mo phríomhoide iontach a thug comhairle is cabhair ag gach aon céim don próiséis seo.

I wish to thank my immediate family – my husband, mother, father and sister for all their support and patience for the last three years. Bheinn caillte gan sibh!

Finally, I wish to thank my son. Míle buíochas as ucht a bheith chomh foighneach liom tríd an phróiséis seo. Is réalt thú!

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List of Acronyms and Abbreviations

US	United States
EDP	Engineering Design Process
PBL	Problem-Based Learning
PSC	Primary School Curriculum
TR	Teacher Researcher
CF	Critical Friend
CLIL	Content and Language Integrated Learning
DES	Department of Education and Skills / Science
STEM	Science, Technology, Engineering and Mathematics

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Chapter 1: Introduction

1.0 Introduction

The knowledge and skills of Science, Technology, Engineering and Mathematics (STEM) education are of utmost importance for young people in a society that has become increasingly driven by science and technology (Banks and Barlex, 2014).

This research study aims to analyse children's experiences and perspectives of integrated STEM in an Irish medium education setting (Gaelscoil). A Gaelscoil is a primary school on the island of Ireland where Irish is the language of communication between staff, pupils and Board of Management (Dillon, 2009).

The Department of Education (2017b) recommends that the optimum method of teaching STEM subjects is in an integrated manner. However, teachers are anxious about their abilities to teach these subjects in a cross-disciplinary manner (Delahunty, Prendergast and Ní Ríordáin, 2021) as no clear definition of integrated STEM exists (Hourigan et al., 2021) and there is an absence of the subjects of technology and engineering on the Primary School Curriculum (PSC) (DES, 1999).

Ireland places a strong emphasis on the voice of the child in a variety of areas including health, education and wellbeing (Murphy, Mullaghy and D'Arcy, 2016). However, there is a paucity of studies both nationally and internationally on the views of children on integrated STEM, particularly those who experience it through a second language. The aim of this study is to contribute to this body of knowledge.

Section 1.1 begins with an outline of the national and international context of STEM, followed by the research rationale in section 1.2 which includes the research questions. Sections 1.3 and 1.4 describe the context of the study and the methodology employed.

Section 1.5 provides the outline of the chapters in this study followed by a conclusion in Section 1.6.

1.1 National and International Context

STEM is the acronym of choice when referring to the disciplines of Science, Technology, Engineering and Mathematics in educational policy documents across the globe (Lyons, 2020). Its origins can be traced back to the early 1990s in the United States (U.S.) (NAS, 2007). Several key reports in the U.S. highlighted the link between economic prosperity and knowledge-based jobs dependent on science and technology but also, the alarming consequences that the country would suffer if they could not compete in a global economy due to a poorly prepared workforce (NAS, 2007). Therefore, attention was focused on STEM research into economic policy and education to maintain U.S. prosperity (NAS, 2007).

Since the inception of the term STEM in the U.S., the idea has expanded globally beyond its shores. Increasing participation rates in the STEM education has become a "global imperative" (Delahunty, Prendergast and Ní Ríordáin, 2021, p.1) and this goal is echoed in most education systems around the world.

The term STEM education has become very ambiguous. Those outside the educational sphere have deemed it to be about proliferating the importance of these four disciplines in education but also in society at large (Wolfmeyer and Chesky, 2015). This is to ensure that there are more highly skilled workers to compete on a global market stage but also empowering these future democratic citizens to progress societal advancement (Wolfmeyer and Chesky, 2015).

However, teachers generally use the term STEM education or integrated STEM education to describe the group of school subjects, emphasising the interconnectedness between them

and whose teaching can strengthen and support one another (Banks and Barlex, 2015; Flinn, Mulligan and Thompson, 2019). Educators often create pedagogy and curricula that link these subjects together so that they can be taught in an integrated manner (Wolfmeyer and Chesky, 2015). Furthermore, as these subjects are inherently linked, it is advantageous for the learner to have real-life, integrated and hands-on projects that demonstrate their interconnectedness (Treacy and O' Donoghue, 2014; Wolfmeyer and Chesky, 2015; Flinn, Mulligan and Thompson, 2019).

STEM education has been pushed to the forefront of the Irish national educational agenda since the publication of the *STEM Education in the Irish School System* report (DES, 2016). One of the main issues highlighted in this document is the need to improve students' higher order thinking skills such as problem-solving and the application of knowledge. A variety of national and international tests such as the *Programme for International Student Assessment* (PISA) have shown that Irish students can find items assessing problem-solving difficult (DES, 2016). Problem-solving skills are of fundamental importance to STEM education (Priemer et al., 2020). Therefore, developing and enhancing these skills is a pathway to better STEM education and in turn, "a highly skilled workforce" (DES, 2017b, p.5) in Ireland.

However, STEM education has become inextricably linked to utilitarian and instrumentalist values of economic productivity and growth (Takeuchi et al., 2020). Mooney Simmie (2012) examined the increasing amount of neoliberal agendas and vested interests which have dominated Irish educational policy from the 2000s onwards. She questioned who is drafting these policy documents and in turn, whose interests are being served by them. Furthermore, it was the Minister for Research and Innovation and not the Minister for Education who commissioned the *Report on STEM Education in the Irish School System* in 2016.

There is a small but growing counterculture in STEM education to reposition its focus away from the macrosystemic and human capital discourses (Takeuchi et al., 2020) and place the whole focus on the learner and the intrinsic educational value of the STEM subjects (Wolfmeyer and Chesky, 2015).

1.2 Research Rationale

In light of moving away from the original genesis of STEM education which was borne out of neoliberal agendas (Takeuchi et al., 2015), the researcher intends to solely focus on the experiences and perspectives of the main stakeholders in STEM education – the children. Despite all the emphasis on integrated STEM in Irish primary schools, there is a paucity of research available internationally on children's perspectives. This is the first study to investigate pupils' experiences and perspectives of integrated STEM in an Irish context. Furthermore, it will be the first to explore these experiences in an immersion context, that of a Gaelscoil.

Phase 1 of the plan to implement *STEM Education Policy Statement 2017-2026* is now complete and under review (Department of Education, 2022). Therefore, this researcher considers it both important and timely to carry out this research study. The main research question is as follows:

1. What are pupil's experiences and perspectives of integrated STEM in an Irish medium education setting?

The secondary research questions are outlined below;

2. How do children communicate and behave during integrated STEM?
3. Are there unique supports required for integrated STEM in an Irish medium setting?

1.3 Context of study

The study took place in the classroom of the researcher. Therefore, the term teacher-researcher (TR) is used when referring to the researcher in this study. The research questions are all framed in the context of an Irish medium school (Gaelscoil). This was a co-educational Gaelscoil in the Munster region of Ireland, outside of the Gaeltacht. The children were between 8 and 9 years of age at the time of the study and in second class.

1.4 Methodology

The children were in 5 mixed ability groups for the eight-week unit of integrated STEM. The study was framed by an interpretive paradigm and qualitative methods were employed. The TR and a critical friend (CF) collected data from the children in the form of observations and documents during each weekly session. After each session, the children were encouraged to reflect on the process in individual STEM journals as well as completing semi-structured group interviews with the TR.

1.5 Overview of Chapters

Chapter 1, the current chapter provides a brief introduction to the context of the study as well as how the research was carried out. Chapter 2 consists of a thorough literature review in terms of problematising what integrated STEM is and Irish educational policies on this. The chapter also analyses the intrinsic educational value of integrated STEM for the learner before considering STEM in the context of a Gaelscoil. Chapter 2 will continue by analysing studies of STEM subjects in Irish medium settings and conclude by considering pupil voice in Irish education.

Chapter 3 provides an in-depth account of how the study was carried out including data collection and analysis. Chapter 4 provides the results of the study in the form of five main themes, critically analysing these findings and relating them to the research questions.

Finally, chapter 5 provides a conclusion to the study as well as making recommendations for policy, practice and research arising from the findings of this study.

1.6 Conclusion

This chapter endeavoured to provide the reader with an introduction to the genesis of STEM education and how it has spread into mainstream educational policy and discourse in Irish primary schools, including Gaelscoileanna. It also explained the methodology of the study and provided an outline of the chapters that lay ahead. The following chapter is a literature review.

Chapter 2: Literature Review

2.0 Introduction

STEM or Science, Technology, Engineering and Mathematics, is an established term in education but can have different meanings depending on whether one is located inside or outside the classroom environment (Banks and Barlex, 2014). In the previous chapter, the national and international context of STEM education was discussed in terms of how it has made its way from industry to the classroom (Kelley and Knowles, 2016).

This chapter will begin by interrogating the notion of integrated STEM education and the different perspectives which exist therein (Section 2.1). Section 2.2 will examine the concept of integrated STEM which Irish educational policy has adopted followed by an analysis of the intrinsic educational value for primary pupils in section 2.3.

Section 2.4 will then introduce the context of the research study, that of Irish immersion settings. Within this section, the interplay of content and language teaching in Gaelscoileanna will be discussed as well as studies which have incorporated STEM subjects into immersion settings.

Finally, section 2.5 will analyse the importance placed on pupil voice in Irish education, followed by a conclusion in section 2.6.

2.1 Integrated STEM

STEM education to those in industry or in government, can mean an area of the educational sector that is of great economic or societal importance (Wolfmeyer and Chesky, 2015). Neoliberalism is a "deliberate intervention by government to encourage particular types of entrepreneurial, competitive and commercial behaviour in its citizens with the market as the regulatory mechanism" (Carter, 2016, p.32). Carter (2016) describes neoliberalism as the ideology driving STEM education and by doing so silences other perspectives (Carter,

2016; Kelley and Knowles, 2016). Mooney Simmie (2012) drew attention to the neoliberal origins of many Irish educational documents from the 2000s onwards.

However, a small but growing counterculture are repositioning the values of STEM education and drawing attention to the joy and intrinsic value of learning these subjects (Wolfmeyer and Chesky, 2015). Despite the debate regarding the underlying philosophy of STEM, all perspectives can see the its value (Wolfmeyer and Chesky, 2015).

In this literature review, the focus will be on the educators' view of STEM education. Traditionally, subjects exist as silos in education and integration can prove difficult for a variety of reasons (Banks and Barlex, 2015; Delahunty, Prendergast and Ní Ríordáin, 2021). Therefore, initially STEM education was used when referring to any one of the distinct subject areas namely Science, Technology, Engineering and Mathematics (Hourigan et al., 2021).

However, in more recent times, STEM education or integrated STEM education, has evolved to become a group of subjects whose teaching can strengthen and support one another (Banks and Barlex, 2015). It refers to both a curriculum which generally consists of cross-curricular, open-ended, real-world problems as well as a pedagogy which refers to the teacher's role as a guide throughout this process (Margot and Kettler, 2009).

Internationally, there is no single agreed upon definition as to what integrated STEM is (Nadelson and Seifert, 2017). STEM integration can be based on content or context (Hourigan et al. 2021). Those who subscribe to the school of thought that is context-based integration (Stohlmann, 2019), highlight the use of varying STEM contexts to make the content more meaningful. Within this, the primary focus is on the content of one discipline and using the contexts of the others to make the content more relevant (Stohlmann, 2019). Johnson (2016), a global leader in integrated STEM education, states that only one

discipline, either mathematics or science curricula can serve as the primary learning goal. Johnson (2016) further opines that the learning goal must be embedded in the practice of the Engineering Design Process (EDP) to provide context and children must complete a real-world problem or task through teamwork and communication.

In terms of content integration alone, across contemporary discourse there is significant debate pertaining to how integrated these subjects should be and how many subjects should be incorporated at any one time. Vasquez et al. (2013) proffer the view that there is a continuum of STEM integration which ranges from disciplinary, where the pupils learn the subjects individually to transdisciplinary, where students learn two or more of these subjects concurrently in a real-life problem. Sanders (2009) suggests that integrated STEM must involve two or more of the STEM disciplines.

In many countries, movements are afoot to encourage STEM teachers to step outside their traditional subject silos (Banks and Barlex, 2015). In the United Kingdom alone, there are many scholars proposing the incorporation of subject areas such as Drama (Patterson, Chesterman and Ramsay, 2019) and foreign languages (Palmer and Lister, 2019) with STEM.

STEAM, the addition of Visual Arts to STEM, is a growing movement in the U.S. (Banks and Barlex, 2015; Flinn, Mulligan and Thompson, 2018). Proponents of this approach hark of the benefits of Visual Arts in STEM encouraging creativity and communication as well as appealing to different interests and learners (Henriksen, 2014; Cook, Bush and Cox, 2018; Caldwell, Edwards and Grantham, 2019). Furthermore, STEAM is about the students as opposed to the subject areas where students can envision themselves in multiple roles and not just as scientists and engineers (Cook, Bush and Cox, 2018).

In summary, there is ongoing debate as regarding the varying perspectives of integrated STEM and there is no consensus as to the characteristics of an effective integrated STEM education programme (English, 2016; Hourigan et al. 2021).

2.2 Integrated STEM in Irish Educational Policy

Enshrined in the *STEM Education Policy Statement 2017-2026* is Ireland's aim to be a leader in STEM education by 2026 (DES, 2016b). The success of the plan is informed by data from the PISA tests (DES, 2018) and the latest indicators have shown that Irish students have scored significantly above the OECD average in mathematics and science in 2018 (Gilleece et al., 2020).

The main aim of this statement is to "ensure we have an engaged society and highly skilled workforce in place" through the development of "curiosity, inquisitiveness, critical-thinking and problem-solving" (DES, 2017b, p.5) and that children should be able to apply their knowledge, creativity and skills across disciplines and in real life situations. Implicitly the foregoing statement alludes to both its neoliberal background and the intrinsic value of education for the children.

In the broader educational sphere, STEM education is strongly linked with integrated curricula (Lyons, 2020). However, the *STEM Education Policy Statement* (2017b) has further confounded the concept of STEM education by defining it as not only involving the teaching of these four subjects in isolation but also involving a cross-disciplinary approach. It also acknowledges that all STEM learning activities must be "underpinned by Mathematics" (DES, 2017b, p.6) and examines the strong link between STEM and Arts education. Furthermore, the Irish definition also recognises that there is no exhaustive list of STEM subjects.

In a study by Delahunty, Prendergast and Ní Ríordáin (2021), Irish primary teachers expressed their frustration at the lack of clarity in curricular documentation and demanded a clear STEM integrated curriculum from the Department of Education. Some of these teachers struggled to understand what the integrated approach meant, and they reported not being comfortable with the subjects of engineering and technology which are not on the PSC (DES, 1999). Furthermore, these problems paired with curriculum overload led the teachers to return to teaching the subjects in isolation (Delahunty, Prendergast and Ní Ríordáin, 2021).

Some of the Irish primary teachers interviewed in Hourigan et al.'s (2021) study felt that rather than defining a specific framework for STEM education at policy level, it should be co-constructed and negotiated across educational contexts. These teachers were concerned that there should not be a trade-off of integrated STEM at the cost of discreet mathematics and science areas. A full transdisciplinary view was not embraced by these teachers but they felt that integrated STEM was an opportunity for the children to apply their knowledge from the discreet subject areas (Hourigan et al., 2021).

Contrary to the concerns of ambiguity and curriculum overload expressed by teachers in the former study (Delahunty, Prendergast and Ní Ríordáin, 2021), the Inspectorate (DES, 2020) posits the view that the integrated nature of the child-centred PSC provides an ideal backdrop for integrated STEM education. This is consistent with international literature of STEM in primary education where the tenets of primary education (cross-disciplinary, child-centred, collaborative, realistic, hands-on approach) informed by educationalists such as Piaget, Vygotsky, Dewey and Bruner, closely align with integrated STEM education (Glancy and Moroe, 2013; Dunphy, Dooley and Shiel, 2014).

Furthermore, the Inspectorate state (DES, 2020) that the skills developed in science and mathematics curricula directly support the activities and priorities outlined in the *STEM Education Policy Statement* (2017b). The Inspectorate (DES, 2020) also recognises that other subjects such as Visual Arts and Geography have identifiable STEM components.

However, despite the Inspectorate (DES, 2020) exalting the appropriateness of the primary school environment for integrated STEM education, they found that in a recent report on schools (DES,2020) that there was still a great amount of compartmentalisation of subject areas in primary schools and integrated STEM learning must be further embedded in the primary sector. Furthermore, there is a mismatch between the intended and implemented curricula in science and mathematics in primary schools (Hourigan et al., 2021) where areas which support STEM education such as problem-solving and child-led investigations are limited.

Despite the Department of Education's (2016) policy statement and the Inspectorate's (2020) guidelines, there seems to be a divergence of views between what should be happening and what is happening in terms of STEM education in Irish primary classrooms (Delahunty, Prendergast and Ní Ríordáin, 2021; Hourigan et al., 2021).

2.3 Intrinsic Educational Value of Integrated STEM Education

The STEM Education Policy Statement (2017b) harks of the virtues of STEM education for the child including instilling a love of learning, problem-solving skills, life and social skills and the application of knowledge and skills. These views are echoed across contemporary discourse in both research and education where STEM education builds discipline knowledge, skills and dispositions which are aligned with their needs to function productively but also ethically in the future (Falloon et al. 2020). The primary teachers in

both recent Irish studies are in consensus (Delahunty, Prendergast and Ní Ríordáin's, 2021; Hourigan et al. 2021) that integrated STEM education is replete with benefits for the child.

Leavy et al.'s (2021) *Reflections on a STEM activity from an Irish classroom* showcases the benefits of integrated STEM for children. They designed an integrated STEM activity for two third classes in an Irish primary school. In their design, they included science and mathematics rich content appropriate to a third-class level, an engineering design challenge as well as considering an engaging context for children that supported collaborative work. Although it did not rely on children's accounts, it is one of the first in the educational landscape to consider the children's enjoyment of an integrated STEM activity. The researchers described how children were immediately excited and engaged about the prospect of the task. Enjoyment of learning science, a STEM subject, can be shaped from several influences including inquiry and hands on activities (Hampden-Thompson and Bennett, 2013) where children access their current perception of enjoyment (Wang et al. 2021)

Integrated STEM education improves children's existing knowledge by activating their prior knowledge when they encounter an integrated STEM problem and they are forced to make sense of relationships and generate a solution (Wang, 2012). Roehrig et al. (2021) highlight the importance of engineering design challenges (EDC) for conceptual integration as engineering is the application of science and mathematics. The Inspectorate (DES, 2020) advocates the use of EDC as they encourage multiple solutions from the children and inquiry-based thinking as well as giving them a way of applying the knowledge they have learned in Science and Mathematics in a real-life context. Indeed, many resources promoted at primary school level for STEM include this framework for thinking (Engineers Ireland, 2020).

Teachers in the Hourigan et al. (2021) study welcomed integrated STEM as opposed to traditional didactic approaches which are common in some primary schools. Within the integrated STEM work, they cited the vital 21st century skills that closely align with the Social, Personal and Health Education curriculum. Integrated STEM in younger children develops empathy and the children's individual self-confidence as they practice expressing their opinions (Carroll et al., 2010; Yalsin and Erdin, 2021). Hourigan and Leavy (2021) designed a set of collaborative integrated STEM lessons for a sixth-class primary group. On completion of the unit, they found that the children's collaboration and communication skills were improved. Group work is of great importance in developing social skills and the ability to relate to one another to achieve a common goal (Woolfolk, Hughes and Walkup, 2015).

2.3.1 Social Metacognition

Leavy et al. (2021) highlight the importance of group work in integrated STEM for children. They described how some children who initially used informal language during the tasks, picked up on the formal scientific and mathematical language of their peers and learned from them. This is consistent with research in which participation in group discourse can influence individual students' conceptions, as well as encouraging them to present knowledge in multiple ways (Warfa et al., 2019).

Furthermore, group work in STEM subjects has been shown to improve individual problem-solving abilities (e.g. Iiskala, et al. 2011; Hurme et al. 2014). Various authors (e.g. Chiu and Kuo, 2009; Larkin, 2009) have examined social metacognition in which young learners distribute metacognitive responsibilities among group members, making metacognition visible and in doing so, improving individual cognitive processes including problem-solving.

These studies above are in line with Vygotsky's (1978) sociocultural perspective. His theory advocates that learning occurs in cultural settings and cannot be separated from it. He furthers this by stating that our social interactions are more than simple influences upon us but actually create our cognitive structures and thinking processes. Children's cognitive development occurs through their interactions with more capable members of the culture such as adults or more able peers.

Goos, Galbraith and Renshaw (2002) suggest reconceptualising individual metacognition as a social practice, in which problem-solving in STEM subjects such as mathematics are reconsidered in light of sociocultural theory. Therefore, in recent years, more emphasis has been placed on the influence of social context and the creation of social classroom environments that support metacognition as opposed to directly teaching strategies and skills (Robson, 2019).

2.4 The Context of the Gaelscoil

The context of this study is in an Irish medium primary school or Gaelscoil, outside of the Gaeltacht. In Gaelscoileanna, the language of communication and instruction is Irish (Gaeloideachas, 2022). There are currently 255 primary schools which operate through the medium of Irish in the Republic of Ireland (Gaeloideachas, 2022). There are two types of Gaelscoileanna – those located within the Irish speaking regions of the Gaeltacht and those situated outside it.

The majority of pupils who attend Gaelscoileanna (outside of Gaeltacht regions) are native English speakers (Ó Ceallaigh, Hourigan and Leavy, 2018). Ó Ceallaigh, Hourigan and Leavy (2018, p.2) refer to these schools, outside of the Gaeltacht, as "whole-school immersion centres". This unique primary school context is pertinent when considering

Vygotsky's sociocultural theory as the social interactions which the children will engage in will be through the medium of Irish, their second language.

One of the main priorities of the *STEM Education Policy Statement* (2017, p.7) is "communicating well" within group work. This immediately places emphasis on how the child interacts with others, language being the main form of communication. Children in Gaelscoileanna can often have a high level of Irish fluency but display a limited vocabulary with simplified grammar as well as being heavily influenced by the English language (Ó Ceallaigh 2016; O Duibhir, 2018). This is often disparagingly referred to as an interlanguage of 'Géarla' - a mix of Gaeilge and English (Béarla) (MacGearailt, MacRuairc and Murray, 2021). Lightbown and Spada (2013) state that while pupils may appear fluent in social situations, they do not possess the language for academic work. Most children partaking in integrated STEM work in Gaelscoileanna will be communicating through a second language not only in a social manner but also sharing their ideas of academic content. Based on the work of the above authors, this has ramifications for how the children communicate during integrated STEM.

Teachers in Gaelscoileanna need to possess a wider range of skills than those required in English medium schools (Ó Ceallaigh, Hourigan and Leavy, 2018). Fundamental to the curriculum of immersion programmes is the integration of content and language, where the second language of the child is the method of teaching the subject content (O Conghaile, 2019). However, research has shown that teachers in Gaelscoileanna have great difficulties balancing and integrating content language and instruction so that children can achieve high levels of content knowledge as well as greater language learning (O Ceallaigh, 2016; O Conghaile, 2019). Therefore, for the majority of children who attend Gaelscoileanna, the STEM education which they experience through their second language is different to that experienced in English medium primary schools in Ireland.

2.5 STEM in Immersion Education

Internationally, there is a lack of research available on the educational landscape examining integrated STEM education in immersion settings. Those studies that exist mainly examine the gap that lies between language and content in the individual STEM subjects of mathematics and science. Turnbull, Hart and Lapkin (2000, p.5), found that teachers and parents of schoolchildren in French immersion schools, reported concerns that children may not learn "as much" mathematics content through a second language. Despite this, it was found that there was no significant difference between English program students' and French immersion students' mathematics tests results, irrespective of language. Furthermore, Turnbull, Cormier and Bourque (2011) also investigated children's communication in Science in French immersion schools and found that schoolchildren reverted to English to explain their ideas when the concepts became more complex.

In an Irish context, Ó Conghaile (2019) conducted a thorough exploration of science teaching and learning in Gaelscoileanna. He interviewed three senior class teachers about the methodologies they use when teaching science in Gaelscoileanna. He found that two of these teachers reported using English to aid the students' understanding. This is consistent with international research in immersion settings where some teachers use the native language of the student when teaching complex academic subjects in the second language (Cammarata and Tedick, 2012). However, these two teachers did not pre-teach the necessary science vocabulary (content) beforehand and still expected the students to pick up the language via "osmosis" (Ó Conghaile, 2019, p.5). This study reinforces the notion that teachers are grappling with content and language teaching in Irish immersion settings.

Furthermore, the teachers in Ó Conghaile's study (2019) who reported using English to aid understanding, found that English was used frequently by their students as the language of

communication during group work. None of the teachers taught content-compatible language which is language that can be used across a variety of domains. Coyle, Hood and Marsh (2010) posit that the learner's ability in the target language is not as advanced as their cognitive ability. Therefore, they may understand the content, but they may not be able to express or demonstrate their learning.

Ní Ríordáin and O Donoghue (2009) carried out a comparative study between secondary school pupils who had been educated in Gaelscoileanna versus those who had attended English medium primary schools. In an English mathematics test, they found that secondary students who had a high competency in English and Irish (educated in Gaelscoil) outperformed those who were educated in English medium primary schools. However, those former Gaelscoil pupils with low competencies in Irish and English performed significantly lower than any other groups. Using the Cummins' Threshold Hypothesis, they posit that there may be a threshold level of language competence that bilingual students need to achieve in order to avoid cognitive deficits and so that the potential benefits of bilingualism are able to flourish.

2.5 Student Voice

Murphy et al. (2012) highlight the strong emphasis Ireland places on children's voice regarding education, health or wellbeing. The pioneering Growing Up in Ireland survey which began in 2009 recognises the value of listening to children about issues that directly affect them. The survey makes a great contribution in terms of children's perspectives of education and recognises the need for pupil voice in curricular change and reform.

There is a paucity of research available on children's perspectives of integrated STEM. Both in Ireland and internationally, any research in this area has tended to focus on children's perspectives of the individual STEM disciplines. McCoy, Smyth and Banks

(2012), based on the data from the Growing Up in Ireland survey, found that boys had more positive views of mathematics at 9 years of age than girls. No variation was found in children's preferences for mathematics between those attending Gaelscoileanna and English medium schools. Finally, they found that children who tended to be involved in group work reported enjoying school more.

Murphy, Varley and Veale (2012) carried out a large-scale survey of Irish primary school pupils, both in Gaelscoileanna and English medium schools, in terms of their preferences of science. Based on a questionnaire, it was the first which examined pupil voice in terms of the STEM subjects in Ireland. There was great enthusiasm for science reported by these pupils. However, many of them did not relate it to their own lives. Furthermore, the children reported that there was an over reliance on didactic approaches as opposed to inquiry-based learning in their science lessons. In a similar study, Murphy, Mullaghy and D'Arcy (2016) investigated pupils' perspectives of science in primary schools. They found that girls reported being less enthusiastic about science in primary school than boys. Furthermore, all children were excited about inquiry-based learning.

Finally, the Department of Education recognised the importance of the children as stakeholders in the *STEM Education Policy Statement* (2017) and their voice will continue to be heard throughout the consultation process (DES, 2021).

2.6 Conclusion

This chapter has explored the origins of STEM as well as the different perspectives in STEM education. It also has examined STEM education in Irish educational policy as well as analysing the intrinsic value of STEM. The chapter continued by introducing the context of the Gaelscoil as well as studies which have examined STEM subjects in immersion

settings, particularly Gaelscoileanna. It concluded by briefly examining pupil voice in Irish education. The following chapter, Chapter 3 will outline the research design.

Chapter 3: Research Design

3.0 Introduction

The purpose of this chapter is to outline the research design and approach to the study. Overall, the purpose of the study is to examine primary school children's experiences and perspectives of integrated STEM in a Gaelscoil setting. A thorough analysis of children's experiences of STEM education at primary level is required because of the publication of the *STEM Education Policy Statement 2017-2026* (DES, 2017). There is a lack of research in this area, particularly examining the views of children who experience integrated STEM education in an Irish medium education setting.

Initially, the primary and secondary research questions are outlined in section 3.1. This is followed by the context of the study in section 3.2 which explains the background of the primary school where this study takes places as well as discussing the position of the teacher-researcher. In section 3.3, the interpretive paradigm which frames this study is introduced as well as the accompanying qualitative methods in section 3.4. Section 3.5 will have a particular focus on interview design which is at the core of this qualitative study.

The primary pupils who took part in this study are described in sampling in section 3.6 followed by how the teacher-researcher conducted a pilot study in section 3.7. The methods of data collection and analysis are outlined in sections 3.8 and 3.9 respectively.

Ethical considerations are discussed in section 3.10 followed by how validity, reliability and triangulation of data were applied in the study in section 3.11. Finally, the limitations of the study are discussed in section 3.12 and this is followed by a brief conclusion in section 3.13.

3.1 Primary and Secondary Research Questions

The research design was framed by the following research questions:

1. What are children's experiences and perspectives of integrated STEM in a Gaelscoil setting?

The secondary or subsidiary research questions are:

1. How do children communicate and behave during integrated STEM?

2. Are there unique supports required for integrated STEM in a Gaelscoil setting?

3.2 Context

The present study took place in second class in a large, non-DEIS, urban, co-educational primary school in Munster, outside of a Gaeltacht region. A Gaeltacht is an area where Irish is the primary language of the majority (UnG, 2022). The school is in an area where English is the primary language of the community. It is a Gaelscoil or Irish medium school where Irish is the language of instruction and communication between pupils, staff and Board of Management members (apart from the teaching of the subject of English). The school is under the patronage of the Catholic Church. Students from various cultural, social and religious backgrounds attend the school.

3.2.1. Teacher-Researcher Rationale

The researcher is the classroom teacher who has worked closely with all the participants since September 2021 and has been known to the children in an informal manner since they began school in September 2018. Woods (2006) states that the researcher must be close to the groups and individuals which he/she is studying in order to see their world viewpoint.

This study is deemed as teacher research as it is based on the tenets of such research as outlined by Lankshear et al. (2004). It is non-quantitative in nature and the teacher is carrying out the study in the context of her own classroom. Furthermore, the goal of this research is to contribute to better quality teaching and learning in the classroom (Lankshear

et al., 2004). The term teacher-researcher (TR) is used to describe a teacher who incorporates an educational research study into their work practice (Hammersley, 2006) and thus, the researcher in this study will be referred to as a TR throughout.

3.3 An interpretive paradigm

"A paradigm is a set of assumptions and perceptual orientations shared by members of a research community" (Given, 2008, p.592). The interpretive paradigm was chosen as a frame for this research study to gain the essence of the children's views. Interpretivism or constructivism "assumes that reality is socially constructed" (Merriam, 2009, p.8) and that there is no single, objective, observable reality. It is based on relative ontology and there are multiple interpretations or realities of a single event (Merriam, 2009). These subjective realities are not formed by the individual in isolation but socially negotiated through their interactions with others but also through the cultural and historical norms that pervade in people's lives (Creswell, 2007).

Epistemology is the relationship between the researcher and reality (Carson et al., 2010). Interpretivism is a 'people-centred' approach to research which acknowledges the integration of the researcher and the research environment (Morrison, 2002, p.18). The researcher is affecting the research process and is in turn, also affected by it. Therefore, issues related to power, status, control and ownership are important (Brundrett and Rhodes, 2014). This view is particularly helpful to the TR in the context of this study when examining her relationship with the students in her class.

Interpretivism is a more subjective way of viewing epistemology, and the researcher makes meaning of the data through their own interpretations which is informed by interactions with participants (Kivunja and Kuyini, 2017). The researcher attempts to immerse themselves in the environment under study and "explore the "meanings" of events and

phenomena from the subjects' perspectives" (Morrison, 2002, p.18). The research process is underpinned by democracy in which participants are granted equal status and a variety of perspectives are welcomed (Brundrett and Rhodes, 2014). For this reason, this paradigm readily lends itself to the purpose of gaining the perspectives of students in relation to integrated STEM in a Gaelscoil setting.

McDonagh et al. (2019) refer to it as an evaluative paradigm where the researcher attempts to describe, explain and interpret what is happening while simultaneously making value judgements. Furthermore, the researcher must realise that participants' views can evolve and change throughout the research process. Therefore, the research questions may not be definitively established until the conclusion of the study (Mertens, 2005). This viewpoint is appropriate to the dynamic nature of the classroom and the pupils within it, which is the context of this study.

The use of an interpretive lens in educational research has often been termed as practical (Carr and Kemmis, 1986). Within interpretivism, we as teacher researchers observe, interpret and comment (Cohen, Mannion and Morrisson, 2018). Therefore, interpretivism seemed the most realistic paradigm to frame this research study.

3.4 Qualitative methods

Although an interpretive paradigm may now promote both the use of qualitative and quantitative methodologies (Lincoln and Guba, 2000), it generally operates using qualitative methods (Silverman, 2001; Brundrett and Rhodes, 2014).

Qualitative research, according to Yin (2016) has five main features that distinguish it from other forms of social research. It involves studying the meaning of people's lives, representing their views, attending to real-world contextual conditions, contributing insights to explain social behaviour and not relying on a single source of evidence. These

five features closely align with the multi-perspective and subjective nature of interpretivism.

The overall purpose of qualitative research is to understand how people make sense of their lives, as well as describing how they interpret what they experience (Merriam, 2009). One of the most important aspects of qualitative research is that of context (Kincheloe, 1991) Qualitative research studies the process of human meaning making within this context and involves analysing social behaviour in natural settings (Kincheloe, 1991; Hitchcock and Hughes, 1995) Critical teacher researchers understand that the meaning of data cannot be separated from human experience and socio-cultural context. Human experiences are shaped in contexts and cannot be stripped from them. In qualitative research, contexts must not be adapted or recreated (Kincheloe, 1991). Therefore, the classroom is an ideal context to study children's perspectives on integrated STEM.

In terms of school-based research, qualitative methods examine what ordinarily happens in classrooms. This is the normal, everyday context of the children. Therefore, the results of such studies are placed firmly within educational practice (Kincheloe, 1991). In many cases, this study included, accessibility for the teacher researcher was a key factor in choosing a qualitative methodology, but it also has the added advantage of drawing the participants and the teacher researcher closer together (Hitchcock and Hughes, 1995). Teacher researchers use qualitative research to enhance their subjective views of education. This type of research acknowledges the complex layers of interpretations, meanings, attitudes and values that make up our schools and classrooms (Kincheloe, 1991). Therefore, it was an ideal methodology to gain the student's perspectives on integrated STEM.

This study is designed as what Merriam (2009, p.22) would term a "basic qualitative study" which has understanding how people make sense of their experiences as its goal. Merriam

(2009) furthers this by stating that these types of studies are the most common form of qualitative research in education with data being collected through a variety of methods such as interviews, observations or documentary analysis. This ensures triangulation which is of great importance in qualitative research (Creswell and Poth, 2018). A variety of qualitative methods were adopted in this research study in order to capture the participants' experiences and perspectives of integrated STEM in a Gaelscoil setting.

The range of qualitative data collection tools in this study were as follows: the researcher's diary, the pupils' STEM journals, semi-structured interviews and a critical friend.

One of the functions of the researcher's diary utilised in this study was for the purpose of logging the researcher's activities and reflections (Bryman, 2004). The second purpose of the researcher's diary was as a method of recording observations also known as field notes (Frey, 2018). Observations have been described as a "technique of choice when behaviour can be observed first hand" (Merriam, 2009, p.55). Therefore, it was an appropriate methodology for the classroom. It allows a more holistic interpretation of the research question when combined with the other methodologies as well as providing a reference point for the subsequent interviews.

The use of reflective journals is recommended by many authors for problem-based learning and teaching design in science particularly for younger students (Puntambekar and Kolodner; 1998 Hmelo Silver 2000; 2004). These journals would be deemed as documents as they are not produced for the purpose of the research question. Documents have been termed "objective" and "unobtrusive" as they exist outside the research study (Merriam, 2009, p.48).

Finally, the TR employed the help of a critical friend (CF) throughout the research study. The term CF was first used by Stenhouse (1975) who proposed that the CF could give vital

advice and support to TR during educational research. Since then, the role has expanded to include a variety of roles. However, CFs generally consult with teachers who are new to research in the classroom to assist with the project and to provide advice afterwards (Kember et al., 1997). The CF in this study was the school principal.

The next section will describe the main qualitative method employed in the study which were interviews.

3.5 Interview Design

This research study used semi-structured interviews as the key qualitative method of collecting data from the participants. DeMarrais (2004, p.55) defines an interview as "a process in which a researcher and participant engage in a conversation focused on questions related to a research study". Interviews are the most common approach to collecting data in qualitative research (Merriam, 2009)

The semi-structured format was chosen as it most favoured by educational researchers (Hitchcock and Hughes, 1995). It gives the interviewer ample opportunity to probe and expand on the interviewee's answers. It gives the researcher the opportunity to alter the sequence of questions every week in order to dig deeper and to avoid the common tendency that respondents can predict the questions. It also allows the researcher time to leave space in the schedule to make notes or add comments. In turn, this leads to a form of balance between the interviewer and respondent which provides room for discussion, negotiation and expansion of responses (Hitchcock and Hughes, 1995). This format allows the researcher to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic. (Merriam, 2009).

Furthermore, the group interview was chosen in this study as they are known to be more practicable than individual interviews for the TR to carry out (Lewis, 1992).

3.6 Sampling

The most common form of sampling in qualitative methods is purposeful, small and non-random sampling (Merriam, 2009). It involves selecting participants that are knowledgeable about the topic of interest (Cresswell and Plano Clark, 2011). The researcher is intending to understand, discover and gain insights and thus, a sample must be selected from which the most can be learned (Merriam, 2009). Due to accessibility and the researcher's close relationship with her class, the class of the TR was selected as the sample for this study.

There were 23 pupils in this class and 22 of the 23 pupils consented to participate in this study. Of the 22 pupils enrolled in this study, 21 had English as a first language and one student had both English and Irish as a first language. The pupils age at the completion of this eight-week study was between 8 years and 1 months and 9 years and 3 months. Of the participants, there were 9 males and 13 females. No pupil reported experience of integrated STEM at home or at school on beginning this study. All pupils had completed the majority of the second-class mathematics and science curriculum before undertaking this unit of work.

3.7 Pilot Study

The interview questions were piloted to the CF before beginning the study with particular focus on the language of the questions. This was to avoid bias and to ensure that the Irish language was not too difficult for the children to understand. As a result of independent knowledge garnered from the pilot study, these questions were recrafted. These recrafted questions were then used for the purpose of this study were recrafted (Appendix 1).

3.8 Data Collection

The researcher completed an 8-week integrated STEM unit of work with this class which began in February 2022 and ended in April 2022. This unit of work was designed by the TR appropriate to the second-class Mathematics and Science Education PSC (1999) aims. It also incorporated Problem-Based Learning (PBL) (Appendix 2) and the Engineering Design Process (EDP) (Appendix 3). The unit of work had been piloted the previous year with a similar class level. Furthermore, it was ensured that mathematics aims underlined each lesson in line with the *STEM Education Policy Statement 2017-2026* and the PSC (1999), and at least two of the STEM areas were included in each lesson. Examples of tasks which the class engaged in are attached in Appendix 4.

The class had never completed integrated STEM before but had experienced Mathematics and Science lessons as outlined in the PSC (1999). Each Tuesday afternoon, for one hour, the children in groups completed an integrated STEM task. The children were in the same mixed ability groups (four to six members) for the eight-week unit. Firstly, they assigned roles to each group member – engineer, architect, speaker, time keeper, quantity surveyor and builder which were rotated on a weekly basis (Appendix 5). They then read the task sheet and they drew individual designs in their STEM journals which were all submitted to the architect. The architect drew a group design based on the children's individual designs. Concurrently, the engineer asked the group members about their previous knowledge on the task as well as what they would like to learn. At the end, he / she also wrote down what the group learned.

During the integrated STEM work, the children used STEM journals to record the EDP as well as using these journals to reflect on the lesson (Example Appendix 6). It is part of the school policy for children to use reflective logs as part of their lessons. When the members

had completed the design challenge, they reflected on the lesson in their individual STEM journals.

While the members were completing the integrated STEM challenge, the TR and CF had researchers' diaries on hand throughout the lessons and noted observations of group work in these journals. Observations included the participants' interactions, activities, conversations, the physical setting and subtle factors (Merriam, 2009) during the integrated STEM tasks. As recommended by Merriam (2009), a recording device, a Samsung Galaxy A12 was place in the room during the work, to aid writing up field notes after the activity and to capture verbal aspects of the integrated STEM work. The TR and CF ensured that these diaries were completed immediately after each lesson. An example of one of the pages in the researcher's diary can be found in Appendix 7.

The semi-structured group interviews took place immediately after each integrated STEM lesson in a quiet corner of the classroom. The interview guide consisted of a list of ten questions in Irish (Appendix 1). These were open ended questions in order to gain "good data" (Merriam, 2009, p.52) and were then followed up by probes and requests for more detail. All pupils answered in Irish. Due to the semi-structured nature of the study, the TR could change the order of these questions, probe further and also ask questions about emergent data. A Samsung Galaxy A12 phone was used to record the group interviews.

3.9 Data Analysis

All audio-recorded group interviews were transcribed verbatim. These interviews, coupled with noted TR's and CF's observations and the children's STEM journals were organised for data analysis. The data analysis procedure for qualitative research is inductive in nature and emergent. Thus, data analysis was ongoing with data collection (Merriam, 2009)

All data was analysed using the six steps of Braun and Clarke's (2006) method of thematic analysis to identify, examine and describe the various patterns in the data (Figure 3.91).

Figure 3.91: Braun and Clarke's Six Steps of Thematic Analysis (2006)

Following the six steps (Braun and Clarke, 2006), the TR first read all the scripts multiple times, thereby becoming immersed in the data. As recommended by Meyer and Avery (2009), Microsoft Excel was used to track and code the themes that were emerging from the data. The initial codes were inputted to reflect the key ideas that were emerging from the data. Then using this programme, the codes were then organised into themes. These themes were reviewed by rechecking the coded data. The themes were then finally named and defined and were related back to the research question.

The diagram below (Figure 3.92) shows the themes and their accompanying subthemes.

Figure 3.92: The themes and subthemes which emerged from the data

3.10 Ethical Considerations

The ethical principles of respect, beneficence and justice guided this study (Mertens, 2012). However, qualitative research presents with complex ethical issues as there is personal interaction with individuals and communities (Mertens, 2012). Therefore, stringent ethical protocols were employed for the duration of the thesis.

Both informed assent and informed consent was received from the parents of the pupils (Appendix 8) and indeed the pupils themselves (Appendix 9). Informed consent was also received from the CF (Appendix 10). Participants were free to withdraw with a verbal confirmation at any stage and were aware that were no consequences for doing so. This is in line with Mertens (2012) recommendations that participants should be fully informed and voluntarily consent. Pseudonyms were assigned to each child at the beginning of the study.

The researcher's personal field journal and the children's STEM journals and work samples were locked in the filing cabinet in school as per school protocol for children's personal data and work samples. Only the class teacher has access to this cabinet.

All audio files and associated transcripts were stored on UCC OneDrive to ensure GDPR/Ethical requirements for UCC research. The researcher had access to it, and it was destroyed on the termination of this thesis. The data was encrypted, and password protected.

3.11 Validity, Reliability and Triangulation

Merriam (2009, p.40) states that triangulation of data is "a principal strategy to ensure validity and reliability" within the interpretive-constructivist perspective. This study employs multiple methods including the researcher's observations and field notes, the

children's STEM journals and semi-structured interviews in order to compare and cross check data. Observation is a common method of data triangulation to validate the self-reporting of interviews (Frey, 2018) and is used in conjunction with both interviews and document analysis to substantiate the findings (Merriam, 2009). The STEM journals produced by the children in this study were not uniquely created for research purposes. Therefore, the presence of the TR does not alter the document. In that sense, it is an objective source in the study (Merriam, 2009)

Another strategy that this study employed to ensure internal validity is what Merriam (2009) would term member check. Maxwell (2005) deems the member check the most important way of ensuring that the participants meant what they said. The teacher researcher solicited feedback from some of the children on the emerging findings of the study. Furthermore, the TR ensured that she was aware of her own biases in the research process.

The researcher ensured that she had adequate engagement in data collection in order to get as close as possible to the children's perspectives of integrated STEM within their setting. Merriam (2009) recommends that data and emergent findings must feel saturated in order to support this. The teacher researcher carried this study out for 8 weeks but deemed 6 weeks as the saturation point. She decided to continue with data collection beyond the saturation point in order to ensure that she had captured the full range of children's perspectives as well as adequately engaging with the data.

Reflexivity in this study was ensured as the TR accepted her own biases, dispositions and assumptions of the research (Merriam, 2009). Atkins and Wallace (2012) draw attention to the fact that impartiality or the ability to step back is a necessity in educational research. The researcher was clear in her understanding that she would have a good rapport with the

children during the interviews but remain neutral vis-à-vis what they were saying during the interviews (Patton, 2002). Due to the use of the interpretive lens, she also accepted the impact she would have on the study. This bracketing bias can greatly enrich qualitative data if the TR can maintain self-awareness as part of the ongoing process (Tufford and Newman, 2010).

Furthermore, to ensure reflexivity, the teacher researcher enlisted the help of a CF, the school principal, for data collection. It is the culture of this class that the school principal often is engaged in assisting with lessons and the children were familiar with him. The critical friend also acted as an observer and provided a new perspective on the class by virtue of having 'blind spots' different from the teacher researcher as well as ensuring the teacher's awareness of any 'blinkered assumptions' which stood in the way of the researcher's understanding. Feldman et al. (1993) refer to the former and the latter as implicit knowledge and assumptions that shroud the TR's understanding. Furthermore, having a CF who is not actively teaching enables the TR to observe more precisely what is going on in the room (Feldman et al. 2018; Atkins and Wallace, 2012).

3.12 Limitations

The main limitation of this study is its subjective nature due the TR as the primary instrument in data collection. However, Merriam (2009) argues that within qualitative research, subjectivity and interaction are assumed. Atkins and Wallace (2012) argue that it is impossible to be objective within the subjective situations. They deem that all educational research involves people and therefore, it is subjective.

It was imperative that the TR in this study attempted to remain impartial and unbiased (Silkes and Potts, 2008) and to problematise her given classroom situation and not to accept her interpretation of the classroom as the "right" interpretation (Taylor and Bogdan, 1984,

p.19-20). It was of utmost importance that she listened to the children's views and challenged her own views and biases. The TR attempted to identify and monitor these biases during the collection and analysis of data (Merriam, 2009). However, this bracketing bias if monitored correctly can become a strength of the study and greatly add to the qualitative data (Tufford and Newman, 2010).

The TR was aware of her relationship with the children and how they would perform in a more socially acceptable manner when they knew they were being observed and recorded (Merriam, 2009). Furthermore, as group interviews took place, the TR was aware of the effects of the children's interrelationships with one another (Lewis, 1992). The TR attempted to identify the effects and account for them in data interpretation.

Finally, this is a small-scale study where generalisations cannot be made, but it provides valuable insights into an integrated STEM experience in a primary Irish immersion setting and can inform both policy and practice.

3.13 Conclusion

This chapter outlined how to the research was conducted in order to explore the primary research question and accompanying subsidiary research questions. It initially provided a rationale followed by the research questions. The chapter then explained the context of the research study followed by a description of the qualitative methods used as well as a description of the sample. An account of the data collection and analysis methods was then provided, followed by ethical considerations and issues of validity, reliability and triangulation. Finally, the limitations of the study were discussed. The next chapter will explore the findings of the research as well as an in-depth analysis of these findings.

Chapter 4: Findings and Analysis

4.0 Introduction

The aim of this study is to critically analyse pupils' experiences and perspectives of integrated STEM in an Irish medium education setting. The previous chapters have introduced models of integrated STEM and what this approach might look like in Irish primary schools, including Gaelscoileanna. The benefits of integrated STEM were also discussed. This chapter presents the findings that emanated from this study and the subsequent analysis.

The children in this classroom completed an eight-week unit of integrated STEM. After each session, the teacher-researcher (TR) conducted semi-structured group interviews with the pupils. (Table 4.1).

To triangulate the data, both the TR and the critical friend (CF) observed and noted the children's behaviours. The TR encouraged the children to reflect on the experience in their STEM journals and also collected and analysed documents completed by the children during integrated STEM.

The next section (4.1) describes the participants in this study. This is followed by main themes which were revealed from this data: Pupils' Dispositions towards Science and Mathematics (4.2), Children's Attitudes towards Integrated STEM (4.3), Group work (4.4), Skills Transferability and Prior Knowledge (4.5), Engineering Design Process and Planning (4.6), and Integrated STEM through the Irish language(4.7). Section 4.8 concludes the chapter.

4.1 Participants

During integrated STEM work, the second class of 23 children was split into five mixed-ability groups demonstrated in table 4.1 below.

Table 4.1: Group Composition

Name of group	Composition
Grúpa NASA	4 children – 2 boys, 2 girls
Grúpa Curie	6 children – 3 girls, 3 boys
Grúpa Newton	5 children – 3 girls, 2 boys
Grúpa Anning	4 children – 4 girls
Grúpa Galileo	4 children – 2 boys, 2 girls

The Critical Friend (CF) was the school principal.

4.2 Children's Dispositions to Science and Mathematics

Before the beginning of this study, the TR asked the children's views of Science and Mathematics as these are two individual STEM subjects which the children study in school. The viewpoints of the children were all positive towards these subjects.

> Is brea liom Eolaíocht .. mar is féidir leat dul amach sa chlós agus ag déanamh domhantarraingt (Caoimhín)
>
> Is maith liom ag deánamh mo sumaí i mo chóipleabhar Mata (Eilís)

They also understood what concepts these subjects were comprised of:

> Eolaíocht ná maignéidí agus na fórsaí go léir ...cosúil le um brú agus tarraingt (Briain)

Le Mata is féidir leat a bheith ag comhaireamh agus ag féachaint ar na cruthanna (Aoibhín)

In two national studies (Murphy et al. 2012; McCoy et al., 2012), it was found that Irish primary school pupils are very positive towards the subject of science. However, children's opinions are somewhat balanced between positive and ambiguous or negative towards mathematics. The overwhelming positive dispositions in this class towards mathematics were incongruent with this previous data. The positive dispositions towards the individual subjects in this class set the tone for the integrated unit of STEM which occurred in the weeks that followed. The CF was surprised at the positive reactions that the children had to mathematics. This was echoed in the TR's reflective journal where the following was written:

deacair a chreidiúint cé chomh dearfach is go bhfuilid fé Mhata.

4.3 Pupils' attitudes towards integrated STEM

During the group interviews, all children expressed the enjoyment and fun that they experienced during integrated STEM work. After the first lesson, children reported:

Is breá liom é (Muireann)

Bhí sé ana speisialta chun déanamh é (Tiarnán)

As the weeks progressed and the children became more familiar with the programme, the sheer excitement and joy was palpable to both the TR and CF in the room every Tuesday afternoon:

Múinteoir! Múinteoir! Féach! (a group of children)

By the end of the eight-week period, all children agreed that it was the best subject or at least on par with sport and art as illustrated by the following quotes:

> Is é an rang is fearr (Bríd)
>
> Ní maith liom ETIM. Is AOIBHINN liom ETIM! (Clodagh)
>
> Tá sé cosúil le duais na seachtaine, like am órga ach i gcomhair gach duine (Briain)

These views are representative of the whole class. These findings are congruent with Shumow et al. (2013) who refer to how children's perception of enjoyment of science in the classroom is based on the fun and happiness they feel during learning activities. Enjoyment is central to the 'push' for STEM education engagement (Wieczeral et al. 2022) in the US which is based on creating positive attitudes with the sciences (Moss-Racusin et al. 2018).

4.3.1 Incorporation of other subject areas

Even though it was not intentional on the part of the TR to incorporate other subjects into the integrated STEM, it was apparent that organically, other subjects had been integrated by the children into the tasks such as art, physical education and drama:

> Is breá liom é seo. Is breá liom ealaín agus ag cruthú rudaí (Tiarnán)
>
> Is aoibhinn liom bheith ag rith timpeall na háite – tá sé mar am spóirt (Dáithí)
>
> Tá sé mar dráma beag anseo (Aoibhín)

The sentiments above reflect their enjoyment at the incorporation of other subject areas. The addition of art draws attention to the STEM versus STEAM debate in the current educational landscape (Banks and Barlex, 2014) whereas the addition of other subjects such as physical education and drama allude to Irish government policy in that there is no infinite number of STEM subjects (DES, 2017).

Similar to the actions of the children in this study, Magnusson and Backman (2021) found that children in their study naturally incorporated art into their STEM projects and they state that teachers' observations of children should fuel their didactic choices. Hourigan et al. (2021, p.) stated that the new STEM policy should be 'co-constructed' with teachers before formally creating a framework. The present study demonstrates the important role of children as co-constructors.

Most children felt that they would rather mathematics and science integrated all the time. They would prefer them:

> measctha suas….. in ionad Mata agus Eolaíocht (Marc).

The children stated that they wished STEM tasks could longer such as over the course of a week and that they could improve on it day by day. Such a curricular framework as described by the children is not available in Ireland as the STEM Policy Statement (2017) does not prescribe how or when integrated STEM should be taught. However, in the U.S., Johnson et al. (2016) propose an entire integrated elementary framework where mathematics and language arts are integrated with science and engineering.

4.3.2 An extra challenge

Some students reported really enjoying the extra challenge and using their problem-solving abilities:

> Is maith liom é a dhéanamh agus a oibriú amach (Prionsias)

On several occasions, the CF noted the children's practical abilities in terms of how the children worked out the problems and noted the satisfaction that the children felt when they solved it.

> Bhí an mirlín ag dul ró-thapaidh. Chuir mé scaileán ansin chun an mirlín a stopadh agus a chur isteach sa chupán (Róise)

In line with the current study, research has shown (e.g. Torres-Crespo et al. 2014; Aldemir and Kermani, 2016) that integrated STEM has increases and improves a whole host of skills including children's problem-solving abilities. For example, English (2019) found that in a longitudinal integrated STEM unit with a class of 9-year-olds, it increased their conceptual knowledge, measurement and spatial skills.

Our current practice must include a larger variety of problems as we have an over-adherence to well-defined and specific task types (Jonassen as cited in Delahunty, 2019). Based on a study to assess problem-solving, over 90% of the variances in student scores was not due to individual differences but differences in learning activities completed (SRI International, 2010). Therefore, the quality of the type of work a teacher prescribes strongly predicts the quality of a student's work (DES, 2016). The open-ended tasks provided in integrated STEM can become part of a new wider repertoire of problem types in the classroom.

4.3.3 Play

Both from the TR's observations and the children's narratives, play was one of the main reasons children enjoyed STEM. The children reported enjoying the opportunity to use new materials or those which they had not used since infants.

> Is maith liom an fáth go bhfuil ana chuid rudai nua anseo (Pilib)

> Nílimid ach ag spraoi anseo. A lán craic anseo (Máire)

Although it was not planned by the teacher, play was also incorporated on the part of the children into the integrated STEM task. The hands-on, open-ended integrated STEM tasks by their very nature were conducive to play. The reflections of the children are in line with

Honey's (2013) work where she highlights the strong link between STEM learning and the child's innate inclination to play, invent and explore.

All of the children enjoyed acting and playing like it was 'an fíor saol' with their I.D. badges and builder's hats. The following quotation represents their sentiments.

> Tá na postanna cosúil le obair gur maith liom. Is breá liom na postanna seo (Muireann)

Play provides an optimal environment for children to practice the skills and knowledge that they need to thrive and succeed as adults (Zosh et al., 2017). This is congruent with the aims of Irish STEM education where children are practicing their skills and knowledge in a real-life context (DES, 2017). The children saw the valuable opportunity to incorporate play into integrated STEM. This provides another example of how children should be involved in the co- construction of a new STEM curricular framework.

In relation to the playful aspect of learning however, the TR noted that a considerable number of the children who complained of being sensitive to touching paint, playdough and natural materials. Furthermore, the teacher had to constantly help with cutting and sticking activities. It is of note that these children missed sensory and fine motor development opportunities in infant classes due to the COVID-19 pandemic.

4.4 Group Work

A number of children reported enjoying integrated STEM as they had the opportunity to work together in a group. The enjoyment of learning science, a STEM subject, is linked to positive relationships with peers and teachers (Jen et al., 2013, Wang et al., 2021).

> Is breá liom bheith ag obair le chéile (Aoibhín)

This view is representative of the majority of the class.

The CF noted the effectiveness of the structuring of the group work in the classroom:

> Is léir go bhfuil obair ghrúpa fiúntach agus éifeachtach i bhfeidhm anseo. Féachann sé chomh nádúrtha ach bhí ana-chuid oibre roimh ré gan dabht. Tá tú tar éis cultúr nua a thosnú sa rang.

He thought that the lanyards which the children wore around their necks with the roles and responsibilities was an effective resource and children were thrilled by the novelty. He felt that the children were engaged in lively discussion with one another. Some quieter students in class when they were given a role and responsibilities took a more active role than they would normally do in class. This is all consistent with the benefits of group work as outlined by the Primary School Curriculum (1999) and the Primary Development Support Service (PDST) (2022).

Although the TR planned group work meticulously with specific roles and responsibilities, there were some initial problems in the formative weeks where some dominant members acted outside of their roles. Apart from this, the teacher did not intend to eradicate every argument that occurred. A certain amount of debate and disagreement is necessary so that groupthink does not occur. (Forsyth, 2014)

For a small minority (n=2) groupwork proved extremely difficult. These two students were strong academically and had an elaborate plan but become frustrated when the other group members did not follow their plan which they felt was the best. The following diary illustrates this pupil's frustrations:

> Bhí mé chomh brónach agus crosta inniu mar bhí an plean is fearr agam agus ní raibh aon duine ag éisteacht liom agus cheap siad go léir go raibh ceann Chillian an ceann is fearr agus ní maith liom obair leis an grúpa sin arís. (Colm)

For one other pupil in a similar position, he enjoyed the weeks where the group members followed his plan and recounted not enjoying the weeks where they were not listening to him.

> Bíonn mo cheann an ceann is fearr agus bhí mé sásta inniu mar éist siad liom ach an seachtain seo caite bhí mé chomh bréan den rud mar bhí orm suí síos agus plean Liam a leanadh agus bhí sé go hainnis! (Jeaic)

The PDST (2022) extolls the benefits of group work for the development of inter and intra-personal skills. Although, the children had much experience with group work, incorporating group work into STEM was entirely new to them. Therefore, with more familiarity with groupwork in integrated STEM, the children's social skills will improve. However, groupwork did draw attention to the fact that developing social skills are important for all and not just a minority group.

4.4.2 Gender differences in integrated STEM

Overall, from initial observations, there appeared to be no gender differences in integrated STEM, apart from the grúpa Curie. At the outset of the project, the children were asked to draw pictures of what they imagined someone involved in STEM would look like and all children drew pictures of a traditional scientist of their gender type (Appendix 11).

However, on the commencement of the project, the TR immediately saw the differences between girls and boys in the grúpa Curie. The girls reported how the boys in their group dominated and made all the decisions.

> Máire: Bhí na buachaillí ag tógáil gach rud.
>
> Aodhán: Ní raibh na cailíní ag déanamh aon obair.
>
> Máire: Ní raibh siad ag rá cad a chaithfimid a dhéanamh.

Aoibhín: Tá na trí buachaillí ansin agus níl aon spás.

Róise: Níl sé fiú an ceannaire agus ceapann sé go bhfuil sé i gceannas ar an ceannaire.

Although the girls felt that they were overpowered by the boys, they automatically expected the boys to tell them what to do. It is interesting to note at this early age that these girls may have already subscribed to the pervasive gender stereotype that boys have stronger abilities in the STEM subjects (Blazev et al., 2017). Meltzoff and Cvencek (2019) found that even in early elementary school, children have established their self-concepts and gender stereotypes in STEM subjects, particularly in the mathematics where both sexes associated mathematics more strongly with boys than girls.

The boys reported their experience in these building tasks at home and the girls often overestimated the boys' abilities and reported how much experience the boys already had.

TR: Cén fáth gur dhein Aodhán an tógáil go léir?

Aoibhín: Déanann sé Lego. Is breá leis é Lego agus rudaí. Déanann sé Lego a lán agus tá sé master tógálaí.

Experience with building toys such as Lego, is associated with improved spatial skills such as better mental rotation and geometric thinking (Jirout and Newcombe 2015; Fulcher and Hayes, 2017). Feeling efficacy in these areas such as construction toys may increase interest in STEM activities (Uttal and Cohen 2012; Fulcher and Hayes, 2017). Therefore, due to the boys' experience with Lego as they described, this is a plausible reason they felt confident in their integrated STEM activities and the girls did not.

The greatest difference in girls' and boys' activities were the integrated STEM tasks which involved Lego in which it became apparent to the TR and the CF that the girls were

preoccupied with the overall aesthetics of the task. In the Grúpa Anning, the single sex girl group, despite stating that aesthetics were not important, they still spent a significant amount of time on aesthetics, at the cost of not finishing the task on one of the weeks. In the mixed groups, the boys frequently complained about the girls' preoccupation with aesthetics. This is consistent with research where Beisser (2005) found that girls in elementary classrooms are more inclined to make aesthetically pleasing scenes such as houses on a Lego computer programme whereas boys tended to construct more functional objects such as cars.

Overall, the CF and TR observed that the girls were still much more task oriented than the boys and spent a lot more time planning and reading the question. The boys tended to rush and were preoccupied with getting the task complete, irrespective of the final product.

It is clear that there are gender differences in STEM and policy has attempted to bridge the gap between male and female participation by various initiatives. The TR endeavoured to present an image of STEM that was inclusive to all. However, recent research has shown that national policies such as diversity initiatives alone cannot close this gender gap (Moss-Racusin et al., 2018).

4.4.3 Metacognition and Problem-Solving during Groupwork

When asked whether science and mathematics should be always integrated, some children expressed their reservations. They stated that it would have to be in a group as the questions were too difficult to do individually, unless as one child stated:

> má thá ceann mór agat (Ruaidhrí).

The TR noted multiple occasions when the children made a breakthrough in solving a problem, particularly when group members clearly communicated what they were thinking

in the form of a ‘think aloud’ which was often prompted by the TR. This was noted in her diary:

> Dúras cad a bhí á smaoineamh agam ós ard, thosaíodar go léir ag labhairt ós ard (díospóireacht) mar gheall ar an damba agus bhí plean acu ana thapaidh ansin.

By virtue of the children engaging in social metacognition as well as the TR’s use of metacognitive instruction, it led to lively discussions in terms of how to solve the problem as well as encouraging other group members to think of alternative views of the problem as well as challenging previously held assumptions. This is line with previous research where engaging in social metacognition leads to more successful problem solving in STEM (e.g. Artz and Armour-Thomas, 1992; Hurme, Palonen and Jarvela, 2006). The effectiveness of such an approach is reflected in the following quote from the CF:

> Cinnte nuair atá siad ag obair le chéile, bíonn deis acu éisteacht le tuairimí difriúla agus cabhraíonn sé sin go mór leo

A recent Irish study (Delahunty, 2019) has drawn attention to the importance of the earlier stages of problem-solving, that of conceptualisation and initial representation. It was found that once the student decided on a course of action, they did not change approaches irrespective of poor performance. In the current research study, it was found that when children engaged in social metacognition, they were willing to listen to and adapt their strategies. This is reflected in the following quotation:

> Bhí mé ag éisteacht le Bríain agus ansin dúirt mé b’fhéidir nach bhfuil mo smaointe a bhí agam ar dtús ró mhaith agus bhí mé ag athrú ansin (Caoimhe).

Despite, research in social metacognition being in its infancy (Smith and Mancy, 2018), it leads one to question that perhaps attention in classrooms should be drawn away from

individual problem-solving strategies and focus on group problem-solving such as integrated STEM.

However, social metacognitive group work may not suit all learners. Despite mitigating individual metacognitive demand as described by Ruaidhrí, those involved must still address communication difficulties, cultural differences, scaffolding mismatches and status effects (Chiu and Kuo, 2009). For example, Máire, a member of the Grúpa Curie, stated that there was no need for planning as all group members had the same idea in their head. She found it difficult to comprehend how other children would have a different viewpoint to her own. Throughout the eight weeks, she continued to struggle in this area.

Despite the present research being grounded in the Vygotskian tradition of socio-cultural theories of learning, it is advantageous to the teacher to incorporate opposing theories of developmental psychology into the classroom (Blake and Pope, 2008). Máire was displaying the egocentrism of thought, common of the Piagetian preoperational stage where she was unable to see the others' viewpoint (Piaget, 1977). Victor (2004) found that metacognitive instruction in is not appropriate for children who are still at the preoperational stage and teachers should revert to traditional, didactic instruction incorporating systematic steps and explicit directions. With the exception of Máire, all children in the class seemed to be able to engage in social metacognition. Máire's case draws attention to what age group is the correct age group to begin open-ended collaborative problem solving such as integrated STEM.

4.5 Planning and the Engineering Design Process

Of all the aspects of integrated STEM, the children found planning and the Engineering Design Process (EDP) the most challenging. They were disappointed when an idea they devised in their head did not turn out the way they had intended.

> Istigh I do cheann, tá sé go maith ach nuair a dhéanann tú é uaireanta ní thagann sé amach go maith (Aodh).

From the TR's observations, especially in the first few weeks, she found that children were in a rush to get the planning and design finished so that they could move on to the more enjoyable aspect of the building of the task:

> Déan é go tapaidh (Eoghan)
>
> Faigh réidh leis (Bríd).

Others, were impetuous and did not plan ahead. Some drew the plans for the sake of it and forgot to use them:

> O dhein mé dearmad ar an plean (Máire).

Certain children did not see the need for plans, especially those in the grúpa Curie:

> Tá an tarraingt go breá ach rud is tabhachtaí ná na supplies. Leis é seo (an plean) bán ceapaim go mbeimid in ann é a dhéanamh fós (Caoimhín).

Despite no child overtly stating that they disliked the planning aspect of the task, it is consistent with literature where children equate any task involving writing which is initiated by the teacher, with schoolwork (Breathnach, Danby and O'Gorman, 2017).

However, towards the end of the project the children realised the importance of planning.

> Gach aon seachtain, déanaimid plean so beidh fhios againn cad atáimid ag déanamh (Aoibhín)

The positive development of the children's planning in the Grúpa Anning can be seen in the three drawings in Appendix 12. Initially the drawings were basic and lacked clarity

(Picture 1). They then progressed to clear, labelled diagrams (Picture 2). By the end, the group had progressed to an instructional drawing (Picture 3).

The CF highlighted to the TR that the EDP is an entirely new concept to the children and would have to be introduced at a whole school level so that the children would become comfortable with it, year after year. Consistent with this study, Hefty (2015) conducted an integrated unit of STEM work with the EDP. He found the development of perseverance and faith in the EDP took a lot of time with his fourth graders, but it was worth it in the end.

However, across the educational landscape there is significant debate pertaining to the capabilities of young children to engage in design processes (English, King and Smeed, 2017). Earlier studies claim that children do not have the skills to engage in EDP (e.g. Mac Donald and Gustafson, 2004) whereas more recent studies (e.g. Cunningham and Lachapelle, 2014) have indicated otherwise.

4.6 Use of Prior Knowledge and Transferability of Skills

The students recounted to the teacher how they used their prior knowledge in the integrated STEM task whether it came from last year's Science course:

> Mar i rang 1, dheinimid bád le bosca im ..(Ruaidhrí)

Or from playing with a magnet at home:

> Lá amháin bhí mo dheirfiúr ag súgradh leis, ag cur é ar an leaba, tá cos miotail ar an leaba. Sin an fath go raibh fhios agam ar scoil (Ciarán)

Or from work done in mathematics or science class this year:

> Bhí mé ag déanamh é ar scoil. Bhí sé Eolaíocht. Nuair a bhíomar ag pleidhcíocht leis an maighnéad ag cur é an treo ceannann chéanna agus ag bogadh ceann amháin I gcoinne an ceann eile (Colm)
>
> Is cuimhin liom an lá go raibhimid ag rith timpeall an scoil agus faigh mé an
>
> Rialóir (Mailí).

The teacher observed several examples of children using mathematical and scientific language in their integrated STEM tasks:

> Ní féidir leat ciorcal a dhéanamh as Lego. Mar tá na brící Lego
>
> dronuilleog agus ní féidir leat ciorcail a dhéanamh as (Aoibhín).

They highlighted the importance of learning these concepts in the individual subject disciplines in order to assist with the integrated STEM.

> Tá an tasc níos éasca mar tá fhios agam é sin (Mailí)
>
> Gan an eolaíocht a bheith ar fhios agat, ní bheidh maighnéadachas ar eolas agat agus rudaí cosúl le sin (Eimear).

Despite the children reporting to the teacher that they would rather mathematics and science integrated all the time, these sentiments seem to reflect otherwise. The children's viewpoints of the importance of studying individual STEM disciplines is congruent with current Irish primary teachers and stakeholders views where children would build up to an integrated STEM activity and work on the relevant concepts and skills in the discrete subject areas beforehand (Hourigan et al. 2021).

Hefty (2015, p.1) stated in his integrated unit of STEM that "STEM gives meaning to mathematics" alluding to the transfer of knowledge and skills from the specific to the

general. From the children's and the CF's descriptions, it is reasonable to assume that integrated STEM is an act of 'far transfer' for children (Ceci and Barnett, 2002) which does not come naturally to young children (Zike, 2022). The children had to apply concepts and skills from specific discreet subject disciplines to a new task which did not share many similarities with the original learning context in terms of social context, knowledge domain, functional domain and modality (Ceci and Barnett, 2002).

It was interesting to note that the children found it much easier to transfer knowledge to the integrated STEM task than skills. For example, the Grúpa Anning for two weeks reported issues with time and did not get their tasks finished. When the TR asked the group timekeeper what the difficulty was, she stated:

> bhí an clog ró dheacair dom (Clíodhna)

Even though the child was able to read the clock in mathematics class, she found it very difficult to put the skill of timekeeping into practice in a real-life context. A second example was when the teacher found a child using a measuring tape upside down even though they had practiced this skill independently for a fortnight previously.

4.7 Completing integrated STEM through the Irish language

All children reported no difficulties communicating during integrated STEM through the Irish language. The TR and CF noted that in general, the children's range of vocabulary, grammatical accuracy and fluency level was well above what would normally be expected from a second-class level in a Gaelscoil. The CF chose the following examples of 'Gaeilge iontach':

> Ní chaithfidh sé a bheith foirfe
>
> An ndéanfaidh mé é?

Cad a tharla?

This fluency is in line with research (O Duibhir, 2009; Swain and Johnson, 1997). However, these previous studies draw attention to the fact that this proficiency can often be grammatically flawed and restrictive in vocabulary. The present study is contrary to the results found in previous studies as the children in this study had elaborate explanations of STEM phenomena such as below:

Caoimhín (elaborate explanation of speed of cars): bhí ceann glas níos éadroime agus níos faide ansin tá sé níos tapúla ná gach ceann eile.

Aodh (explaining why the car worked): Caithfidh brú agus frithchuimilt a bheith ann.

There was virtually no English (Language 1) recorded and a low level of 'Géarla', the interlanguage of English and Irish.

When questioned on their abilities to communicate through the Irish language, some children stated that it was helpful that they had already learned the language and concepts in science and mathematics and then it made it much easier to communicate their ideas. This draws attention to the importance of teachers in immersion settings supporting the children's subject specific vocabulary (Ó Conghaile, 2019), something that is often neglected in these settings (Cammarata and Tedick, 2012). The children in this class were pre-taught subject specific vocabulary in discreet science and mathematics lessons earlier on in the year which aided their communication during integrated STEM. The children spoke of the importance of hearing and practicing the word multiple times so that they would remember it and be able to use it:

Bhí mé ag abairt é seo,féachann tú ar an bhfocal uair amháin, muna bhfuil tú ag cleachtáil é, ní bheidh sé ar eolas agat má fhéachann tú ar uair amháin (Séimí)

O Conghaile's study (2019) of language and science teaching in Senior classes in Gaelscoileanna found that some teachers reported that their students spoke English during group work and English can sometimes be used by the teacher to explain difficult concepts in science. Furthermore, teachers in some of these classrooms did not overtly prohibit the use of English as they wanted the children to enjoy themselves and they wanted to ensure that the children understood everything. This was not the case in this classroom.

The CF discussed the culture of the classroom where speaking Irish to one another with and without the teacher was enjoyable and seen as the norm. The children possessed both the subject specific vocabulary which was pre-taught as well as content-compatible language i.e. a toolbox of phrases that are used to negotiate tasks and used for interactions across subject domains (Cammarata and Tedick, 2012). There was not a culture of reverting to English explanations in the classroom. The CF noted how even if the children didn't know a particular word, they were able to work their way around by using an alternative explanation.

> Ailín (explaining symmetry): Tá an clár ró-bheag. Ní raibh sé cothrom an cheád uair.

When the TR asked a child if she didn't have the words brú and domhantarraingt to explain push and gravity, what other words would she use, she replied:

> cuir é síos (Caoimhe)

She explained that she would still be able to communicate. Others stated:

> tá sé ag dul síos an bóthar (Eoghan)

They reported no difficulties in being able to work around terminology that they did not know.

Apart from the positive culture of the classroom, part of the reason why the children may have been so competent at communicating STEM ideas through Irish may be due to their lack of exposure to English STEM terminology due to their young age. When questioned by the teacher, only 4 out of 22 students heard of the word 'gravity' in English and of these 4, only one knew what it meant. Whereas 21 out of 22 pupils knew and understood what the word 'domhantarraingt' meant. The children had learned the word for gravity in Irish and linked their understanding of this concept to its Irish counterpart before they had heard about the English.

4.8 Conclusion

In summary, this chapter outlined the six main themes from the study which were: Pupils' Dispositions towards Science and Mathematics, Children's Attitudes towards Integrated STEM, Group work, Skills Transferability and Prior Knowledge, Planning and Engineering Design Process and Integrated STEM through the Irish language. Within each theme, the findings were presented as well as a thorough analysis of findings in tandem with current research in the area.

Overall, the chapter revealed that children had positive dispositions towards individual STEM subjects at the outset and thoroughly enjoyed integrated STEM. The main reasons they enjoyed was because of the opportunity to play, incorporation of other subject areas and group work. Group work was not without its difficulties for a minority and there were gender differences apparent in this groupwork. Furthermore, the children found problem-solving much easier in groups due to social metacognition.

The children found planning and the Engineering Design Process difficult and reported no difficulties completing integrated STEM through the Irish language. Despite children stating that they would rather that STEM subjects should be integrated all the time, they

reported that learning the knowledge discreetly in science and mathematics class was of great benefit to integrated STEM. The TR observed that children found it more difficult to use previously learned skills in integrated STEM than prior knowledge.

The final section is Conclusion and Recommendations which will summarise the findings of the study as well as providing recommendations for the future based on these findings.

Chapter 5: Conclusion and Recommendations

5.0 Introduction

The purpose of this study was to critically analyse children's experiences and perspectives of integrated STEM in a Gaelscoil setting. The framework of interpretivism and the qualitative methods of interviews, observations and documents were employed. This study added valuable knowledge to the sparse repository of studies which seek to gain children's perspectives of STEM education in immersion settings.

Section 5.1 presents a synopsis of the findings, followed by the strengths and limitations of the study in 5.2 and 5.3 respectively. The recommendations for policy, practice and future research are outlined in 5.4. Reflexivity is presented in section 5.5 followed by a conclusion in 5.6.

5.1 Synopsis of Findings

This study found that children in this class had positive attitudes to science and mathematics before they began integrated STEM. All children reported enjoying the integrated STEM unit for a variety of reasons including integrating it with other subject areas and the extra challenge it posed. Two of the main reasons children enjoyed it was that they were afforded the opportunity to play and to work in groups. This is consistent with research such as Shumow et al. (2015).

A small minority of children found groupwork difficult. These children tended to be those who were strong academically but found it difficult to see other children's viewpoints.

Overall, differences between boys and girls were noted by the TR and the CF. In one group, boys particularly dominated over girls. Furthermore, from observations, it was noted that girls were more task oriented than boys in the class and placed greater importance on the aesthetics of the task. These findings are congruent with those such as Beisser (2005).

It was also observed and noted that the children frequently shared their ideas with group members and verbalised their thinking. Several children reported finding it was easier to solve problems in groups. This is in line with research on social metacognition (e.g. Larkin, 2009).

Some children initially struggled with the Engineering Design Process and planning which is consistent with Hefty (2015). Children were well able to transfer prior knowledge and the language of mathematics and science into tasks that were presented to them. However, some struggled with applying skills.

From both observations and reports, the children had no problems communicating through the Irish language in integrated STEM. This is incongruent with previous studies (e.g. Ó Conghaile, 2009). They were well able to reuse the language that they had previously learned and had a high level of grammatical fluency.

5.2 Strengths of Study

The strength of this study was that it was qualitative in nature. By using qualitative methods, the TR could immerse herself in the cultural context of the Gaelscoil and gain the perspectives of the children in her classroom (Woods, 2006).

Furthermore, this research addressed a gap in research in Ireland, that of integrated STEM in Irish immersion settings and has contributed to the discourse around policy, practice and future research in this area.

5.3 Limitations of Study

One limitation of this study was the small sample size and that generalisations cannot be made from this.

Furthermore, the TR, due to her relationship with the students had preconceptions and assumptions before beginning this study but she made every attempt to bracket her bias (Tufford and Newman, 2010).

5.4 Recommendations

The following are a list of recommendations based on the findings of this study for policy, practice and future research.

5.4.2 Recommendations for Policy

5.4.2.1 Policy Recommendations for all Primary Schools

- It would be of great benefit if the Department of Education could provide a clear definition of integrated STEM as well as a general outline of how teachers can design and teach units of work (Delahunty, Prendergast and Ní Ríordáin, 2021). With this general outline, the STEM education curriculum could be co-constructed at the school level instead of at policy level (Hourigan et al., 2021). Children should be involved as co-constructors of this curriculum by gathering their viewpoints and also be given ownership of its design and thus, become the driving force behind it.
- This study shows that play should be extended beyond infant classes and older children should be afforded the opportunity to play in school. Although play-based learning is reiterated throughout the PSC (1999), play for play's sake is not commonly used beyond infant classes (Aistear, 2009).
- It is recommended that the Department of Education should provide additional funding to ensure high quality STEM experiences. There was a significant cost incurred on the part of the TR to purchase the integrated STEM materials so that an optimum experience could be provided. The TR is extremely grateful for the scholarship money which she received to purchase these materials.

5.4.2.2 Policy Recommendations for Gaelscoileanna

- Additional professional development opportunities and support must be provided to all teachers designing integrated STEM (Delahunty, Prendergast and Ní Ríordáin, 2021) but especially those who teach in Gaelscoileanna. It is clear from this study that a Content and Language Integrated Learning (CLIL) approach to teaching in this classroom worked to the advantage of the integrated STEM. Further guidance is needed by the Department of Education on the delicate balancing act of CLIL but also incorporating CLIL into integrated STEM.

5.4.1 Recommendations for Practice

5.4.1.1 Practice Recommendations for all Primary Schools

- This study drew attention to the importance of practising and structuring group work before embarking on integrated STEM. Furthermore, social skills within groupwork should be taught consistently to all.
- The Engineering Design Process is a framework that will need to be implemented at a whole school level, year after year, so that children will have adequate exposure and experience with it.
- Further work on fine motor skills and sensory processing should be encouraged in senior classes as opposed to junior classes alone.

5.4.1.2 Practice Recommendations for Gaelscoileanna

- Despite difficulties in implementing CLIL in Gaescoileanna (Ó Conghaile, 2019), this study demonstrates the benefits of using such an approach particularly in the teaching of science and mathematics so that the children have the necessary language and concepts to proceed at ease through integrated STEM. For this reason,

it would be beneficial to the learner to complete integrated STEM at the conclusion of linked topics in science and mathematics.

- In younger classes, this study also highlights the importance of learning science and mathematics terminology through Irish before the children encounter the equivalent English terminology.

5.4.3 Recommendations for Future Research

- Further research is warranted in the area of social metacognition and whether it will impact on a child's initial conception of a problem and the subsequent problem-solving trajectory which they embark upon (Delahunty, 2019).
- Future research is warranted at a deeper level to investigate what educators can do at a classroom level to challenge and interrogate girls' perceptions and stereotypes about STEM education (Moss-Rascusin, 2019).
- Finally, it would be interesting to see whether integrated STEM could improve pupils' dispositions of the individual subjects of mathematics and science if they were negative at the outset. This in turn may fuel greater engagement in pupils and academic self-image later in life.
- Integrated STEM as a framework is still very much in its infancy in education (Smith and Mancy, 2019). Much research is needed into areas such as the appropriate age to begin integrated STEM as well as how much of our curriculum should be devoted to it and whether discreet subject areas should exist.

  These questions will pose many difficulties for researchers in policy and practice for years to come.

5.5 Reflexivity

The TR acknowledges her own assumptions, beliefs and experiences as part of the qualitative process. After contemplation and reflection on this research study, the TR drew parallels with what Freire (1970) termed 'transformative education'. In this classroom, the traditional roles of learner and teacher were blurred. The TR became a teacher-learner and the pupils became learner-teachers. This process occurred through the importance placed on pupil voice and ensure that the children were involved in the co-construction of the knowledge that was occurring. Despite its neoliberal origins, the STEM education experience that occurred in this classroom was one that celebrated the intrinsic value of learning (Wolfmeyer and Chesky. 2015).

5.6 Conclusion

The research study has answered the research questions as it has successfully garnered pupils' experiences and perspectives of integrated STEM in a Gaelscoil setting. Furthermore, the study has analysed how children behave and communicate during these lessons as well as outlining the unique supports that Gaelscoileanna require to successfully implement integrated STEM.

The research process has afforded the TR an opportunity to address an area of the educational landscape in where there is a dearth of research. Integrated STEM in Irish primary classrooms is still very much in its infancy. Children's perspectives are more important than ever in terms of reframing educational policy and children should be seen as equals or co-constructors in the creation of a new integrated STEM education curriculum.

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Appendix 1

1. Cad a chiallaíonn ETIM duitse?
2. Cad a cheap tú faoin gceacht seo?
3. Ar bhain tú taitneamh as? Cén fáth?
4. An raibh aon deacrachtaí agat?
5. Cad a cheapann tú faoi Matamaitice i Rang 2? - an Mata a dhéanaimid gach maidin.
6. An raibh Mata á dhéanamh agat inniu?

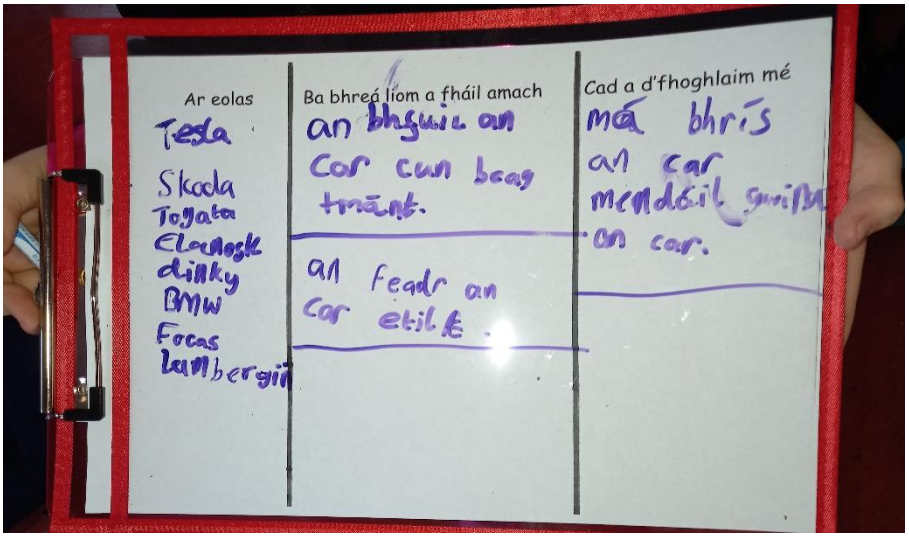
Má fhreagraíonn na páistí go raibh Mata á dhéanamh acu, cuirfidh mé an ceist seo orthu ; Cé acu is fearr leat - Mata ina aonar nó Mata mar chuid den ETIM?

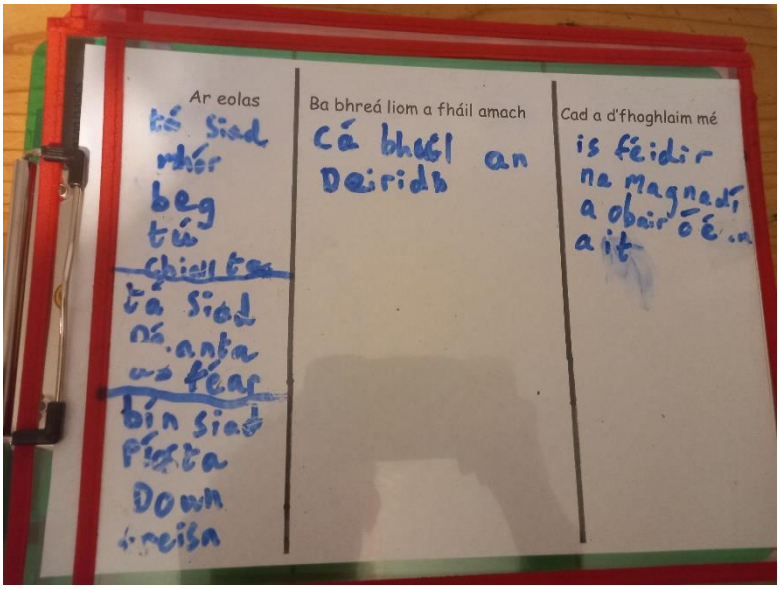
7. Cad a cheapann tú faoin Eolaíocht a dhéanaimid i Rang 2?
8. An raibh Eolaíocht á dhéanamh againn inniu?

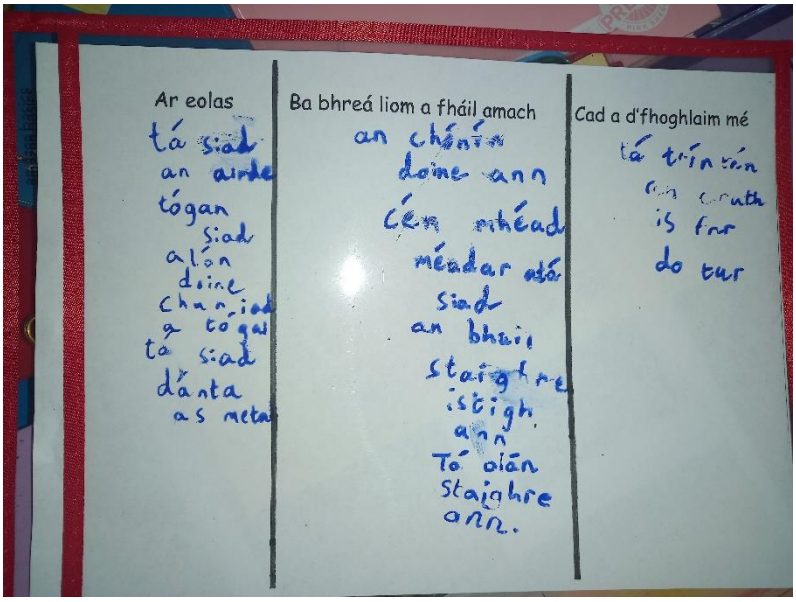
Má fhreagraíonn na páistí go raibh Eolaíocht á dhéanamh acu, cuirfidh mé an ceist seo orthu ; Cé acu is fearr leat - Eolaíocht ina aonar nó Eolaíocht mar chuid den ETIM?

9. Cad a cheapann tú faoi na hábhair nua?
10. Conas ar éirigh leat le do ghrúpa inniu?
11. An raibh gach focal ar eolas agat?
12. An raibh aon rud nach raibh ar eolas agat?
13. Ar chabhraigh éinne leat i do ghrúpa inniu?
14. An raibh gach éinne ag obair le chéile? Dá mba rud é nach raibh, cad a tharla?
15. Ar dhein tú aon rud cosúil le seo cheana féin? Cé leis? Cén áit?

Appendix 2


Ar eolas
Ba bhreá liom a fháil amach
Cad a d'fhoghlaim mé


Ar eolas
Ba bhreá liom a fháil amach
Cad a d'fhoghlaim mé


Ar eolas
Ba bhreá liom a fháil amach
Cad a d'fhoghlaim mé

Appendix 3


Maor Ama
Suirbhéir Cainníochta
Cainteoir
Tógálaí
Ag smaoineamh mar innealtóir
1. Ceistigh
2. Déan taighde ar
3. Pleanáil
4. Cruthaigh é
5. Bain triail as!
6. Feabhas
7. Roinn é
8. Súil siar
Innealtóir
Ailtire

Appendix 4

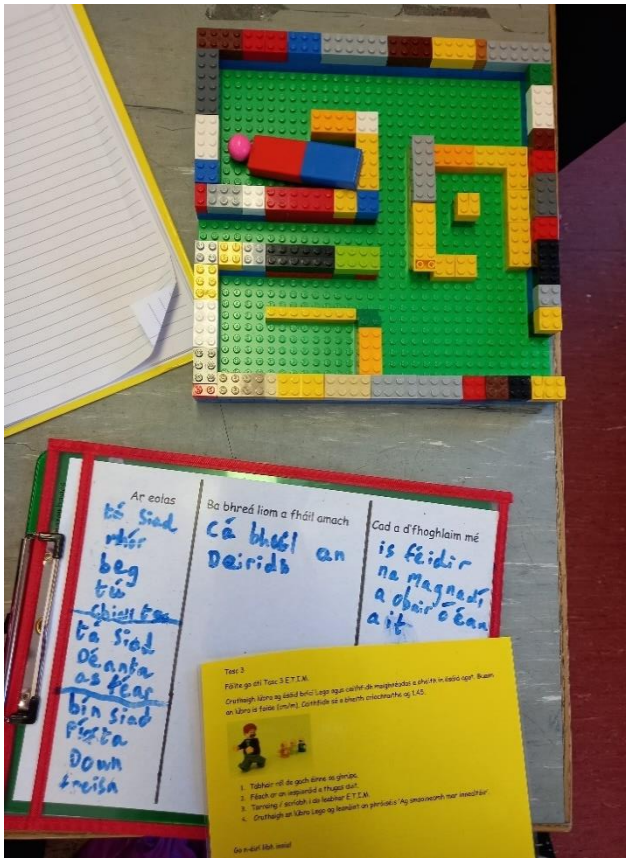
Tasc 3

Fáilte go dtí Tasc 3 E.T.I.M.

Cruthaigh lúbra ag úsáid brící Lego agus caithfidh maighnéadas a bheith in úsáid agat. Buann an lúbra is faide (cm/m). Caithfidh sé a bheith críochnaithe ag 1.45.

1. Tabhair ról do gach éinne sa ghrúpa.
1. Féach ar an inspioráid a thugas duit.
1. Tarraing / scríobh i do leabhar E.T.I.M.
1. Cruthaigh an lúbra Lego ag leanúint an phróiséis 'Ag smaoineamh mar innealtóir'.

Go n-éirí libh inniu!



Tasc 5
Fáilte go dtí Tasc 5 E.T.I.M.
Cruthaigh rafta ag úsáid cipíní líreacán. Buann an rafta atá in ann an méid is mó brící Lego a choimeád nuair atá sé in san uisce.

Tabhair ról do gach éinne sa ghrúpa.
Féach ar an inspioráid a thugas duit.
Tarraing / scríobh i do leabhar E.T.I.M.
Cruthaigh an lúbra Lego ag leanúint an phróiséis 'Ag smaoineamh mar innealtóir'.

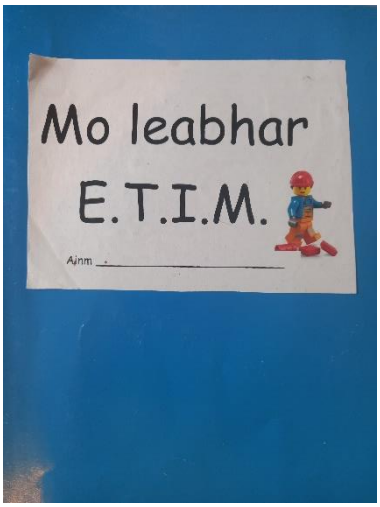
Go n-éirí libh inniu!

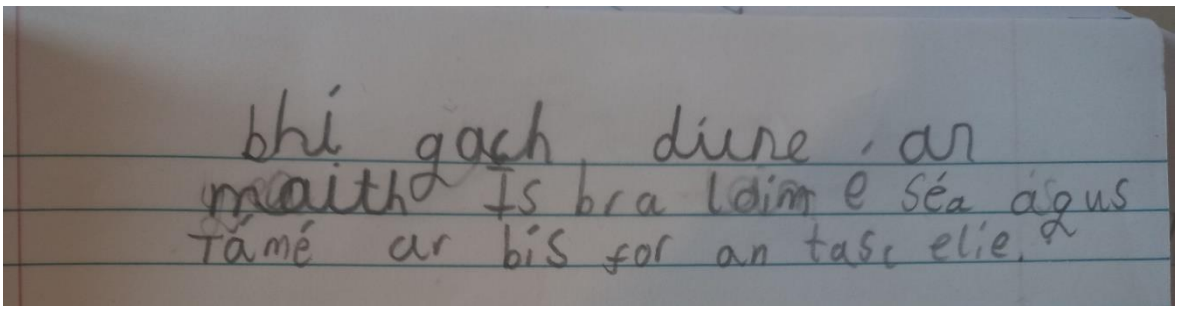
Tasc 8
Fáilte go dtí Tasc 8 E.T.I.M.
Cruthaigh damba atá in ann uisce a choimeád ar thaobh amháin den bháisín. Buann an dearadh is fearr.

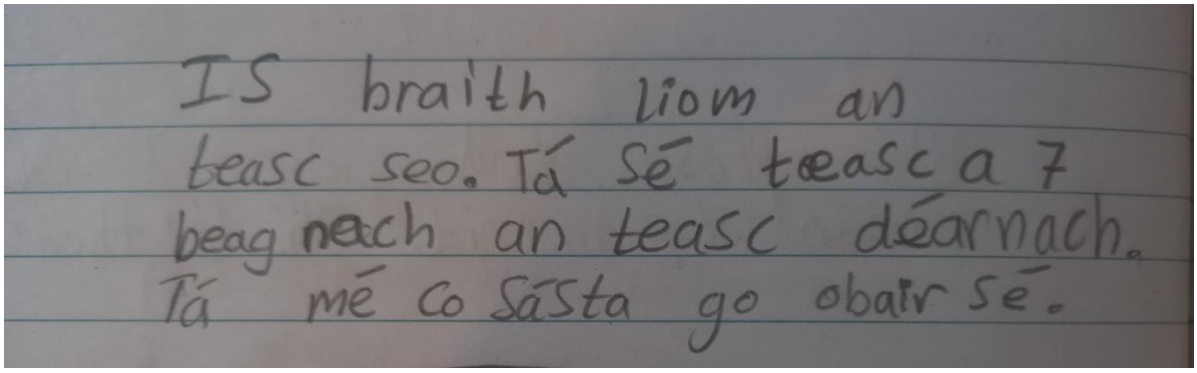
Tabhair ról do gach éinne sa ghrúpa.
Féach ar an inspioráid a thugas duit.
Tarraing / scríobh i do leabhar E.T.I.M.
Cruthaigh an damba ag leanúint an phróiséis 'Ag smaoineamh mar innealtóir'.
Go n-éirí libh inniu!

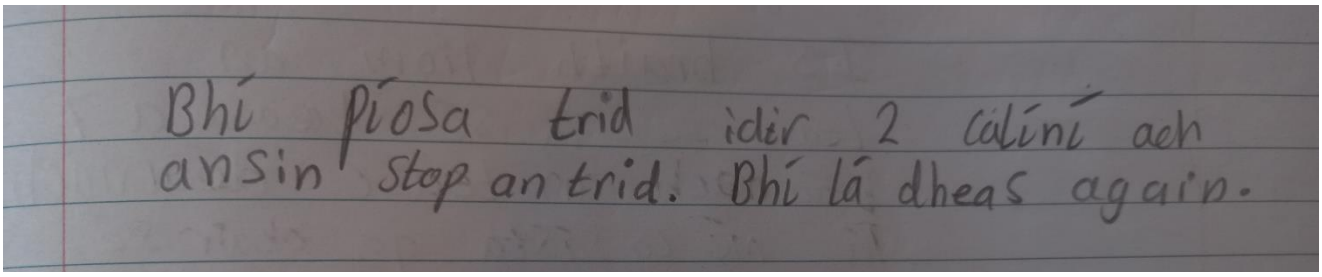
Appendix 5

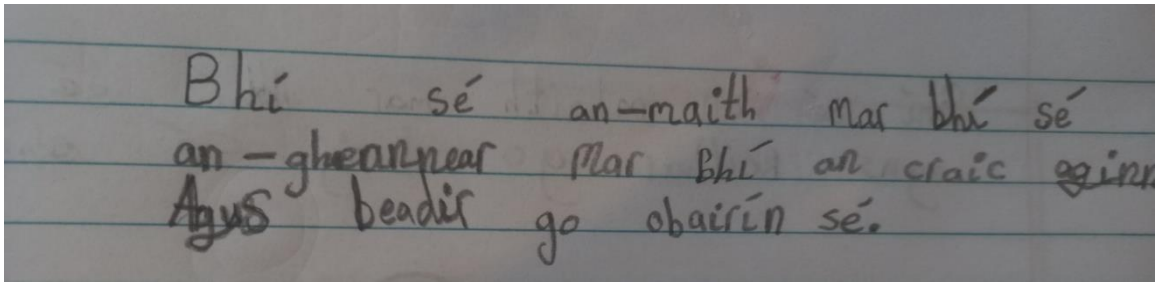
Appendix 6

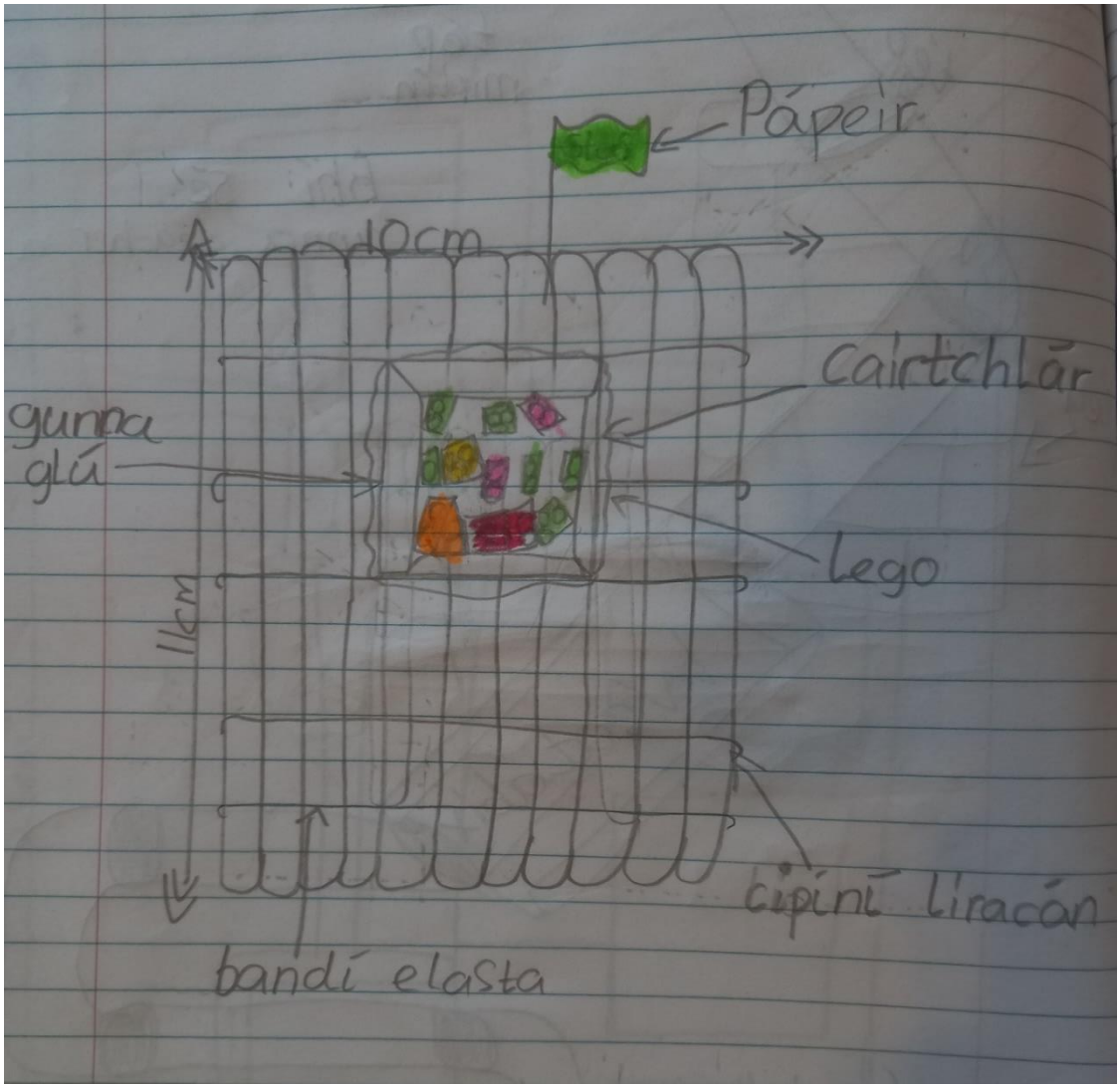

Mo leabhar
E.T.I.M.
Ainm

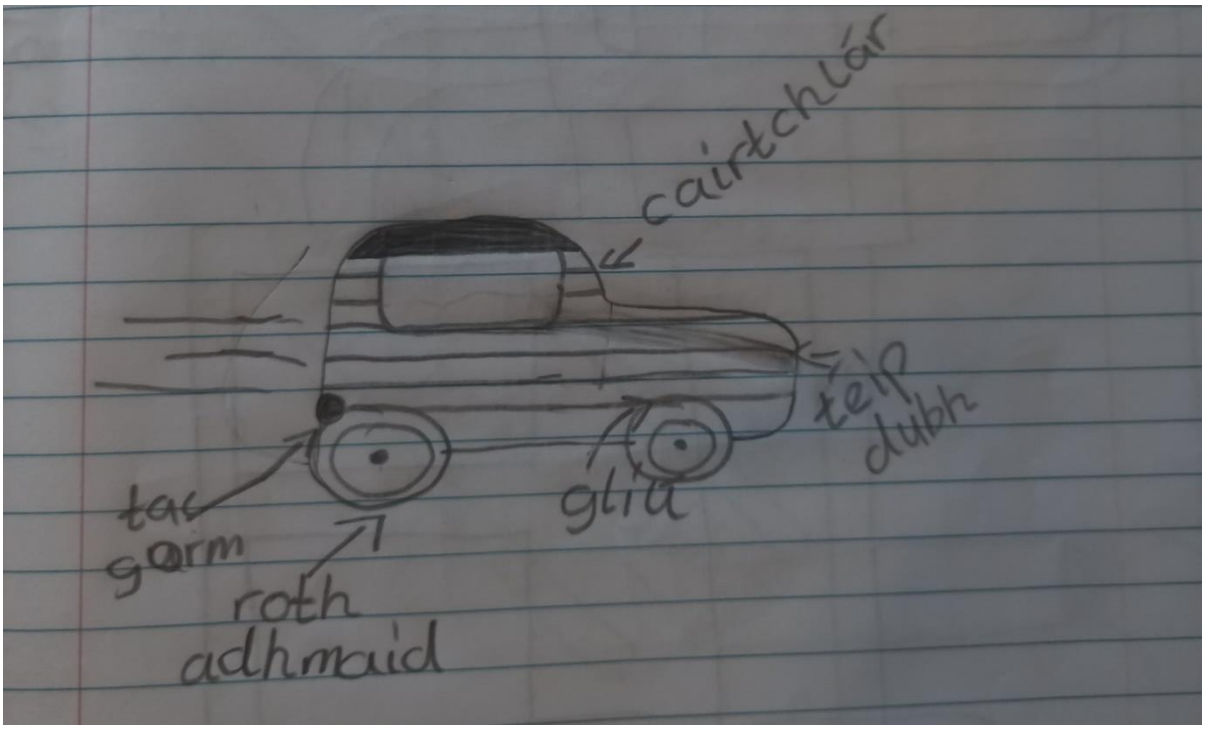

bhí gach duine ar
maith Is bra liom é séa agus
Tá mé ar bís for an tasc elie.

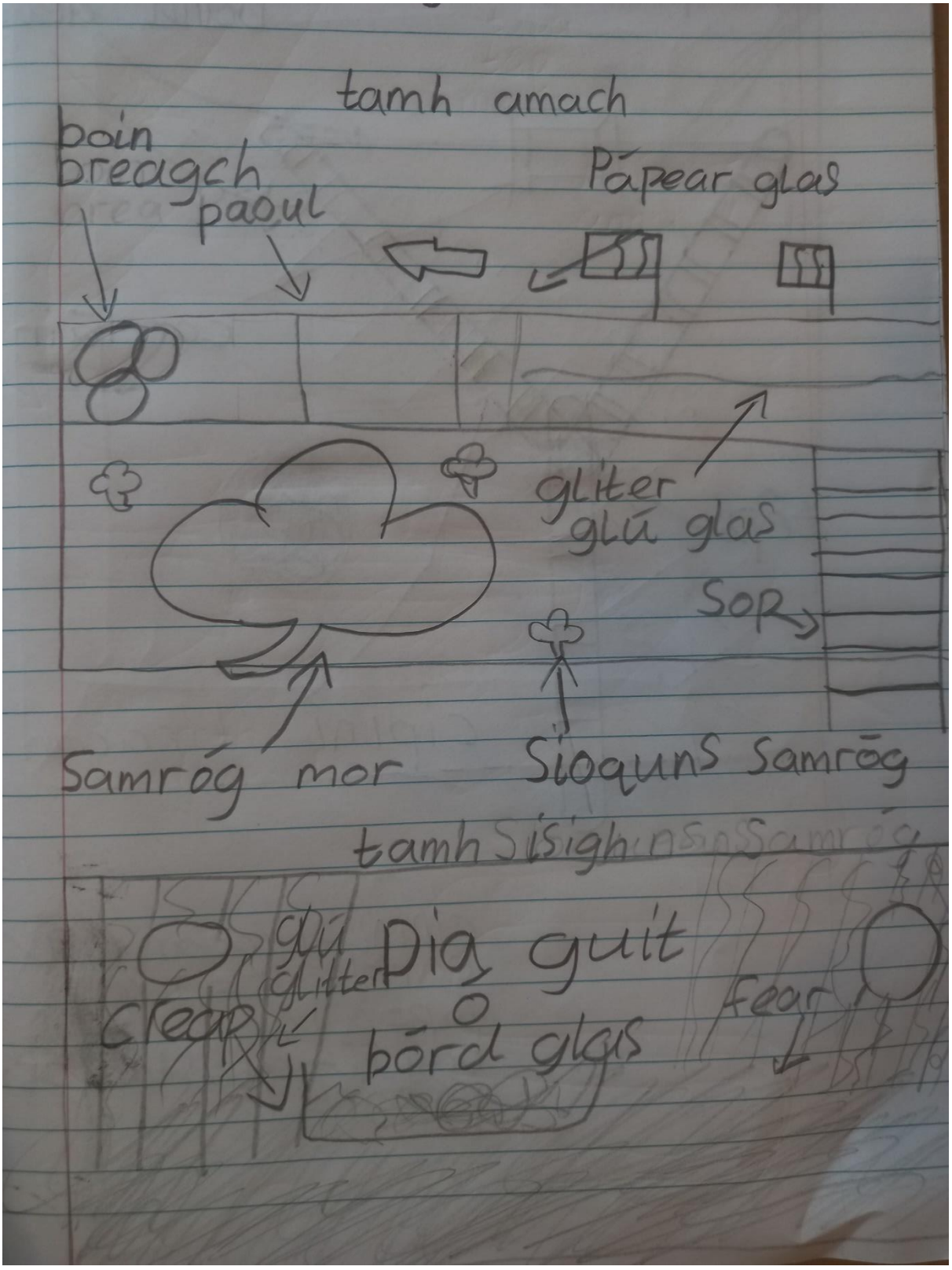

IS braith liom an
teasc seo. Tá sé teasc a 7
beag nach an teasc déarnach.
Tá mé co Sásta go obair sé.

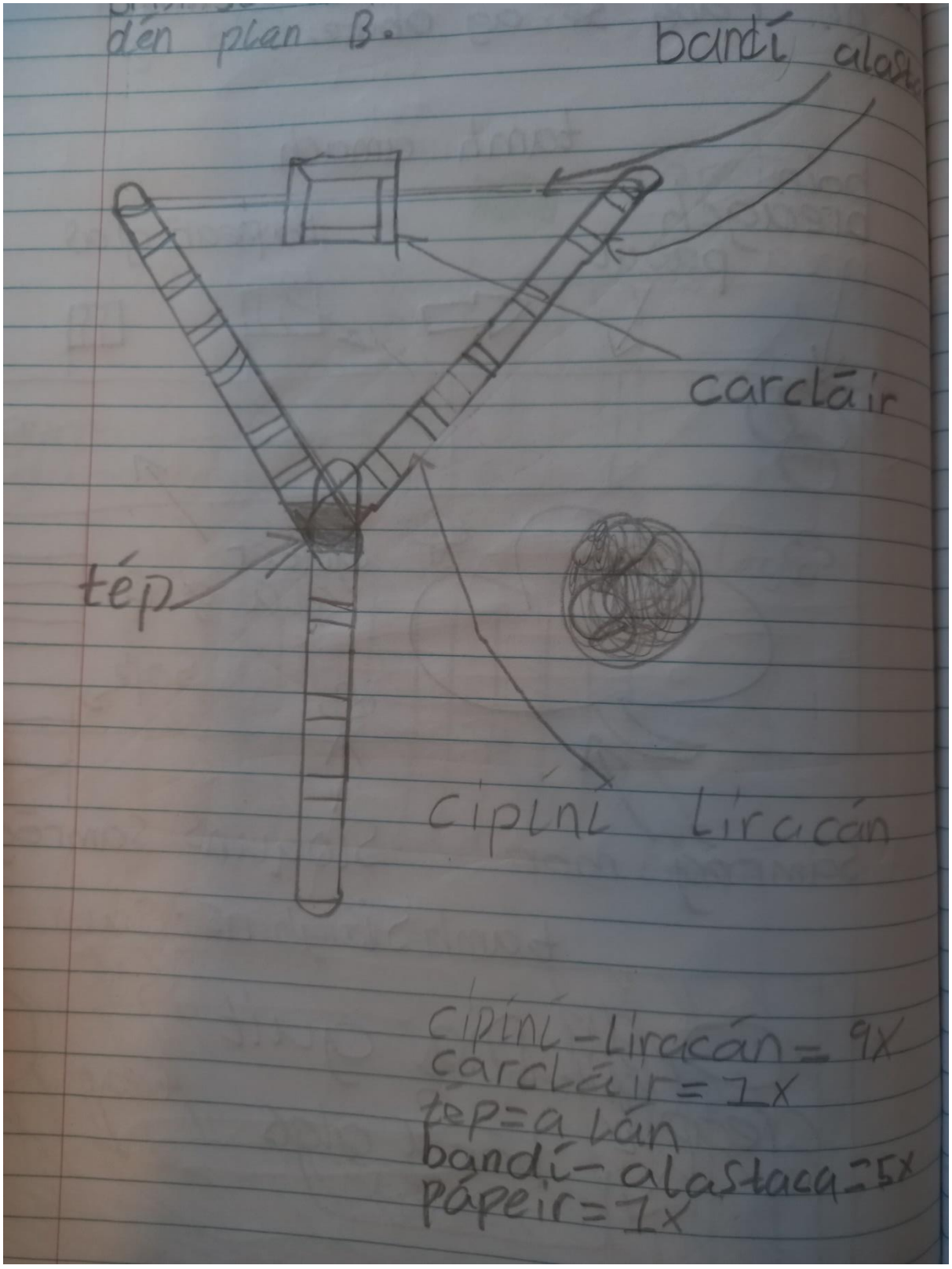

Bhí píosa trid idir 2 cáiní ach
ansin stop an trid. Bhí lá dheas again.


Bhí sé an-maith mar bhí sé
an-ghearnear Mar Bhí an craic agus
Agus beadir go obairín sé.

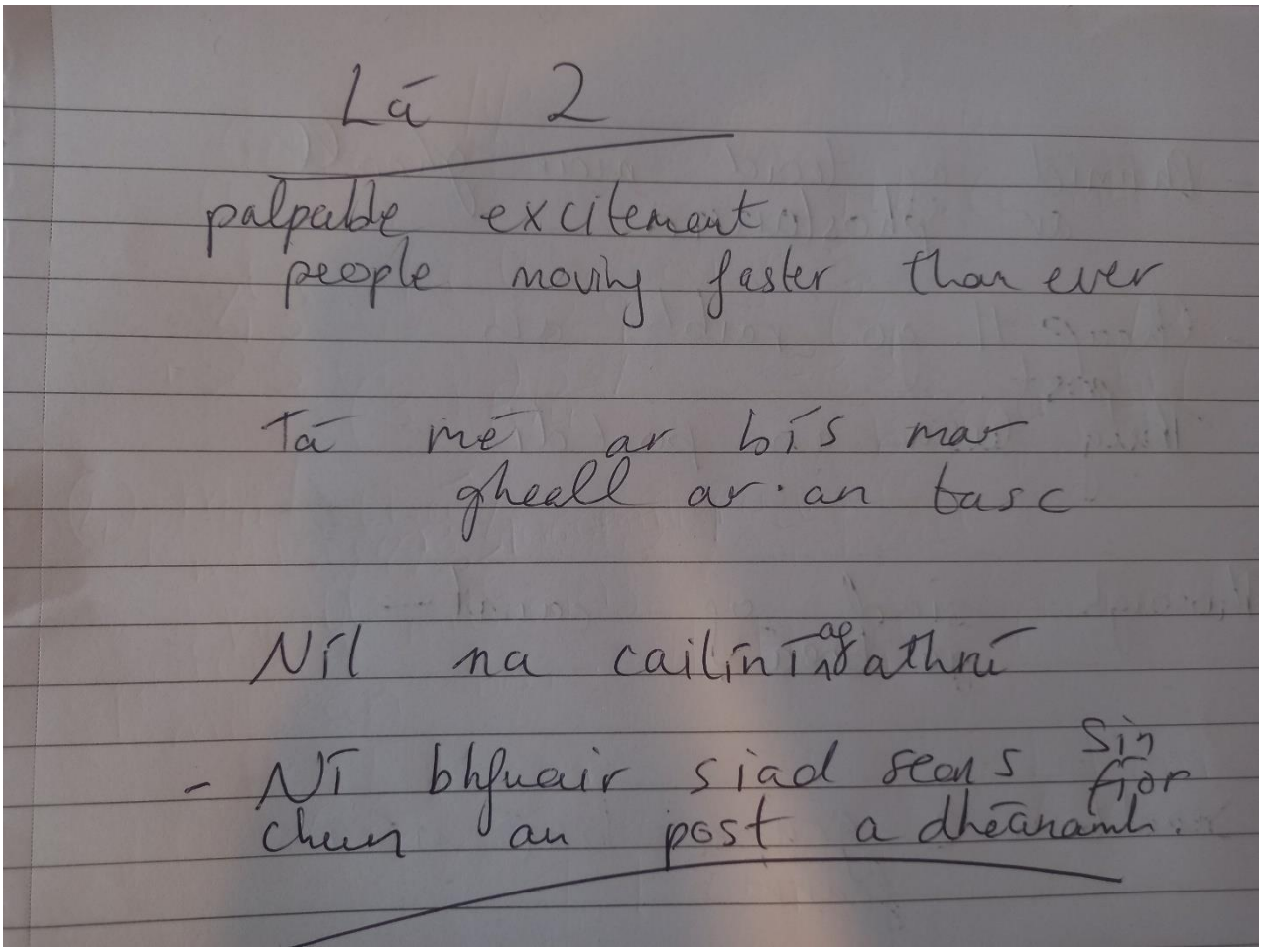

Páipéir
10cm
cairtchlár
gunna glú
lego
11cm
cipíní liracán
bandí elasta


cairtchlár
téip dubh
glú
roth adhmaid


tamh amach
boin
breagch
paoul
Páipear glas
gliter
glú glas
SOR
Samróg mor
Sioquns Samróg
tamh sisigh
glú
gliter
Pia guit
crean
bord glas
fear


dén plan B.
bandí alast
carclāir
tép
cipíní
lircacán
cipíní-lircacán=9x
carclāir=1x
tep=a lán
bandí-alastaca=5x
pápeir=1x

Appendix 7


Lá 2
palpable excitement
people moving faster than ever
Tá mé ar bís mar
gheall ar an tasc
Níl na cailíní ag athrú
- Ní bhfuair siad seans sin
chun an post a dhéanamh.

Appendix 8

School of Education,
University College Cork

Parent/Guardian Information Sheet

A thuismitheoirí,

I am currently studying for a Masters in Education (M.Ed) at University College Cork (UCC). I am really enjoying learning about the latest teaching methodologies and bringing innovative ideas to my classroom. Thankfully, I am in my final year and must now complete a study in my classroom for my dissertation. This study will be part of my final grade as well as being published on a teachers' website. I have selected the area of integrated STEM (Science, Technology, Engineering, Mathematics) education for my topic of research as I am really interested in these subjects but also because of their importance in education and society today. I would really appreciate it if you could read this information sheet. If you could return the assent and consent forms as soon as possible, I would be very grateful.

Title of Project: *Children's perspectives on integrated Science, Technology, Engineering and Mathematics (STEM) Education in a Gaelscoil setting.*

What is the research about?

This research aims to investigate how children feel about participating in group work in Science, Technology, Engineering and Mathematics (STEM) education in an integrative manner as opposed to stand alone subjects. This will all be framed in the context of a Gaelscoil.

Who is undertaking it?

This research is being undertaken by Múinteoir Síle Ní Ríogáin (the class teacher) as part of her dissertation for a Masters in Education at University College Cork.

Why is it being undertaken?

The STEM Education Policy statement 2017-2026, published by the Department of Education (2017) advocates teaching STEM (Science, Technology, Engineering and Mathematics) subjects in an integrative manner in primary schools.

We are living in an increasingly technological world and the children of today need to be equipped with the skills to solve the complex problems of the future. Many of these problems (such as climate change) require people who have the ability to integrate skills from a variety of disciplines, in real-life contexts as well as being able to communicate their ideas to others.

Mathematics and Science are traditionally taught as stand-alone subjects in primary schools. Technology and Engineering are not taught in primary schools. The Department of Education recognises that children need to be introduced to these subjects and integrated skills at an earlier age to prepare themselves for the future.

I would like to introduce the methodologies advocated by the Department of Education into my classroom. I would like to understand how children feel about learning about these subjects in an integrative manner in school as opposed to stand alone subjects.

I would also like to understand their experiences of these subjects in a Gaelscoil.

What are the benefits of this research?

The benefit of this research is the children are:

- *Children will be involved in solving problems which are related to the real world.*
- *They will learn about practical applications for their science and mathematics.*
- *They will learn about problem solving and how to use a variety of skills at once e.g. science, mathematics, engineering and technology.*
- *They will be introduced to technology and engineering for the first time.*
- *They will learn how to work and solve problems as a team.*
- *They will learn how to communicate science, technology, engineering and mathematics ideas.*

Exactly what is involved for the participant (time, location, etc.)

There is no extra time or resources needed to participate in this study. Mathematics will continue as usual every morning. Integrative STEM time will take place on one afternoon, once a week, after the core subjects are complete. It will not take from core subject time. It will take place for a maximum period of 8 weeks.

The children will be involved in practical project work in their pods. They will have a STEM journal to make their plans. They can use resources from school and of course, from home. I, the teacher-as-researcher will compile field notes of my observations during this group work as well as taking samples of their work from the STEM journals. I will also audio record a focus group interview with each pod after each integrative STEM session.

Right to withdraw

All children will remain anonymous. They are free to withdraw from the study at any time without giving a reason. The child only has to provide me with verbal confirmation that they wish to withdraw from the study and they can immediately do so. As it is curricular work, they will continue to participate in the integrated STEM group work but I will immediately cease taking notes and observations on the particular child. They do not need to participate in focus groups if they wish to withdraw. Any previous data recorded about a child who wishes to withdraw will be destroyed that evening after school. If they choose not to participate in this study, it will not affect them in any way.

How will the information be used / disseminated?

The thesis will be used as part of my final mark for my Masters in Education degree.

Furthermore, it will be published on the Comhairle um Oideachas Gaeltachta agus Gaelscolaíochta (cogg.ie) website. This website is a repository of information for educators working in Gaelscoileanna.

How will confidentiality be kept?

Any personal data which the children provide will be treated with the highest standards of security and confidentiality, in accordance with Irish and European Data Protection legislation (GDPR). All information gathered will remain confidential and will not be released to any third party. The project has been designed so that it does not ask for identifiable information. All children will be assigned pseudonyms for the purpose of this thesis. All data will be stored securely for 2 years.

Contact details:

This research study has received Ethics approval from the School of Education Research Ethics Committee, UCC. If at any time you have any queries/issues about this study, our contact details are as follows:

Síle Ní Ríogáin – 119225904@umail.ucc.ie / s.niriogain@gaelscoilthomaisdaibhis.ie

Dr. Margaret O'Donovan – margaret.odonovan@ucc.ie

School of Education,
University College Cork

Consent Form (Parent/Guardian)

Title of Project: Children's perspectives on integrated STEM in a Gaelscoil setting

This research is about STEM education and involves recordings of children's views on STEM education

*Your child is under **no** obligation to participate in this study. If they agree to participate, but at a later stage feel the need to withdraw, they are free to do so. It will not affect them in any way.*

Please answer all of the following (tick the appropriate box):

I have read the information letter and understand what the research is about and what it involves.
☐

I understand that participation is voluntary and that participants have the right to withdraw at any time, without giving any reason, and without consequences.
☐

I understand that information will be confidential or anonymous.
☐

I understand that the research will be audio recorded. ☐

I understand that only the researcher, supervisor, and examiners will have access to the data.
☐

If interested, you may request a copy of the research by contacting me at 119225904@umail.ucc.ie / s.niriogain@gaelscoilthomaisdaibhis.ie

I agree for my child to participate in the above study

_____ _____
Signature of Participant Date

Signature of Parent/Guardian	Date
Signature of Researcher	Date

Appendix 9

School of Education,
University College Cork

Bileog Eolais na bPáistí

Teideal: *Cad a cheapaim faoi ETIM sa Ghaelscoil seo?*

Cad air a bhfuil an taighde bunaithe?
Tá an tionscadal seo mar gheall ar a bheith ag obair le chéile ar ETIM agus ag úsáid scileanna réiteach faidhbe. Ciallaíonn ETIM – Eolaíocht, Teicneolaíocht, Innealltóireacht agus Matamaitice. Déanaimid Eolaíocht agus Matamaitic gach lá ar scoil. Déanann páistí na meánscoile Innealltóireacht agus Teicneolaíocht. Beimid ag tosú ar scileanna innealltóireachta agus teicneolaíochta agus á n-úsáid iad lenár scileanna Matamaiticie agus Eolaíochta.

Cé atá i gceannas air?
Tá Múinteoir Síle i gceannas ar an dtionscadal seo mar tá sí ar ais sa choláiste agus teastaíonn uaithi a fháil amach mar gheall ar cad a cheapann páistí faoi ETIM. Seo rud nua atá á chur i bhfeidhm sna bunscoileanna.

Cén fáth go bhfuil Síle ag déanamh é seo?
Na laethanta seo, tá ETIM ana thábhachtach agus caithfimid níos mó a fhoghlaim mar gheall air. Nuair a bheidh sibh níos sine, beidh scileanna nua ag teastáil uaibh. Beidh fadhbanna difriúla ann agus beidh ar dhaoine teacht le chéile agus smaointe difriúla a roinnt. Beidh orainn a bheith i bhfad níos fearr a bheith ag obair le chéile. Ba bhreá le Síle ETIM a dhéanamh libh agus a fháil amach cad a cheapann sibh mar gheall air.

Cén fáth go bhfuil sé go maith domsa páirt a ghlacadh?

Is féidir leat níos mó mata agus eolaíochta a fhoghlaim.
Beidh sé bainteach leis an bhfíor saol.
Beidh tú ag obair le do chomhdhaltaí.
Beidh tú ag foghlaim faoi innealltóireacht agus teicneolaíocht.

Cad a chaithfidh mé a dhéanamh?
Ní chaithfidh tú aon rud sa bhreis a dhéanamh. Beimid ag déanamh ETIM uair amháin sa tseachtain um thráthnóna ar feadh 8 seachtain. Beidh Síle ag scríobh nótaí mar gheall ar cad a bheidh tú ag déanamh sna grúpaí agus ag rá. Beidh sí ag bailiú samplaí oibre. Nuair a bheidh an obair sna grúpaí thart, beidh Síle ag labhairt leat agus do chomhdhaltaí mar ghrúpa. Cuirfidh sí ceisteanna ort mar gheall ar an obair a bhí á dhéanamh agat sa ghrúpa. Beidh sí ag taifead an páirt seo.

Cead tarraingt amach

Is féidir leat stopadh leis an dtaifead ag aon am. Abair liom ar an spota agus stopfaidh mé ag tógaint nótaí ort agus stopfaidh mé aon taifead. Beidh mé ag loiteadh do shonraí tar éis am scoile ar an lá sin.

Cad a dhéanfaidh Síle leis an eolas?
Seo obair bhaile Múinteoir Síle i gcomhair an choláiste agus beidh sí á chur ar shuíomh idirlíne cogg.ie i gcomhair múinteoirí eile chomh maith.

Conas a choimeádfaidh Síle an sonraí?
Beidh Síle ag coimeád súil géar ionas nach mbeidh fhios ag éinne eile cé tusa sa staidéar. Beidh sí ag tabhairt ainm bréagach do gach duine nuair atá sí á fhoilsiú agus ag coimeád gach rud faoi ghlas ar scoil ar feadh dhá bhliain. Ansin, caithfidh Síle amach gach rud. Ní chaithfidh tú a bheith buartha faoi aon rud.

Má thá tú buartha faoi aon rud, labhair liom agus is féidir leatsa stopadh díreach.

Assent Form

Title of Project:

Name of Researcher:

Declaration:

I _____ (participant's name) agree that the following is true:

Please tick as appropriate:

1. *As a participant in this study, I confirm that I have read through the information sheet.*
   YES ☐ NO ☐
2. *As a participant in this study, I do understand the information contained in the information sheet and I have had enough time to consider whether or not I want to participate in this study.*
   YES ☐ NO ☐
3. *I was provided with contact details for the researcher of this study and was encouraged to ask any questions I may have.*
   YES ☐ NO ☐
4. *My participation in this study is completely voluntary.*
   YES ☐ NO ☐
5. *I understand that I may stop participating in this study at any time and rejoin at another stage if desired.*
   YES ☐ NO ☐
6. *I understand that my class work may be used for the purpose of this project and that it will be protected at all times*
   YES ☐ NO ☐
7. *I agree that the audio recordings, field notes and STEM journals will be stored securely, for a period of 2 years after the completion of this study.*
   YES ☐ NO ☐

_____ _____

Signature of Participant Date

Signature of Parent/Guardian	Date
Signature of Researcher	Date

Appendix 10

School of Education,
University College Cork

Eanáir 2021

A phríomhoide, a chara,

Tá tráchtas á dhéanamh agam fé láthair mar chuid de mo staidéir don Mháistreacht san Oideachas i gColáiste na hOllscoile, Corcaigh. Chomh maith le sin, tá sé ar intinn agam é a fhoilsiú ar an suíomh Comhairle um Oideachas Gaeltachta agus Gaelscoilaíochta (cogg.ie). Tá mo chuid taighde bunaithe ar thuairimí na bpáistí i Rang 2 i leith E.T.I.M. (Eolaíocht, Teicneolaíocht, Innealltóireacht, Matamaitice) comhtháite.

Táim ag scríobh chugat chun cuireadh a thabhairt duit páirt a ghlacadh sa tionscadal taighde seo.
Is éard atá i gceist le rannpháirtíocht ná;

- *Cead ag na daltaí i mo rang (Rang 2) páirt a ghlacadh sa tionscadal taighde seo.*
- *Ní bheidh aon acmhainní scoile sa bhreis ag teastáil is ní chuirfidh sé isteach ar ghnáth imeachtaí na scoile. Déanfaidh mé na grúpaí fócais is taighde breathnóireachta mé féin gan cur isteach ar éinne eile.*
- *Beidh orm labhairt leat i rith an phróiséis is tú mar 'chara criticiúil' dom. Toisc go mbíonn an bheirt againn ag labhairt go rialta mar gheall ar chúrsaí curaclaim, ní bheidh aon am as an ngnáth uaim.*
- *An méid is mó ama go mairfeadh an tionscadal seo ná 8 seachtain.*

Tá an t-oideachas E.T.I.M. go mór i mbéal an phobail fé láthair i gcúrsaí oideachais in Éirinn agus ar fud an domhain, ar ndóigh. Measaim go mbainfidh mo rang an-tairbhe as pháirt a ghlacadh sa tionscadal seo. Níl brú ar aon dalta nó ball fóirne páirt a ghlacadh sa tionscadal seo. Is féidir leo aistarraingt as rannpháirtíocht ag aon am. Ní bheidh aon drochthionchar orthu mar gheall ar seo. Féadfaidh siad páirt a ghlacadh arís más mian leo. Beidh cosaint ar neamhainmníocht is rúndacht. Ní bheidh an scoil ainmnithe in san taighde. Beidh sonraí na tuairisce coimeádta go slán sábháilte.

Tá an Scoil Oideachais (UCC) tar éis faobhadh eiticiúil a thabhairt don tionscadal seo. Beidh sonraí pearsanta na rannpháirtithe caite leis na caighdeáin is airde sábháilteachta agus rúndachta, de réir an Rialachán Ginearálta maidir le Cosaint Sonraí (RGCS) na hÉireann is na hEorpa. Iniata le seo, tá cóip den fhoirm eolais is aontú duitse agus foirmeacha eolais is aontú dos na tuistí agus na leanaí. Má ghlacann an scoil páirt sa tionscadal seo, beidh mé fíorbhuíoch díot má líonann tú an fhoirm thoilithe atá iniata leis an litir seo.

Ba bhreá liom mo chuid buíochais a ghábháil duit as ucht an t-am a thógaint chun an litir seo a léamh. Má thá aon eolas sa bhreis uait, ná bíodh aon leisce ort dul i dteangmháil liom. Más mian leat dul i dteangmháil le m'fheitheoiran Dochtúir Margaret O' Donovan, is féidir leat ríomhphost a sheoladh chuici ar margaret.odonovan@ucc.ie.

Ag súil go mór le labhairt leat aríst go luath. Má thá suim agat an tuairisc dheireanach a léamh, bheinn sásta í a roinnt leat nuair atá an taighde críochnaithe agam.

Le meas,

Síle Ní Ríogáin

School of Education,
University College Cork

Le do thoil, freagar iad seo a leanas (cuir tic sa bhosca ceart):

Tá an litir eolais léite agam agus tuigim an réimse taighde agus cad atá ag baint leis. ☐

Tuigim cé a bheidh ag glacadh páirte sa staidéar, na sonraí a bheidh bailithe agus agus na modhanna a úsáidfear chun an t-eolas a bhailiú ó thaobh na leanaí i mo scoil. ☐

Tuigim go bhfuil an rannpháirtíocht deonach agus d'fhéadfadh na rannpháirtithe aistarraingt amach ag aon am, gan cúis is gan píonóis. ☐

Tuigim go mbeidh an t-eolas príobháideach is anaithnid. ☐

Tuigim go mbeidh taifead ag baint leis an taighde. ☐

Tuigim nach mbeidh rochtain ag an taighdeoir, an feitheoir is na scrúdaitheoirí ar an sonraí. ☐

Tuigim go mbeidh an staidéar foilsithe ar www.cogg.ie nuair a bheidh sé thart . ☐

Tugaim cead do mo scoil páirt a ghlacadh sa staidéar seo.

Síniú an phríomhoide	Dáta
Síniú an taighdeora	Dáta

School of Education,

University College Cork

Participant Information Sheet (over age 18) – Cara Criticiúil

Title of Project: *Tuairimí na bpáistí i leith E.T.I.M. (Eolaíocht, Teicneolaíocht, Innealltóireacht, Matamaitice) comhtháite.*

Cén réimse taighde atá ann?
Tá an taighde seo ag lorg tuairimí na bpáistí mar gheall ar na hábhair ETIM comhtháite.

Cé atá á dhéanamh?
Múinteoir Sile Ní Ríogáin – Múinteoir Rang 2.

Cén fáth go bhfuil an taighde seo ar siúl?
Tá an taighde seo ar siúl chun a fháil amach conas a bhraitheann na leanaí faoin modh nua seo.

Cad é an buntáiste a bhaineann leis an taighde seo?

Beidh páistí na scoile ag cur feabhais ar na scileanna ETIM agus obair ghrúpa.

Cad atá i gceist don rannpháirteach?
Labhair le Múinteoir Síle mar 'chara criticiúil' i rith an phróiséis ag am a oireann duit.

Cead aistarraingt
Beidh gach rannpháirtí anaithmid agus tá cead tarraingt amach ag aon am.

Conas go n-úsáidfear an t-eolas?
Beidh sé mar chuid den tráchtas i gColáiste na hOllscoile, i gCorcaigh agus foilsithe ar www.cogg.ie.

Conas a choimeádfar rundaíocht?
Beidh sonraí pearsanta na rannpháirtithe caite leis na caighdeáin is airde sábháilteachta agus rúndachta, de réir an Rialachán Ginearálta maidir le Cosaint Sonraí (RGCS) na hÉireann is na hEorpa. Beidh ainm bréige ort agus ní bheidh aon fhaisnéis inaitheanta phearsanta ag baint leis an dtionscadal seo. Beidh an t-eolas coimeádta faoi ghlas ar feadh dhá bhliain agus é criptithe.

Sonraí teangmhála:

Fuair an taighde seo faobhadh eiticiúil ón gCoiste Taighde Eiticiúil Scoil Oideachais i gColáiste na hOllscoile i gCorcaigh. Má thá aon ceist agat ag aon am, ná bíodh leisce ort dul i dteangmháil liom nó mo fheitheoir acadúil;

Síle Ní Ríogáin – 19225904@umail.ucc.ie

An Dochtúir Margaret O' Donovan - margaret.odonovan@ucc.ie

School of Education,

University College Cork

Foirm Toiliú – Cara criticiúil

Teideal an tionscadail: *Tuairimí na bpáistí i leith E.T.I.M. (Eolaíocht, Teicneolaíocht, Innealltóireacht, Matamaitice) comhtháite.*

Tá an tionscadal seo ag lorg tuairimí na bpáistí mar gheall ar ETIM i ngrúpobair agus tá nótaí taighde ag baint leis.

Le do thoil, freagar iad seo a leanas (cuir tic sa bhosca ceart):

Tá an litir eolais léite agam agus tuigim cad air a bhfuil an taighde bunaithe agus cad atá ag baint leis. ☐

Tuigim go bhfuil an rannpháirtíocht deonach agus d'fhéadfadh na rannpháirtithe aistarraingt amach ag aon am, gan cúis is gan píonóis. ☐

Tuigim go mbeidh an t-eolas príobháideach is anaithnid. ☐

Tuigim nach mbeidh rochtain ag an taighdeoir, an feitheoir is na scrúdaitheoirí ar an sonraí. ☐

Tuigim go mbeidh an staidéar foilsithe ar www.cogg.ie nuair a bheidh sé thart . ☐

Má thá cóip den taighde uait, ná bíodh leisce ort dul teangmháil liom ar s.niriogain@gaelscoilthomaisdaibhis.ie

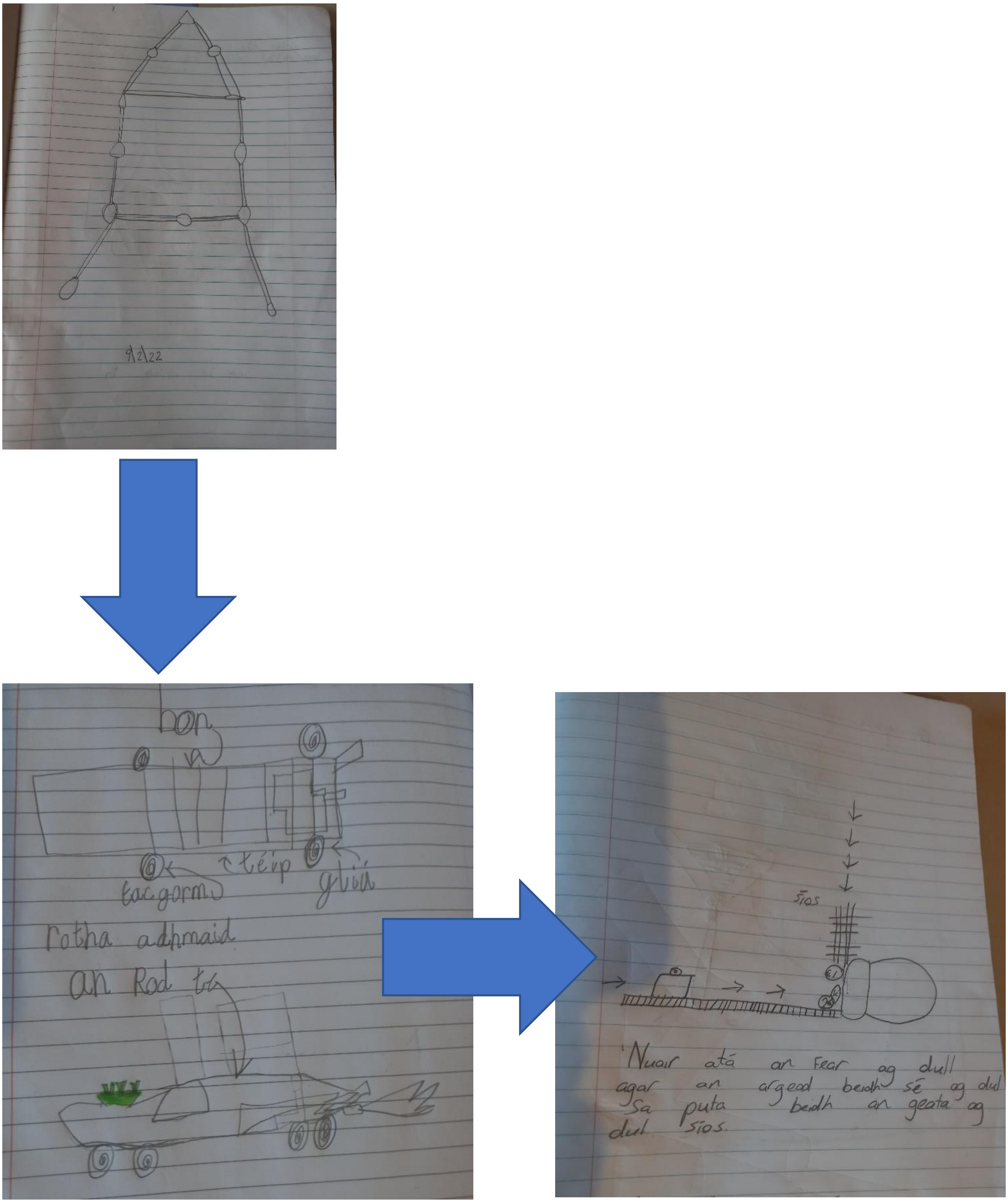
Táim sásta páirt a ghlacadh sa staidéar seo.

Síniú an rannpháirtí Dáta

Síniú an Taighdeora Dáta

Appendix 11

Appendix 12


9/2/22
téip
gliú
rotha adhmaid
síos
Nuair atá an fear ag dul
agar an argead beidh sé ag dul
sa puta beidh an geata ag
dul síos.