An Action Research project exploring pedagogical approaches to reduce misconceptions in Year 4 primary physics.

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Contents

Abstract

99 words

In England, research suggests that learners are progressing through their science education retaining physics misconceptions. This study explores the learner experience, through the pedagogical approach of guided practice, to learn the concept of 'light reflection'. This mixed-methods action research study focuses in on the learning experience of 4 case-learners to gain an in-depth insight into the learner experience and how their learning progresses and develops. From questionnaires, observations and interviews, data collected supported the research conclusions that exploration, modelling, and collaborative learning were central themes to providing a positive learner experience to bridge from preconception to correct scientific knowledge.

Key words: misconception, preconception, pedagogy, guided practice, primary science, primary physics.

Chapter 1 - Introduction

616 words

When learners begin statutory education in England at 5 years old, they arrive with a pre-existing set of skills, experiences, attitudes, and knowledge, which have been formed from prior experiences and interactions with their surrounding environment (Kiray and Simsek, 2019). The wonders of natural phenomenon are engaging and inspiring, leading learners to form their own preconceptions about the world that exists around them, this construction can lead to the development of preconceptions which conflict the correct scientific facts (Ofsted, 2021), this is particularly prevalent for physics concepts as the scientific knowledge is often abstract, where concepts cannot be visualised. Current research shows these preconceptions are not being valued or considered when planning to teach the correct concept, with many primary teachers lacking confidence and skills in science, (Bianchi et al, 2021), meaning misconceptions are remaining unaddressed and even become reinforced, becoming permeating barriers to science learning. The aim of this small-scale study is to explore the potential for pedagogical approaches in supporting teaching to target preconceptions to reduce their prevalence and impact on future learning.

This study has been conducted in a larger than average primary school which serves a predominantly white-British, diverse socio-economic community. Results in KS2 statutory assessments are consistently above the national average, though assessment of Early Learning Goals in the EYFS are currently below national average. The school puts an emphasis on attainment, the curriculum written with English and mathematics at the core. When analysing science assessment data, it was found there was a repeating trend of data decline in Year 3. On follow-up monitoring, it was found, that learners could recite knowledge but when asked questions around their understanding, misconceptions were often evident, this was most prevalent in physics topics. The chosen cohort for the study were a Year 4 class whose attainment in science is the lowest in the school, according to end of Year 3 data.

This study aims to identify how learners learn scientific concepts, acknowledging the changing reality of their knowledge. The study will focus on how conceptions adapt and change during the process of learning from preconception to accurate scientific

concept, from the experience perspective of the learner. This should, in turn, allow insight into how pedagogies can be structured and planned to support teaching in a succinct way to support learner understanding of scientific concepts. To enable this knowledge to be gathered, the following research question was developed:

Can the pedagogical approach of guided practice prevent misconceptions in the Year 4 physics concept of light?

The full development of this question is outlined in chapter 2.

This small-scale study was completed using an action research design in my own educational setting. It utilises a mixed-method methodology, focused predominately on qualitative data. Previous research has used only quantitative data which is a missed opportunity to gain depth of knowledge about the learning process and learner experience. Data was collected through observations, interviews and questionnaires. It is focused on 4 case-study learners to gain a more in-depth understanding of learner experience (The Open University, 2022a). The research methods are discussed in further detail in Chapter 3.

As an action research study, findings are specific to the class within the educational setting, valuing the unique perspectives of learners (Thomas, 2022). Researchers, learners, and the environment in which they all exist, are interrelated (Corbetta, 2003), to consider these as isolated variables would fail to illustrate the complexities of knowledge and learning, hence the findings of this study cannot be generalised beyond the setting. Instead this study is embracing the value in building and adding to existing knowledge to set the foundations for future studies. The full data presentation, analysis and implications can be found in Chapters 4 and 5.

Chapter 2 - Literature Review

3077 words

My ontological view as a researcher was developed through the literature below, embracing the multiple, dynamic realities that exist within contexts created by individuals (The Open University, 2020). My belief is, to understand more about how to support children gaining a secure comprehension of scientific concepts; you firstly need to understand how they learn, appreciating and interpreting their lived experiences: the pathway from misconception to scientific concept. This chapter outlines how literature shaped my research question, critically reviewing existing research in pedagogical approaches to addressing misconceptions in primary physics.

Misconceptions

The terminology surrounding misconceptions gives opportunity for misinterpretation, often lacking clarity and definition. Conceptions that learners bring to the classroom from their own experience and interpretation of phenomena are referred to by many different terms, among them: naïve ideas, preconceptions, preliminary concepts (Cartrette and Melroe-Lehrman, 2012). The same meaning can be encompassed by the term 'misconception'. Misconception can also be used to refer only to misconceptions generated from lack of clarity and understanding between preconception and a taught scientific concept (Ronen, 2017). For consistency, in this paper, when I refer to misconception, I will refer to learner's understanding that differs from the correct scientific concept which has occurred before formal learning at school as well as after (Malleus et al, 2017), whilst preconception will only refer to knowledge obtained prior to formal learning of a concept.

Current research suggests that preconceptions are not replaced by correct scientific concepts, instead the concepts co-exist, this has been shown at both a behavioural and neural level (Mason and Zaccoletti, 2021). This idea challenges historic research that considered how to replace preconceptions (Potvin and Cyr, 2017), instead, more recent research has focused on learning how this concept balance can be achieved. Yet current research suggests this is not starting to disseminate into teaching and educational settings. Bianchi et al (2021) identified the current 10 key issues in science in English primary schools, number 2 on the list: children's preconceptions are not adequately valued. With evidence heavily showing preconceptions continue alongside

the scientific concept, this is concerning. 86% of the teachers in the study had observed children's preconceptions not being planned for and yet zero felt it was currently the most important issue for them to address in their setting. Primary teachers often lack confidence and skills in teaching science; this is resulting in misconceptions being brought to lessons and often being reinforced, as opposed to them being bridged. The report had a follow-up model (Bianchi et al, 2023), with a planning and monitoring format for primary science leaders to utilise in their schools, but if preconceptions are not valued as an issue, are they going to be addressed as a priority? It states that preconceptions should form part of the learning process, yet there are no clear approaches or strategies suggested that would support implementing this change. It could be considered that a lack of knowledge of how to plan and approach preconceptions, once identified, is a barrier to effective learning and teaching strategies in the classroom.

Malleus et al (2016) also looked at teacher perception, analysing how accurately they assessed the level of learners' misconceptions. The study showed, without accurate assessment, teachers under-estimated a learner's misconception, with this becoming more significant as learners get older, teachers believing misconceptions just resolve as they get older. This goes against conclusions draw from Potvin and Cyr (2017), identifying that misconceptions continue to interfere with performance even when there is a higher degree of scientific expertise. Furthermore, when Malleus et al (2016) asked about learner misconceptions, many teachers in the study understood misconceptions to be gaps in knowledge. This links back to a possible reason for the findings in Bianchi et al (2021), teachers not planning for misconceptions if they hold a belief that learners merely had gaps in their knowledge rather than a more complex misunderstanding.

Similar to Potvin and Cyr (2017), Gouvea and Simon (2018) explored the dynamic nature of misconceptions. They found dynamic constructs to be most significantly linked and sensitive to contextual changes; the learner's own environment and setting. Similar conclusions were draw by Murphy et al (2021), they summarised the need to apply 'science to life'. Though neither of these studies looked at physics concepts, which are typically more abstract and have a higher level of misconceptions (Neidorf et al, 2020), where it is even more critical that learners can apply and see these concepts in their own lives. They concluded the need for more training and structures for teachers to guide learning, without this, teaching reverted to being teacher-led

lecturing, as opposed to child or teacher guided. With misconceptions being contextually rooted and evidence of teachers lacking skills in guiding learning, I wanted to understand more broadly, how pedagogical choices could incorporate and plan for misconceptions to deliver primary physics concepts.

Pedagogy

Pedagogy is another term in education that can cover many aspects within its definition. For this study, I take pedagogy to mean teaching practice, how it integrates and delivers a curriculum (UCL, 2019). This differs to some definitions that consider pedagogy to encompass the culture and structure of the practice context (Alexander, 2006); I believe this aspect lies more within teacher agency. The relationship between pedagogy and teacher agency is discussed in Chapter 3 for consideration during action research design.

There is a broad range of UK-based and international research on different ways to assess misconceptions (Soeharto et al, 2019). Teachers in England follow the National Curriculum, giving clear substantive and disciplinary knowledge that should be taught at each stage of learning. From this, resources have been created to assess individual misconceptions (Atkinson et al, 2020) or schemes that highlight common misconceptions learners may hold (PLAN,2020). Yet there is little clear evidence about how learners move from preconception to co-existing with correct scientific concepts.

Moodley and Gaigher (2017) explored teacher's perception of their pedagogy. They found a gap between teachers' knowledge of learners' misconceptions and being able to plan to address them. Though this was only a study of six teachers, it supports what was observed by Bianchi et al (2021), suggesting that rather than teachers not valuing preconceptions, it could be they were not equipped or did not have an in-depth knowledge to adequately plan to address preconceptions. As Moodley and Gaigher (2017) used teacher voice, as opposed to observations, to gather their data there could be further discrepancies between theory and practice. As Murphy et al (2021) showed, often teacher's intentions can deviate back to teacher-led approaches if they are not secure with knowledge and learning sequence.

Though much research, as with Moodley and Gaigher (2017), is suggesting the need for more training on teaching misconceptions, there is a lack of clarity on how to

approach this. Teachers in England follow the National Curriculum whilst also being guided by reports conducted on current practice by Ofsted. Ofsted (2021) criticised the teaching of science, highlighting many themes similar to Bianchi et al (2021), including prevalence of misconceptions. Within this report, they discuss pedagogical approaches based on Mostafa's review report (2018) of the PISA 2015 results.

Mostafa (2018) identifies two main pedagogical structures analysed in PISA: teacher-directed instruction and inquiry-based teaching. In this report, UK data showed teacher-guided approaches the most effective, due to the impact of behavioural issues during inquiry-based approaches. The Ofsted (2021) report does not relay this information, still stating inquiry-based approaches as considered 'best practice' when learners have some prior knowledge of the topic. Considering the target audience, with many primary teachers being non-specialists in science, this makes it difficult to comprehend an appropriate approach to pedagogical choices. Though Mostafa (2018) outlined teacher-directed instruction to have better outcomes, inquiry-teaching showed a significant improvement in learner's attitudes to science. This demonstrates a key discrepancy between learners' achievement and their perception of the subject. Learner process had not been considered, there was a gap in understanding of what aspect of teacher-directed learning supported progress and yet prevented the approach being as engaging and enjoyable as inquiry-teaching, this shaped the question and methodology for my SSI.

Considering the use of inquiry-based learning, Raganová and Pivarči (2019) based their study on the theory that misconceptions come from learners not having the opportunity to apply their knowledge. This a sentiment shared in Murphy et al (2021) and Gouvea and Simon (2018), the importance of contextualising and experiencing knowledge to bridge misconceptions, something which the PISA teacher-directed learning approach does not. Raganová and Pivarči (2019) showed a small reduction in the number of learners with a misconception post-teach but when looking at the data results, 60% of all learners retained their misconceptions. As with the process of inquiry-learning, they had collected information on misconceptions pre-teach, but did not utilise them for planning; only using them as a comparative measure post-teach. The study was small-scale but demonstrated retention of preconceptions for the majority of learners. This approach follows what has been considered as the key issue in the Bianchi et al (2021), not valuing preconceptions, which is the practice of

inquiry-based instruction. Similar to Mostafa (2018), this paper began to look at pedagogical approaches but missed an opportunity to truly understand how learners could use inquiry-learning to bridge misconceptions, due to quantitative methods being used to collect data, focusing on outcomes, rather than the process of learning. This further developed my research question, wanting to understand more about how learners learn and how they experience their learning, rather than only considering quantitative measures to monitor whether an approach is successful.

Little other research has been conducted on the use of inquiry-based learning on substantive knowledge, most focused on disciplinary knowledge, with learners already having existing knowledge of the concept (Ong et al, 2021). Given the conclusions from Mostafa (2018) on the more successful approach from UK data, alongside the lack of research conducted using substantive knowledge in inquiry-based learning, this led my research towards approaches based on teacher-directed learning. A key aspect I considered was awareness of the importance of learners experiencing their learning (Raganová and Pivarči, 2019), the Mostafa (2018) PISA definition of teacher-directed learning does not include opportunity for learners to independently explore or manipulate concepts practically. To encompass the practical steps of teacher-directed learning, whilst also adding the opportunity to apply and explore concepts practically, I looked to research conducted on the pedagogical approach of guided practice in science.

Guided Practice.

Guided practice is a form of teacher-directed learning with its basis rooted in supporting the learner to be taught a concept, before being supported and led to witness the concept first-hand through exploration of phenomena representations (Tyter et al, 2022). It follows Bloom's theory that without knowledge and comprehension, application and analysis cannot be successfully achieved (Bloom et al, 1956). There is little recent research on the use of guided practice to support teaching of substantive knowledge to address misconceptions in England. However, insights can be gained from exploring both the application of guided practice for substantive knowledge with older learners and from research conducted with primary-aged learners on disciplinary knowledge.

Sari and Cahyo (2020) is an Indonesian study working with learners aged 14-16, it demonstrates the application of guided practice to overcome misconceptions in biology. They set out a clear method for how they delivered the guided practice lesson; this was a structure I based further methodological research on. It uses features of the 5Es (Elicit, Engage, Explain, Explore, Evaluate) of instructional learning, though not directly referring to this approach. Much research has been conducted on the 5Es, though not in relation to misconceptions, but the majority of this research is pre-2010 (Kilavuz, 2005; Bybee et al., 2006; Cardak et al., 2008). More recent papers have focused purely on application and quantitative results, many being conducted as part of masters level studies (Hokkanen, 2011) or purely theorist rather than empirical studies into application (Ruiz-Martín and Bybee, 2022). Sari and Cahyo (2020) study showed a positive improvement compared to a control class, though the authors do not seem to have fully comprehended the complexities of educational settings, referring to control variables and quasi-experimental trials without any clear information to suggest how these could have been adequately controlled. With only a small sample of one class, claims made of statistically significant results are a little premature but shows promise for guided practice having a positive impact on reducing misconceptions.

Focusing on physics concepts, which are typically more abstract and learners possessing more misconceptions, Wartono et al (2018) focused on guided practice for the topic thermodynamics. Wartono et al (2018) is another Indonesian study with 14-16 year old learners, but contrary to Sari and Cahyos (2020) use of quantitative measures, they utilised a mixed-method approach to consider the dynamic nature of a classroom. They found guided practice ‘contributes greatly’ to reducing the prevalence of misconceptions. Yet when looking at the data, it demonstrates from 20 concepts, 8 reduced in the percentage of learners’ misconceptions, while 2 concepts show an increase post-teach. Another criticism of this paper is the lack of clarity of the pedagogical structure, whereas Sari and Cahyo (2020) breakdown the aspects of the lesson, there is no information on how they conducted ‘guided practice’, leaving room for misinterpretation and limits the ability to replicate. This paper demonstrates a pedagogical approach with some positive signs to reducing misconceptions in physics topics, but the results and concluding sections focused on the quantitative data collected from a mixed-method study. Looking at qualitative data would have provided more information to understand what worked and where this approach

could be developed in future practice. They base their study on addressing misconceptions of a topic area just covered, as opposed to preconceptions, focusing on preconceptions ought to result in a reduction in misconceptions.

Current research on application of guided practice in primary aged learners is focused on disciplinary knowledge, otherwise known as ‘working scientifically’ or process skills. Tyter et al (2022) followed a guided practice approach, which they stated possessed broad features in-line with the 5E instructional approach. They concluded guided practice to be essential in allowing learners to apply knowledge in varying contexts to gain a broader understanding. The study observed two primary teachers, learners age 6-7 years, looking at the teacher role, wanting to address a gap in teacher pedagogical strategies that enabled the bridging. It is the other side of this which my SSI is aiming to address, not the teacher moves but instead the learner experiences, and how these support the bridging from initial ideas to correct concepts. The study acknowledged its limitations, identifying it poses more challenges addressing misconceptions in older years where concepts are more complex. Another consideration needed is the amount of training which these teachers have had, linked specifically to science and maths, monitoring, coaching and reviewing of delivering this pedagogical approach, with detailed lesson guides and resources. Ofsted (2021) highlighted, this is not the case currently in many schools in England, often overshadowed by focuses on mathematics and English.

Choirunnisa et al (2018) also explored the application of guided practice following the 5Es approach. This paper, similar to Tyter et al (2022), looked at disciplinary process skills, rather than substantive knowledge. Choirunnisa et al (2018) showed positive improvements in learner’s ability to apply their knowledge in process skills and an increase in the use of disciplinary skills, the study was conducted with learners age 8-9, the target age group for this SSI. The paper fails to explain what concept or investigation the study is observing, only describing the process of 5Es model, not how it is being applied, this makes it difficult to understand how the learners have experienced their learning and hence how the approach has influenced this.

This positive outcome from use of guided practice for improving process skills opens the questions as to why it is not being used whilst teaching the initial substantive

knowledge concept. Using the 5Es approach could allow opportunity to introduce new knowledge in the engage and explain stages, before exploring and applying in subsequent steps. This follows the idea of Gouvea and Simon (2018) that knowledge should be applied to be understood. Utilising this approach could prevent the formation of misconceptions and allow preconceptions to be addressed and monitored through the process of learning.

Summary

Several papers show guided practice produces positive outcomes in reducing the prevalence of misconceptions for some learners (Wartono et al, 2018, Sari and Cahyo, 2020, Restiana and Djukri, 2021). Though papers often lack clarity on the structure of implementing pedagogical structures (Kloos et al, 2019) or the research has not been conducted in a relatable setting or topic area to which I endeavour to explore (Sari and Cahyo, 2020, Sliogeris and Almeida, 2017). Most papers trialling guided practice as a research method utilise quantitative data with the focus being on whether the approach works or not. This misses the essence of teaching and the purpose of pedagogy. This study aims to address this gap, looking at the learners' journey from misconception, through guided practice of the correct scientific concept, striving to understand how a learner's understanding changes, adapts and develops.

From this, I propose the research question:

Can the pedagogical approach of guided practice prevent misconceptions in the Year 4 physics concept of light?

Though research is clear that planning for preconceptions is critical, and research exists on how to identify them, current research is still inconclusive as to the 'best' pedagogical approach to organise preconceptions into clear scientific concepts (Kloos et al, 2019). There is a lack of research, particularly England based, which translates the theory of misconceptions into practical terms and pedagogical approaches that can be utilised by primary teachers, this is evident in how teachers are still failing to plan and value misconceptions in their planning and pedagogical approaches (Bianchi et al, 2021). Though this research will be unique to the educational setting in which it is conducted, this study is not striving to find a solution. I acknowledge that learning is shaped by local knowledge, routines, personal practices and beliefs but it has been shown that valuable lessons can be

learnt and developed from small-scale qualitative studies. Conceptual change research could help educators understand the best ways to ensure students give scientifically inspired answers rather than intuitive or non-scientific ones. (Potvin and Cyr, 2017). My SSI is aimed at gaining an in-depth understanding of learner's experience through the process of using guided practice to address a specific misconception within my setting. This will set out the clear structure I will utilise for this pedagogical approach.

Chapter 3 - Research Design

3062 words

Research Philosophy

As outlined at the start of Chapter 2, my ontological perspective is that reality is constructed based on how an individual interprets and experiences the world around them (Thomas, 2022), embracing multiple, dynamic realities (The Open University, 2020). Dilthey distinguished natural science from social science, stating natural phenomena can be explained by cause and effect, but human mind and realisation are not determined by natural laws (Makkreel, 2021), hence cannot be perceived or measured through the same means. Though it is debated whether natural and social science ontological views should be distinct in their terms of laws of nature (Bastalich, 2023), it is my view that social phenomena cannot be generalised. This is the essence of preconceptions, individuals will come to the classroom with a unique set of experiences, views, and knowledge of the world, and therefore reality cannot be presumed to be analogous. Through the process of learning, the perceptions and knowledge which learners possess will change and adapt. Through teaching, learning allows reality to be in a constant state of revision (Grix, 2002). In this chapter, I will outline how my literature review, guided by my ontological and epistemological positions, has shaped the choice of methodology, and in turn research methods for this study.

To explore an individual's experience and reality, we needed to explore how a specific approach could shape a learner's learning and how this learning could be experienced. The specific approach of 'guided practice' was identified from literature as a pedagogical strategy showing promise for addressing misconceptions in learners (Wartono et al, 2018, Sari and Cahyo, 2020, Restiana and Djukri, 2021), but all current research focuses on quantitative conclusions of whether it works, with little information on the nature of learning. This informed my decision to focus on a qualitative approach, to understand the process rather than the outcome. Knowledge and learning are not as simple as right or wrong, learner perception and experience need considering to comprehend what aspects of a pedagogical approach support learning and what does not. With misconceptions being unique to each learner, and

with the constant revision of knowledge (Grix, 2002), this cannot be measured quantitatively.

To address the research question, I am assuming a descriptive-interpretivist position. This will allow description of the learning experience from the perspective of the learner. By adopting this approach, the research question is open-ended, with a focus on learner experience, rather than merely the overall success of the approach. This is important to understand what about guided practice has the impact, allowing focus and planning on how to further develop and explore it as a pedagogical method for addressing misconceptions, which is a gap from previous research. The study aim will gather qualitative information from observations and verbal expressions about the experience, aiming to look at not just how the individual realities are constructed but how they are experienced (Parsons, 2018). This information will be represented through organising, theming, and linking information, striving to understand learning by representing learner experience through these themes (Elliot and Timulak, 2021). There is no fixed reality, how one learner perceives their experiences will be unique, these cannot be generalised (Thomas, 2022), but a rich plethora of information can be gained on learner experience through this approach which can feed into further research and refining of this approach. Understanding the contribution of each section of ‘guided practice’ to the overall process of learning, knowing which aspects support understanding the knowledge and looking specifically at bridging and balancing the concept to their initial misconception is central to development of this pedagogical approach.

Methodology

This study’s methodology, informed by my paradigm position, is a small-scale action research study. Following the paradigm position to focus on understanding in a natural environment, utilising researcher-participant relationship (Bunnis and Kelly, 2010). Considering the definition of pedagogy to mean teaching practice, how it integrates and delivers a curriculum (UCL, 2019) as outlined in Chapter 2, I have considered the pedagogical approach process of guided practice to not encompass the context. An interpretivist paradigm, when applied to social phenomena, such as the process of learning, must be understood in relation to the subjective

interpretation of human experience (Gall et al, 2007), which means the consideration of teacher agency.

Teacher agency is a teacher's ability and competence to deliver educational acts (Sang, 2020), unlike pedagogy, I deem teacher agency to be achieved by the interplay between the teacher and their environment, that encompassing resources, setting structures, cohort make-up, and many other social and economic factors (Biesta and Tedder, 2007). Priestley et al (2015) stated that prescriptive policy, including pedagogy, can restrict and deny a teacher the ability to exercise agency, this fails to consider the interplay considered by Biesta and Tedder (2007), the process of evaluating and adapting pedagogical approaches to fit the educational context (King and Nomikou, 2018). When considering how teachers approach addressing science misconceptions, Murphy et al (2021) showed, often teacher's intentions can deviate back to teacher-led approaches if they are not secure with knowledge and learning sequence. For teachers who lack specialism or confidence in teaching science, pedagogical structures and prescribed practice can support (Leat, Reid and Lofthouse, 2015), this does not remove teacher agency, instead provides supportive structure to frame their teaching approach.

Utilising action research, recognises and supports the gap from 'theory of practice' to 'theory in practice' (Cohen et al, 2018a). To embrace the experience of the learners in the complexities of how a pedagogical approach is delivered within a specific educational setting, action research is the most appropriate research design. Action Research is not just focused on improving practice but generating information on the complexities of teaching and learning, this is individual and setting specific (Cohen et al, 2018a), acknowledging that this study will not generate 'the answer', but instead be 'one-cycle' as part of an ongoing cycle that will continue beyond the duration of this research project. To gain a thorough perspective of how learners interact, learn and knowledge develop, I felt that focusing on a small number of explanatory case-learners within Action Research would generate rich, in-depth data, rather than shallower wide ranging data (The Open University, 2022a). Triangulation of research I feel is essential to gain as much insight into the learner's experience as possible to bring together a detailed picture, this will be discussed in detail in methods.

When trialling a new pedagogical approach, it is critical for this to come from an informed perspective (Costley et al, 2010). As an inside researcher, I have an in-depth understanding of the environment and ethos of the educational setting, which is essential for considering learning and interpreting a whole picture of what is happening (Thomas, 2022). As stated in the introduction, the educational setting is a larger than average primary school which serves a predominantly white-British, diverse socio-economic community. Pre-assessments are not routinely conducted, and knowledge is planned to build from prior year learning. Teaching in science is striving to be more learner-led but due to time constraints and a lack of teacher confidence, lessons often revert to being more teacher-led, as evidenced in a previous staff voice survey. Science is assessed using retrieval knowledge-based questions, rather than application, at the end of each topic, in the same format as foundation subjects.

The class I have chosen for my study is Year 4 (8-9 years old), they were identified from subject data analysis, as the cohort with the lowest percentage of learners reaching age-related expectations in science, this makes the study relevant and beneficial to the school which gave a specific focus and also investment from the school to try to improve outcomes for our learners. They have a lower percentage of Pupil Premium when compared to the school overall but a higher percentage of children on the SEND register. I have selected the topic of light, as learners find this challenging due to preconceptions from everyday experiences, and in previous pupil voice interviews, have found learners retaining misconceptions. As this was an area for development for the school, I had support from the senior leadership to trial new approaches. I was aware of feeling the need to remain impartial, using the qualitative approach of this study to analyse the whole process of guided practice to understand the contribution of each part to the learner's development of concept understanding. As this cohort were the lowest performing cohort, being a data weakness, there is the possibility of bias pressure to find an 'answer' to improve outcomes. I ensured the senior leadership team were clear about the importance of understanding the learner experience, including it being critical to comprehend drawbacks of this approach before considering trialling for different topics or year groups.

When planning for this study, the class teacher was made aware that if she participated, observations made would not note any aspect of her teaching, only that

it followed the guided practice approach. Nor would any results from the questionnaire reflect her teaching, as they were to assess preconceptions learners have and post-teach the impact of the guided practice pedagogy. It was important to be clear on this as guided practice was a new experience to both the learners and class teacher. The school's approach to curriculum is focused with English and mathematics at the core. The basis of science lessons structure around the substantive knowledge, whereas guided practice centres around using disciplinary knowledge and skills to experience substantive knowledge. Guided practice, for my study, I adapted the 5Es model for teaching (Bybee, 2014), as shown in Appendix 1, discussed in more detail in methods.

Though imbalance of power relations can never be fully resolved (Costley et al, 2010), I implemented a range of strategies to lessen the impact of these on the study. The class teacher was asked whether she would like to participate by an impartial member of staff, for her not to feel pressured to agreeing to participate in the study. Though the pedagogical structure was defined for the class teacher, she utilised her teacher agency to apply the structure to her class, including heterogenous groupings, identifying where to apply adult support, and ensuring regularity in routine. This also created more equality in power relations between researcher and class teacher (Cohen et al, 2018b).

For school-based research, where the activity is similar to standard practice, only consent from Headteacher and learners is required. Learner assent was sought verbally, with written permission from the head teacher as gatekeeper (appendix 2). Expectations and aims of the study were shared with both parents and learners through written communication (appendix 3).; with the expectation that the research would take place (BPS, 2021). To minimise potential stresses, the science lesson was conducted on the classes usual science day and time with their class teacher leading. Within an educational setting, time is a potential limitation to insider research, as a part-time member of staff, the chosen class have science timetabled on my non-contracted day, meaning I could come into school to conduct the study. This ensured my class did not require covering and allowed me time within the setting to process and absorb, rather than having finite time limits to conduct this study. Though completed on the same day, this lesson was completed on the final week of half term and the subject content was not a continuation of work which they

had been doing in their half term topic, hence this was a stand-alone lesson which could have an impact on effectiveness of the approach.

With the benefits of an insider researcher, I am also aware it could impact my collection and interpretation of research, conscious of being transparent and objective (The Open University, 2022b). I will outline experiences, insights and measures put in place at each stage of data collection in methods below. At every stage of the process, I have kept my headteacher informed as gate-keeper. The topic is non-sensitive, with no personal or identifiable information required. The main ethical concern being the research subjects are under the age of 18. Ethical considerations and measures put in place are also noted in the methods section for each part of the study.

Methods

For an action research project focusing on learning using guided practice, triangulation of data felt essential to gain an in-depth understanding of the learner experience. Through using an embedded mixed-method design, this study is framed under interpretivist views, not mixing methodologies (Creswell, 2010). Triangulation was used to gain different perspectives of the experience (Flick, 2018): quantitative questionnaires to assess the impact of the pedagogical approach, observation for researcher perspective of what is happening from learner outward expression and experience, concluding with interviews to gain the learner's view of their experience. By gaining multiple outlooks and datasets, comparing and contrasting these findings, a deeper and more thorough knowledge can be formed.

Guided practice, for my study, I adapted the 5Es model for teaching (Bybee, 2014), as shown in Appendix 1. For the initial stage, elicit, a questionnaire was used to identify case-learners. For the study, it was critical that case-learners possessed the preconception. Usually, questionnaires are used for larger samples, but as Munn and Dreyer (1990) outline, they are valuable in small-scale studies to deliver standardised questions simultaneously, making an effective use of time. The main limitation of using questionnaires is that outcomes cannot be generalised due to the sample size being so small and setting contained. As an action research study, aiming to understand learner experience, generalisation of results is not an intent, with clarity and transparency of this given through analysis.

The questionnaire is included in Appendix 4, it had two clear questions to ascertain if the learners had the preconception, the questions were carefully structured, using principals on diagnostic assessment from Best Evidence Science Teaching assessments (EEF, 2018), to ensure nothing is read into the data which is not substantiated. Thomas (2022) makes clear the importance of only having essential questions so not to generate unnecessary data. Ethically, the designed questionnaire is similar to those that learners are used to, as part of the setting's assessment policy. As outlined in Appendix 5, from the data collected, only the results were recorded against a letter to represent each child, no additional information was collected. These were used to randomly select four case-learners working at age-related expectation in science, possessing the preconception. From the pre-assessment, 6 case-learners were selected, these were chosen by the class teacher as all 29 learners in the class demonstrated the tested misconception. She chose children working at the expected level in all core subjects, with an equal gender split, this allowed a more complete picture without considering impact of abilities, socio-economic status or other unique characteristics (Cohen et al, 2018a). Though only 4 were needed, additional learners were sought to compensate for lack of consent, this proved to be a critical step as only 4 consent forms were returned.

Learners were taught through Engage and Explain (Appendix 1), where they received knowledge of the correct scientific concept and witnessed it through demonstration, before completing Explore. I was a non-participant observer, Lui and Maitlis (2012) compared details missed when participating in a study, I did not want to miss or overlook details that could be critical during my analysis, such as body language, gestures and voice tone, so felt that being on the outside allowed me to gain a full insight and narrative. Due to the nature of this study, by being a participant, this may have interfered with the natural progression of talk and interactions between peers giving a skewed or unreliable view. However, the balance in this possible negative was that by observing on the side line, I was able to pick up more subtleties, view learner talk, group dynamics and individual development. Parents of case-learners were informed of the study and provided with opt-in consent for this section (Appendix 6 and 7). Learner consent was paramount throughout, being aware and vigilant of learner's body language and emotions, to look if the learner was displaying signs of being uncomfortable or is showing

indications of withdrawing assent (Oates, 2019). Luckily all learners remained comfortable and showing willingness to participate through all parts of the study. As an insider researcher, I am aware of safeguarding procedures and disclosure processes.

Following on from the observations and the post-assessment, the four case-learners were interviewed to gain a deeper understanding of their perceptions and opinions. I feel this part of the triangulation is critical for learners to have the right to express their views on their learning journey (Bahou, 2011), comparing their experiences to mine as an observer. Taking from Roulston's (2010) advise, to create an open discussion, the interview was focused on shorter, open questions. Using a semi-structured interview, there was less of a power imbalance between teacher and learner, the questions outlined in Appendix 8 gave some structure, but their open nature allowed flow and gave the learner more ownership on their dialogue (Burton and Bartlett, 2005), lowering the likelihood of the learner feeling 'led' to an answer (Chamerlain et al, 2019). The interview was conducted in the same way to usual pupil voice interviews in this educational setting which are commonplace, as recommended in BPS Framework (2021), this also set the expectation on a suitable length (Skinner, 2018).

Once all the data had been collected, it was stored as outlined in Appendix 5. No identifiable information was collected as this was not a relevant for analysis. All notes were stored under the codes A,B,C,D for the case-learners, in accordance with the Data Protection Act (2018). Questionnaire data was analysed using comparative tests to compare the percentage of learners with the preconception pre-teach against post-teach. From the observation and interview information, thematic analysis was conducted following the structure set out in Braun and Clarke (2006). Systematically reading, before initial code allocation and thematic grouping (Robert and Timulak, 2005). Though a considerably different subject matter that Braun and Clarke (2006), this study focuses on social science analysis and experiences. By using data collected through triangulation in data collection, this gave a wider view of learner experiences, perceptions from learner, researcher and quantitative views. Bringing these together, valuing each (Flick, 2018), and through thematic mapping and analysis, allowed consideration of the depth of learner experience. How the data collected from this study contributed to development of this picture is outlined

clearly in the following analysis section, with considerations and interpretations stated clearly and with transparency.

Chapter 4 - Data Presentation and Analysis

4,127 words

This chapter aims to process, analyse and interpret the information collected from questionnaires, observations and interviews, to explore the potential of guided practice as a pedagogical approach to address misconceptions in primary physics concepts. The analysis will begin with discussion of the quantitative questionnaire data. Following this, the findings of the open-questionnaire, observations and interviews were processed through thematic analysis before presenting a discussion in relation to the research questions and literature.

Data collected was considered more generally, rather than specific to individual learners, to create a more reliable and fuller picture of the overall learner experience, cross-referencing and validating with multiple opinions (Cohen et al, 2018c). To ensure credibility, the research methods used were evaluated to ensure they enabled data relevant to the research question to be collected, all interpretations and data presentation decisions will be outlined in the context of the educational setting in which the study was conducted (Stutchbury and Fox, 2019). Conclusions and their implications will be discussion in further detail in Chapter 5.

Quantitative data

It was critical for this study that case-learners possessed the target misconception, ‘only shiny things reflect light’, a common misconception for this concept (Shallcross, 2017). The results, through the 2-step questionnaire, showed that all learners possessed this misconception. The initial question, shown in Appendix 4, targeted the substantive knowledge of whether the children could articulate the correct scientific concept, with 100% of the 29 learners stating, ‘shiny things reflect light’ and 5 learners (17%) also ticking ‘light things reflect light’. To follow up this question and explore learner’s experiences of materials around them, question 2 identified learners’ perception of how objects in their environment reflect light. Results showed 100% of learners identified foil and the ring to reflect light, with 93% also selecting the Hi-Viz jacket and 86% the puddle.

Whilst the questionnaire was essential for assessing which learners possessed the misconception, it was also critical to understand more about the misconception to

plan the guided practice lesson. Having the additional follow-up question showed that though some learners had identified ‘light-coloured objects’ to reflect light, when presented with images from their own experiences, they did not select any of the ‘light’ objects to reflect light. Puddles and Hi-Viz showed that some learners considered objects reflective which you would not usually deem to be ‘shiny’. Considering these preconceptions allowed careful planning (Bianchi et al, 2021) following the 5Es approach, as outlined in Appendix 1 and discussed in Chapter 3’s methodology section.

Though the focus of the study is looking at how children learn, as the research question outlines, the study is looking at can guided practice prevent misconceptions. Therefore, before considering how learners learn, the question of ‘do they learn?’, needs to be assessed. To address this aspect of the research question, the questionnaire was repeated directly post-teach, with 100% of children selecting the statement ‘all materials reflect light’ to question 1 and ticking all objects in question 2. This quantitative data shows positive support toward the approach of guided practice to address the target misconception, looking at the question from an attainment angle. Wartono et al (2018) also drew this conclusion, but their data did not support their claims as clearly, with 20 thermodynamic misconceptions being assessed, there was inconsistency, whereas this study focused on how guided practice targeted one defined misconception. This study showed the guided practice structure, outlined in Appendix 1, to be successful for addressing the target misconception, a possible suggestion for its success is the focus and planning around one specific misconception.

Results from quantitative evidence only shows that the lesson had been effective at bridging learning between preconcept and correct scientific concept. The key aspect for this study is exploring not just ‘does it work’ but delving into learner experience. To be able to answer the research question of can guided practice prevent misconceptions, more depth is needed to explore the learner experience which can only come from observing and interviewing learners through qualitative data collection approaches.

Qualitative Data

Through the study, the key focus has been understanding the learner experience, to build a picture of this, three forms of qualitative data were collected: questionnaire, observation, and interview. As discussed in Chapter 3, the decision was made to focus on 4 case-learners as a means of collecting in-depth, detailed evidence (Cohen et al, 2018b). Observations were planned during the engage, explain, explore and evaluate sections (Appendix 1). Following the lesson, as part of the post-questionnaire, they were asked to represent 'what reflects light' on a piece of paper, allowing a more open-ended approach to assessing their understanding of the concept. Finally, the 4 case-learners were interviewed individually using a semi-structured approach (Appendix 8).

For the study, validity was central. Multiple sources of evidence were sought to allow comparison, striving to consider and deliberate alternative views and rival explanations, understanding multiple realities exist within sets of personal narratives and observed behaviours (Guest et al, 2012), identifying weaknesses in perspectives but why it is preferable or a more compelling decision than alternatives (Costley et al, 2010). Though due to the small-scale nature and paradigmatic view of knowledge being individual, the findings are unique to this context and individuals within it.

When completing action-research social studies, particularly in educational settings, being prepared and aware of potential for adapting and changing research methods is vital (Cohen et al, 2018a) and acknowledgement of how these may have influenced evidence collected. Observations were planned as non-participant but during 'engage', the class teacher sought support. The lesson had been structured and planned by myself, as the researcher but then adapted and rehearsed with the class teacher prior to the lesson. When completing the 'engage' the class teacher doubted her concept knowledge to explain it through the model, particularly using the model to bridge from the misconception, this then impacted her confidence to deliver the explanation. Analysis of this in relation to guided practice as a pedagogical approach will be considered in the thematic sections, but from a method view this had an impact on the amount of observation data collected as it limited my ability to note during this section. Though, as the class teacher sought my support, it ensured the learners received clear knowledge and that the lesson content mirrored that

planned in Appendix 1 to create the bridges from misconception, critical for co-existence of concepts (Mason and Zaccoletti, 2021).

The interviews were conducted in the same format as the school's pupil voice interviews and therefore the learners were familiar with the process, they remained at ease and comfortable throughout (Burton and Barltett, 2005). Conducting the interview, whilst also scribing was challenging and did slightly interrupt the flow of the interview but it was not unsettling for the learners. The addition of an open question to finish the post-questionnaire was useful to enrich the knowledge gained from the quantitative questionnaires. Due to the closed questions on the questionnaire and to reduce the potential bias of the same questionnaire being repeated (Thomas, 2022), I wanted to gain more depth of understanding of how the learner's conception has altered and adapted by allowing them freedom to explain and represent their learning.

Following data collection, to enable the qualitative data to be interpreted, thematic analysis was used to find and analyse patterns in data. The process outlined by Braun and Clarke (2006) was used, as outlined:

1. Familiarise with data- thorough reading of the data to ensure all is considered. Taking a step back and viewing impartially (Wellington, 2015). Familiarisation of the flow and sequence of learning and how data collected was placed within this.
2. Generate initial codes- coding with an impartial view so as not to miss aspects from the data through viewing from a contextualised bias.
3. Search for themes- searching for themes across the data which capture something important in relation to the research question, considering the multiple sources of evidence (Braun and Clarke, 2006)
4. Review themes- collating and refining themes to place them within the educational context in which the study has taken.
5. Define and name themes- selecting those themes which are significant and prominent to answer the research question and offer rich insight into learning through this pedagogical approach.

Using mapping, themes were linked through codes to build a narrative of the learners' experiences (Cohen et al, 2018c) to understand how learning develops and

thinking happens through the lived experience of guided practice (Clarke and Braun, 2017).

The following key themes were identified through thematic mapping of codes:

- Modelling
- Exploration
- Collaboration

Each theme will be outlined, explored and analysed in the context of how it has impacted the learner's experience of guided practice to address the misconception in the Year 4 physics concept of light reflection.

Modelling

Modelling of concepts is an aspect of pedagogical approaches which extends beyond guided practice. When Mostafa (2018) define PISA teacher-direct learning, the central aspect is the modelling of the concept by the teacher, with Ofsted (2021) attributing this to it being so effective when utilised in UK classrooms. Modelling was a key theme which ran across observations from the exploration section and was mentioned by 2 of the learners during interview. Due to the need to support the class teacher during the engage and explain sections of the lesson, I could not make any observations, meaning no data was collected for body language of learners. But from observations during the other parts of the lesson, some information can be gained about their engagement and aspects taken from the model to support their development of concepts from their initial misconception.

Appendix 1 outlines the engage section of the lesson, centralised around the model of the baking trays. During the exploration section, learners showed links to the model and made clear reference to this to build their knowledge. Child D, when shining light on a pompom, stated:

> *' it's like the cupcake tray, it isn't smooth so the light is reflecting everywhere.'* (Child D, 2023)

The learner has shown good comprehension of the model in their ability to extend the knowledge beyond the tray to the object they are exploring. When articulating this to their peer, they showed confidence, pointing towards the cupcake trays and

modelling with their hands how the surface texture was impacting the direction of light. Without the reference point of the model to bring their learning together, then the learner would not have been able to visualise an abstract concept before extending this knowledge.

Whilst child A did not explicitly refer to the model, as they explored foil, which prior to the lesson had always been perceived as a 'shiny' surface, they explained to their partner:

> *'when you screw it (the foil) up, it's not really shiny anymore so the light doesn't look as bright as it's reflecting everywhere but it is still reflecting, look,' (handing the other learner the torch).* (Child A, 2023)

Child A had been shining the different torches at the foil for around 3 minutes, they then sought another piece of foil, which they then scrunched up and tried out with 2 different torches before screwing the foil up even more, again unfolding and testing. They compared the two surfaces, this child then left their seat to go and look at the baking trays, feeling the surfaces before returning and repeating. Observing during this period showed the child become more relaxed and their confidence building in what they were observing, nodding and brief smiles to themselves as their ideas came together. After around 8 minutes of exploring, they articulated their findings to their peer, as above, showing them what they had found. Similar to Child D's exchange, the other child then repeated these themselves, showing agreement.

Child A and D both showed through their exploration a direct link to the model which they had witnessed during the engage section of the lesson, bringing in the knowledge from the explanation. Child D using the foil to link between their misconception, that the foil would need to be shiny, to now confidently explaining to their partner that it still reflects, even though it is now not clearly shiny, shows a balance between their misconception and the correct scientific concept which Mason and Zaccoletti (2021) have evidenced is how our learning process needs to form, bridging the misconception to the correct concept.

Moreover, this interview extract corroborated what I observed through their learning. By re-visiting the model, they were building their learning whilst using the model as a reference point to explain what they were seeing. Child D stated:

> *'The explanation at the start helped me to understand why it's not just shiny things but also why I thought that. I now know how it happens. It makes sense when you see the trays and how different surfaces reflect the light differently. '* (Child D, 2023)

Models used as a pedagogical approach alone have yielded varying results. Sari and Cahyo (2020) showed positive results using a direct model in their guided practice approach, as the concept was biological, the learners could explore visually the actual concept and the misconception be bridged. Whereas Wartono et al (2018) showed mixed results, the lack of specific planning for the misconceptions needs to be considered as a factor in these results, instead focusing on too many and presenting a more generalised model. This study used a model specifically designed to address the misconception identified from the pre-assessment, ensuring that this classes preconceptions were valued and fed into the lesson's model (Bianchi et al, 2021). Using the explain section of the 5Es to explain to learners why they may have perceived their misconception, bridging that understanding. Though it is noted that only half of the case-learners had codes mapping to the theme 'modelling', from the learner's views and on balance of the previous studies, a specific targeted model seems significant for learner's experience of guided practice, providing not just a visual but also a transferable model for the concept to start to balance the co-existence of conceptions (Mason and Zaccoletti, 2021).

It is important to consider that this lesson was intended to be conducted by the class teacher solely, even after being part of planning and having rehearsed the lesson, the class teacher doubted herself when having to make such specific links between the model and the scientific concept. Had I not been there, questions surround how the class teacher would have proceeded with the lesson. This is a key factor discussed in literature, teachers often lack confidence which can lead to misconceptions being compounded or further ones generated (Bianchi et al, 2021), or else deviating back to more teacher-led or lecture style approaches (Murphy et al, 2021). Stepping in to support and deliver the engage and explain sections of the guided practice was a positive move as it ensured the knowledge was succinct and clear for the learners, facilitating the model to bridge from pre-assessed misconceptions to the current scientific concept to apply in the explore sections, this ensured the integrity of the guided practice model and in turn the study itself.

Analysis of this observation is important to highlight when referencing the significance of the model for the learners' experience, as use of the model would not have been as effective and may have been to a detriment had the explanation not been clear and bridging links not clarified.

Exploration

Through observations, exploration was a prevalent theme due to the adaptations needed through the course of the study, resulting in this being the lesson section where most observation data was collected. When coding, exploration also featured heavily in both the interviews and in the post-questionnaire open question. Whilst interviewing, all 4 learners referenced the exploration section of guided practice to being significance in their experience.
Child D, referred to the plethora of materials which they could explore.

> *'All the different materials helped me to see for myself the different amounts the light was 'bouncing off'* (Child D, 2023)

The misconception that learners possessed centralised around the idea that only materials characterised as 'shiny' reflect light, or those associated with reflection in the dark, e.g. Hi-Viz jackets. Though evident that the utilisation of the correct scientific vocabulary is not fully embedded, having been shown and explained the correct scientific concept, then explained why they have thought it was only 'shiny' materials modelled, by having carefully chosen materials which have a wide range of different characteristics to explore, learners can perceive and witness the phenomena themselves (Raganová and Pivarči, 2019, Murphy et al, 2021).

> *'We don't usually get chance to try things out for ourselves, usually watch a video or the teacher. Doing it helped me see it myself and I could explore what I wanted to and the objects I wasn't sure about. Like, when you see something, you don't always believe it but when you try it yourself then you have to believe it.'* (Child C, 2023)

Child C captured their learning process through their answer to, 'How does this lesson compare to your usual science lessons?'. They showed a clear passion and enjoyment for the lesson which has been shown to be a theme from inquiry-based learning pedagogies (Mostafa, 2018), this is significant for learner's long-term

engagement with physics but in terms of the impact of guided practice, it is much more than that. They have articulated the importance for their understanding to have been given the opportunity to explore firsthand (Murphy et al, 2021), that this was required in addition to support their learning experience and understanding of the concept.

When coding post-assessment questions, across the 29 papers, learners varied with how they presented ‘what reflects light?’, but it was clear that the exploration activities featured heavily, with 27 of the learners referring or drawing items which they had explored, compared to only 2 who referenced the model example. As Child C articulated, the impact of the exploration was clear in how the majority of learners explained the concept through their exploration context, by giving learners autonomy over their learning, they have opportunity to apply the knowledge.

During the evaluation section of guided practice, the class teacher adopted the explore approach to address remaining misconceptions. When asked whether there were any objects that they still thought did not reflect light, Child B stated brick, no other learners agreed and, though they could not articulate why they believed this, Child B was adamant that it would not. The class teacher took the class outside, with each learner having a torch, whilst they tested the brick’s reflection. Child B’s facial expression showed disbelief initially that the brick was reflecting the light but after repeating, there was visible facial change, before saying, ‘it does,’ to their peer. Though all the other learners in the class were stating that it would reflect light, it was clearly important that this learner had more than peer reassurance, the value in seeing it for themselves was critical to addressing this remaining misconception.

As mentioned in the quotation from Child C, this level of hands-on, practical exploration is not common-place in this educational setting, which could have helped or hindered this section of the lesson. Mostafa (2018) found inquiry-based learning models were not as effective in the UK as teacher-directed, due to behavioural issues. This was not an issue observed in this study, with the class teacher using her own autonomy to judge where this part of the lesson should be ending. I did not note any low-level behaviours in the case-learners, but this could be due to the presence of an additional teacher or that these learners were aware of the observation on their group. This was something different for the learners, which could have impinged as

they have not been given the independence to explore in this manner before, or the novelty of a different activity could have maintained their engagement for longer. In this study, behaviour was not an issue but awareness of timings and class teacher knowledge of the class dynamic is critical (King and Nomikou, 2018).

It is my view that everyone will come to the classroom with a unique set of experiences, this is the essence of misconceptions (Grix, 2002). The model during the engagement and visually linking may be enough for some learners to bridge the misconception to concept, adapting and changing their conception but others will need to experience this. Child B's experience with the brick shows that some learners have very specific misconceptions, with Child D referring to black paper during interview, social phenomena cannot be generalised. Exploration gives the learners more autonomy and choice over how and what they explore, opportunity to take hold of their learning and target their own misconception in a way that cannot be done on a whole class level (Raganová and Pivarči, 2019), this has shown to be critical to learner experience in the guided practice pedagogy.

Collaboration

Collaboration between learners is a key aspect of many pedagogical approaches utilised in primary school (Van Leeuwen and Janssen, 2019) in this educational setting it is used during most lessons. It was a prominent theme coming through observations, as noted in all quotes from observations so far. When referencing the model or exploring different materials and objects, at the end the learners shared this knowledge with their partner, each time with their partner then trying it out for themselves with this often resulting in development and further investigation. Child A was exploring light reflection on a transparent cup to a napkin, they sought Child C:

> *'look at this one, some of the light goes through but some is reflected. You can see it on the napkin but then see some is reflected back'* (Child A, 2023)

Then compared using a slit light to see if it was the same- nod as satisfied that it was the same.

> *'Does it reflect to the ceiling?'* (Child C, 2023)

Shoulder shrug, then without a word, Child C shone the torch through the cup Child A was holding to the ceiling. Compared through cup vs not through cup.

> *'Less light on the ceiling with the cup, must be as some is reflected even though it's see through.'* (Child A, 2023)

When working with their partners, the learners were verbalising their understanding, building on each other's learning by asking further questions and pushing the boundaries of their knowledge. Interestingly, no learner mentioned collaboration during interview, this could be due to its regular practice within the setting, or it could be that they did not value or feel it impacted their experience. When looking through previous literature, there is no reference to how learners were grouped or sat during guided inquiry, though this could be down to the quantitative nature of these studies. If a learner was relying on internal talk, as opposed to collaborating with their peers, they are just remembering. Whereas if they are collaborating, they are needing to explain and apply their knowledge verbally, in a way in which another learner can comprehend, this requires extension and developing of concept knowledge (Bloom et al, 1956).

Another consideration is the opportunity for identifying remaining misconceptions at the point of learning. During the observations, I did not witness any residual misconceptions but nor did I hear any peer-to-peer debate, discussion, or questioning. By verbalising, it is giving the peers and the teacher opportunity to identify residual misconceptions, but this heavily relies on peer confidence and teacher role. If a learner had a misconception in their exploration and it was not questioned or picked up, discussion could embed this misconception. This is similar to what was identified when teachers lacked confidence in the scientific knowledge, that misconceptions remained unchallenged and by applying and practicing this further embedded (Bianchi et al, 2021). This group of leaners were all working at age-related expectations across the curriculum, so working collaboratively allowed them to build on knowledge, but by not questioning each other, it allowed potential for misconceptions to go unchecked. Though, as discussed in the exploration theme, where a misconception remained unchallenged, the evaluation section worked as a formative assessment opportunity for the teacher to identify and address. Similarly to exploration, clearly collaboration showed to be valuable from the observations but the importance of teacher agency in groupings is notable (Biesta and Tedder, 2007) and the teacher's confidence in the scientific concept (Bianchi et al, 2021).

Summary

Though distinct themes generated through code-mapping, there are threads which flow through which contribute significance to each theme as part of the learner journey through guided practice. This study is not striving to find a solution but instead attribute and explore the key aspects of guided practice which assist learners moulding and bridging their knowledge to prevent misconceptions. The findings of this study will be summarised in Chapter 5, along with recommendations both for the educational setting and for further research.

Chapter 5 - Conclusions and Implications

1121 words

The focus of this study has been exploring the impact pedagogical practice can have on reducing the prevalence of misconceptions in primary physics to prevent these being a barrier to further science learning. Through providing the class teacher with a clear methodical pedagogy, we explored how guided practice influenced the learner's learning experience to bridge their concept gap from preconception to scientific concept. This chapter begins by discussing the findings in relation to the research question. Before outlining the implications for the educational setting, along with limitations of the study and possible further research.

Guided Practice was identified, from the literature, as a pedagogical approach with potential for preventing misconceptions, by utilising the 5Es structure. This approach encompassed teacher-directed use of models and explanations (Mostafa, 2018), along with providing learners opportunity to experience and apply the concept through practical exploration (Bybee, 2014). From observing learners and verbalisation of their own learning development, the physical model was clearly a spark for learners to question their misconceptions, placing doubt on their prior concept. Modelling was verbalised by one of the case-learners as the turning point for their learning, but only 2 learners reference the model in their open question. During interview, all case-learners stated models are frequently used in their science lessons, what stood this lesson apart was the exploration section. When considering the significance of this theme to the experience of the learner in addressing misconceptions, it is clear the model is the starting point of the learner experience, it is needed for the learner to question their preconception and also equip them with the base knowledge on which to explore (Opfer and Pedder, 2011). It is the balance and understanding of how misconceptions and scientific concepts relate and differ that supports understanding with their coexistence (Mason and Zaccoletti, 2020).

In this study, three of the case-learners talked about the explore section being significant to their learner journey. For all the learners, there were key sections during exploration which you could observe were pivotal to their understanding of the concept and their confidence in bridging knowledge from their preconception, formed on their naïve viewing of the world, to the scientific concept. From the perspective of

the learner, exploration was critical to their understanding, allowing them the independence to experience the concept was invaluable (Raganová and Pivarči, 2019) and their perception of science as learners (Mostafa, 2018). Sharing their learning with their peers through collaboration, at times, took their learning to a higher level, by verbalising the knowledge they had to have a secure explanation and confidence in their knowledge (Bloom, 1956), the significance of this to the learner experience and its role in reducing misconceptions was less clear from the study but it is an important theme through observations which has shown to have a potential positive influence.

For the educational setting moving forward, the key will be to keep the scale small and specific. As the study followed an action research design, this will inform the next stages, keeping with the 5Es approach to guided practice. This study was conducted on one of the Year 4 classes, lower KS2 will remain the focus for exploring this pedagogical approach further due to the drop in data coming into the key stage and the significance of the physics topics in these year groups, including sound and friction. In a setting with such a diverse socio-economic intake there is huge variance across cohorts alone, which effects the impact of practice.

It is hard to comprehend how a teacher can plan to bridge and explore the links between misconceptions and scientific concepts when they themselves may lack clarity and understanding of misconceptions (Malleus et al, 2016). If the learners had not had the confident and clear explanation, would the lesson have been as successful? Learners identified the explore aspect was most important to understand the concept, but there needs to be clear confidence and factual knowledge before learners can then see the concept through the explore phase. The class teacher found implementing guided practice challenging, as it was a new approach which relied on confidence in bridging from misconception to scientific concept. Even though she had been involved in planning and rehearsing, it has been at a surface level. Educating the teachers will be essential for them to understand, not just the surface, but the significance and role of each section of the 5Es approach. This is critical to the success of the approach, to allow teachers to take ownership of the approach, to feel autonomy and confidence, not to feel restricted in the delivery with it being a prescript pedagogy (Priestley et al, 2015). Working and mentoring the

teachers on this approach will build their confidence and fluency in delivery, allowing them to exercise their teacher agency.

Targeting just one misconception had a positive impact by allowing the model to be specific, based on pre-assessment misconception data. This will inform and flow through the whole approach to bridge misconception to concept. In previous literature, when more than one misconception was addressed, the pedagogical approach had a less consistent impact (Wartono et al, 2018). By focusing the continuation of the action-research cycle in this key stage, it will allow development and refinement by targeting concepts within other physics topics. As physics concepts are generally more abstract, it will also allow exploration into the existence of a repertoire of models which allow transferable knowledge for learners to then explore concepts. Establishing new pedagogical practice is challenging, with teachers needing time to develop, reflect and practise (Opfer & Pedder, 2011). This next stage will need the continuation of SLT support to ensure the class teachers are not just ‘left-alone’ when they may have questions or challenges regarding implementation (Education Week, 2018) and to allow increased allocation for science CPD (Ofsted, 2021).

This study was small-scale, only gathering information from 4 case-learners. The research approach and methods allowed for the data required to be gathered effectively and enabled the research questions to be answered. However, the findings of this study are limited to the research class, for the target physics concept. This study has a concise pedagogical structure for guided practice, outlined in Appendix 1, which will allow a consistent approach to follow for confirmability (Rapley, 2017). For wider conclusions to be drawn, further studies need to be completed involving varying classes from several primary school settings to discover if the findings remain similar. This master’s module was in-part funded by The Ogden Trust. They have had no influence nor created any bias over any aspect of this study, with no conflict of interest to disclose. This study will be disseminated through their organisation from which it may be used as the basis of further study or research.

Postscript- Narrative Critical Reflection

585 words

The reflection grid (Appendix 9) details the key points of reflection on completing this dissertation. In the appendix, I have outlined my targets of developing my knowledge and understanding of research paradigms and targeting structural aspects of my writing style. I have decided to discuss these two areas as I feel that these have the most impact on my study, and development as a researcher within the social science field.

My educational background is predominantly in science and mathematics, reducing my exposure to social and critical writing opportunities. When studying level 2 module towards Masters in Education, I selected the topic of, 'improving the retention of physics knowledge'. Feedback, shown in Appendix 9, outlined discrepancies between the discussion I had created and my intended research outcomes. Upon reflection, I recognised that my literature review took a very interpretivist angle, focusing on pedagogical skills, considering the dynamics of a classroom, yet my conclusions were defaulting to trying to find 'the answer'. This became a key development area for my level 3 study and is critical to the essence of my dissertation.

Educational settings are not clinical laboratories, you cannot predict what may change from moment to moment. Standing back and reflecting on my ontological outlook of knowledge, I realised that this is what I have always valued about teaching, how I would never consider what works for one child would work for all the children, so why would this be the case as a researcher. My heart was interpretivist, but my head kept saying positivist. It was a steep learning curve, focusing on the learner experience, wanting to understand more about their learning journey. I felt that in each TMA I made positive steps in the development of my paradigmatic position, but it has needed to remain a constant focus throughout the dissertation process. When conducting the analysis, I kept reverting to presenting my data as factual 'answers', needing to keep revisiting and questioning, considering alterative interpretations. I recognise that this is still a focus area for myself as a researcher, it will be an awareness which I carry forward, to continue to embrace the dynamic

nature of both knowledge and learner, whilst appreciating the progress and contribution this type of research has on education.

Issues with my writing style I feel were influence by my paradigmatic challenges. As outlined in Structure, communication and presentation of Appendix 9, my paragraph structure was not consistent. When I was starting to write from an interpretivist angle, as my understanding was not secure, my writing tended to lack clarity and direction. Reflecting on TMA02, I was not clear on how I wanted to present my knowledge, the need to consider alternative explanations and balance possible conclusions. I could not signpost my initial sentence as I did not always know where it was going. From TMA02 feedback, I selected my literature review chapter as a tutor draft chapter, then, as outlined in Appendix 9, I created a process pathway for writing. Being systematic with my writing ensured that each part of the paragraph was there before then applying flow and fluency. This allowed my writing to be succinct and, in turn, more appealing to the reader. My writing could be understood, and the reader follow my thought pathway, being transparent with the decisions I had made and where the study was going.

I have found my masters journey essential to my development, personally, professionally, and academically and I look forward to seeing where it will take me in the future.

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Appendix 1- Proposed lesson study for guided practice pedagogical approach, adapted from the 5Es model for instruction. (Bybee, 2014)

Elicit- pre- assessment questionnaire. Identify which children have the misconception, 'only shiny materials reflect light.'
Misconception taken from Shallcross (2017), PSTT report on misconceptions in light in primary physics.

Engage- balls on flat surfaces, balls on baking trays to replicate the direction of light reflection.
Key knowledge: IT LOOKS LIKE SHINY THINGS REFLECT LIGHT AS ALL THE LIGHT COMES BACK IN EXACTLY THE SAME DIRECTION.
WHEREAS DARK OR DULL SURFACES, THE LIGHT ISNT ALL REFLECTED IN THE SAME DIRECTION BUT IT IS STILL REFLECTED.

Explain –torch onto these objects.
Explain concept **'light is reflected from surfaces.**'
Everything, which isn't a light source, reflects light, that is how we can see it.
Dark, viewing different objects, wide range of materials (shiny, dull, bumpy, dark, white etc.)

Explore- black surfaces set up.
Variety of materials, objects to explore. Foil, hi-viz, pom poms, tissue paper, plastic cups, stones, water bottles, different coloured card.
Bear caves/light boxes, look at pictures at the back- can they see dull vs shiny.

Evaluate- link explore back to explain.
Draw explicit link from scientific concept, back to preconception. Explain why they think the preconception, explaining linked to everyday experiences, but reinforce why.
We have witnessed …. You have experienced…. , explained how they can know their preconception is not scientifically correct.

Post-assessment, also learners to complete the task of creating a small picture/text/diagram to show their understanding of 'What reflects light?'

Appendix 2- Ethical Appraisal Form.

E822 Ethical Appraisal Form

Masters: Education, Childhood and Youth

NB: it should be noted that The Open University is unable to offer liability insurance to cover any negative consequences students might encounter when undertaking 'in-person' data collection. It is therefore very important that you follow appropriate research protocols which should include seeking Gatekeeper permissions to undertake any data collection within your setting and adhering to ethical principles for the safety of yourself and your participants.

Because ethical appraisal should precede data collection, a completed version of this form should be included with TMA02 for those developing a Small-Scale Investigation (SSI) and as part of the EMA submission for those completing an Extended Literature Review and Research Proposal (EP) form of the Dissertation.

Fill in section 1 of this document with your personal details and brief information about your research.

For section 2, please assess your research using the following questions and click yes or no as appropriate. If there is any possibility of significant risk please tick yes. Even if your list contains all "no" you should still return your completed checklist so your tutor/supervisor can assess the proposed research.

Section 1: Project details

a.	Student name	Jennifer Muir	
b.	PI	[redacted]	
c.	Project title	Action research project exploring pedagogical approaches to reduce physics misconceptions in primary schools.	
d.	Supervisor/tutor	Dr Tina Barnes-Powell	
e.	Qualification	Masters in Education	X
		Masters in Childhood and Youth	

f.	MA pathway (where applicable)	Learning and Teaching
g.	Intended start date for fieldwork	27th March 2023
h.	Intended end date for fieldwork	28th April 2023
i.	Country fieldwork will be conducted in *If you are resident in the UK and will be conducting your research abroad please check www.fco.gov.uk for advice on travel.*	England

Section 2: Ethics Assessment		Yes	No
1	Does your proposed research need initial clearance from a 'gatekeeper' (e.g. Local Authority, head teacher, college head, nursery/playgroup manager)?	X	
2	Have you checked whether the organisation requires you to undertake a 'police check' or appropriate level of 'disclosure' before carrying out your research?[1]	X	
3	Have you indicated how informed consent will be obtained from your participants (including children less than 16 years old, school pupils and immediate family members)? Your consent letters/forms must inform participants that they have the right to withdraw from the study at any time.[2]	X	
4	Will your proposed research design mean that it will be necessary for participants to take part in the study without their knowledge/consent at the time (e.g. covert observation of people in nonpublic places)? If so have you specified appropriate debriefing procedures? [3]		X

[1] You must agree to comply with any ethical codes of practice or legal requirements that maybe in place within the organisation or country (e.g. educational institution, social care setting or other workplace) in which your research will take place. If required an appropriate level of disclosure ('police check') can obtained from the Disclosure and Barring Service (England and Wales), Disclosure Scotland, AccessNI (Northern Ireland), Criminal Records Office (Republic of Ireland), etc.

[2] This should normally involve the use of an information sheet about the research and what participation will involve, and a signed consent form. You must allow sufficient time for potential participants to consider their decision between the giving of the information sheet and the gaining of consent. No research should be conducted without the opt-in informed consent of participants or their caregivers. In the case of children (individuals under 16 years of age) no research should be conducted without a specified means of gaining their informed consent (or, in the case of young children, their assent) and the consent of their parents, caregivers, or guardians. This is particularly important if your project involves participants who are particularly vulnerable or unable to give informed consent (e.g. children under 16 years, people with learning disabilities, or emotional problems, people with difficulty in understanding or communication, people with identified health problems). There is additional guidance on informed consent on the Masters: Education and Childhood and Youth website under Project Resources.

[3] Where an essential element of the research design would be compromised by full disclosure to participants, the withholding of information should be specified in the project proposal and explicit procedures stated to obviate any potential harm arising from such withholding. Deception or covert collection of data should only take place where it has been agreed with a named responsible person in the organisation and it is essential to achieve the research results required, where the research objective has strong scientific merit and where there is an appropriate risk management and harm alleviation strategy.

5	Does your proposed design involve repetitive observation of participants, (i.e. more than twice over a period of more than 2-3 weeks)? Is this necessary? If it is, have you made appropriate provision for participants to renew consent or withdraw from the study half-way through? [4]		X
6	Are you proposing to collect video and/or audio data? If so have you indicated how you will protect participants' anonymity and confidentiality and how you will store the data?		X
7	Does your proposal indicate how you will give your participants the opportunity to access the outcomes of your research (including audio/visual materials) after they have provided data?		X
8	Have you built in time for a pilot study to make sure that any task materials you propose to use are age appropriate and that they are unlikely to cause offence to any of your participants?		X
9	Is your research likely to involve discussion of sensitive topics (e.g. adult/child relationships, peer relationships, discussions about personal teaching styles, ability levels of individual children and/or adults)? What safeguards have you put in place to protect participants' confidentiality?		X
10	Does your proposed research raise any issues of personal safety for yourself or other persons involved in the project? Do you need to carry out a 'risk analysis' and/or discuss this with teachers, parents and other adults involved in the research?		X
11	Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?		X
12	Will the study involve recruitment of patients or staff through the NHS or the use of NHS data?		X

[4] Where participants are involved in longer-term data collection, the use of procedures for the renewal of consent at appropriate times should be considered.

Appendix 3- Expectations and information for parents.

Faculty of Wellbeing, Education, Language and Sport

Study related to Masters module 'E822 Multidisciplinary Dissertation: Education, Childhood and Youth'

For participants invited to complete a questionnaire and observation.

Dear Parent/Guardian,

I am currently studying on the Masters dissertation module 'E822 Education, Childhood and Youth: Learning and Teaching' at the Open University. My studies are being supervised by a personal tutor and I am following research protocols recommended by the University which have been approved by a named supervisor in this setting.
I am using a range of ways of collecting information to answer the following question, 'Can guided practice address preconceptions, in the physics concept of light, to prevent misconceptions?'. This is part of a small-scale investigation aimed to help me better understand and develop science pedagogy here at SCHOOL NAME and to also share my findings with others for whom the findings will be relevant to changing practice.

As part of this research, I will be inviting your child to complete a questionnaire. The questionnaire is estimated to take no longer than 5 minutes, this will be completed on paper in their usual classroom setting. Following this questionnaire, your child will be taught a science lesson using the teaching approach of guided practice, which I will observe and take written notes. This has been agreed with the organisational leadership, HEADTEACHER.

Information collected will be de-identified and kept confidential, being stored securely on password protected devices. In the case of paper copies of the questionnaire, these will be kept confidential and responses typed up as soon as possible. The original notes will then be stored in your child's book, in line with the school's assessment policy.

Please feel free to ask me any questions about the questionnaire or observation.

Thank you for your support.

Yours sincerely,

Mrs Crompton.

Science Subject Leader.

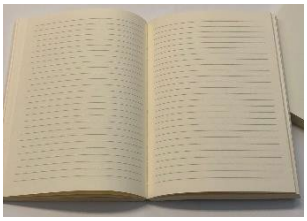
Appendix 4- Questionnaire

Reflection of light _____

Which materials reflect light?

shiny materials	
dark materials	
light materials	
all materials	

Which of these objects reflect light?

Appendix 5 - Summary of data protection plans in terms of safe data storage and handling.

Data	Type of data	Participants	Storage
Preconceptions. Numerical quantitative data.	Questionnaire	All study class (30 learners)	Paper in class books, stored in usual classroom according to school's assessment policy. Transfer results to spreadsheet, anonymise under lettered aliases for each child.
Written comments on verbal talk, gestures, body language during lesson. Qualitative data.	Observation of case-learners	4 'typical' learners	Type up observation notes as soon as possible following observation onto password protected Word document. Original notes disposed of with confidential waste. Learners' names anonymised under pseudonyms.
Written comments on verbal talk, gestures, body language during interviews. Qualitative data.	Interview of case-learners	4 'typical' learners	Type up interview notes as soon as possible onto password protected Word document. Original notes disposed of with confidential waste. Learners' names anonymised under pseudonyms.

Appendix 6- Expectations and information for case-learners and their parents.

E822 Information letter for children and young people (pre-18): Interviews

What is the aim of this interview?

The aim of the interview is to gain your view on the use of guided practice as a teaching method for teaching physics in primary schools.

Who is conducting the research and who is it for?

This interview is part of my studies on a masters-level course at The Open University in which I am carrying out a small-scale investigation. I am using a range of ways of collecting information to answer the following question: **Can guided practice prevent misconceptions in the physics concept of light?** This is aimed to help me better understand and develop science pedagogy here at SCHOOL NAME and to share my findings with others for whom the findings will be relevant to changing practice.

Why am I being invited to participate in this research?

You have been chosen because your views would be valuable in answering the question set for the study and I hoped you might be prepared to talk to me about your experiences and opinions.

If I take part in this research, what will be involved?

The interview should take no more than 15 minutes and I will make sure that I have checked with your teachers that when and where we talk is the most convenient for you and them. Our conversation will not be recorded but I will make notes about what you say. Permission has been given from HEADTEACHER for me to invite you to this interview. In any part of the interview which will be shared with my tutor or form part of the final dissertation report, you and anyone else you name during our discussion will be referred to by a false name (pseudonym) and you will be asked if you would like to suggest what name I use.

What will we be talking about?

In the interview, I will ask you questions about what you think about guided practice after the lesson. I can share the questions with you in advance, if you would like to see them, but it will be more of an informal chat about your experience of the lesson.

Will what I say be kept private?

Your participation will be treated in **strict confidence** in accordance with the Data Protection Act (2018). No personal information about you, such as contained in your consent forms, will be shared. In the case of my notes of the interview, these will be kept private only to me and typed up as soon as possible. However, if you let me know anything during your interview which I consider means that you might be unsafe or have been involved in a criminal act, because this is a safeguarding concern, I will need to pass this information immediately to the school's Designated Safeguarding Officer. I can confirm that neither you as an individual nor the setting will be identifiable in my submissions to the University or any presentations I make of my findings to interested audiences.

What happens now?

After reading this information sheet with your parent/carer, please read and complete the consent form. This means that you and your parent/carer sign your and their names and the date to say you are all happy for me to set up a time and place for the interview. Whether you agree or not is entirely up to you and your parent/carer, as the invitation is for you to take part voluntarily. You can change your mind later and withdraw from the study by letting me know and I will destroy the information (consent forms and interview files) I have created. This will be possible up until the time I am using your information as part of my final dissertation, 10.04.2023.

What if I have other questions?

If you have any questions about the study, I would be very happy to answer them. Please contact me at SCHOOL EMAIL ADDRESS.

Appendix 7- opt-in consent form for case-learners.

E822 INTERVIEWS CONSENT AND ASSENT FORM

(to be completed by all participants and, if the participant is a child/young person under age 18, with and by their parent/guardian)

If this request relates to a child/young person under the age of 18 and a child or young person would benefit from this, please would a parent, carer or guardian read these questions to them and, if necessary, complete the replies for them.
Please indicate YES or NO for each of the questions below and return the completed form by 27.03.2023 to Mrs Crompton.

Have you read (or had read to you) the information about this interview?	YES	NO
Has someone explained this interview to you?	YES	NO
Do you understand what this interview is about?	YES	NO
Have you asked all the questions you want?	YES	NO
Have you had your questions answered in a way you understand?	YES	NO
Do you understand it is OK to stop taking part at any time?	YES	NO
Are you happy with how your data will be stored?	YES	NO
Do you understand that your and any other real names as well as any identifiable information will be removed from what will be shared after the interview?	YES	NO
Are you happy to take part?	YES	NO

If any answers are 'no' you can ask more questions. But if you **don't** want to take part, please let me know and **don't** sign your name.

If you **do** want to take part, please write your name and today's date

Your name _____

Date _____

If the person to be interviewed is a child or young person under 18 and you are happy for the child or young person you are responsible for (as their parent, carer or guardian) to participate, please could you also sign and date below.

Print name _____

Sign _____

Date _____

Return form to Mrs Crompton, SCHOOL EMAIL ADDRESS

Thank you for your help.

Appendix 8- Semi-structured interview questions.

1. How did you find today's lesson?
2. At the start of the day, you said only shiny things reflect light- why did you think that?
3. What do you think now?
4. Do you know which part of the lesson helped to change your view?
5. How did this lesson compare to a normal lesson?
   What was different? Which did you prefer?

Appendix 9- Master's level skills reflection grid.

Category	Feedback received, targets achieved and areas of development worked on	How did this shape my dissertation
Knowledge and understanding: Targets, reflections or feedback relating to knowledge of current debate and issues in your specific area of focus; drawing out concepts and themes; choosing a focus area for your dissertation; identifying and overcoming ethical issues.	Following my Level 2 module EMA results, I received the following feedback, 'There was a discrepancy between the literature review which focused heavily on teacher knowledge / skills / pedagogy but a practice project which focused on children's outcomes.' My lack of consistency, I felt came from my gaps in paradigm competency and knowledge. I set the PDP target on exploring more about interpretivist paradigm.	For my dissertation, my paradigmatic outlook has been interpretivist. This is stark contrast to any previous study I have undertaken. Reflecting on the discrepancy between my outlook and research design in my level 2 module made me reflect on my ontological view of what I felt knowledge was. How could I research cause and effect when you cannot control a classroom environment, with each classroom being different and unpredictable from one moment to the next. Once I embraced and began to understand interpretivism, my outlook began to make more sense and allowed me to create meaningful research, practical for an educational setting.
Critical analysis and evaluation: Targets, reflections or feedback relating to justifying or challenging your personal perspective; interpreting and critically analysing evidence and methodologies from your own and others' research; analysing and evaluating themes and issues; sourcing and critically reviewing a wide range of	Analysis of qualitative data. Having previously only ever conducted research following scientific methods, handling, and analysing qualitative data was something I no experience. Given the need to triangulate and bring together my data which was from multiple sources, I focused	Thematic analysis was a new process, I read multiple social science papers who used the process of thematic analysis on their data and decided to focus on the Braun and Clarke (2006) method. Developing skills in this method allowed me to bring together all the data collected from not only multiple learners by

publications; creating an academic argument using synthesis; comparing and connecting practice and theory.	research and learning on the process of 'Thematic analysis'.	multiple sources (interviews, observations, questionnaires). Having such a large quantity of data initially, by coding the sections, themes began to emerge and ideas link. Thematic mapping was the process of linking I chose to develop the central themes from the study. Having multiple sources of information gave multiple reasonings but also allowed weight to be given for more secure and reliable conclusions. Without the process of thematic analysis, I would have struggled to see the central themes of my study but more significantly I would not have been able to articulate them with as much confidence and reliability from evidence and transparency of results.
Links to professional practice: Targets, reflections or feedback relating to: designing and/or applying research methods; developing ideas from previous research and frameworks; reflecting and making adaptations during the research and writing process; addressing problems in research design; identifying implications for practice and professional debate; challenging your own assumptions; managing workload and personal motivation.	Conducting research in my own educational setting was a new experience. Completing my level 2 module had brought up challenges in completing inside research, I debated whether outside research would be more appropriate.	When balancing the insider/outsider research, there had been challenges for time, support from SLT when completing my level 2 studies, alongside the development of my self as a researcher and ensuring impartiality. For a time I considered conducting my small-scale study at another setting, but felt that I would lose the purpose and context of the issue I was researching. By being an inside researcher, it allowed me to understand how this

		approach differed from usual practice, it also ensured that methods implemented caused as little disruption for the learners. Though there were still hurdles in completing insider research, having the in-depth knowledge of the educational setting enriched the study and also gave real purpose and pathway for moving forward from this SSI.
Structure, communication and presentation: Targets, reflections or feedback relating to using academic style and referencing; presenting, managing and sharing information in different modes; communicating concepts, findings and ideas for different audiences.	Feedback from E822 TMA02: 'try to be as specific as you can when you formulate your sentences. Keep your sentences succinct.' 'Try and get on top of your sentence/paragraph construction before you begin drafting your dissertation.' 'In academic writing the general advice is that a paragraph should include: an initial sentence signposting the content of the paragraph; followed by evidence to support that idea then; an evaluation of that evidence. Each new idea or theme needs a new paragraph.'	The focus needed to be on sentence structure. To target this, I firstly bullet pointed a paragraph, ensuring that the theme/topic remained consistent. Then I structured the paragraph as suggested in TMA02 feedback by labelling each aspect before then ensuring flow across the sentence. The process slowed my writing down which increased accuracy of my writing whilst also allowing to consider points more deeply that I had previously. Ultimately, working towards this target had more than just a structural impact on my academic writing but gave me a deeper understanding.